eurostat

Harmonised Index of Consumer Prices (HICP)

METHODOLOGICAL MANUAL

2024 edition

MANUALS AND GUIDELINES

Harmonised Index of Consumer Prices (HICP) METHODOLOGICAL MANUAL

2024 edition

Manuscript completed in January 2024

Luxembourg: Publications Office of the European Union, 2024

Theme: Economy and finance
Collection: Manuals and guidelines

PDF: ISBN 978-92-68-12009-5 ISSN 2315-0815 doi:10.2785/055028 KS-GQ-24-003-EN-N

Foreword

The HICP Methodological Manual represents a comprehensive overview of methods that are used in the compilation process for the harmonised index of consumer prices (HICP). The manual intends to be a practical guide to all steps necessary to produce an HICP and is thus useful for statisticians who are new to the field of price statistics and statistical offices aiming to set up a similar inflation measure. Users of the HICP, such as businesses, policy-makers and researchers may also find this manual useful to help them understand and interpret HICP data.

The first version of the manual was published in 2018. This updated version reflects the latest legislation, developments on the use of new data sources such as scanner data and web scraping, the use of multilateral index methods and a variety of other developments since 2018. It also describes the methods used for the compilation of the HICP during the COVID-19 crisis.

The drafting of the first version of the HICP Methodological Manual was co-ordinated by Eurostat and supervised by a dedicated task force that was composed of experts from the statistical institutes of France, Germany, Italy, Luxembourg, the Netherlands, Norway, Portugal, the United Kingdom and the European Central Bank. The drafting work was carried out by a team of international experts and Eurostat.

The update of the manual has been prepared by Tiziana Laureti, Marc Prud'homme and Michael Baxter working under the coordination of Hionia Vlachou of GOPA Luxembourg. The drafts of the updated chapters have been reviewed by Eurostat and commented on by the HICP experts of the Member States and other countries, both in writing and during dedicated meetings. A number of countries provided examples from their practices which have been included.

Eurostat would like to thank the experts and all those that contributed to the drafting process of the manual, as well as all others who contributed in the form of comments or suggestions.

Paul Konijn

Head of Unit Price statistics; Purchasing power parities; Housing statistics

Contents

1

Aim and history of the HICP

1 Aim and history of the HICP

1.1 Introduction

Consumer price indices (CPIs) measure changes in the prices of goods and services that households purchase for consumption. They are used for a wide variety of purposes, such as conducting monetary policy; indexing commercial contracts, wages, social protection benefits and financial instruments; deflating national accounts aggregates; and, more generally, expressing monetary values in real terms.

Within the European Union (EU), a specific CPI has been developed — the harmonised index of consumer prices (HICP). The HICP is calculated using a harmonised approach and a single set of definitions for all countries. The key HICP aggregates are the euro area index, covering the countries whose currency is the euro, and the national HICP for each EU Member State. National statistical institutes produce the national HICPs, while Eurostat produces the country-group aggregates. The production of the HICP, its methodology and the data to be sent to Eurostat are governed by EU law.

This chapter outlines the aim and history of the HICP and notes some key elements of the harmonisation process.

1.2 Aim of the HICP

The HICP was designed to provide a high quality and comparable measure of consumer price inflation. It serves two main purposes:

- It is used to quantify the definition of price stability in the European Central Bank's (ECB) monetary policy strategy. Maintaining price stability is the primary objective of the ECB and the national central banks of the euro area, as set out in the Treaty on the Functioning of the

European Union (1). Following a thorough evaluation of its monetary policy strategy in 2021, the ECB Governing Council specified that 'price stability is best maintained by aiming for a two per cent inflation target over the medium term' (2).

- It is used to assess price convergence when deciding whether a country can join the monetary union.

In addition to these specific EU uses, it can be used, similar to other consumer price indices, for economic analysis and for indexing contract prices.

1.3 History of the HICP

The HICP has been produced and published since March 1997; however, attempts at harmonising CPIs stretch further back.

In the mid-1970s, Eurostat saw the need to harmonise CPI methodologies and pushed for this. One of the early initiatives was a Eurostat-commissioned report (3) that reviewed how the then nine Member States constructed their CPIs. In the late 1980s, the International Labour Organisation (ILO) devoted considerable effort to the development of the theory and practice of CPIs. The ILO's work led to the publication in 1989 of an important CPI manual (4). While highlighting the conceptual and practical issues involved in the design of CPIs, the manual left it to individual countries to resolve these issues, as they deemed appropriate for their purposes. Therefore, it did not directly lead to greater comparability in practice. At about the same time, in 1988, Eurostat commissioned a further report on the prospects for harmonising CPI methodologies (5).

These attempts by Eurostat and the ILO did not lead to any consensus on the best way of calculating comparable indices. Countries were either unwilling or unable to change a key statistic such as the national CPI to serve the then limited purpose of international comparison.

This situation changed in 1992, when the Maastricht Treaty laid down the criteria for joining the euro area (i.e. stage III of economic and monetary union (EMU)). One such criterion was sustainable convergence in price stability, to be assessed in comparison with the best-performing Member States.

Thus, with the Maastricht Treaty, it became imperative to compare consumer price inflation between Member States, unaffected by differences in the way it was measured. A harmonised CPI was needed because national indices had evolved over the years in many different ways, reflecting national needs and circumstances. Although they met national needs, they were demonstrably not comparable with each other.

(1) Here and in the following see: The Monetary Policy of the ECB, 2011 (europa.eu).

(2) See ECB (2021), 'An overview of the ECB's monetary policy strategy', published in July 2021.

(3) Eurostat, Consumer Price Indexes in the European Community — Comparison of existing indexes and approaches to their harmonisation, Josef Stadlbauer, Luxembourg, March 1975.

(4) ILO: *Consumer price indices: an ILO manual*, Ralph Turvey, Geneva, 1989.

(5) Eurostat: 'Consumer Price Indices in the European Community – Similarities and proposals for harmonisation', Rudolf Teekens, Luxembourg, January 1989.

In 1993, the first attempt was made to establish new harmonised CPIs based on a uniform set of rules binding on all Member States. The Statistical Programme Committee (SPC), the predecessor of the European Statistical System Committee, dismissed this proposal. National CPIs had been designed for a variety of national purposes and were politically sensitive, sometimes to the extent of being protected by law. Citing Protocol No 6 on the convergence criteria referred to in Article 109j(1) of the Maastricht Treaty, which stipulates that 'inflation shall be measured by means of a consumer price index on a comparable basis, taking into account differences in national definitions', the SPC endorsed Eurostat's initial proposal that the requirement be met through the implementation of HICPs based on national CPIs.

On 23 October 1995, the European Union's Council of Ministers adopted Council Regulation (EC) No 2494/95 concerning harmonised indices of consumer prices ([6]), which provided the legal basis for the establishment of a harmonised methodology for compiling consumer price indices for the Member States of the European Economic Area ([7]). The Regulation laid down basic definitions, the scope of the indices, the timetable and frequency for their production and publication. It also provided for further methodological improvements of the HICP using minimum standards. The minimum standards laid down in the implementing regulations specify the outputs to be provided, but leave it to Member States to decide how to achieve this. In the years after 1995, some 20 implementing regulations were adopted ([8]), each addressing specific areas of methodology. Priority has been given to the issues viewed as most likely to be of longer-term importance.

Council Regulation (EC) No 2494/95 was implemented in two stages. In 1996, Member States compiled interim indices of consumer prices, to provide early results for inflation comparisons pending more harmonised indices. In 1997, the HICP replaced the interim indices.

In the interim indices, certain categories of expenditure were excluded where there was not enough time to reach agreement on how best to construct comparable measures. For example, the expenditure faced by owner-occupiers when acquiring housing, which was not covered in some countries, measured by imputed rents in others, and by mortgage interest payments in the rest, was entirely excluded. Expenditure on health and education was also excluded, because of major institutional differences between countries in the ways in which consumers pay for such services: either directly (with or without subsidies) or via direct taxes such as income tax.

In addition to the exclusions listed above, certain products and some other categories of expenditure were not covered in some national CPIs, in particular, alcoholic drinks and tobacco. The countries concerned added these products to their interim HICP.

All the Member States plus Iceland, Norway and Switzerland compiled the interim indices throughout 1996 (with retrospective data from 1994).

In line with Regulation (EC) No 2495/95, the official HICP started with the index for January 1997. Eurostat published the first set of official HICPs on 7 March 1997 (with retrospective data from January 1995). In contrast to the interim indices, the HICP was harmonised in several methodological areas as well as coverage.

Regulation (EC) No 2494/95 was repealed in May 2016, when the EU adopted a new basic

---

([6]) Regulation - 2494/95 - EN - EUR-Lex (europa.eu).

([7]) EUR-Lex – 2494/95 - EN - EUR-Lex (europa.eu)..

([8]) Compendium of HICP reference documents - 2013 edition - Products Manuals and Guidelines - Eurostat (europa.eu).

regulation for the HICP — Regulation (EU) 2016/792 of the European Parliament and of the Council of 11 May 2016 on harmonised indices of consumer prices and the house price index ([9]) (the 'Framework Regulation').

The new act simplified and clarified legal requirements for the compilation of the HICP and other harmonised indices, and provided for a modernisation of the framework in order to adapt it to new requirements. In particular, it improved the framework for quality assurance and gave a legal basis to a more detailed classification for the HICP, the European classification of individual consumption according to purpose (ECOICOP — see Section 2.3.3). It also required euro area Member States to provide flash estimate data, and all Member States to provide the information needed to compile HICP-administered prices ([10]).

1.4 The harmonisation process

The programme to develop a harmonised methodology for the HICP has relied on the active participation of Member States and CPI experts, coordinated and led by Eurostat ([11]).

The Price Statistics Working Group (known as the HICP Working Group until 2012) is the principal forum for developing the HICP. The Working Group includes representatives from Eurostat, the Member States, the European Economic Area and the candidate countries. User representatives — from the ECB, national central banks and the Commission's Directorate-General for Economic and Financial Affairs — also participate. Other international organisations (IMF, UNSD, ILO, OECD, and UNECE) are invited to the meetings as observers. The harmonisation work was also supported by a range of specific task forces set up to further methodological work or to contribute to drafting legislation, recommendations and other guidelines. The European Advisory Committee on Statistical Information in the Economic and Social Spheres was also involved in the early years. As required by EU law, the opinion of the European Statistical System Committee is sought for all implementing regulations.

The implementing regulations established since the 1995 Framework Regulation cover several technical issues that Member States needed to address: product coverage, the classification to be used, the formulae for the elementary aggregates, the treatment of missing price observations, minimum standards for the quality of weights and the treatment of tariff prices, etc. Table 1.4.1 lists them.

In particular, the HICP's product coverage has expanded in stages since its initial launch. With effect from the January 2000 index, the coverage of goods and services was extended to include the following services, which had previously been excluded: out-patient services (ECOICOP Group 06.2), some educational services such as university tuition fees (part of Division 10), childcare services (part of Group 12.4) and insurance services (Group 12.6).

Further extensions to coverage took place with effect from the January 2001 index, with the inclusion of hospital services and nursing homes (Group 06.3) and retirement homes (part of

([9]) Regulation - 2016/792 - EN - EUR-Lex (europa.eu).

([10]) The HICP-administered prices is covered in Chapter 9.

([11]) See also Astin, John (2021): Measuring EU Inflation: The Foundations of the HICP, pub. Palgrave Macmillan

Group 12.4).

From January 2002, the HICP included service charges expressed as a proportion of the transaction value, e.g. unit trust and stockbrokers' charges, and foreign currency exchange commission (part of Group 12.6).

Currently, implementing Regulation (EU) 2020/1148 ([12]) that the EU Member States must apply when producing their HICP and that repealed the former implementing regulations listed below in Table 1.4.1 is in force.

Table 1.4.1

HICP implementing regulations repealed

Commission Regulation (EC) No 1749/96 of 9 September 1996 on initial implementing measures for Council Regulation (EC) No 2494/95 concerning harmonised indices of consumer prices([1])
Commission Regulation (EC) No 2214/96 of 20 November 1996 concerning harmonised indices of consumer prices: transmission and dissemination of sub-indices of the HICP([2])
Commission Regulation (EC) No 2646/98 of 9 December 1998 laying down detailed rules for the implementation of Council Regulation (EC) No 2494/95 as regards minimum standards for the treatment of tariffs in the Harmonised Index of Consumer Prices
Commission Regulation (EC) No 1617/1999 of 23 July 1999 laying down detailed rules for the implementation of Council Regulation (EC) No 2494/95 as regards minimum standards for the treatment of insurance in the Harmonised Index of Consumer Prices and modifying Commission Regulation (EC) No 2214/96
Council Regulation (EC) No 2166/1999 of 8 October 1999 laying down detailed rules for the implementation of Council Regulation (EC) No 2494/95 as regards minimum standards for the treatment of products in the health, education and social protection sectors in the Harmonised Index of Consumer Prices
Commission Regulation (EC) No 2601/2000 of 17 November 2000 laying down detailed rules for the implementation of Council Regulation (EC) No 2494/95 as regards the timing of entering purchaser prices into the Harmonised Index of Consumer Prices
Commission Regulation (EC) No 2602/2000 of 17 November 2000 laying down detailed rules for the implementation of Council Regulation (EC) No 2494/95 as regards minimum standards for the treatment of price reductions in the Harmonised Index of Consumer Prices([3])
Commission Regulation (EC) No 1920/2001 of 28 September 2001 laying down detailed rules for the implementation of Council Regulation (EC) No 2494/95 as regards minimum standards for the treatment of service charges proportional to transaction values in the Harmonised Index of Consumer Prices amending Commission Regulation (EC) No 2214/96
Commission Regulation (EC) No 1921/2001 of 28 September 2001 laying down detailed rules

([12]) Commission Regulation (EU) 2020/1148 of 31 July 2020 laying down the methodological and technical specifications in accordance with Regulation (EU) 2016/792 of the European Parliament and of the Council as regards harmonised indices of consumer prices and the house price index (Text with EEA relevance).

for the implementation of Council Regulation (EC) No 2494/95 as regards minimum standards for revisions of the Harmonised Index of Consumer Prices and amending Regulation (EC) No 2602/2000
Commission Regulation (EC) No 1708/2005 of 19 October 2005 laying down detailed rules for the implementation of Council Regulation (EC) No 2494/95 as regards the common index reference period for the Harmonised Index of Consumer Prices and amending Commission Regulation (EC) No 2214/96 ([4])
Council Regulation (EC) No 701/2006 of 25 April 2006 laying down detailed rules for the implementation of Council Regulation (EC) No 2494/95 as regards the temporal coverage of price collection in the Harmonised Index of Consumer Prices
Commission Regulation (EC) No 330/2009 of 22 April 2009 laying down detailed rules for the implementation of Council Regulation (EC) No 2494/95 as regards minimum standards for the treatment of seasonal products in the Harmonised Index of Consumer Prices
Commission Regulation (EU) No 1114/2010 of 1 December 2010 laying down detailed rules for the implementation of Council Regulation (EC) No 2494/95 as regards minimum standards for the quality of Harmonised Index of Consumer Prices weightings and repealing Commission Regulation (EC) No 2454/97
Commission Regulation (EU) No 93/2013 of 1 February 2013 laying down detailed rules for the implementation of Council Regulation (EC) No 2494/95 concerning harmonised indices of consumer prices, as regards establishing owner-occupied housing price indices

([1]) Amended by Council Regulation (EC) No 1687/98, Council Regulation (EC) No 1688/98, and Commission Regulation (EC) No 1334/2007.

([2]) Amended by Commission Regulations (EC) No 1617/1999, No 1749/1999, No 1920/2001, and No 1708/2005.

([3]) Amended by Commission Regulation (EC) No 1921/2001.

([4]) Amended by Commission Regulation (EU) No 2015/2010.

In addition to the regulations that the Member States must implement, Eurostat collaborates with the Member States to improve steadily the quality of the indices on a voluntary basis. This work consists of seeking agreement on recommendations for the treatment of different product groups and the use of new data sources and methods by organising workshops to discuss different HICP-related issues and to share knowledge and good practice. Additionally, Eurostat financially supports the Member States' methodological and technical improvement projects in the area of index production.

1.5 Procedures

At EU level, the European Parliament and the Council (sometimes referred to as 'the co-legislators') can use the 'ordinary legislative procedure' to adopt measures for the production of statistics needed for the EU's activities (see Article 338(1) of the Treaty on the Functioning of the European Union).

For the HICP, the Council and Parliament have given the Commission some implementing powers in Regulation (EU) 2016/792. In the Commission, Eurostat, the statistical office of the European Union, is responsible for statistics, and the HICP comes under the unit *Price statistics, purchasing power parities and housing statistics* in Eurostat's directorate for *Macro-economic statistics*.

All HICP-related Commission implementing acts are adopted under the 'examination procedure', which means they must first receive a favourable opinion following a vote in the European Statistical System Committee (ESSC).

When drafting new implementing acts and in general to guarantee the quality of the HICP and to develop it further, Eurostat relies on advice from external experts in addition to in-house expertise. This advice may be provided by expert groups and external consultants or may take the form of specific studies. Consultation with stakeholders follows the normal Commission rules.

The relevant expert groups ([13]) for the HICP are the Directors of Macroeconomic Statistics (DMES) and the Price Statistics Working Group (PSWG).

The DMES has a strategic role in guiding and coordinating work on national accounts and other macroeconomic statistics, including the HICP. It acts as an intermediary between activities at more technical levels and the ESSC.

The main expert group for the HICP at operational level is the PSWG. Its remit covers the HICP and housing price indices. It assists Eurostat in the preparation of HICP regulations and other HICP-related initiatives. The group agrees on standards for the methodology, compilation and dissemination of the HICP. It also gives advice on how best to ensure that the HICP is of high quality and complies with the standards. Group meetings are used to exchange information, experience and good practice. The PSWG can set up task forces to deal with specific HICP issues. These task forces are normally temporary and have fewer members than the PSWG. They report back to the PSWG.

Given the importance of accuracy, reliability and comparability for the HICP, Eurostat systematically monitors Member States' compliance with the legal requirements. Compliance monitoring is based on detailed documentation, analysis of data and methods, and visits to Member States to discuss procedures with those responsible for producing the HICP. Eurostat publishes these reports ([14]) on its website.

([13]) For further information on expert groups see: Register of Commission expert groups and other similar entities (europa.eu).

([14]) Quality - Harmonised Indices of Consumer Prices (HICP) - Eurostat (europa.eu)

2

HICP concepts

2 HICP concepts

2.1 Introduction

This chapter describes the general concepts underlying the HICP. It also covers some general issues that are not dealt with in detail in the other chapters, such as the concept of comparability and the domestic concept of consumption expenditure. It also provides a summary of some of the topics covered in more detail in the other chapters.

2.2 General concepts

2.2.1 The measurement target

The HICP is designed to be a measure of pure price change for goods and services (generally termed products) that fall within the scope of household final monetary consumption expenditure (HFMCE) on the economic territory. This means that it is essential for the HICP to refer to monetary transactions only ([15]).

The HICP is a cost of goods (and services) index (or COGI), i.e. it measures the changing costs of a *fixed basket of products* at different sets of prices over time. The HICP is not designed to be

([15]) Report from the Commission to the Council on Harmonisation of Consumer Price Indices in the European Union, COM(2000) 742 final, 21.11.2000, Section 6.4.4.

a cost of living index (or COLI) ([16]). Given its primary use as a macroeconomic indicator for monetary policy, a COLI approach was never seen as an option for the HICP.

As the HICP compares prices by measuring the cost of a fixed basket of goods and services, this implies that the price relatives should follow identical or nearly identical product offers; that is, the product offers should remain of similar specification or quality. In this way, the price changes recorded are *pure price changes*, i.e. they are unaffected by differences in the quality of the product offers priced. A product offer is an observable entity comprising a specific model/variety of a single good or service (individual product) offered for purchase at a stated price in a specific geographical area, location, place of purchase (an outlet or a shop) and point in time (Article 2(4) of Regulation (EU) 2020/1148). The same principle applies to all types of data sources, survey, administrative, transaction and web-scraped data (see Chapter 5 — Price collection).

The sample can be viewed as consisting of two levels. Level I, where products are selected according to the ECOICOP lowest level (5digits) ([17]). Level II (below the 5-digit level), that by contrast, uses no predefined classification system. The availability of detailed expenditure data by product, the sampling approach used, and resource availability will often dictate how a country decides to structure its classification system below the ECOICOP. This lower level is generally not for publication but is required because elementary product groups and elementary aggregates (EAs) are commonly defined well below the level of the ECOICOP 5-digit sub-classes. It is at this level that products are sampled, which in turn determines the structure of price collection (see Chapters 3, 4 and 5). The EAs represent the building blocks of the HICP (see Chapter 8). It is worth noting that normally only price indices and weights at the 5-digit sub-class level and above are required to be transmitted to Eurostat each month.

At the elementary aggregate level the product descriptions and expenditure weights remain unchanged or *fixed*, at least within the year. Below the level of the elementary aggregate are the individual products that are priced each month. These may be implicitly or explicitly weighted. Figure 3.3.1 at the end of Section 3.3.1 shows these two levels in graphical form for a specific product (nuts).

New products frequently appear on the market, while others disappear. Their dynamics cannot be ignored without risking degradation of the sample. When an individual product in the sample is no longer available or no longer popular, it needs to be replaced to keep the sample representative. Article 10 of the Implementing Regulation 2020/1148 states that

> *'Member States shall select a replacement product that is similar to the disappearing product, while ensuring that the target sample remains representative'.*

In other words, replacement products should be either identical or essentially equivalent to the one replaced. When making such replacements, it is essential to follow the HICP principle of comparing prices of individual products on a like-with-like basis in order to reflect pure price changes. Where the replacement product is not considered equivalent from the consumer's point of view, i.e. its characteristics differ from those of the replaced product, it is necessary to apply some form of quality adjustment to the price comparison. Quality adjustment is discussed in detail in Chapter 6.

([16]) The COLI approach would theoretically involve comparisons of different baskets providing the same level of utility.

([17]) ShowVoc (europa.eu)

Replacements as described above can occur at any time of the year. They may be forced by the disappearance of an individual product, or they can be planned, i.e. a new product model has appeared on the market which has become representative of current consumer purchases, so the existing individual product which is no longer representative is replaced by the new one in order to keep the sample representative. It is essential that the sample is representative of the target universe in the reference period and over time. To this end, HICP samples must be reviewed and updated on a regular basis. See Implementing Regulation (EU) 2020/1148).

In December of each year the samples of products should be reviewed to determine whether they are still representative. New representative products can be added and products that are no longer representative should be removed from the sample.

Annual resampling keeps the basket representative of consumer expenditure (see Chapter 3 - Weights and Chapter 4 - Sampling)

2.2.2 Comparability

A key requirement for country HICPs is that they be comparable. This means that differences in HICPs between countries should reflect only differences in price changes or expenditure patterns and not differences in methods.

The objective is comparability of results. This means that different countries would produce the same results from the same data set of prices and weights. Where prices develop differently or the consumption pattern is different (i.e. the weights are different), the HICPs will naturally differ.

Where results differ due to differences in concepts, methodology or compilation practices, the aim of the HICP is to eliminate these through harmonisation. However, the principle of subsidiarity means that Member States are allowed to use methodologies which best reflect their national circumstances, on condition that the results can be demonstrated to be comparable.

The comparability threshold for deviation in the average annual change of HICPs is defined to be one part per thousand (one tenth of a percentage point) at the all-items level (see Article 4(2) of Regulation 2016/792).

The Implementing Regulation 2020/1148 sets out a number of methodological and technical specifications which Member States must apply when compiling an HICP. This manual sets out examples of preferred methodologies or good practice in many areas of the HICP. These go beyond the legal requirements of the regulations and are as such only advisory in nature.

2.3 Scope and coverage

2.3.1 Household final monetary consumption expenditure

In general, the concepts, definitions and conventions adopted in the HICP are as far as possible consistent with those used in the global framework for national accounts (the United Nations System of National Accounts (SNA 2008)), and its European Union version, the European System of Accounts (ESA 2010).

One of these concepts is household final consumption expenditure. A subset or derivation of household final consumption expenditure is household final monetary consumption expenditure, which refers to the part of household final consumption expenditure that takes part exclusively in monetary transactions. Household final monetary consumption expenditure is thus a narrower concept than household final consumption expenditure, which includes both non-monetary and imputed transactions. Household final monetary consumption expenditure is a fundamental concept of the HICP. It defines the *scope* of the HICP. *Coverage*, although related to the concept of scope, is more associated with how much of what is defined by scope is actually covered, i.e. the coverage of the HICP is that part of Household Final Monetary Consumption Expenditure which is actually included in the HICP.

Article 2(20) of Regulation 2016/792 defines household final monetary consumption expenditure in accordance with ESA 2010:

> *'Household final monetary consumption expenditure means that part of final consumption expenditure incurred:*
>
> i. *by households,*
>
> ii. *in monetary transactions,*
>
> iii. *on the economic territory of the Member State*
>
> iv. *on products that are used for the direct satisfaction of individual needs or wants, as defined in Annex A paragraph 3.101 of ESA 2010,*
>
> v. *in one or both of the time periods being compared.'*

Further specifications regarding the Household final monetary consumption expenditure are given in the Annex of the Implementing Regulation (EU) 2020/1148.

The HICP is a *consumer* price index, i.e. it covers the expenditure of the household sector but not that of other sectors of the economy such as the government and business sectors.

The definition of households is provided in ESA 2010 (Chapter 2, paragraph 2.118):

> *'Households as consumers may be defined as small groups of persons who share the same living accommodation, who pool their income and wealth and who consume certain types of goods and services collectively, mainly housing and food.'*

Paragraphs 2.119 (a) and (b) of Chapter 2 - Units and groupings of units further define the household sector as:

> a. *'Individuals or groups of individuals whose principal function is consumption;*
>
> b. *Persons living permanently in institutions who have little or no autonomy of action or decision in economic matters (e.g. members of religious orders living in monasteries, long-term patients in hospitals, prisoners serving long sentences, old persons living permanently in retirement homes). Such people are treated as a single institutional unit: a single household.'*

As defined above, households can range from one person living alone to a large collection of individuals living in a group, e.g. individuals living in institutions such as retirement homes. In the latter case, only the private expenditure of the residents is covered. Expenditure of the institution itself, for example on food or nursing services, is excluded. All fees paid by residents to the institution fall within the scope of the HICP.

Business expenditure, including business expenditure incurred by household members, falls outside the scope of the HICP.

All households, irrespective of nationality or residence status, are covered by the HICP (see Section 2.3.2 - The domestic concept).

The economic territory of a Member State is defined in Regulation 2016/792 Article 2(19):

> *‘economic territory means the territory as defined in Annex A, paragraph 2.05 of ESA 2010, with the exception that the extraterritorial enclaves situated within the boundaries of the country are included and the territorial enclaves situated in the rest of the world are excluded.’*

In household final monetary consumption expenditure, *final* is a technical term used in national accounting conventions, which refers to goods and services used by individual households to satisfy their individual needs or wants.

Monetary is the key word in household final monetary consumption expenditure. It means that to qualify as a transaction for inclusion in the HICP, money must change hands. Naturally, this does not refer only to cash, but to any kind of money, including electronic transfers or purchases on credit. Imputed transactions, own production and barter are excluded.

Examples of non-monetary transactions excluded from the HICP are the following:

- Own production covers goods produced by households, such as food produced by small farms for their own consumption. There are no prices to observe since there are no sales transactions, so prices would have to be imputed. Own production is excluded from the HICP.
- Households may also incur non-monetary expenditure when employees acquire goods and services from their employers as remuneration in kind. This can be seen from a conceptual viewpoint as a household paying in labour (as an employee) rather than in cash. Consumption stemming from income in kind is also excluded from the HICP. Examples include free or subsidised housing, meals, free use of company cars for private use, etc.

Owner-occupied housing costs pose a particular challenge([18]). Some national CPIs include a proxy for the cost of shelter by owner-occupation in the form of estimates of the rent that would be payable if the property was rented rather than owned. This is known as imputed rent or rental equivalence. This is currently not permitted in the HICP on conceptual grounds, as there are no actual transactions and no money changes hands. Imputed rents are outside the scope of household final monetary consumption expenditure. A measure of owner-occupied housing cost using the net acquisition approach would meet the requirement of being based on actual monetary transactions, but would normally also introduce an investment component. An owner-occupied housing price index according to this approach has been developed as a stand-alone index in the EU.

The phrase *in one or both of the time periods being compared* reflects the fact that HICPs are sample statistics that represent the change in prices, on average over the target ‘universe’ of prices, between two specified periods of time. While expenditure on a particular product can

([18]) See Eurostat (2023), Owner-occupied housing and the harmonised index of consumer prices - Outcome of the work of the European Statistical System - 2023 edition.

occur either in the first period or the second, or in both periods, the price must be recorded in both periods for a price index to be calculated. Exceptions are prices which change from zero to positive and vice versa (see Section 7.5).

The final key term in the expression *household final monetary consumption expenditure* is *consumption expenditure*. This is the expenditure on consumption products by the household sector. It therefore excludes all capital expenditure, such as the purchase of land or financial assets such as stocks and shares.

Interest payments, especially interest on mortgages for house purchases, but also interest on other types of loan, or lost potential interest on paid-up capital, are also excluded from the definition of household final monetary consumption expenditure even though they are monetary transactions. They are classified in the European System of Accounts (ESA 2010) as distributive transactions, not consumption. Social transfers received by households can be in kind or in cash. A transfer in kind is defined as a transaction in which one unit provides a good, service or asset to another without receiving any good, service or asset in return (see ESA 4.108). A transfer is outside the scope of household final monetary consumption expenditure since the household acquires no good or service; a social transfer may contribute to a household's welfare or standard of living but, by definition, no price can be observed.

Examples of social transfers in kind excluded from household final monetary consumption expenditure:

- education,
- health,
- kindergarten and other social protection services,
- housing.

Social transfers in kind do not include collective services provided by the government to the community as a whole, such as public administration and defence.

In some Member States households pay a charge for these kinds of services rendered by government or non-profit organisations.

If government or non-profit institutions serving households introduce a charge and the price changes from zero to a positive value, this change should be captured in the HICP (see Sections 7.5, 12.1 and 12.4). Household final monetary consumption expenditure covers goods and services provided to households at low non-market prices.

Reimbursements, i.e. expenditure initially made by households for which they are subsequently reimbursed by social security, government units or non-profit institutions serving households, are also classified as transfers. When purchasing a good or service that is subsequently reimbursed in part or in whole, the household is treated as an agent acting on behalf of a social security fund, government unit or non-profit institution serving households. The amount being reimbursed is treated as a social transfer in kind and not as a cash transfer to households and does not form part of a household's disposable income. Article 5(2) of the Implementing Regulation (EU) 2020/1148 states that:

> *'Observed prices for health, education and social protection products shall be net of reimbursements'.*

This means that the price used for the HICP is the amount paid by the household less the reimbursement.

Transfers in cash are money received by the household; it is regarded as part of the disposable income of the household and therefore not covered by the HICP. Households will subsequently spend this income and the expenditure financed by these transfers falls within the scope of the HICP.

All *other rebates by public authorities*, especially housing payments to tenants in order to reduce their rents (including payments which, at the tenant's discretion, go directly to the landlord), are considered social benefits in cash and so contribute to the household's disposable income. When households pay for goods or services from their disposable income, the full price of the good or service before the rebate is to be included in the HICP.

Gifts, subscriptions, tips and gratuities, *and transfers paid*: gifts are not part of household final monetary consumption expenditure since they are defined as transfers. Subscriptions or contributions to non-profit institutions serving households such as trade unions, professional societies, consumers' associations, charitable organisations, churches and social, cultural, recreational and sports clubs are not covered if no identifiable services are received in return. However, if a club, union, society or association can be considered a market producer selling its services at an economically significant price, then subscription contributions and dues paid to it by households are considered to be not a transfer but a payment for the services, which is thus covered in the HICP. Non-compulsory tips or gratuities for services rendered are outside the scope of household final monetary consumption expenditure. They are also to be regarded as transfers. In some cases, even though tips are not compulsory, it can be difficult to obtain a good or service without some form of additional payment. In such cases, tips are included in household final consumption expenditure as a part of the purchaser price of goods and services.

Compulsory or voluntary social contributions, such as employers' actual social contributions to social security funds, public health insurance or other insurance companies are not covered in household final monetary consumption expenditure, as social contributions are treated as transfers and are thus not included in final consumption.

Fines and penalties are excluded from final monetary expenditure. They are imposed by institutional units like courts of law or other institutions and are treated as compulsory current transfers.

Licences: payments by households for licences to own or use certain goods or facilities are classified as consumption expenditure and not as transfers if they constitute payment for a *specific service*. Licences for the ownership or use of vehicles, boats or aircraft and for hunting, shooting and fishing are treated as direct taxes since no specific, individual good or service is received in return for the payment. However, tolls (turnpike money) for the use of roads, bridges and tunnels are consumption expenditure and are included in the HICP, as they are payments for a specific service. Because of the ambiguity as to whether licences are taxes or service charges, a number of conventions have been developed. These are listed in the International Monetary Fund's (IMF) Government Finance Statistics Manual 2014 ([19]) (Section 5.72) and have also been adopted in the ESA.

([19]) Available at Government Finance Statistics Manuals and Guides (imf.org).

Second-hand goods are included if they are not bought from another household. In many Member States there is a market for second-hand (used) goods. Households may buy second-hand goods through different channels:

- directly from another household, or
- directly from another sector, e.g. from an enterprise or from abroad, or
- from an enterprise or from abroad through an importer.

The weights for second-hand goods are based on households' net expenditure, total purchases less sales. All current transfers in cash between households (both residents and non-residents) are not part of final monetary consumption expenditure. This means that the purchase or sale of second-hand goods from or to another household within the same economic territory is not recorded as the net expenditure is zero.

The purchase of second-hand goods from another sector (an enterprise or from abroad) is part of household final monetary consumption expenditure. The corresponding expenditure to be covered in the HICP will be households' purchases of the goods less sales to other sectors. For example, in the case of second-hand cars, if a dealer is involved in the transaction (either through purchase within the household sector or from an enterprise or from abroad), the fee for the service provided by the dealer is part of consumption expenditure (see Chapter 3).

2.3.2 The domestic concept

The geographical coverage used in the HICP is the *domestic concept*. This takes into account all household final monetary consumption expenditure within the economic territory of a Member State, whether made by resident or non-resident households. The economic territory is defined in Section 2.3.1. Consumption expenditure incurred by residents when they are outside the Member State of residence is excluded from the HICP (see also Section 7.2 for cross-border internet purchases), while expenditure incurred by visitors from other countries (e.g. tourists and expatriates visiting home) is included.

Bearing in mind the principal use of the HICP as an indicator for monetary policy purposes, there are two main reasons for using the domestic concept for the coverage of the HICP:

1 By confining expenditure to that incurred within an economic territory, the resulting HICPs cover only those price changes that national/euro area monetary policy can directly influence.

2. Consistent aggregation of national HICPs if a European aggregate HICP (e.g. for the euro area) is compared with another country or economic bloc, it must be certain to represent the whole of consumer price inflation within the euro area and none of it must be double-counted.

The use of the domestic concept ensures that these conditions are met.

An alternative to the domestic concept is the *resident concept*, which measures all expenditure incurred by residents of a country (whether nationals or non-nationals), irrespective of whether it is incurred inside or outside the economic territory. The resident concept excludes expenditure incurred within the economic territory by non-residents such as tourists.

Note that on the production side, GDP (gross *domestic* product) uses the domestic concept. In contrast, household final monetary consumption expenditure, which is based on the expenditure approach, uses the resident concept. This means that to be able to use household final monetary consumption expenditure data to estimate HICP weights, an adjustment is required to exclude residents' expenditure abroad and to include non-residents' expenditure within the economic territory (see Section 3.3.5).

It should also be noted that both the domestic and resident concepts at the global (world) level would produce the same results in terms of aggregate expenditure. However, at the EU and euro area levels they would not, because of the expenditure of EU/euro area residents outside Europe, and the expenditure of non-EU residents within Europe. In practical terms, this makes the domestic concept in some ways easier to implement, as the resident concept would require detailed information on residents' expenditure and prices paid outside the economic territory.

2.3.3 Product coverage

It is essential that the HICP is based on a clear and unequivocal classification system for consumption products and that the same classification is used by all EU countries. It has been decided to adopt the Classification of Individual Consumption According to Purpose (COICOP) developed by the United Nations. This classification divides the basket of goods and services into divisions (2-digit), groups (3-digit) and classes (4-digit). Further work in the EU has resulted in a refinement of COICOP to incorporate an additional level of (5-digit) sub-classes. The version used in the HICP is known as the ECOICOP; the full ECOICOP classification is given in Annex I. ECOICOP is the version of COICOP used in all EU economic statistics covering consumer expenditure (national accounts, purchasing power parities, household budget surveys and the HICP) ([20]). For each specific application, certain categories may be omitted — for example, non-monetary transactions such as imputed rents (see below) are omitted from the HICP.

Some categories of consumption expenditure are excluded either in principle or on practical grounds from HICP coverage. These are (with ECOICOP categories):

02.3	Narcotics
04.2	Imputed rentals for housing
09.4.3	Games of chance
12.2	Prostitution
12.5.1	Life insurance
12.5.3.1	Public insurance connected with health
12.6.1	Financial intermediation services indirectly measured (FISIM).

Narcotics (02.3) and prostitution (12.2) are included in principle in household final monetary consumption expenditure but are not covered in the HICP for practical reasons. Price collection was deemed too problematic in these areas. Whether the purchase of a good or service is legal

([20]) The full COICOP 2018 codes and names are provided in Annex II of this Manual.

or illegal in a country is not relevant for its treatment. They are included in GDP and are also included in private consumption expenditure.

Games of chance (09.4.3) fall within the scope of household final monetary consumption expenditure according to the ESA and the Framework Regulation. However, they are currently (in 2023) excluded from the HICP on the grounds that no harmonised method for their treatment has yet been agreed upon.

For owner-occupiers, the national accounts assume that dwellings provide a flow of capital services, which represent an input into the production of housing services. Therefore, owner-occupiers may be considered to consume the housing services produced as outputs from this production. In household final consumption expenditure, these services are included by way of imputed rentals (04.2). As these costs are imputed and not monetary transactions, imputed owner-occupier housing costs are not part of household final monetary consumption expenditure and are not within the scope of the HICP.

The HICP also excludes financial intermediation services which are indirectly measured (FISIM) (12.6.1), i.e. those parts of financial services where the implicit charge involved is the net interest earned by financial institutions. No explicit (monetary) charge can be identified for the intermediation services that financial institutions provide to their customers. As an imputed (non-monetary) transaction, financial intermediation services indirectly measured are excluded from the HICP. Note that financial services that attract explicit charges, for example annual charges for credit cards (excluding interest charges), bank charges for money transfers, and currency exchange commissions etc., are included in the HICP — see Section 12.8.

As a rule, the scope of the HICP includes the prices of all goods and services included in household final monetary consumption expenditure. *Non-consumption* expenditure, such as financial transactions, transfers and purchases of financial assets, is excluded. According to ESA 2010, all insurance services are within the scope of household final monetary consumption expenditure and are to be included by the amount of the implicit service charge. However, life insurance is excluded from HICP coverage. Premiums paid for life insurance (12.5.1), including pension-funding services, are regarded as savings and so are not part of the HICP. Life insurance is excluded because it is not possible to separate out the implicit service charge for the insurance component from the implicit service charge for the investment component. Non-life insurance services are, however, included in the HICP. Public insurance connected with health (12.5.3.1) falls outside the scope of the HICP because compulsory contributions under social security schemes are not included in household final monetary consumption expenditure.

2.3.4 Product coverage: special cases

A number of important product types pose specific measurement problems. These are dealt with individually in Implementing Regulation 2020/1148. They are as follows:

- *Non-life insurance (see Section 12.2)*. These include motor vehicle, travel, dwelling ([21]) (contents only) and private medical insurance, pet insurance, etc. The bulk of total premiums paid by policyholders is paid out to claimants. Article 3 (6-7) of Regulation 2020/1148

([21]) Dwelling insurance (covering the physical building) is one of the indices required to estimate owner-occupied housing costs in accordance with the net acquisitions approach.

provides the rules for insurance weights. ‘The sub-index weights that relate to non-life insurance shall be derived from aggregate expenditure by households on implicit service charges. Consumption expenditure financed from non-life insurance claims, including payments made directly by insurance companies, shall be included in the sub-index weights of the relevant ECOICOP categories.’ Article 5 (6) of this regulation prescribes that ‘Observed prices for insurance shall be actual premiums’, which are defined as ‘the amounts paid for a specific insurance policy to obtain insurance cover over a stated time period’.

- *Tariff prices (see Section 7.4)* refer to a list of prices and conditions for a product, differentiated according to the quantities purchased, the time of consumption or the characteristics of the purchasers. Measuring price changes for products listed in a tariff (e.g. a list of rail fares taking into account the day of the week, time of day, type of passenger, etc.) may pose some difficulties. Implementing Regulation 2020/1148 states that

  ‘changes in the observed prices or conditions of a tariff shall be shown as price changes in the HICP.’ Section 7.4.4 provides further details on how tariff prices should be treated in the HICP.

- *Proportional service charges (see Section 7.3)*. Some service charges, such as those charged by stockbrokers, are charged as a proportion of the amount of the relevant transaction. This method of charging for a transaction raises the question of how these charges can be best reflected in the measured inflation rate. Section 7.3 illustrates rules and methods for service charges proportional to the transaction.

- *Prices dependent on purchasers’ income or other socioeconomic characteristics (see Section 12.1).* Some prices are dependent on or linked to such factors as household income or the number or age of children. Changes in purchaser prices resulting from changes in purchasers’ incomes are to be shown as price changes in the HICP. Article 4 (4) of Implementing Regulation 2020/1148 prescribes that ‘if household income is a condition determining the price, changes in the observed prices resulting from changes in household income shall be shown as price changes in the HICP’.

- *Seasonal products (see Section 7.1)*. The non-availability of certain types of products during parts of the year poses problems for index calculation. These products are usually related to the seasons, often because certain types of fresh produce or clothing are available only during a particular season. More precisely, a seasonal product is defined as an ‘individual product that is available for purchase or purchased in significant amounts only part of a year in a recurring pattern. In any given month, the product is considered to be either in-season or out-of-season. The in-season period may vary from one year to another.’ These products should also be included in the index calculation.

2.4 Index type

The HICP uses different formulas for aggregating prices and price indices, depending on the level at which weights are available and the size and characteristics of the data. Within an elementary price index, the prices of individual products may be weighted if they are obtained from transaction data containing itemised information on turnover and quantities (see Chapter 5) or using other supplementary information to derive weights, or unweighted if they are collected with a survey or administrative data. At the level of the elementary price index and above, weights are always available. At those levels the HICP uses a Laspeyres-type formula.

The HICP is a Laspeyres-type index obtained by annually chain-linking price indices. Details on aggregation and a numerical example of one-month chain-linking are given in Chapter 8.

In the HICP the weight reference period is a calendar year and the price reference period is a month (December of the previous year). Weights at all levels of the ECOICOP must be updated every year (see Section 2.6 below, Chapter 3 and Chapter 8 for the price-updating of weights to the price reference period). It should also be noted that the sample is fixed only at the level of elementary aggregates (the lowest level at which expenditure weights are generally available) and above (see Section 5.3.1). Below this level, individual products are continually replaced to reflect market changes.

2.5 Price concept

The prices used in the HICP should be *purchaser prices*, which are the prices actually paid by households. Purchaser prices also include all unavoidable additional costs such as booking (see Section 7.2). *Acquisition prices* are what consumers actually agree to pay when they purchase goods and services to satisfy their consumption needs.

In traditional price collection, price collectors generally focus on *shelf prices* in physical outlets or *offer prices* in price lists as it is not possible to collect acquisition prices. This deviation from the target measure is often admissible even if price collectors should preferably verify that the offer price is the price most commonly paid.

Statistical offices may use transaction data for price collection. In this case, the definition of price is more similar to the price actually paid by consumers, as unit value prices are often computed as the ratio between total sales and quantity sold for that individual product/product offer. Transaction data can also include product prices per package (euro/package) for a given week or month. This may be very common in some countries for products that have fixed prices for a month such as alcoholic beverages and prescription medicines.

Product-related taxes such as VAT and other sales taxes and excise duties are included and any subsidies are deducted. Discounts and inducements such as sales prices should be taken into account according to a set of criteria (Article 6 of Regulation 2020/1148). Interest payments or service charges added under credit arrangements, and any extra charges incurred as a result of failure to pay within the period specified at the time of purchase, are disregarded (see Section 5.3.3 and Table 5.3.7).

The HICP follows the acquisition approach to the recording of prices. Under this approach, an acquisition is deemed to take place when the purchaser incurs a liability towards the seller. In practice, goods are generally considered to be consumed at the time of purchase, so prices for goods enter the HICP in the month in which they are observed. However, many services (flights, package holidays, etc.) are either purchased in advance of when they are consumed or are consumed over a period of time (e.g., season tickets for transport and sporting services). Article 8 of Commission Regulation 2020/1148 lays down detailed rules on the timing of entry of observed prices into the HICP. Prices for goods shall be included in the HICP for the month in which transactions can take place at that price, while the price of a service shall be included in the HICP for the month in which consumption of the service can commence. More detailed information on the price concept is provided in Chapter 5.

2.6 Weights

The overall inflation rate in a country, as measured by the HICP, is calculated in stages from the price changes measured at the most detailed level, product offers, aggregated up to the all-items (all-products) level. Section 2.2.1 referred to two levels of aggregation. Level I involves aggregation within the ECOICOP classification starting at the 5-digit sub-class level. Level II aggregation occurs below this level to obtain elementary price indices, which is the lowest level at which expenditure weights are generally available. Within elementary price indices, expenditure weights are unavailable for survey collected prices and generally for web-scraped and internet data. (See Chapters 3, 5 and 8). Without weights, a meaningful HICP cannot be calculated, since there would be no differentiation between expenditure on different categories of products, each with their particular rates of price change. Transaction data allow the use of weights, based on turnover or sales value at the level of individual products.

Therefore, the elementary price indices below the 5-digit sub-class level are compiled either with variable weights, in particular but not exclusively in the context of multilateral methods (Eurostat, 2022 ([22])), or without weights.

It is very important, to be able to determine sufficiently accurate weights for all groups of products at the level of the elementary aggregate and above. These higher groupings are always related directly to one or more categories in the ECOICOP classification.

To construct the weights of the HICP different data sources may be used. National accounts data are the primary source as their use for determining the weights in the HICP is mandated by regulation (Implementing Regulation No 2020/1148). Other sources of information for estimating weights in the HICP are household budget survey (HBS) data, market research data, various administrative sources and more recently transaction data from the retail trade distribution.

The weights used in index compilation are updated every year to have the most representative expenditure patterns and obtain the most accurate aggregate indices (Regulation EU 2016/792). The procedure and key requirements for the practical compilation of the weights have changed since 1 January 2023, according to the Implementing Regulation 2020/1148:

Article 3

1. *Member States shall derive the sub-index and elementary aggregate weights used in the index for year t as follows:*

    a. *Until 31 December 2022, national accounts data for year t–2 and any available and relevant information from household budget surveys and other data sources shall be used to obtain subclass expenditure shares and divide them among the elementary aggregates of the subclass. From 1 January 2023, national accounts data for year t–2, which can be complemented with data from a recent household budget survey and*

([22]) Eurostat (2022) Guide on multilateral methods in the Harmonised Index of Consumer Prices (HICP) — 2022 edition — Products Manuals and Guidelines. .

other sources, shall be used to obtain subclass expenditure shares and divide them among the elementary aggregates of the subclass;

b. The expenditure shares for year t–2 shall be reviewed and updated to make them representative of year t–1;

c. The expenditure shares for the elementary aggregates shall be adjusted with an appropriate price change between year t–1 and December of year t–1.

Consequently, NSIs should estimate new sub-index weights using the latest available data from the national accounts (normally estimates relating to calendar year t–2) and should price-update the weights. More details on the weights are provided in Chapter 3, while Section 8.2.3 explains the price-updating of weights.

2.7 Sampling and representativity

Every day, billions of consumer transactions take place in outlets across the EU. These involve purchases of millions of different products. In practice, it is not possible to record all consumer transactions. Therefore, the construction of CPIs has always relied on sampling — and so does the HICP. Not only do products (goods and services) have to be sampled, but also the outlets where transactions take place.

The HICP is a sample statistic that represents the change in prices, on average over the target universe, between two specified periods. Given the differences in the national markets and populations of the EU Member States, it would not be possible to impose a uniform sampling structure in all countries.

Nevertheless, certain minimum standards must be followed. Article 4 of the Implementing Regulation 2020/1148 is devoted to sampling and representativity. It states that:

'1. Member States shall make a target sample that is representative of the target universe by defining elementary aggregates and selecting individual products for these elementary aggregates.

2. The number of individual products and elementary aggregates shall depend on the weight of the subclass and the variance of price movements of the individual products belonging to it.

3. Member States shall ensure that the target sample remains representative of the target universe over time by conducting at least an annual review and update of the target sample, and selecting replacement products.

4. Products for which the expenditure share is at least one part per thousand shall be represented in the target sample.'

Sampling in the HICP is discussed in depth in Chapter 4.

2.8 Frequency

The HICP is a monthly statistic. It has to be compiled every month. This means that in principle prices have to be collected at least once a month. Less frequent price collection for some goods or services may be justified if it is known that prices do not change from one month to the next and all price changes are sure to be captured by the index. Information contained in transaction data on sales and quantities (and thus unit value prices) typically covers the two, three (or sometimes four) first weeks of the month, depending on the data supply arrangements.

While HICPs are produced and published every month, their corresponding weights are reviewed and updated every year. The weights of a new year refer to *t*–1 (expressed in prices of December of the preceding year). At the same time, the HICP country weights used in EU aggregates are also updated (see Chapters 3 and 8).

2.9 Methodological changes and revisions

HICPs are generally not subject to revision (Implementing Regulation 2020/1148).

HICPs are considered final when they are released, except in cases where a Member State provides provisional HICP estimates which may be revised when finalised. In this case, changes between the HICP flash estimate and the HICP for the same reference month shall not be considered a revision.

In limited circumstances, revisions can be made. Article 17 of Implementing Regulation 2020/1148 stipulates that:

> ‘1. *Member States shall correct mistakes and transmit the revised sub-indices or sub-index weights to the Commission (Eurostat) without unjustified delay.*
>
> *2.Member States shall provide the Commission (Eurostat) with information on the cause of the mistake at the latest with the transmission of the revised data’*.

Any other type of revision must be agreed with Eurostat. Chapter 10 discusses how to handle methodological changes and revisions.

3

Weights in the HICP

3 Weights in the HICP

3.1 Introduction

Calculating the HICP is a two-stage process. The first stage consists of computing price indices for each elementary aggregate (i.e. the elementary price index) within the classification structure. The second stage involves arranging these elementary price indices into a number of higher-level indices up to and including the all-items HICP. Aggregation up to the all-items level is accomplished by taking weighted averages of the lower-level indices. The individual weight for each of these indices equals the expenditure share for the corresponding good or service. More precisely, this second stage consists in computing the arithmetic weighted average of the price changes of the elementary indices as defined by a Laspeyres-type price index formula. The weights in the HICP mean that price changes of items on which households spend the most money will affect the HICP more than items on which little money is spent.

The data used for constructing the weights of the HICP are derived from various sources. National accounts data are the primary source, as their use for determining the weights in the HICP at given levels of aggregation is mandated by regulation. Also, national accounts data are structured and organised according to the European classification of individual consumption according to purpose (ECOICOP) classification regime down to level 3 as well as having an annual updating cycle, both essential features of the HICP. Other sources of information for estimating weights in the HICP, though typically for lower levels of aggregation, are household budget survey (HBS) data, market intelligence information, retail trade data, various administrative sources and more recently scanner data.

This chapter elaborates on the role of weights in the compilation of the HICP and describes how they are estimated before they are applied in the compilation of the HICP.

The rules for the estimation of weights for the HICP have certain important and distinctive features. For instance, it is often recommended in CPI literature that the basket be updated as frequently as possible — at least every 5 years. EU regulations are more prescriptive, and state that the basket and its weights (at least starting at the ECOICOP 5-digit level) must be updated annually; moreover, the link period for the new basket including its new weights scheme, again according to the HICP framework, is fixed as the month of December. Also, the weights at the ECOICOP 5-digit level and above should generally be based on household final monetary consumption expenditure data derived from the national accounts.

This chapter discusses the sources of information and the derivation of the sub-index weights to be used in the HICP. More specific topics are also covered, including data sources and derivation of weights for second-hand motor vehicles, etc. For additional and more specific discussions on methodological and conceptual issues related to the topic of weights, consult Chapter 4 of The Practical Guide to Producing Consumer Price Indices (2009) and Chapter 4 of The ILO Consumer Price Index Manual: Theory and Practice (2004).

3.2 Legal framework, definitions and terminology

3.2.1 Legal framework

The legal framework provides the minimum standards for producing the weights in the HICP. The issue of weights is covered in the following articles of the HICP Framework Regulation and Implementing Regulation.

The Framework Regulation

Regulation (EU) 2016/792 of the European Parliament and of the Council of 11 May 2016 on harmonised indices of consumer prices and the house price index, and repealing Council Regulation (EC) No 2494/95 states:

> '*Article 3 — Compilation of the harmonised indices*
>
> *(10) Each year, Member States shall update sub-index weights for the harmonised indices. The Commission shall adopt implementing acts specifying uniform conditions for the quality of weights of the harmonised indices. Those implementing acts shall be adopted in accordance with the examination procedure referred to in Article 11(2).'*

The Implementing Regulation

Commission Implementing regulation (EU) 2020/1148

> *'Article 3 – Weights*
>
> *1. Member States shall derive the sub-index and elementary aggregate weights used in the index for year t as follows:*
>
> > *(a) Until 31 December 2022, national accounts data for year t–2 and any available and relevant information from household budget surveys and other data sources shall be used to obtain subclass expenditure shares and divide them among the elementary aggregates of*

the subclass. From 1 January 2023, national accounts data for year t–2, which can be complemented with data from a recent household budget survey and other sources, shall be used to obtain subclass expenditure shares and divide them among the elementary aggregates of the subclass;

(b) The expenditure shares for year t–2 shall be reviewed and updated to make them representative of year t–1;

(c) The expenditure shares for the elementary aggregates shall be adjusted with an appropriate price change between year t–1 and December of year t–1.

2. Sub-index weights shall be kept constant throughout the calendar year.

3. The weight of an elementary aggregate shall be kept constant throughout the calendar year unless the list of elementary aggregates within a sub-class is adjusted to reflect significant changes in the target universe.

4. The sub-index weight for any ECOICOP division, group or class shall be equal to the sum of the sub-index weights of its constituent categories. The sum of all sub-index weights at any ECOICOP level shall equal 1 000.

5. The sub-index weight for any subclass shall be equal to the sum of the weights of the elementary aggregates of that subclass.

6. The sub-index weights that relate to non-life insurance shall be derived from aggregate expenditure by households on implicit service charges.

7. Consumption expenditure financed from non-life insurance claims, including payments made directly by the insurance companies, shall be included in the sub-index weights of the relevant ECOICOP categories.'

The new regulation has removed references in the previous manual that pertained to the use of 'preliminary' national accounts data for *t*–2, as well as the possibility of using weights that are no older than seven years below the sub-class level. National accounts data may still be subject to revision under this regulation. The main change from the previous legal framework is that after 2023 the focus will be on using national accounts data for the weights, while previously some countries used other primary sources such as the Household Budget Survey.

Unlike the previous regulation, there is no longer a requirement to use three-year averages of insurance services. According to the now repealed Regulation (EC) No 1617/1999, the weight for insurance used to be derived as a three-year moving average of household expenditure on the service charge. The current implementing regulation specifies that weights for insurance should be based on the service charge for a single year as defined in paragraph 16.51 of ESA2010. According to ESA2010, the output of non-life insurance services should be estimated from 'adjusted' claims to allow for possible volatility in the claims that can occur each year.

The sub-index weights that relate to non-life insurance will be derived from aggregate expenditure by households on implicit service charges.

The sub-index weights of the relevant ECOICOP categories will include consumption expenditure financed from non-life insurance claims, which includes payments made directly by the insurance companies.

3.2.2 Definitions and terminology

Implementing regulation (EU) 2020/1148 gives the following definitions relevant to HICP weights:

'Article 2: Definitions

(1) 'expenditure share' means a percentage of total household final monetary consumption expenditure, as specified in the Annex;

(2) 'sub-index weight' means the weight for any category of the European classification of individual consumption according to purpose (ECOICOP), as set out in Annex I to Regulation (EU) 2016/792, included in the HICP;

(13) 'elementary aggregate' means the smallest aggregate used in a Laspeyres-type index;'

Below are some further definitions and terminologies related to weights:

Coverage is the statistical *target universe* (as defined in the implementing regulation) to be represented by the HICP.

Expenditure share (as defined in the implementing regulation) is the share of the total expenditure on all goods and services covered by the index spent on a certain product in any given period.

Sub-index weight represents each product's relative importance in the fixed basket, regardless of its level in the aggregation structure. It is the share, possibly affected by some price-updating or other adjustments.

In the HICP, both expenditure share and sub-index weight are usually expressed as a percentage of total household monetary consumption expenditures, so that the total equals 100 or in parts per 1 000 so that the total equals 1 000.

Price-updating of the weights: A procedure where expenditures in the weight reference period are revalued at the prices of a later period, which is also known as the price reference period. This procedure is applied at the sub-index level of the HICP to adjust for the relative price changes which have occurred between the weight reference period and the price reference period.

Laspeyres-type price index: This is defined in Article 2(14) of the framework regulation; it is an index that measures the average change in prices from a price reference period to a comparison period using expenditure shares from some period prior to the price reference period; and where the expenditure shares are adjusted to reflect the prices of the price reference period (see Chapter 8).

3.2.3 HICP weights: What the Regulation requires

The Regulation requires that *HICP weights at all levels of ECOICOP are updated every year* and under *Article 3(1) the procedure changes from 1 January 2023*: In practice this means that compilers should estimate new sub-index weights using the latest available data from the national accounts (normally estimates relating to the calendar year *t*–2). These data are a subset of household final monetary consumption expenditure that includes non-resident expenditure within the economic territory and excludes residents' expenditure abroad in accordance with the domestic concept (see Chapter 2). While the requirement is only for consistency at the 3-digit level, in many countries, this should be possible down to the 4-digit class level. If this detailed expenditure is not available, then other data sources (normally the household budget survey) can be used to subdivide the higher-level ECOICOP expenditures derived from the national accounts to estimate 4-digit class and 5-digit sub-class weights. Other data sources such as retail sales data and data from administrative sources can also be used so long as they are sufficiently reliable. The Regulation also requires the weights to be updated to *t*–1 (which is the weight reference period in a Laspeyres type index) in order to include newly significant goods and services, and to adjust weights accordingly where known changes in expenditure have occurred (e.g. some types of administered prices). Due to the Covid-19 pandemic, it is currently necessary to adjust everything, mostly based on NA data for calendar year quarters123 *t*–1 compared to Q123 *t*–2.

Weights should relate to a 12-month period: Annual data must be used because averaging data over longer periods has the potential to smooth out real changes in expenditure patterns, which may be detrimental to the relevance of the HICP. For example, rapid and large changes in fuel prices can significantly impact HICP weights.

New weights are to be estimated for December of each year: However, weights are price-updated to the December of each year (price reference period) and are first used for the index for January of the following year (see Chapter 8 — Index calculation).

Weights should not be revised unless a mistake is found: For the purposes of the HICP, mistake is defined in Chapter 10. As noted above, HICP sub-index weights are estimated annually from national accounts estimates. Subsequently, national accounts estimates are frequently revised; such revisions do not constitute a mistake; accordingly, the weights should not be revised.

3.3 The structure, data sources and reference period for HICP weights

3.3.1 Weighting structure: Two levels of weights

The classification regime of the HICP can be divided into two levels.

- Level I comprises product groupings and their respective weights that reflect the ECOICOP classification.
- Level II (below the 5-digit level), by contrast, follows no pre-defined classification system. Individual countries decide how to organise this lower level, and it often depends on the detailed expenditure data available by product type, the sampling approach they use, and the resources available.

Regardless of how Level II is organised, elementary aggregates should be defined somewhere within that Level II structure. Elementary aggregates are the building blocks of the HICP.

Figure 3.3.1, at the end of this section, illustrates a possible stratification structure showing the two levels: Level I groupings of products down to and including the 5-digit sub-class level, and Level II entries below the 5-digit level for a specific example (nuts). (From 2026, ECOICOP will be replaced by COICOP2018.

Below the all-items level, three examples are shown for the 2-digit division level: (1) Food and non-alcoholic beverages, (2) Alcoholic beverages and tobacco, and (3) Other divisions (the latter for completeness). At the next level, the 3-digit group, Food and non-alcoholic beverages, is then split into two distinct and separate groups of products: (1) Food, and (2) Non-alcoholic beverages. Moving down from Food, two examples of the 4-digit class level are shown (plus a catch-all ‘Other classes’): (1) Fruit, and (2) Vegetables. Fruit is further divided into four corresponding 5-digit sub-classes: (1) Dried fruit and nuts, (2) Fresh or chilled fruit, (3) Preserved fruits and fruit-based products, and (4) Frozen fruit. The 5-digit ECOICOP marks the dividing line between Levels I and II.

Within the Level II area of the classification hierarchy, there is no common classification system which Member States must use. The only condition is that the elementary product groups/elementary aggregates must be constructed in such a way that they generate acceptable estimates for the corresponding 5-digit sub-class. The example given in Figure 3.3.1, moving down from the 5-digit sub-class Dried fruit and nuts (ECOICOP 01.1.6.3) illustrates the various relationships in the HICP structure. The Figure splits it into two sub-sub-classes: (1) Nuts and (2) Dried fruit.

Moving down the hierarchical structure, the next level of aggregation is the elementary product group (a set of product offers that are sampled to represent a sub class in the HICP). In this example, the compiler has decided that three elementary product groups are needed: 1) Peanuts, 2) Almonds, and 3) All other nuts. These categories of products have been selected to represent price changes for the broadly defined product category called Nuts.

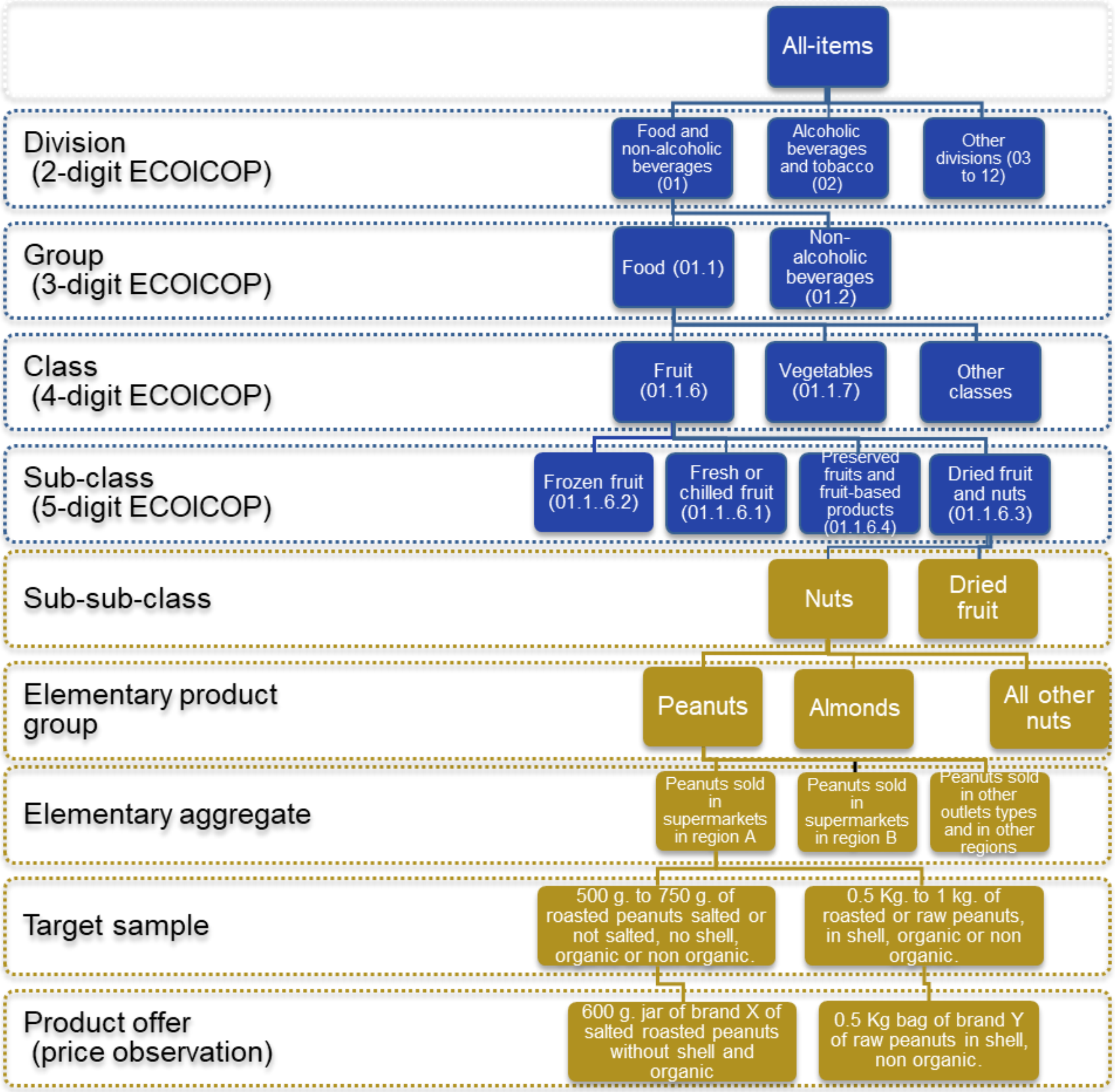
The lowest level of a Laspeyres-type index is elementary aggregate (EA) level. This example includes several elementary aggregates, one of them being ‘Peanuts sold in supermarkets in region A’. Thus, the elementary aggregate acts as a sampling frame, setting the boundaries for the nature of the prices to be collected in terms of product offers, i.e., price observations. If data limitations prevent stratifying an elementary product group by outlet type and region, then the elementary product group and the elementary aggregate become the same. Detailed weighting information may sometimes be obtained from scanner data.

The various elementary aggregates and their corresponding indices will produce an indicator of price changes for all peanuts from the universe of peanuts bought by consumers within the economic territory. Figure 3.3.1 includes an area at the bottom that shows the universe of peanuts from which the sample of peanuts for the HICP can be drawn.

To estimate the elementary price indices corresponding to the various elementary aggregates for peanuts, a sample of product offers will be selected. The prices from these offers will then be used in calculating the index. The concepts of the *Target sample (TS)* and *Product-offer (PO)* were developed to achieve this objective, providing compilers with a common set of guidelines and procedures for sampling prices. (This refers to traditional methods of price collection and index calculation; it may not be valid when new data sources such as scanner data are used. Using scanner data, the product offer/price observation can be an individual product offer indicated by a GTIN or EAN code). While the two concepts are not formally part of the classification system, Figure 3.3.1 includes them to illustrate their relevance and position within it. Chapter 4 covers sampling for the HICP in more detail.

Figure 3.3.1

Classification structure for the various levels of aggregation of an HICP



3.3.2 Weights by geographical breakdown

This section explains how the weights for geographical areas (e.g., breakdown by region and/or rural versus urban) can be estimated. To increase sampling efficiency and the quality of the price index, elementary product groups can be stratified by region. These weights can usually be obtained from the HBS, as the questionnaires will contain a geographical code for the location of the respondent. Note, however, that with these data, the respondent's location may differ from the location of some of their purchases. For instance, many households living in what is defined as a rural area may shop in urban areas when it is convenient for them. For practical purposes, however, this issue can be ignored without compromising the reliability and accuracy of the HICP.

In some countries, national accounts data are available by region (e.g., state or province) and this can be a realistic option for obtaining weights data by geographical area for the HICP. Scanner data may also be used. If neither HBS, scanner nor national accounts data are unavailable, then regional population counts, though less than ideal, may be the only realistic option available to compile regional weights.

3.3.3 Weights for outlet types

Another dimension of stratification is by type of outlet. This approach can be used to complement the stratification by region described above. Alternatively, if no regional breakdown is possible, then elementary product groups could be stratified by type of outlet alone. For example, in Figure 3.3.1, the elementary product group for peanuts is divided into elementary aggregates which are defined along the lines of outlets that are supermarkets and other outlet types, which could be, for example, speciality stores that sell mostly nut-based products.

Outlet type is perhaps the most important stratification variable, as both price levels and price changes can vary significantly among the various kinds of outlets that co-exist. The growth of national and international chain stores (which often engage in national pricing practices) in many countries has in some situations reduced the relevance of regional differences in prices (both levels and movements). Where independent stores are still significant in terms of where consumers choose to shop, it is important that elementary aggregates are appropriately weighted to reflect their relative importance for each elementary product group.

The source information for outlet types can usually be obtained from retail trade data for at least the broadest categories of products. Sometimes, the household budget survey may include sufficient information for the statistician to derive the outlet type from which the household made its purchases. Some countries have used other techniques for deriving outlet-based weights for constructing finer levels of detail for their elementary product groups, by either using a point-of-sales survey or scanner data or consulting their country's business register. There will be two possible sources of weights: scanner and traditional. If outlets with different sources are combined into the same elementary aggregate, combining the data to get an overall figure for the aggregate may be difficult. To avoid this problem, it may be convenient to divide outlets into those for which scanner or web-scraped data are available, and other outlets. This requires the scanner data to be classified according to the existing EA structure (for example classify nuts into 'peanuts', 'almonds' and 'other nuts').

Another possibility would be to integrate the new data source at a higher level (for example, at the level of the sub-sub-class). In Figure 3.3.1, the Elementary Aggregate level might then read:

- Peanuts sold in region A in outlets providing scanner data
- Peanuts sold in region B in outlets providing scanner data
- Peanuts sold in other regions in outlets providing scanner data
- Peanuts sold in outlets that do not provide scanner data (possibly stratified by region)

Purchases made over the internet are of growing importance. More consumers are now buying online. This may involve buying goods from other countries, possibly outside the European Union, so the guidance on cross-border purchases in section 7.2.5 should be considered. In particular, some categories of products are well-known for being bought predominantly over the internet, e.g., books, music and package holidays. Ideally, at least for those products that are known to be mainly bought online, elementary product groups should be stratified to reflect this. Information for weighting the internet stratum can be drawn (if available) from market research companies, which closely monitor consumers' use of the internet for online shopping. Additionally, some HBS surveys now record information about outlet type (including internet purchases). This, along with the corresponding expenditure, is a potential data source for stratifying elementary product groups by outlet type.

3.3.4 Weights within the elementary aggregate

The price index of an elementary aggregate (the elementary index) is calculated directly from collected prices. The price indices are first calculated for goods and services that have been sampled or chosen because their price behaviour is considered characteristic of the elementary aggregate they were selected to represent. Typically, this will lead to prices within the elementary aggregate that have a similar pattern of change. See also Chapter 8, which discusses index compilation methods to calculate elementary indices that use weights.

Unlike weights for the five levels of the ECOICOP, weights below sub-index level do not need to be updated annually. This recognises that some Member States only conduct household budget surveys at five-year intervals. While the household budget survey is often used for such detailed weights, other data sources such as scanner data, retail sales data and market research data may provide more reliable information, as household budget survey samples can often be small and so lead to statistically unreliable results (see Section 3.3.5).

To distinguish the weights used within elementary aggregates (which are the lowest level of a Laspeyres-type index) from the sub-index weights used for the Laspeyres-type index, compilers often refer to these as either sampling weights or implicit weights (although the latter is somewhat of a misnomer since these weights are explicit). An example of the use of this type of weighting would be market share data derived from retail sales in countries where the necessary information is not available: out of a sample of 100 prices collected for white sliced bread, 80 prices are collected from national supermarket chains, and 20 prices are collected from independent outlets, therefore giving more weight to chain store sales, which should reflect consumers' tendency to purchase most of their bread from these larger stores.

Sometimes, elementary aggregates can be a broadly defined product (e.g., musical instruments) which may include more than one representative product (e.g., a piano and a harmonica). If their prices are thought to move differently, then it might be more realistic to stratify the elementary aggregate further, for which a finer layer of detailed weights based on relative shares of the total expenditure on musical instruments can be applied to each stratum — data availability permitting. Data sources may include retail sales, market intelligence, scanner data, etc. In each case, it is the relative market share rather than the actual expenditures which is used to derive these implicit weights.

Another option is to narrowly define the elementary aggregates at a lower level in the aggregation structure; in the above case, two distinct elementary aggregates — one for pianos and one for harmonicas — could be defined. In that case, the market shares for each class of instrument, which could be derived from retail sales data or market intelligence information, could be used as the source of the weights. These weights remain fixed until the next period of reweighting for this level of detail. If the elementary aggregates do not cover the whole of this category, it would be necessary to allocate the weight for excluded items among the elementary aggregates that are used. For example, if for the fruit category only oranges, bananas, plums and apples are the chosen elementary aggregates it might be appropriate to give oranges the weight for all citrus fruit, bananas just their own weight, plums the weight for all stoned fruit, and apples the weight for all remaining fruit.

3.3.5 Data sources for the weights

Level I weights for the HICP should be derived from national accounts data using the aggregate household final monetary consumption expenditure estimates (see Chapter 2). There are two main practical advantages to using these data for estimating the weights. First, national accounts data are disseminated on a calendar year basis, so the timeframe is consistent with the weights reference period of the HICP. Second, and most importantly, the scope and coverage of household final monetary consumption expenditure, adjusted to cover all expenditure by households within the economic territory, is consistent with the scope and coverage of the HICP as defined by the domestic concept.

At lower levels of aggregation below the ECOICOP 5-digit level (i.e., Level II) of the classification system, household final monetary consumption expenditure data may lack the necessary detailed information for deriving the associated weights, so other sources of information must be consulted. Ideally, the data for Level II weights should be available on a timely basis so that the weights can be updated annually. The data used for these weights should also be consistent with the scope of the HICP. For example, using data from a survey of local hotel revenues as a source of weights in the HICP is likely to include revenues from business travellers, which are out of scope of the index. In cases such as these, and for lack of a better alternative source, the original data will need to be adjusted to separate the business travellers' portion of the revenues from those derived from household spending.

Often, the HBS is the best option for weights at Level II, but adjustments need to be made to it to reconcile the inconsistencies with coverage (i.e., the HBS only covers private resident households). Other data sources such as retail trade data, market research data, cross-border expenditure surveys and scanner data can be used for Level II weights, but these will often require an adjustment to align their coverage with that of the HICP. If more than one data source is used, there may also be some issues in reconciling different data sources. However, for some expenditure categories, HBS surveys are well-known to underreport expenditure on categories such as alcohol and tobacco; this may require additional adjustments to be made or alternative data sources (such as the revenues from specific taxes or duties) for these categories to be used.

For Level I weights, this issue is usually not a problem when national accounts data are used as the source of weights. This is because national accountants will often use a commodity flow approach when conducting the routine exercise of balancing their supply-use tables. In this case, all available information (i.e., domestic production, retail sales, tax information, and export and import data) is used to estimate the supply of products. For example, tobacco and alcohol destined for households. Consequently, the resulting expenditure estimates that make up household final monetary consumption expenditure are likely to be less biased and thus more accurate than the corresponding household budget survey expenditure.

For categories below the 5-digit ECOICOP level, where the household budget survey may or may not provide sufficiently detailed information, other sources of information for the weights can be consulted. The guiding principle when selecting sources of weights data at these lower levels (and all others for that matter) is that having some information, regardless of the source, often leads to better results than making do with no information at all. In the latter case, the elementary aggregate is populated with implicitly equally weighted price observations — an option which may generate an outcome that is far from the reality of the marketplace, leading to an unrepresentative indicator of price change as estimated by the corresponding elementary price index.

The list below provides possible sources of information that can be consulted to construct weights for the lowest levels of aggregation below the ECOICOP 5-digit sub-class level. Most likely, these data would be used to weight the elementary aggregate depending on the circumstance. This information can either be used independently or be combined to arrive at an estimate, which might be somewhat imprecise but nevertheless useful, for the lower-level weights.

a. If the categories are sufficiently important in the HICP basket, it might be worthwhile to conduct a basic survey with certain targeted retailers to get a general sense of the breakdown of sales for a specific product category. For example, in the example using nuts and dried fruit, a sample of retailers may lead to detailed sales data for these products. From the survey, the compiler could define the respective weights for nuts and dried fruit and split the sub-class into the corresponding consumption segments. Although the method will probably be a better option than not having any weighting information, the quality of the results will depend on the choice of the sample and the cooperation of the retailer. Furthermore, there is a financial and opportunity cost to consider when conducting such surveys.

b. Using existing market intelligence information may also be an option. If there is an association of importers or distributors, other industry groups or marketing agencies and boards, then they are likely to have at their disposal at least some general information on the breakdown of sales for the product. For example, the association of peanut distributors in a country may have knowledge of sales volumes and revenues for the different kinds of peanuts that are sold in that country. One disadvantage of this approach is that some of these sales may be to businesses and therefore outside the scope of the HICP; they could even include exports. Further estimating procedures will be needed to subtract these values from the total sales of the product to pick out the sales to households and the domestic market.

c. Scanner data is another option that can be used to estimate sales by product category in a similar fashion to that presented in (a). However, scanner data offers more detailed and accurate information because of the large number of price observations involved. For example, scanner data may be suited to deriving weights at a more detailed level, e.g. between peanuts, almonds and other nuts. Again, a disadvantage to this approach is that some of these sales may be to businesses and therefore outside the scope of the HICP.

d. Use of the commodity flow approach from the national accounts: production – exports + imports. The same caveat applies here as in b), i.e., sales to businesses need to be excluded.

e. Other data sources may for example include those compiled by the banking sector or health care institutions.

f. In some Member States, the above data sources may not be available for all product groups. In such cases, an expert judgement approach could be applied when weighting an elementary aggregate. Take a case where, when constructing an aggregate for men's shirts, no weighting information is available for its two constituent EAs: men's dress shirts and men's casual shirts. If it can be inferred that sales (in terms of expenditure) of dress shirts are greater than those of casual shirts, then one possible strategy would allocate a weight of 60 % to the dominant segment (i.e., dress shirts) and the remaining weight of 40 % to the smaller segment (i.e., casual shirts). Alternative weights would be acceptable if dress shirts are allocated the largest weight. The use of expert judgement, particularly where it is based on some type of evidence, is generally superior to using no explicit weights at all.

Explicit weighting at even lower levels than those just described is sometimes used to enhance the quality of the index. This leads to a more complex construction of the index, but the final goal of the exercise remains the same and that is to arrive at the best possible indicator of price change given the resources available to the compiler.

Contrary to weighting in Level I, the reference period for the weights used for Level II categories does not have to be the calendar year. For example, it may be a 12-month period such as April to March that differs from that used for Level I categories. Recognising that various data sources, which may not have been produced for the purpose of weighting the HICP, are used, it is understood that the weights may not map perfectly to the January to December period. Therefore, some flexibility is called for and is acceptable when constructing these lower-level weights. If data are available for two consecutive April to March periods, they can be converted to approximate calendar year data by adding a quarter of the data for the first period and three quarters of the data for the second period.

3.3.6 Combining data sources for estimating weights

As explained above, for higher (Level I) weights down to the ECOICOP 5-digit sub-class, national accounts data from two years earlier must be used, because they cover all households. Below that level (i.e., in Level II), the household budget survey, market intelligence, scanner data, etc. and combinations of these are often used to estimate weights. As these data sources may not cover non-residents or residents living in institutional households, they may need to be adjusted. These differing data sources must be combined with national accounts expenditure estimates in such a way that they can lead to an acceptable estimate of HICP weights within the hierarchical structure of the ECOICOP.

The following approach can be applied to obtain the desired weights. Using the chosen data source (e.g., the household budget survey), the percentage of expenditure recorded for each elementary aggregate by that data source at the 5-digit sub-class level is applied to the total expenditure estimated for the national accounts data at that 5-digit sub-class. This produces an estimated national accounts expenditure for the elementary product group/elementary aggregate.

For some Member States, national accounts data may only be able to provide reliable data for estimating weights at the 4-digit class level. In such cases the above approach is still applicable, with the inclusion of an additional step to estimate the 5-digit sub-class weights.

As noted above, at this detailed level — especially if the household budget survey is used as the data source — the resulting weights may not necessarily reflect the expenditure patterns of institutional and non-resident households. However, as the published weights and indices (5-digit and above) are based on household final monetary consumption expenditure data, the impact on the higher-level aggregates and the all-items HICP is likely to be negligible. Additionally, stratifying the index in Level II (the elementary product group and below), even if imperfect, is a superior option to not stratifying it at all.

3.3.7 The weight reference period

The *weighting reference period* is the 12-month period of consumption expenditure from which the weights are estimated. Weights should reflect consumers' expenditure patterns in the weights reference period and should aim to be as representative as possible of consumers' expenditure prevailing in the previous calendar year.

As data for t–1 are not generally available so promptly, the annual expenditure of t–2 obtained from the national accounts should be used to estimate t–1 weights. Any adjustments made to weights shall take effect with the index for January of year t, and HICP weights shall take effect with the index for January each year and be price-updated to prices of the preceding December.

3.4 Derivation of weights

3.4.1 Treatment of expenditure for categories that fall below the 0.1 % threshold

All expenditure by households which falls within the scope of the HICP should be included in the calculation of weights. For most items, expenditure on second-hand and used goods is outside the scope. The major exception is cars. If the weight of an ECOICOP category or product falls below the threshold of 1 part per thousand, regardless of its position (i.e., 4-digit, 5-digit, elementary aggregate, or other), this weight should be redistributed at the index compiler's discretion. For example, this may involve redistributing the weight of components at the 5-digit sub-class level under the relevant 4-digit class).

However, in some cases this may not be the solution, even if the weight of the 5-digit sub-class falls below 1 part per thousand. If the product in question is important to consumers (it may have a low price and expenditure but nevertheless be popular among consumers), the compiler could instead produce a new sub-index for it. In that case, the 5-digit sub-classes should not be combined.

Excluding the expenditure is not an option, regardless of its size. If, for example, there is only one other 5-digit sub-class within the 4-digit ECOICOP class, then that is where the expenditure should be allocated. In that case the 4-digit class and 5-digit sub-class will be identical in terms of their weight and index. The difficulty arises when a 4-digit class contains more than one 5-digit sub-class. There are three options available to deal with this situation:

1. Re-allocate the expenditure in proportion to the relative expenditure shares of the 5-digit sub-classes in the 4-digit class. This option assumes that the price developments of the excluded expenditure are unknown but are assumed to be similar to those of the corresponding 4-digit class, which if there is no evidence to the contrary is likely to be a valid assumption. Again, this is relatively straightforward to apply, and it does not affect the price development of the 4-digit class index, which is clearly advantageous.
2. Directly re-allocate the expenditure to another similar 5-digit sub-class in the 4-digit class. This is also simple to apply but assumes that the price developments of the two sub-classes are more similar than are those of the 4-digit class as a whole. While this may be a valid assumption in cases where 5-digit sub-classes are comprised of either goods or services, it is very unlikely to be the case if expenditure on goods and services is combined. Care must be taken even if 5-digit sub-classes appear similar, as is the case for the 5-digit sub-classes of alcoholic beverages, as tax and duty rates can and do vary between different types of alcoholic beverage, which can potentially affect the inflation rates measured, especially if there is a change in tax rates.
3. Re-allocate the expenditure of the non-covered 5-digit sub-class equally among the other 5-digit sub-classes in the 4-digit class. This has the advantage of simplicity but assumes that price movements across those sub-classes are similar, which is unlikely to be true.

None of the above options is ideal in all situations; all entail a degree of risk as they are all based on certain assumptions. It is preferable that the reallocation of 5-digit expenditure for which sub-class indices are not calculated should be in proportion to the relative expenditure shares of the 5-digit sub-classes for which sub-class indices are calculated (Option 1), as this is the only option which neither affects the rate of inflation measured nor relies on the judgement of the index compiler. While both Options 1 and 3 ensure comparable treatment of 5-digit expenditures for which sub-class indices are not calculated, Option 3 is less desirable due to potential impact on the measured inflation rate. Option 2 may also be an acceptable or even the preferred approach if there is evidence of similarity in inflation rates, but if there is no supporting evidence this approach should be avoided. In addition, as this option relies on the judgement of the index compiler, it might not be applied in a comparable way in all Member States. Note that the same logic applies if the expenditure recorded at 4-digit class level is too low or insignificant and must be distributed at the relevant 3-digit group level.

3.4.2 Second-hand goods: the case of vehicles (cars)

Purchase of vehicles includes purchases by households of new vehicles and net purchases by households of second-hand vehicles from dealers (or other non-household sectors). Sales of second-hand vehicles between households are excluded. In the HICP, household expenditure includes expenditure on second-hand cars (and in theory if not in practice, at least, other second-hand goods also bought from dealers) while the sale of second-hand cars to dealers is treated as a negative expenditure. Consequently, the weight for second-hand goods is based on households' *net* expenditure (i.e., the value of purchases minus sales).

The purchase and sale of second-hand cars among households on the economic territory will cancel out, meaning that the net weight is nil for these transactions. However, households also buy second-hand vehicles from dealers and garages, for which the weights will not necessarily be negligible. In some countries, purchases of second-hand cars through these channels result in a weight for this category which is higher than that of new cars.

Although household final monetary consumption expenditure does include information on used car sales, this information may be grouped with the sales data on new car sales. If the aim is to construct a sub-index for second-hand cars (at the 5-digit level), then a weight for this sub-class will need to be set. This is particularly true if price changes for second-hand cars differ from that for new cars.

In general, other second-hand goods purchased from dealers (e.g., vintage clothing and items from charity shops) are not included in the HICP for practical (as opposed to conceptual) reasons. This is because it is not normally possible either to define product descriptions or to price equivalent products each month. In addition, the dealer's margins — which would reflect the weight — may be insignificant or unobtainable.

Special attention is needed for the treatment of weights for new and second-hand cars. These weights should cover purchases by households of new vehicles and of second-hand vehicles from other institutional sectors such as garages or car dealers. Sales of second-hand vehicles between households are not covered.

Purchases are net of sales by households of second-hand vehicles to other institutional sectors. There are two options on how to distribute the weight of new and second-hand cars within the total.

The first option is to split the weight into the net weight for new cars and the net weight for second-hand cars. The second option splits the total weight between a gross weight for new cars (not considering trade-in value) and a weight for second-hand cars that includes the total trade margin of car dealers in relation to households. The trade margin is the difference between the value of the sales to households and the cost of those cars to the car dealers. (In principle it does not matter here how car dealers subsequently dispose of cars traded in, such as whether these are subsequently exported).

The first option is preferred but requires appropriate data be available. The second option might be more feasible in practice. That is because it does not require data on individual sales but in principle only data on the turnover and trade margin. These data are available from normal business accounts, with an approximate deduction for business cars. The actual calculation of these weights is generally carried out as part of the production of national accounts.

Purchases also cover purchases through financial leasing arrangements.

Purchases of recreational vehicles such as camper vans, caravans, trailers, aeroplanes and boats are covered by 09.2.1.

Note: The trade-in value refers to the price offered by the seller to the household for the used car when purchasing a car, be it new or second-hand.

A special situation can arise when car dealers in a country purchase and export a significantly larger quantity of second-hand cars than they sell to consumers within the country. Then the second option could imply a negative weight for second-hand cars, which would not make sense in the HICP, and in that situation a modified approximation should be applied. Even if second-hand cars are both exported and imported, it could happen that the net flow is an export, potentially resulting in a negative weight for second-hand cars.

The following example in Table 3.4.2 illustrates the options:

Table 3.4.2

Purchases and sales of cars between households and car dealers — an example

New cars	Purchases by households	2 000.0
	Value of cars traded in by car dealers from households purchasing new cars	200.0
Second-hand cars	Purchases by households	1 000.0
	Value of cars traded in by car dealers from households purchasing second-hand cars	100.0
	Sales of second-hand cars by households to the business sector	300.0

The total weight for all (new and second-hand) cars is 2 000+1 000-200-100-300 = 2 400.

The distribution of weights between new and second-hand cars will be:

1. For new cars: 2 000-200=1 800; and for second-hand cars: 1 000-100-300= 600

or

2. For new cars: 2 000; and for second-hand cars: 1 000-(200+100+300)= 400

The first method is preferable as it is more accurate but requires data on how to split the value of trade-in cars between purchased new and second-hand cars. If the value of the trade-in cannot be split or is very small, it is recommended that it be deducted from second-hand cars.

In effect, the second, less accurate, method seems liable to undershoot expenditure on second-hand cars and overshoot expenditure on new cars. This is because the second method uses less detailed data and thus cannot appropriately recognise cars traded in.

As ECOICOP is used in the national accounts, expenditures (if available) obtained from them for use in HICP weights should be compliant with the above. If the household budget survey includes specific questions on second-hand car purchases, then the above net weight can sometimes be obtained from the survey. Alternatively, administrative records of, for example, the value of imported second-hand cars and of changes in second–hand car registrations may provide another source of information to compute approximate weights. Weights can be estimated *top–down* by taking total sales and making an approximate apportionment between old and new cars or *bottom–up* by computing separate estimates and totalling them. Explicit weighting is recommended even when approximate estimates of expenditure are used.

It is recommended that index compilers discuss this issue at national level with national accounts experts.

Sections 11.170 to 11.178 of the *ILO Consumer Price Index Manual*: *Concepts and Methods* (2020) provide some additional information on the treatment of second-hand goods in general and second-hand cars in particular.

3.4.3 Newly significant goods and services

Member States have a duty to conduct an annual review to determine if the market has changed in such a way that the sub-division quantities have changed between periods. Any resulting adjustments made to weights should take effect with the index for January of year ***t***. Article 4(3) of Regulation 2020/1148 states that the HICP should include price changes for a newly significant good or service and that this should be done within 12 months of their identification either by adjusting the weight of the relevant category of ECOICOP or the weights within that category or by assigning part of the weight specifically to the new significant good or service.

A newly significant good or service in the HICP is defined as a product whose expenditure exceeds the one part per thousand threshold — see Article 4(4) of Regulation 2020/1148. Examples of goods and services that have, in the past, been classified as newly significant include internet services, computers, smart phones and mobile telephone services, music and movie streaming, and satellite/cable television channels. With the timely inclusion of these products in the HICP, the index remains current and relevant by reflecting households' current consumption purchases. Delaying their introduction into the HICP basket results in a loss of representativity and biases the index.

The annual weights review is intended to pinpoint products which have become significant under this rule for inclusion in the HICP. The fact that an entirely new product may appear — for example *smart watches* — does not imply that they are necessarily significant enough in terms of expenditure to warrant automatic inclusion in the HICP.

Chapter 8 of *The Practical Guide to Producing Consumer Price Indices* (2009) gives guidance on the introduction of new products in the index, with examples on the various technical approaches available for introducing new products into the index.

The Guide makes the distinction between an evolutionary product and one that is revolutionary. A revolutionary product is an entirely new good or service that is not closely tied to a previously available product (e.g., mobile phones when they first appeared). In contrast, an *evolutionary product* is an existing product whose features and, by consequence, *quality* have changed; for example, it can include newly added features to an already existing product such as a new and improved detergent or a new type of coffee machine that uses capsules instead of a filter.

3.4.4 Calculating the change in the sampling weights within an elementary aggregate

ECOICOP 5-digit level weights are updated every year. Under certain conditions, elementary aggregates may be constructed using some form of weighting strategy such as implicit sampling weights to aggregate the price movements of constituent products in order to provide a more accurate elementary price index (see Section 3.3.4).

Table 3.4.3 shows an example where new data on market shares (based on revenues) becomes available. This new information can be used to update the *sampling* weights within the elementary aggregate for electricity. The use of such weights will result in an elementary price index that more accurately reflects the price development for the product represented by the corresponding elementary aggregate.

In this example, the elementary aggregate is split into three strata according to consumption levels: below 2500 kWh, between 2500 and 10000 kWh, higher than 10000 kWh, with respective weights (or market) shares of 0.30, 0.50 and 0.20. Note that these weights represent the relative importance of each of the three consumption segments in the elementary aggregate for a given period, which will usually be the price reference period.

Now let us assume that, over time, consumer behaviour has changed and as a result the corresponding revenue shares in a subsequent period are now respectively, 0.35, 0.55, and 0.10. Replacing the old weights with these new weights in the elementary aggregate price index will make the calculated price change for electricity more accurate.

In Table 3.4.3, a Laspeyres price index formula is used to calculate the elementary price index for November to December, with a resulting index of 112.5.

Using the same December prices as previously, but this time measuring the price movement to January and applying the new set of weights produces an elementary index for electricity of 99.7. From this period on, subsequent monthly indices will be calculated using the new weighting structure until the next update.

Although not shown, had the price movements for period 2 been calculated using the old set of weights, the index for December to January would have been 101.1. The elementary index calculated using the new weights provides a more faithful representation of the overall increase in the price of electricity over this period.

New weights at this level should be updated annually where possible and refer to December of each year. However, as noted above, dependent on the data sources an annual update at this level may not be possible for all products.

Table 3.4.3

Adjusting weights within an elementary aggregate

	kWh	< 2500	> 2500 and ≤ 10000	> 10000		
Price (period 1)	Old weights	0.30	0.50	0.20	Weighted arithmetic mean of price ratios	(0.30 x (9.00/7.00) + 0.50 x (21.00/20.00) + 0.20 x (30.00/28.00)) x 100 =
	Nov	7.00	20.00	28.00		
	Dec	9.00	21.00	30.00		
	% change Dec/Nov	28.6	5.0	7.1	Index	112.5
Price (period 2)	New weights	0.35	0.55	0.10	Weighted arithmetic mean of price ratios	(0.35 x (8.00/9.00) + 0.55 x (22.00/21.00) + 0.10 x (33.00/30.00)) x 100 =
	Dec	9.00	21.00	30.00		
	Jan	8.00	22.00	33.00		
	% Change Jan/Dec	-11.1	4.8	10.0	Index	99.7

3.5 Price-updating

Although ECOICOP weights are derived from the national accounts expenditure of period calendar year *t*–2, they are deemed to be representative of the consumer expenditure patterns of calendar year *t*–1.

All weights from the ECOICOP 2-digit to 5-digit levels shall be price-updated annually, i.e., all expenditure categories in Level I. In contrast, the weights located in Level II of the HICP classification do not have to be price-updated; it is left to the Member State to decide if it wants to do this. In some cases, it is not advisable to price update at this level, particularly where an expenditure category has a low weight but covers a variety of products which is represented by only a few representative elementary aggregate indices, e.g. non-durable household goods (ECOICOP 05.6.1).

The first type of price-updating goes from *t*–2 to *t*–1. This is a consequence of Article 3(1)b. This price-updating is not compulsory. The second type of price-updating goes from *t*–1 to December *t*–1. This price-updating is a consequence of Article 3(1)c and is compulsory.

There are two reasons to price update the weights. Firstly, this exercise is needed for each Member State's HICP to be referenced to a common period; this way, the EU and euro area HICP aggregates can be calculated.

The second reason is more technical. Whatever source is used for the sub-index weights, collecting, and processing the information for this purpose takes time. As a result, the weight reference period always pre-dates the price reference period. However, if the aim is to calculate a Laspeyres-type price index, as required by EU Regulations, the expenditure to be used for the weights must be adjusted for any price change over the interval between their weight reference period and the price reference period.

It should be emphasised that updating only the prices while leaving the quantities unchanged does not result in more up-to-date sub-index weights (i.e., price-updating the weights is not a substitute for updating the basket weights from external sources of information such as the latest available national accounts data and/or other sources of expenditure information).

Three requirements follow from three rules: first, that the HICP should be reweighted every year; second, that the link month (as opposed to another month or another time period such as a year) of the newly reweighted HICP is December, immediately preceding the month when the new weights take effect in the HICP (i.e. in January of year t); and thirdly, that the sub-index weights must be price-updated to December *t*–1 before being included in the HICP in January of year *t*.

The following is a step-by-step description of the price-updating exercise. The notation used is described below:

***t*–2**	is the weights reference year from which the expenditure patterns are determined. For example, the new weights implemented with the January 2022 index are based on national accounts data for the calendar year 2020 price-updated to December 2021.
***t*–1**	is the period (calendar year) the household consumption (weights) patterns relate to (normally the previous calendar year except for weights below the 5-digit level).

***t*–2**	is the weights reference year from which the expenditure patterns are determined. For example, the new weights implemented with the January 2022 index are based on national accounts data for the calendar year 2020 price-updated to December 2021.
t	Is the year that the new weights will take effect (i.e., new weights come into effect with the January index of each year).
$p_i^{t-2} q_i^{t-2}$	is the expenditure for product *i* at time *t*–2, which in the case of the HICP is derived from national accounts data or other sources. Note that the product is a generic term to describe a so far non-specified level of aggregation in the HICP classification regime.
p_i^{0t}	is the price of product *i* in December of year *t*–1, the price reference month or otherwise known as the link month.
q_i^{t-2}	is the implied quantity of product *i* that is inferred from the weight reference period at *t*–2 and for which the information will be drawn either from the national accounts (for annual updates) or a combination of national accounts, household budget survey, and other sources when the reweighting is done at the lower levels of aggregation (usually with the given reweighting cycle of the elementary aggregates).
$p_i^{0t} q_i^{t-2}$	is the price-updated expenditure for product *i* and where the basket q_i^{t-2} is from period *t*–2, which is revaluated at December of year *t*–1 prices, p_i^{0t}.

The weight reference year is the calendar year *t*–2, i.e., 2 years before the new basket comes into effect in January of year *t*. The reference year expenditure is defined by the expression $p_i^{t-2} q_i^{t-2}$ as obtained from the national accounts (or another source such as a household budget survey or other data sources) for product *i* at the weight reference year *t*–2. The expenditure data used should aim to be representative of year *t–1* household consumption patterns. However, *t*–2 data are used as it is very unlikely that actual expenditure data for period *t*–1 would be available in time to be included in an index that will be reweighted to the month of January immediately following year *t*–1. In practice, expenditure from period *t*–2 is used, as this is the most up-to-date information available for the weights.

Two approaches have been used to estimating expenditure at December *t*–1. Expenditure can either be price-updated directly from *t*–2 to December of *t*–1, or alternatively expenditures from *t*–2 can be used as a direct estimate of expenditure for *t*–1, if this is considered the *best available* estimate for the year *t*–1. Where this occurs, the expenditure must be price-updated from year *t*–1 to the December of *t*–1. (See Chapter 8 — Index calculation).

These two approaches were not always satisfactory. For example, in the context of the COVID-19 pandemic. This is because the *t*–2 expenditure patterns were no longer representative of *t*–1 expenditure patterns. Since 2021, the *t*–1 weights have been determined based on *t*–2 NA data updated to *t*–1 with National Accounts data and additional available data from *t*–1. Thus, three approaches can be used:

1. Use *t*–2 weights if they can be considered as representative for *t*–1.
2. Use *t*–2 weights, modified for exceptional cases where clear changes have taken place.

3. Use *t*–2 weights and update all the weights with as much as information possible, starting with National Accounts data and other timely data sources from *t*–2.

Note that as the basket of the price-updated weight is the same as the basket from the weight reference period, a product's quantity will remain unchanged between year *t*–2 and December of year *t*–1 when price-updating the weight.

When reweighting the index annually, price-updating will be applied to the reference year expenditure values of a product that are consistent with weights found at the 4-digit (class) level or 5-digit (sub-class) level of the ECOICOP classification structure (i.e. sub-index weights).

Depending on how the weights are estimated, as a minimum, price-updating should occur at the 5-digit sub-class level. Below the 5-digit sub-class level, countries can choose whether to price update the aggregates or not, including the elementary aggregates. Price-updating is, however, not required at elementary aggregate level if the elementary aggregate weights are, for example, estimated as a fixed percentage of the 5-digit sub-class weight (which is often the case) during the basket's one-year life. Take for example the 5-digit ECOICOP sub-class Fresh or chilled fruit, which is further divided into three elementary aggregates: Type A, Type B, and Type C fruit for which a given data source shows that each fruit type has a respective weight (or share of fruit expenditure) of 20 %, 30 %, and 50 %. Price-updating the sub-index weight for the Fresh fruit sub-class would adjust the sub-index weight for each fruit type accordingly, while their respective shares would remain unchanged.

See also Section 7.1.4.6 - The price updating of weights for seasonal products.

3.6 The treatment of volatile expenditure groups, errors in weights and adjusting weights to reflect the scope of the HICP

3.6.1 Calculating the weight of highly volatile expenditure

Expenditure on certain categories of products, such as furniture, can exhibit significant year-to-year volatility often. This is because samples from the household budget survey (or from other information sources) are weaker for some products. This can be explained by too narrowly defined geographical stratification or the value and frequency of purchases are low. As a consequence, the derived weighting information at some of the lowest levels of aggregation (e.g. at the elementary aggregate level) can be of poor statistical quality and thus be unreliable. To remedy the situation, the annual expenditure data at the elementary aggregate level can be smoothed by averaging them over a few years. This should not be done at higher levels, where as a rule only annual data should be used.

3.6.2 Errors in weights

The greater the variation in price changes among ECOICOP categories over time, the greater the sensitivity of the index to possible errors in the sub-index weights. If all prices behave in a similar fashion, then errors in the weights should not have an impact on the overall HICP.

Two principal sources of errors can distort the accuracy of the weights: (1) sampling errors, and (2) reporting (or non-sampling) errors. Regarding sampling errors, more frequent updating of weights might entail a higher rate of sampling errors. This is because fewer source data are available at higher frequency or the survey data are based on fewer responses. Non-sampling reporting or keying errors can be controlled for by having statistical or other processes in place to ensure accuracy.

Studies have shown that the estimation of the index is usually far less sensitive to uncertainty in the levels of weights than to changes in the underlying prices. In other words, an error of, say, 10 % in the level of a weight will have a smaller impact on the HICP than, say, an error of 10 % in the price level. Nevertheless, it is necessary to have systematic processes and controls in place to ensure that weights are sufficiently reliable and representative. For example, the weighting schemes between two successive years should be compared and it should be possible to explain major differences. The comparison should consider all the available information on the nature of consumption in the weight reference period. If errors or mistakes in the weights are found, they should be treated in accordance with the guidance given in Chapter 10.

3.6.3 Adjusting national accounts weights to comply with the coverage of the HICP

This example assumes that the 5-digit sub-index weight for lager beer as derived from the national accounts is EUR 500 000 for the reference year and that this value will be the weight for this product. Furthermore, it has been decided that this sub-class will be divided into two elementary aggregates: domestic lager and imported lager. To conduct this exercise, the compiler turns to the household budget survey (or an alternative source) to obtain the share-weight for each of these two products (although a household budget survey would probably not contain such detailed questions, it is assumed for this example that it provides this information).

Lager beer as calculated by the national accounts will include the universe of lager beer purchased on the economic territory of the country, including by tourists, which falls within the scope of the HICP. However, the share or weight of domestic and imported lager beer will exclude non-resident consumption since it is derived from the household budget survey, which by design excludes purchases by non-residents. Therefore, the weights of domestic and imported lager beer will need to be adjusted to correct for the under-reporting.

The approach used to estimate the correct share of each category of beer will often vary according to data availability. For imported beer, one strategy could be to use import data as a starting point and apply the following formula to calculate the estimated value of the consumption of imported lager beer:

> Estimated value in EUR of the consumption of imported lager beer = Value in EUR of lager beer imports (including) import duties and taxes minus sales in EUR to businesses (e.g. restaurants and pubs) = EUR 200 000.

For estimating the value of domestic beer consumption, the following logical steps can be applied:

> Estimated value in euros of the consumption of domestic beer = Value in EUR of domestic production minus exports plus taxes on beer minus sales in EUR to businesses = EUR 300 00.

The weight share of the domestic beer elementary aggregate would thus be 0.60 (=EUR 300 000 / EUR 500 000) while that of imported lager would be 0.40 (=EUR 200 000 / EUR 500 000). These estimates would now reflect all in-scope expenditure on beer for the HICP because of the above adjustments.

3.6.4 The treatment and estimation of weights in cases of atypical events

This section discusses how to deal with large changes in consumption patterns because of abnormal events. It summarises Eurostat documents: ‘Guidance on the compilation of HICP weights in case of large changes in consumer expenditures’ and ‘Derivation of HICP Weights for 2022’. Reference was also made to methodological notes from several countries and organisations, inside and outside the EU.

Introduction

Exceptional events such as the Covid-19 pandemic may have a significant impact on household consumption expenditure. Consumption patterns observed in normal times may be disrupted during and after lockdown periods as households adjust their consumption habits to the new circumstances. For some products, changes in consumption expenditure may only be temporary, while for other products the changes could be more long-lasting.

As noted above, Article 3 of Implementing Regulation (EU) 2020/1148 requires HICP weights used in year t to be based on national accounts weights for year *t*–2; expenditure shares should be reviewed and updated to make them representative of year *t*–1. Due to the exceptional conditions of the pandemic, whether this distorts year *t*–2 or year *t*–1, accurate year *t*–1 data cannot be obtained simply by updating year *t*–2 data so additional data sources must be used to generate accurate weights for year *t*–1.

At the most detailed level possible, use available data to estimate the expenditure for each ECOICOP sub-class in the later year. This can be done by either:

- estimating the year *t*–1 expenditure values directly from other data sources (in which case data for year *t*–2 are not used);
- multiplying the value for year *t*–2 by an indicator of the change in expenditure; or
- by combining an indicator of the change in volume with an indicator of the change in price.

If the last quarter or months of calendar year *t*–1 are not yet available in the source data, the shares of consumption derived for the available quarters and months of that year can be used as approximations, or data for this period from year *t*–2 can be updated.

If the most detailed level possible is different from the sub-class level, changes to the class or higher levels can be allocated proportionally to the lower levels using the HICP weights for the last available year.

If no data at all are available for certain segments outside the most heavily affected ones, assume no change in the share in HFMCE. Additionally, a price adjustment may be made using the change in HICP between the last two years.

Compare the sum of the expenditures of all sub-classes in the last year with the total of HFMCE in that year. If the difference is very large, the least reliable estimates (which may also be the total) should be reviewed and adjusted to make the difference smaller and thus the estimates will be more coherent.

Finally, when the difference in the previous step is sufficiently small (as a rule of thumb, a threshold of ± 5 % may be used), scale the expenditure of the sub-indices to the estimated total of HFMCE to eliminate any discrepancy between the total and the sub-components.

Calculate the expenditure shares for each sub-class by dividing the corresponding expenditure by the total HFMCE. The final estimate for the total of HFMCE should be used as country weight for the calculation of European aggregate HICP indices and need to be provided to Eurostat at the same time as the weights.

The above process will be similar to the typical national accounts process for estimating expenditures in a normal year. It is strongly recommended that price statisticians, national accountants and other statisticians (e.g. from household budget survey or short-term statistics) work together in obtaining the best possible HICP weights for the current year. At the end of the year, the results of the above estimation procedure can be evaluated against more comprehensive national accounts data for the previous year. Any lessons learned can be taken into account similar situations that may occur in the future.

The HICP of year t is defined as a Laspeyres-type index where the weights refer to t–1 and the price reference period corresponds to December t–1. The expenditure shares for the previous year, obtained above for each sub-index, need to be multiplied by the difference between the corresponding HICP sub-index for the average of that year and December of that year. This is the normal procedure (see Article 3.1(c) of Regulation 2020/1148). Some of these sub-indices may partially have been imputed; they should nevertheless be used when price-updating, to maintain consistency.

3.6.5 Example of HICP weights when faced with large changes in consumer expenditures because of certain extraordinary events

Example 1: The 2021 weights update for the French CPI and HICP

As every year in January, the weights of the Consumer Price Index (CPI) and the Harmonised Consumer Price Index (HICP) were updated for the current year. They are used to aggregate the 21,000 indices calculated by families of elementary products and geographic area of collection. These weights represent the share of expenditure associated with the index concerned about household consumption covered by the CPI.

In accordance with European regulations, these weights are usually updated based on semi-final estimates of consumption by the national accounts for year *t*–2, valued at the prices of December of year *t*–1 and possibly supplemented by volume corrections between year *t*–2 and *t*–1 if this would improve accuracy.

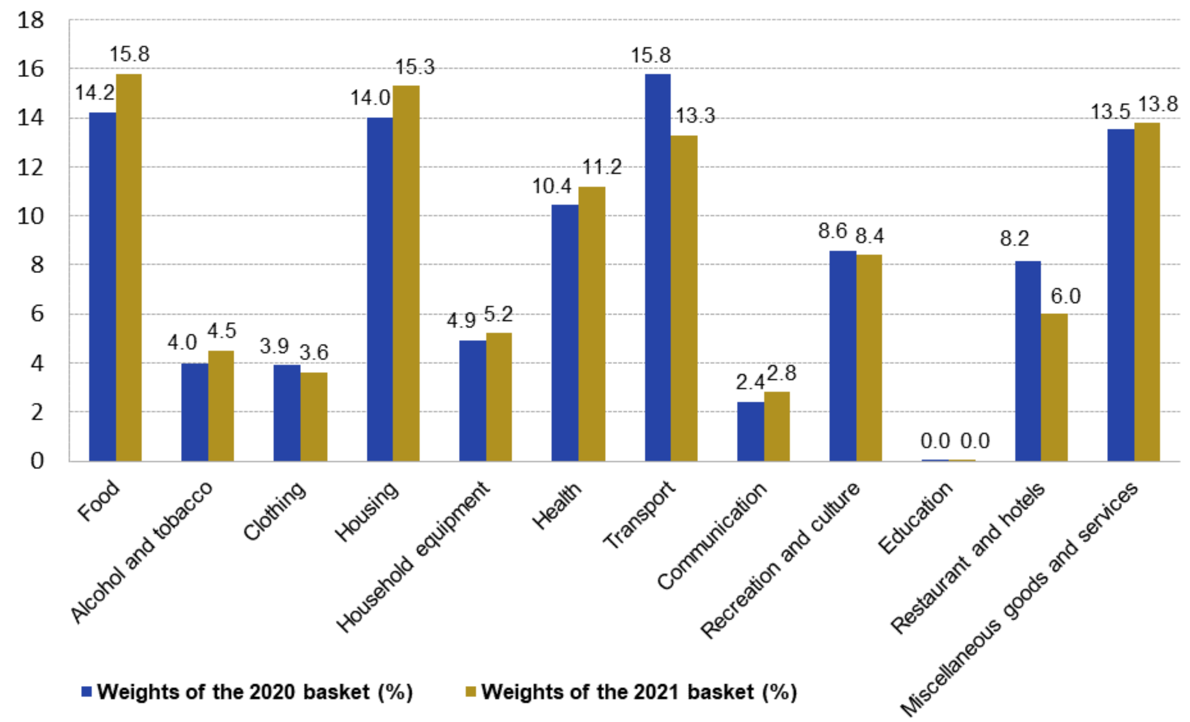
This method to obtain representative weights of consumption for year *t*–1 is usually acceptable because households tend to adjust their consumption patterns gradually. However, with the latest health crisis, the structure of consumption changed markedly between 2019 and 2020. Additional work was therefore carried out in accordance with the new European directives on updating weights in the event of a major shock on consumption.

To calculate the 2021 weights, the first estimates of the quarterly accounts for the whole of 2020 were used to apply changes to volume 2019 consumption amounts provided by the annual accounts. A finer level of details than that at which they are published (95 positions) was used. If necessary, adjustments have been made to an even finer level of the classification structure by using available turnover indices.

The weights in the 2021 CPI basket for food, housing, alcohol and tobacco, health and communication are thus greater than in the 2020 basket, as while their consumption fell slightly during the health crisis, overall consumption fell more (Figure 3.6.2). Conversely, the weight of transport, restaurant and hotels, recreation and culture fell in the 2021 basket as expenditure on these fell more than on other items.

Figure 3.6.2

Weighting of consumption functions in the CPI basket for 2020 and 2021 (%)



Scope: Metropolitan France
Source: Insee, quarterly accounts detailed results Q1, Q2, Q3 2020 and first estimate Q4 2020; semi-final national accounts 2019

Reading note: The weight of food in the CPI basket goes from 14.2 % in 2020 to 15.8 % in 2021.

These differences between the 2020 and 2021 baskets affect the measurement of the overall consumer price index, In particular because products with very seasonal or very volatile prices are not weighted in the same way in the two baskets. Thus, the weight of international air transport in the basket drops by 68 % between 2020 and 2021, while its price varied very significantly (11 % on average, in absolute value, from 2015 to 2020). The weight of tourism in the CPI (rental of rooms, camping, lodgings, etc.) also fell sharply, while its price variations are very seasonal (Figure 3.6.2). As a result, the year-on-year changes in the CPI risk being affected since seasonal phenomena will have a different weight between 2020 and 2021. For instance, in January, the air transport price cuts after the seasonal increases in December have a lower weight in the 2021 basket, which contributes to the year-on-year rise in the CPI. Conversely, the airfare increases in the summer have a lower impact on the all-item index (Figure 3.6.3 and Table 3.6.4).

Table 3.6.4

Product categories whose weight changes sharply and with volatile prices
(%)

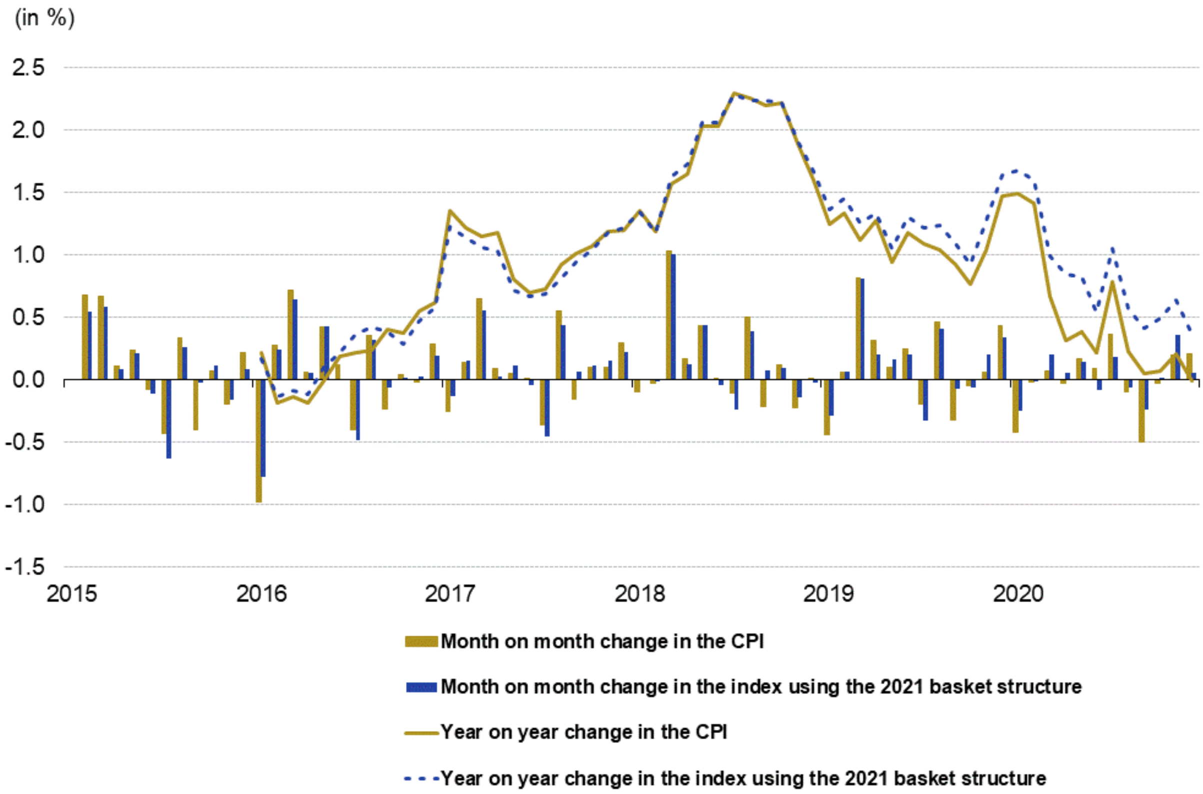
Product categories	2020 weight	Change of weight 2021/2020	Average monthly change (absolute value)	Weight × Evolution × Average monthly change
International air transport	0.82	-68	11	0.060
Holiday or leisure centres	0.16	-32	25	0.013
Domestic air transport	0.25	-66	8	0.013
Diesel	2.09	-26	2	0.012
Campsites and youth hostels	0.45	-37	5	0.009
Room rentals	0.80	-39	2	0.008
Package international holidays	0.18	-36	9	0.006
Petrol	1.43	-21	2	0.006
Liquid fuels	0.69	-20	3	0.005

Scope: Metropolitan France
Source: Insee, quarterly accounts detailed results Q1, Q2, Q3 2020 and first estimate Q4 2020; semi-final national accounts 2019; CPI.

Reading note: The international air transport item has 0.82 % of the 2020 basket weight. In 2021 its weight is reduced by 68 %. With the absolute monthly change averaging 11 %, updating the weight has an effect of around 0.060 points on the overall index.

Figure 3.6.3

CPI and price index using the 2021 basket structure



Scope: Metropolitan France
Source: Insee, quarterly accounts detailed results Q1, Q2, Q3 2020 and first estimate Q4 2020; semi-final national accounts 2019; CPI

Reading note: if the structure of consumption had been that of the 2021 basket since 2015, the monthly price change in December 2020 would have been + 0.1 % compared to + 0.2 % observed using the consumption structure used by the CPI (2019 consumption structure for the 2020 indices, year A-1 structure for year A). The year-on-year price change would have been + 0.4 % with the 2021 basket versus + 0.0 % for the year-on-year change in the CPI.

Table 3.6.5

Month on month change in the CPI and the price index using the 2021 basket structure *(%)*

Month	Month on month change in the CPI using the 2020 basket structure	Month on month change in the CPI using the 2021 basket structure
Jan-20	-0.4	-0.3
Feb-20	0.0	0.0
Mar-20	0.1	0.2
Apr-20	0.0	0.1
May-20	0.2	0.1
Jun-20	0.1	-0.1
Jul-20	0.4	0.2
Aug-20	-0.1	-0.1
Sep-20	-0.5	-0.2
Oct-20	0.0	0.0
Nov-20	0.2	0.4
Dec-20	0.2	0.1

Scope: Metropolitan France
Source: Insee, quarterly accounts detailed results Q1, Q2, Q3 2020 and first estimate Q4 2020; semi-final national accounts 2019; IPC.

Example 2: The Case of Weight Update on Domestic and International Flights During Covid-19 Pandemic – an Example from Norway

Context

The COVID-19 pandemic impacted all aspects of society; one of the consumption areas of the HICP most affected was related to travel, and passenger transport by air in particular. Travel restrictions were imposed in Norway and in most other countries worldwide for both domestic and international flights in 2020. International travel was strongly discouraged, quarantine regulations put restraint on travels and even entry bans were imposed for long periods to prevent travellers entering the country. In Norway domestic travel was also ***strongly*** affected. The Norwegian Government advised against all travelling activities for most of 2020 and larger periods in 2021.

The travel restrictions resulted in significant reductions in the number of travellers. According to the Norwegian state-owned airport operator, passenger traffic was reduced by close to 50 per cent for domestic travel and close to 80 per cent for international travel in 2020 compared to 2019 ([23])([24]). This sudden and sharp change in the number of travellers had implications for the HICP weight update for 2021.

HICP weight update

In line with Eurostat HICP Commission Implementing Regulation (EU) 2020/1148, the Norwegian HICP weights are annually updated based on household final monetary consumption expenditures from annual National Accounts (NA). To subdivide the higher-level ECOICOP expenditures into subclass levels, other data sources such as scanner data, household budget surveys and industry reports are used. Compared to NA figures, expenditure shares based on other data sources normally provide more recent information.

According to HICP Regulation, the HICP weights shall reflect household expenditure patterns of the previous year. Annual NA at the level of detail needed to compile weights is available for year *t*–2. To account for lagged information, the expenditure shares at the elementary level are price updated from year *t*–1 to December year *t*–1. In ordinary years the price updated NA figures are regarded as relevant information and not considered a problem as changes in consumption expenditure are typically small from one year to another, so NA year *t*–2 data are normally considered representative for year *t*–1. However, because of the sudden changes in consumption caused by the COVID-19 pandemic, this assumption was no longer valid.

HICP weight update during the COVID-19 pandemic

To account for the abrupt changes in consumption pattern, the NA data from year *t*–2 were updated to be representative for year *t*–1 by using monthly NA ([25]) from year *t*–1. Monthly NA are however less detailed compared to the annual NA as the expenditure is divided at 3-digit class level. For domestic and international travels this meant an adjustment to the aggregated COICOP 07.3 Transport services according to the monthly NA *t*–1 data. The 4-digit class levels proportional relation was kept constant according to the annual NA *t*–2 data. At lower levels, other data sources were needed. The resulting HICP weights for COICOP 07.3.3 Passenger transport by air fell from 1.3 per cent in 2020 to 0.8 per cent in 2021 ([26]).

Case: International flights – prices and weights

The COICOP 07.3.3 Passenger transport by air is separated into 07.3.3.1 Domestic flights and 07.3.3.2 International flights. Due to the COVID-19 pandemic, the relative weights between

([23]) The most important change introduced by this new regulation is that the weights for the sub-classes and the elementary aggregates should be derived, after 1 January 2023, from national accounts data drawn from year t-2 and complemented, when necessary, by ‘recent’ data from a household budget survey and other sources.

([24]) Avinor, Statistics - Avinor.

([25]) Quarterly NA is calculated as the sum of three months from the monthly NA, see: National accounts – SSB.

([26]) Database, Eurostat (europa.eu).

domestic and international flights were also affected. The relative expenditure share of domestic flights increased at the expense of international flights. The Norwegian state-owned airport operator is the main data source for subclass level weight information for passenger transport by air in Norway. Updated figures on domestic and international travels from Norwegian airports are provided regularly. Normally, the numbers of travellers are split between passengers travelling for business purposes and for private purposes, making it possible to exclude business travelling from the HICP weight compilation. Due to infection control however, the survey was not conducted as normal and therefore no updated figures on travel purposes were available for 2020.

To establish the weights at COICOP 5-digit subclass level, more recent measures of expenditure were needed. The total expenditure was estimated by using aggregated annual numbers of passengers and measures reflecting average prices for the various domestic and international destinations covered in the 07.3.3 index. Some of the destinations, both for domestic and international flights, are characterised by a high share of passengers travelling for business purposes. It is therefore important to take into the consideration the share of business travellers so that they can be excluded from the new expenditure estimate. Given that no updated figures were available on travel purposes for 2020, the information on the share of passengers travelling for private purposes and business purposes from the most recent year was used as proxy weight shares in the weight calculations for 2021. An element of uncertainty in this regard is of course that the travel patterns may have changed due to the pandemic.

4

Sampling

4 Sampling

4.1 Introduction

In order to construct a perfectly accurate HICP, prices of the entire universe of goods and services that are covered by the HICP would be needed. As it is not possible to observe all transactions of the target universe of the HICP, defined by the 'household final monetary consumption expenditure' within the economic territories of the countries compiling the HICP, sampling techniques are used to select a subset of prices that eventually enter the index compilation. Consequently, the HICP is a sample statistic that represents the change in prices, on average, over the target universe in the two periods being compared.

Sampling occurs at different levels (or dimensions):

- Geographic (locations) and outlets of all places and outlets where a product is offered.
- Product: all goods and services for purchase.
- Time: the sub-periods of the index.

Within each sampling level, the sampling approach can vary from country to country, reflecting different administrative arrangements. Both probability and non-probability sampling methods can be considered for each dimension.

When using probability sampling, the units in the sample are selected so that each has a known non-zero probability of selection. However, since sampling frames for probability samples are usually not available, non-probability sampling techniques are adopted, which include cut-off sampling, quota sampling and representative item methods.

Probability sampling has a strong scientific basis; the point estimates are generally not biased, and the sampling error can be estimated. In surveys designed to collect price observations that will be used for a price index, probability sampling is rarely used except in a few countries; purposive sampling is the most common method used. While the use of probability sampling could be expanded with the use of new data sources that allow for a sampling frame, there are valid reasons for employing non-probability techniques. The main problem with non-probability sampling is that there is no way to emulate a random design on which to base variance estimates - (even if an increasing number of studies address this issue; see for example Dorfmann, 2012 ([27])). Nevertheless, there is general support and some empirical evidence for using non-probability sampling (De Haan, Opperdoes and Schut, 1999) ([28]).

In the past decade, data collection methods have been significantly improved through the utilisation of automated digital data sources, including web scraping data from web pages and direct collection from enterprises and government agencies via register and transaction data. This means that the collected information is often more comprehensive, with increased sample sizes and, at the same time, reduced response burden.

Probability and non-probability sampling procedures can be employed when utilising scanner data for index compilation ([29]). Scanner data will typically not cover the entire universe that is in scope of the HICP. For instance, in most Member States, scanner data do not encompass services, restaurants, or cafés. Furthermore, transaction data may only be available for large retail chains but not for small independent stores or other types of outlets and traditional shops. However, for those product categories and outlets covered, scanner data may be used as sampling frames for selecting a sample of representative products following different methods. In contrast, several Member States have incorporated scanner data into production by using all available data that may cover the target universe for certain sub-classes (e.g. processed food products) which enter the index compilation without conducting sampling.

Web scraping usually involves the use of a non-probability sampling procedure of appropriate web sites for scraping prices in ECOICOP sub-classes, such as fuels, electricity, insurance, books, clothing, medicines, electronics, airfares and accommodation. The use of web scraping is common for individual products for which it is known that online purchases are becoming increasingly representative (Eurostat, 2020). As web scraping is limited to retail outlets that have an online presence, there is the potential for under-coverage (see Chapter 5).

In this chapter we use ‘sampling’ to refer to any practice that amounts to including only a subset of all transactions, whether this is done by purposive decision or by probability sampling techniques.

We consider a variety of situations and give criteria for and advice on choosing one method over another in particular circumstances. Examples are provided to support these recommendations.

Overall, it should be stressed that for sampling there is no universal solution. For example, the availability of low-level expenditure data and sampling frames for outlets and products varies considerably between countries, and the objective is to make the best use of whatever data is accessible in each Member State.

([27]) Dorfman, A. H., (2012). Inference in Cutoff Sampling, U.S. Bureau of Labor Statistics.

([28]) De Haan, J., Opperdoes, E. Schut, C. (1997). ‘Item sampling in the consumer price index: a case study using scanner data’. Paper presented at the joint ECE/ILO meeting of the Group of experts on consumer price indices, working paper n.1, Geneva 24–27 November.

([29]) Eurostat (2017), Practical guide for processing supermarket scanner data.

Both the *CPI manual* ([30]) and the *Practical guide* ([31]) have chapters on sampling. Where appropriate, reference is made to information in those chapters without repeating what is already provided there.

4.2 Legal framework, definitions, and terminology

4.2.1 Legal framework

Commission Implementing Regulation (EU) 2020/1148 of 31 July 2020 establishes the methodological and technical specifications for the HICP and HICP-CT, and consolidates and modernises (and repeals) all previous implementing legislation.

Article 4 is dedicated to sampling and representativity. It is stated that:

> *'1. Member States shall make a target sample that is representative of the target universe by defining elementary aggregates and selecting individual products for these elementary aggregates.*
>
> *2.The number of individual products and elementary aggregates shall depend on the weight of the subclass and the variance of price movements of the individual products belonging to it.*
>
> *3. Member States shall ensure that the target sample remains representative of the target universe over time by conducting at least an annual review and update of the target sample, and selecting replacement products.*
>
> *4. Products for which the expenditure share is at least one part per thousand shall be represented in the target sample.'*

In accordance with Article 4 as quoted, this chapter provides principles to be followed by Member States when sampling:

i. The target sample should be representative of the target universe in the reference period and over time. To this end, the HICP samples must be reviewed and updated on a regular basis to remain representative of the target universe.

ii. The HICP must be based on samples sufficient to yield reliable and comparable results. As products or retail outlets disappear from the market, they need to be replaced with new ones.

iii. The target sample should be designed considering 1) the weight of each subclass and 2) the variation in price movements of individual products belonging to elementary aggregates within a subclass and 3) the costs associated with collecting and processing a price observation of the subclass. A simplified approach to variance estimation and optimal sample allocation will be illustrated in Annex 4.1.

Article 2 (7) of Commission Regulation 2020/1148 defines the 'target sample' as a set of individual products that pertain to transactions from the target universe and for which price data

([30]) ILO (2020), Consumer price index manual: Concepts and methods.

([31]) *Practical guide to producing consumer price indices*, United Nations, Economic Commission for Europe, 2009.

are to be used for HICP compilation. The scope and the coverage of the HICP are explained in Chapter 2. While all transactions are targeted, it is necessary to identify a sample of product offers that is representative and for which price comparisons are made over time.

Article 10 of Regulation 2020/1148 'Replacements' regulates the case of individual products that are no longer representative or disappear from the market and therefore need to be replaced. 'Replacement product' signifies an individual product that replaces another individual product in the target sample. The replacement of products must meet the following conditions:

> *'1. Member States shall select a replacement product that is similar to the disappearing product, while ensuring that the target sample remains representative.*
>
> *2. Member States shall not select replacement products on the basis of a similar price.'*

EU Implementing Regulation 2020/1148 also sets forth rules that are relevant for sampling the time periods used in price collection. Indeed, the time dimension must be considered for sampling and the target concept is the monthly average price (see Sub-section 4.2.2 for definition of individual products and product offers and 4.4.6 for sampling of points in time).

Article 8 reads:

> *'4. Observed prices shall refer to at least 1 working week at, or around, the middle of the month.*
>
> *5.If prices for an individual product are known to be volatile within a month, the observed prices shall refer to more than 1 week.'*

This rule establishes a minimum requirement for sampling in time as collecting all prices on a single day is not permitted and price collection must be spread over an extended period (see 4.4.6).

Products for which retailers have concordant (synchronous in some sense) pricing, such as for petrol and electricity, must also be collected over a long period.

The new sources of data (scanner and web scraped data) allow a greater frequency of price recording and broader coverage of the reporting month for the HICP compilation.

Scanner data are usually collected weekly, i.e. all transactions occurring during a week are aggregated. Collecting and processing data per week at weekly intervals is granular enough to monitor developments in prices and check whether there are new individual products to be considered. Depending on the data supply arrangements and the production and publication calendar, the individual product could cover the first three (or occasionally the first four) weeks of the month. This is an acceptable strategy for most scenarios (Task Force Quality Imporvement, 2022) ([32]).

The web scraping frequency is a crucial factor to be determined as online prices can occasionally exhibit high volatility over time with some websites implementing dynamic or personalised pricing strategies (see 4.4.6 and Chapter 5).

([32]) Eurostat (2022), *Guide on multilateral methods in the Harmonised Index on Consumer Prices (HICP)* — 2022 edition - Products Manuals and Guidelines.

4.2.2 Definitions and terminology

Elementary aggregate

The term ‘elementary aggregate’ is defined in Article 2(13) of Implementing Regulation (EU) 2020/1148 as follows:

> ‘*Elementary aggregate means the smallest aggregate used in a Laspeyres-type index*’.

The Implementing regulation further states the important principle motivating the elementary aggregate concept:

> *‘The harmonised indices should be annually chain-linked Laspeyres-type indices. Therefore, it is necessary to define elementary aggregates and to specify methods for combining observed prices to form elementary price indices.’*

Since, in practice, reliable expenditure information is typically unavailable for weighting purposes within an elementary aggregate (except when scanner data are used), a price index for an elementary aggregate may comprise only price data.

The definition of elementary aggregate is strongly related to the sampling strategy and to the methodological approach followed for compiling consumer price indices in each Member State. Generally speaking, an elementary aggregate can be defined as a partition of the product universe that may be linked to the harmonised ECOICOP 5-digit sub-class level. This partition is determined by each country according to its needs and the data available to support such a partition.

The elementary aggregates can serve as strata for the sampling procedure, setting the boundaries for the nature of the prices to be collected in terms of product offers. The stratification model used to calculate indices contributes to identifying the elementary aggregate if the stratification involves geographical area (i.e. NUTS-3, NUTS-2 or NUTS-1), distributional channel and outlet type. Therefore, an elementary aggregate refers to the level at which observed prices enter the HICP and can be identified by a group of goods and services that are as similar as possible by limiting them to those sold in particular types of outlets (e.g. hypermarket and supermarket) or in particular locations (e.g. regions). When stratification is not adopted, an elementary aggregate may correspond to an elementary product group.

Elementary aggregates are fixed at least throughout an index link (normally a year). However, as a result of the introduction of newly significant goods or services in the HICP, it may be necessary to define a new elementary aggregate. Indeed, Article 3(3) of Regulation 2020/1148 states that:

> ‘*The weight of an elementary aggregate shall be kept constant throughout the calendar year, unless the list of elementary aggregates within a sub-class is adjusted to reflect significant changes in the target universe*.’

Alternatively, a newly significant product (good or service) may be included in an already existing elementary aggregate.

New products may be introduced to represent specific markets where consumer spending is significant or growing and existing products may not adequately represent price changes for such goods. The definition covers both completely new products and products that have been available on the market for some time but on which expenditure was previously relatively low. Examples of newly significant products are not only technological innovations such as electric cars and electric scooters but also face masks, hygiene gel and men's loungewear bottoms, which have recently accounted for a significant proportion of consumer expenditure due to the effects of the coronavirus (COVID-19) pandemic ([33]). For example, hand hygiene gel expands coverage of the personal healthcare area while the loungewear item reflects the continuing shift towards more casual clothing.

Newly significant products are usually included in the HICP by resampling and introduced in December each year at the time of the basket update. This method is also adopted when scanner data are used following a static approach. The first step in the annual update of the sample for year *t* is the selection of representative individual products in each elementary aggregate. In order to ensure that the sample is stable, the individual products should cover a sufficiently high percentage of turnover from a sufficiently long period, possibly the whole year *t*–1. If a new product becomes important with regard to the distribution of turnover within the elementary aggregate, it should be included at time *t*. In contrast, to ensure that the sample is representative, individual products for which turnover falls below a specific percentage or value of December *t*–1 should preferably be replaced.

Individual products and product-offer

An 'individual product' is defined in Article 2(6) of Regulation 2020/1148 as a product-offer or as a 'homogeneous product', that is a set of product-offers among which there are no significant quality differences. Article 2(4) states that

> '*product-offer*' *means a product specified by its characteristics, the timing and place of purchase and the terms of supply, and for which a price is observed* while *Article 2(5) specifies that 'homogeneous product' means a set of product-offers among which there are no significant quality differences and for which an average price is calculated.*

The specification of the individual products and product offers is largely dependent on the data characteristics and on the product category. In traditional field price collection, within elementary aggregates, generic specifications of representative products are usually determined centrally by adopting non-probability sampling. Product descriptions are relatively broad to ensure that one and the same product description can be used for a reasonably long period of time and across different retailers. Then, for a given product, the shelf prices of most popular product-offers are observed at one or more points in time, in a specific outlet. Conversely, when using scanner data, an exhaustive listing of all individual products sold with their sales and quantities sold is available for a specific outlet belonging to a specific retail chain and time period. The specification of individual products when scanner data are used may be very narrow, i.e. by considering 'items' identified using specific codes (GTINs). The shelf price at which the product is offered to the consumer, related to the concept of product-offer, is not available but 'unit value price' is calculated by dividing weekly sales by number of units sold (see Chapter 5).

([33]) In the HICP, products for which the expenditure share is at least one part per thousand shall be represented in the target sample (Article 4(4) Regulation 2020/1148). However, Member States may include products that have not reached this threshold if they are considered as representative of consumers' expenditure, or if the product is likely to exceed the threshold for inclusion in the near future.

4.3 Sampling, resampling and replacements

4.3.1 Representativity and comparability

Representativity

The essence of survey sampling lies in methods for drawing representative samples from a target population. However, in the statistical literature, there are many different interpretations of the ‘representativeness’ or ‘representativity’ concept even if they may be ambiguous and require discussion. Frequently adopted concepts of representativity are the absence of selective forces in sampling process, meaning that the sample should not be biased in favour of a subgroup of the population (for example, non-response in survey is often cited as a source of bias) and the miniature version of the population, meaning that a representative sample from a population will be a scaled-down version of the entire population, where all different characteristics of the population are present. Other interpretations refer to representative sampling designs as those permitting good estimation or as sample good enough for a particular purpose (see Kruskal and Mosteller, 1979; Schouten et al 2009 ([34])).

The concept of representativity is even more difficult to interpret in sample survey design for HICP, which can be considered to be among the most complicated sampling enterprises. A HICP is an estimate based on data from at least two surveys, one giving prices, and one giving ‘weights’. The sample size and sample selection methods for location, outlets, goods and services for which price movements over time are to be observed should ensure that the prices collected are representative and sufficient to meet the requirements for the accuracy of the index, and also that the collection process is cost-effective.

The sample of prices should reflect the importance, in terms of relative expenditures, of the goods and services purchased by consumers in the reference period, the number, types and geographic spread of outlets that are relevant for each good and service, and the dispersion of prices and price changes across outlets. Emphasis is placed on representative products, defined as those that account for a significant proportion of the total expenditure within an elementary aggregate, and/or for which the average price change is expected to be close to the average for all products within the aggregate (Unece, Practical guide 2009 ([35])). Since the HICP is a Laspeyres-type index, the target sample is defined with respect to the elementary aggregates and outlets existing in the price reference period. Therefore, representativity of the sample is maintained at the lowest level of the index, i.e. individual product offers within elementary aggregates in the outlets sampled. At that level, the objective should be for the sample to represent the actual universe of transactions in each time period.

([34]) Kruskal, W., and Mosteller, F. (1979), ‘Representative sampling, III: The current statistical literature’, *International Statistical Review*, pp. 245–265.
Schouten, B., Cobben, F., and Bethlehem, J. (2009), ‘Indicators for the representativeness of survey response’, Survey Methodology, 35(1), pp. 101–113.

([35]) United Nations (2009), *Practical Guide to Producing Consumer Price Indices*, New York and Geneva.

In this framework, probability or design-based sampling techniques are the preferred methods, in principle, as they permit sound statistical inference and allow estimation of sampling errors. In probability sampling, a sample of n units from the universe of N units is selected by attaching a nonzero inclusion probability π_j to each unit j. The inclusion probabilities π_j for units in the frame population are assumed to be strictly positive and known in advance (see 4.3.4).

However, probability sampling may be costly to implement and can result in the selection of products that are very difficult to observe in constant quality. Indeed, as the HICP measures price change over time, representativity refers to all transactions that occur in the two periods being compared. Therefore, an additional challenge is that the requirement of representativity is not static but evolves over time. To make sure that the sample remains representative, individual products should not only be present in the new month but also have sufficient turnover or be sold in sufficient quantities.

When appropriate sampling frames are lacking or it is too costly to obtain them, samples of location, outlets and products must be obtained by using non-probability methods, such as cut-off sampling and quota sampling, to ensure representativity (see 4.3.4).

When traditional data (from field price collection) are used, general specifications of representative products (for product specification see chapter 5) are determined centrally using a purposive sample. For each individual product, instructions should be given to the price collectors to choose the most popular product offers, i.e. those that sell the most (in volume) during their first visit to the selected retail outlets. Product offers must be substituted in the sample if they significantly lose market relevance or disappear from the market. In such a case, the price collectors shall choose a product that is both reasonably comparable with the former and representative.

The use of new sources of data, such as scanner data and web scraped data, can be of benefit to the HICP for various reasons, including improving representativity and comparability. It has been claimed that the scanner sample is more representative of the universe thanks to the increased product coverage and to the fact that prices and weights may be estimated more accurately and updated more frequently. The representativity might be assessed through the careful comparison of characteristics of the covered population and the target population. However, in reality, representativity from scanner data, and in general from big data, may be an issue. Many big data sources are composed of observational data and, therefore, have no well-defined target population, often lack structure and are of varying quality. In addition, the market coverage of scanner data may vary between different outlet types/retail chains and product groups and the amount and quality of data available can vary depending on the commercial source. This makes it difficult to apply traditional statistical methods based on sampling theory (Daas, Puts, Tennekes, Priem, 2014 ([36])).

When a sampling design is adopted, scanner data may mitigate the problem of small samples (traditional approach) given that sample sizes in a typical scanner data set are large. If a static approach, which closely mimics traditional price collection methods, is used, firstly an initial sample of products is selected in December after which, for each month, the sample is maintained as in a traditional survey. The selection over a longer preceding period may be

([36]) Daas, P. J., Puts, M., Tennekes, M., and Priem, A. (2014), 'Big Data as a Data Source for Official Statistics: experiences at Statistics Netherlands', In *The Survey Statistician*, Proceedings of Statistics Canada Symposium.

needed to ensure that the sample is representative for the whole year (January to December). A balance must be struck between representativeness and the ability to maintain the sample. The representativity of the sample may be maintained for an elementary aggregate by letting the processing system, possibly automatically, select the most sold products (EU-Eurostat, 2017 ([37])).

Internet and web scraping provide an opportunity to significantly enhance the sample of products and prices collected, by expanding product coverage, thus increasing representativeness, as a miniature version of the target population, thanks to the inclusion of online products (e-commerce). When targeted scraping (referring to a specific group of products to be represented) is adopted, the individual products that are going to be scraped are predetermined and should be stable (EU-Eurostat, 2020 Practical guidelines on web scraping for the HICP). However, the range of products shown on websites may not be the same as offered in the corresponding physical outlets and tends to change frequently. This aspect needs to be considered for maintaining representativity over time (see also Chapter 5).

Comparability

Although achieving a representative sample is important for a statistically sound HICP, it is not the only challenge that needs to be considered. The second consideration is comparability, in the sense that we need to find prices that are comparable between two points in time. To make these possible, individual products must be identical, essentially equivalent or made equivalent by way of quality adjustment (see Chapter 6) over the two periods being compared. Therefore, the comparability condition is an additional constraint for appropriate sampling in the HICP.

Product comparability over time is needed to ensure the HICP measures pure price changes. Meaningful price indices can only be computed for homogeneously defined products. When using scanner data, strict comparability of products may be achieved by considering a narrow definition of product, using barcodes or GTINs, which contain the highest degree of homogeneity. However, the use of barcodes or GTINs may be hampered by the occurrence of so-called ‘relaunches’ ([38]) (see Chapter 5). In this case, a method to link comparable new and disappearing products needs to be adopted and broader product concepts are needed. The relaunch problem plays a crucial part in selecting an approach for defining comparable products (homogeneous product groups). Chessa (2019) ([39]) suggested a method for defining products, named MARS, which combines explained variance in product prices with product match over time. MARS can be used to evaluate and rank different partitions of GTINs.

Combining representativity and comparability

When considering specific recommendations and guidelines for sampling, this dual criterion of representativity and comparability must always be in the forefront of the compilers’ minds. Frequently, compromises will be necessary to achieve the best possible balance between these two objectives and examples of such situations are given below.

Generally speaking, comparability problems can potentially give rise to a quality bias (non-

([37]) Eurostat (2017), Practical Guide for Processing Supermarket Scanner Data.

([38]) ‘Relaunches’ occur when individual products are removed from the market and reintroduced with a modified packaging.

([39]) Chessa, A. G. (2019), ‘MARS: A method for defining products and linking barcodes of item relaunches’, In 16th Ottawa Group meeting, Rio de Janeiro, Brazil.

sampling error) in the index, whereas representativity problems mainly result in sampling errors, which may be random or systematic. For example, representativity bias may result from the use of an old, out-of-date basket which deviates systematically from the consumption baskets in both the periods compared.

It requires the price statistician's judgement, informed by their experience and training, to evaluate (or gauge) the severity of potential errors in each situation.

4.3.2 Resampling and replacements

As a fixed-basket index, the HICP should ideally follow the price development of a fixed representative sample of product offers. Given the dynamics of the markets for consumer goods and services, this poses a significant challenge. A compromise has to be found between the two aims of (i) keeping the basket fixed and (ii) keeping the sample representative. Therefore, the sample must be continually updated.

When an individual product (product offer) ceases to be representative or is removed from the market, replacement products should be considered for inclusion in the target sample.

Replacements are one-to-one within the same elementary aggregate and product specification; that is, a previous individual product is replaced by a new one of the same or similar specification. Prices are then compared between them. In Chapter 6, replacement criteria and quality adjustment practices are discussed in greater detail.

The 2003 ILO Resolution states that:

> '*when a quality change is detected, an adjustment must be made to the price, so that the index reflects as near as possible the pure price change*.'

Within each year, in traditional field price collection, annual replacement strategies should aim to ensure that the observed product offer sample remains representative of the current month's product descriptions. While the headline product descriptions remain fixed (e.g. chocolate bar 65 grammes, laptop computer with 2GHz processor and 4 GB of RAM) some detailed aspects of the product description may change to reflect changes in the market such as package sizes and speed of micro-processors. Where such changes represent a change in quality, appropriate quality adjustments are required — see also Chapters 5 and 6.

The application of scanner data may significantly impact the process of identifying replacement products. In some respects, it mitigates the problem, as the availability of sales and quantity data makes it easier to identify a discontinued product quickly and select a replacement for the annual basket. Nevertheless, the size of individual products considered (all data or a sample) and individual product churn may increase the number of replacements needed over the course of a year. One strategy to address this challenge involves defining comparable product groups (see Section 4.3.1). This implies that an automated decision-making process may be developed.

Resampling involves a complete review and update of the sample of products, locations and outlets for all product groups and normally occurs in December when a new index link is started and new weights are estimated. An explicit part of this review is identifying and including newly significant goods and services (see Section 4.2.2).

For the subset of the sample that includes transaction data, for each elementary aggregate a dynamic approach may be adopted (4.4.5) so that individual products will be resampled every month based on the monthly data on sales volumes. In this way the sample of individual products within an elementary aggregate is automatically updated each month.

Unlike the replacement of product offers, which are one-to-one, direct price comparisons between the new December sample and the old December sample that it replaces are not required. Resampling involves an overlap period (i.e. in December of each year) in which the old and new samples are both observed. This forms the basis for annual chain-linking. In the HICP, prices for both the old and new samples are simultaneously collected in December of each year. The index starting with the following January is calculated using only the new price sample. (See Chapter 8 - Index calculation).

Resampling serves two primary objectives:

1. It allows for the introduction of new products, new elementary product groups (specifications), new elementary aggregates, new outlets or outlet groups, and new locations (towns and cities).
2. It facilitates the removal of obsolete products, elementary product groups (specifications), elementary aggregates, outlets or outlet groups, and locations (towns and cities).

New expenditure weights for existing products or outlet groups are usually introduced at the same time as resampling takes place; however, new weights can be introduced without complete resampling (see Chapter 3).

Compilers should be aware of the distinction between resampling and replacement. Replacements are one-to-one at product offer level. They are triggered by the permanent disappearance or rapid loss of representativity of a product offer and are therefore normally forced upon the price collector and compiler and not planned in advance.

Resampling, on the other hand, is a planned activity, which should occur at least every year. The central office first identifies the new product, outlet or locality that needs to be included in the sample.

Annual resampling is necessary to keep the reference sample representative in a dynamic economy where products are continuously and rapidly introduced and withdrawn from the market. Resampling can be used to bring new products into the HICP but also to update representation (new models, new outlets, new locations) within a given product category.

As part of annual resampling, the number of elementary aggregates or product offers can be changed and the weights redistributed among them. It is also possible to maintain the set of elementary aggregates and elementary aggregate weights and partially or wholly renew the product specifications within them.

4.3.3 Different sampling dimensions and their interrelations

As previously mentioned, an HICP essentially involves three sampling dimensions: product, geographic (locations), outlet ([40]) and time. For each of these dimensions, there is a universe from which a sample will be drawn. In general, prices and price changes will depend on each of these three dimensions. For some product groups these dimensions are less pronounced than for others. For example, for utility tariff prices or rentals, the time dimension is not as relevant because payment applies to a whole month's worth of consumption at once.

The universe of products is classified into ECOICOP 5-digit sub-classes, within which a sample of elementary product groups must be selected. Often a finer sub-division at national level is first needed (ECOICOP 6-digit sub-sub-classes) which is normally also exhaustive. Note that there is no generally agreed 6-digit level for the ECOICOP; however, national sub-divisions should comply with the ECOICOP 5-digit classification. Such 6-digit groups could be sampled or covered exhaustively, depending on their size. A common procedure is to decide on a sample of *representative products* in each sub-class but often a more elaborate hierarchy of elementary product groups and elementary aggregates is used, which is the preferred approach if resources allow. The number of prices to be collected for each sub-class or elementary aggregate, which can also be stratified by regions within a Member State, strongly depends on price variability of individual products within the group and is related to the importance or weighting of the elementary aggregate. Finally, in each outlet, one or more unique product offers are sampled to be tracked over time. The detailed procedures for this are discussed below.

The universe of outlets includes all outlets that sell consumer products in a certain ECOICOP category. This universe has a geographical aspect: outlets have a specific location on a map, with internet (including mail or phone order) retailers being an additional category that may serve the country as a whole or one or more macro areas within a country (e.g. NUTS-2 or NUTS-1).

For the time of price collection (the temporal dimension), the universe is all days of the month, to reflect the fact that consumers can make purchases on any day of the month.

For certain products such as travel services (airfares in particular) the time of day and day of week also matters, because the price paid by consumers can vary according to this parameter (see Section 12.5).

In practice, product groups will have unique features that determine the best sampling strategy. Therefore, the price collection system is different depending on product characteristics. A few examples are given here.

Example 1: 01.1.6.1 Fresh or chilled fruit. These products often have particularly marked seasonal purchasing and consumption patterns, and certain fruit may not be available at all at certain times of the year. In addition, they have highly variable prices over time, including within a month. Therefore, a sampling strategy for collecting fresh and chilled fruit prices needs to focus explicitly on the time dimension as well, and not only on the product and outlet dimensions.

Example 2: 04.1.1 Actual rentals paid by tenants. Prices are normally expressed per month, which makes the time dimension of sampling irrelevant. Also, rents are for single rental units

([40]) Geography and outlets form one dimension together since outlets are located somewhere on a map. The sample of outlets is usually two-stage, clustered by location. This also holds for internet retailers, although they may serve a larger area or even the whole country.

which can be sampled in one or two stages depending on whether there is a central register. Recently, there is an increase in the use of government administrative data to replace the need for a sample survey and use different compilation methods (see for example Portugal ([41])). So actual rentals are an exception to the multi-dimensional nature of transactions in HICP. (See Section 12.4).

Example 3: 04.5.1 Electricity. Consumption is continuous over a month and prices are set according to a structured tariff schedule, which may or may not differentiate between different days and hours. If there are only one or a few electric utility companies, it is often possible to include all of them and they do not need to be sampled. Where tariffs are decentralised (by region/municipality, etc.) geographic sampling is needed. If a single company offers multiple tariffs, this will require a sampling approach at tariff level. (See Section 7.4.).

Example 4: 07.2.2.2 Petrol. For petrol, the time dimension takes on major importance since there are only a few homogeneous varieties of petrol and competition is usually intensive, which often leads to similar prices across outlets, although regional and other differences may exist among member countries. However, the volatility in oil prices and exchange rates results in prices that may change several times each month. The best sampling strategy for petrol focuses mainly on the time dimension and to a lesser extent on the outlet dimension. If the petrol market follows this pattern, a relatively small number of geographically representative outlets with prices collected several times a month will be an appropriate approach.

The HICP sample-design process involves multiple stages. In the first stage, a sample of geographic areas may be selected. In subsequent stages, other samples may be identified: a sample of outlets and a specific sample of products for the selected area.

The sampling design adopted in each of the three sampling dimensions may produce different effects on the HICP biases ([42]). In many cases, the underlying reasons for the existence of biases in price indices are a result of practical constraints ([43]). The sampling methodologies for elementary indices that correspond to more lower-level prices may have effects that cannot be ignored at the both the product level and at higher levels of aggregation ([44]). Substantial biases may occur depending on the selection of representative products and outlets ([45]).

([41]) Mendonça, V., and Evangelista, R. (2018), 'Exploring new administrative data sources for the development of the consumer price index: The Portuguese experience with actual rentals for housing'. In ILO/UNECE meeting of the Group of Experts on Consumer Price Indices.

([42]) De Gregorio, C. (2012), 'Sample size for the estimate of consumer price subindices with alternative statistical designs', *Rivista di Statistica Ufficiale*, vol 1, pp.19–47.

([43]) De Haan, J., Opperdoes, E., & Schut, C. M. (1999), 'Item Selection in the Consumer Price Index: Cut-off versus probability sampling', *Survey Methodology*, 25, pp. 31-42.; Dorfman, A.H., J. Lent, S.G. Leaver, E. Wegman (2006), 'On sample survey designs for consumer price indexes', *Survey methodology*, Vol. 32, No. 2 (December), pp. 197–216.

([44]) Imai, S., Diewert, E., & Shimizu, C. (2015), *Consumer Price Index Biases*, Ottawa, Group Meeting Tokyo 2015.

([45]) Heravi, S., & Morgan, P. (2014), 'Sampling schemes for price index construction: a performance comparison across the classification of individual consumption by purpose food groups', *Journal of Applied Statistics*, 41(7), pp. 1453–70.

4.3.4 Sampling methods: an overview

In probability sampling, a sample of n units from the universe of N units is selected by attaching a nonzero inclusion probability π_j to each unit j. The inclusion probabilities π_j for units in the frame population are assumed to be strictly positive and known in advance.

In Simple Random Sampling (SRS) each unit is sampled with probability $\pi_j = n/N$. In SRS (without replacement), a common procedure is to assign a random number to each unit in the frame and the n highest (or lowest) values are selected.

In Systematic Sampling the units in the sampling frame are preferably sorted in some relevant order. A random starting point z ≤ N/n is selected. Now the sample is number z, z+N/n, z+2·N/n, … z+(n-1)·N/n (assuming N/n is an integer).

The probability proportional to size sampling approach specifies an inclusion probability proportional to some auxiliary variable x_j. In systematic sampling the cumulative sum of x_j is computed; $x_1, x_1+x_2, x_1+x_2+x_3, \ldots, \sum_{i=1}^{N} x_i$. Now start by a random number z ≤ $\sum_{i=1}^{N} x_i$/n and step by $\sum_{i=1}^{N} x_i$/n in the cumulative series. Order sampling is a practical class of probability proportional to size sampling procedures. Pareto πps-sampling by Rosén and Sequential Poisson sampling by Ohlsson ([46]) are two examples. The latter is convenient allowing for flexible replacement of over-coverage in the frame population. The first is more stringent with formulae for variance estimation. Both use permanent random numbers (PRN), thus allowing for rotated sampling.

In two-stage sampling or cluster sampling we split a population into clusters, then randomly select a sample of the clusters and secondly include all members or a second stage sample from those clusters in the sample.

In two-phase sampling first randomly select a sample of the clusters (like two-stage) and then a joint frame population includes all members of the clusters. For each member it is essential to remember the inclusion probability in the cluster sampling. The second phase sample of members is selected with probabilities proportional to the inverse of the probabilities in the first phase. A final sample of members can be produced with probabilities proportional to individual size.

Therefore, a two-phase sampling refers to designs in which initially a sample of units is selected for obtaining auxiliary information only, and then a second sample is selected in which the variable of interest is observed in addition to the auxiliary information. The purpose of two-phase sampling is to obtain better estimators by using the relationship between auxiliary variables and the variable of interest. In contrast, in a two-stage sampling, primary units are first selected (PSUs) and then a sample of secondary units (SSUs) is selected from each of the primary units selected. With two-stage designs, the estimator has variability even for a given selection of primary units, because different subsamples of secondary units will give rise to different values of the estimator (Thompson, 2012 ([47])).

Since non-probability sampling does not require a complete survey frame, it can be easier and less expensive than probability sampling. The most commonly used non-probability sampling

([46]) Ohlsson, E. (1990), 'Sequential Poisson Sampling from a Business Register and its Application to the Swedish Consumer Price Index', R&D Report 1990:6 from SCB. Rosén, B. (2000) 'A User's Guide to Pareto πps sampling'. R&D Report 2000:6 from SCB.

([47]) Thompson S.K.(2012), Sampling, Third Edition, John Wiley & Sons, Inc., Hoboken, New Jersey.

schemes are cut-off sampling, through which representative products are selected by considering an appropriate variable measuring product size (i.e. expenditure share information), and quota sampling where the sample is drawn to have the same proportions as the total population or universe to ensure representativity.

Cut-off sampling means a sample from which some portion of the population is deliberately excluded. To apply cut-off sampling, a sampling frame is required that contains an appropriate variable measuring the size of the unit. The term 'cut-off' refers to the threshold value between the included and the excluded units (ILO, 2020). This non-probability sampling method can be considered when the size variable is highly skewed. The purpose is to select the n largest units and disregard the small units. The main disadvantage of cut-off sampling is that it does not produce unbiased estimators, since excluded outlets or products may display price movements that systematically differ from all the remaining products. Theoretical frameworks for assessing CPI accuracy in cut-off sampling have been introduced over the last years (see for example, Benedetti et al, 2010 ([48]) and Dorfmann, 2012 ([49])). Another non-probability sampling technique frequently used is quota sampling where a sample is drawn to have the same proportions as the total population or universe to ensure representativity. Sampling is done until a specific number of units (quotas) for various subpopulations have been selected. Therefore, quota sampling is a stratified sampling method with a sample allocation that is proportional to the stratum weights and where the sampling within a stratum is carried out in a judgmental way (ILO, 2020 ([50])).

4.4 Sampling stages

4.4.1 Sampling of products

Many different approaches to sampling within a certain ECOICOP sub-class can be used, depending on the specific features of the sub-class. Each country has its own way of partitioning each sub-class based on its national market/circumstances, using a variety of data sources to support this partition. The aim is to produce a set (or basket) of elementary product groups, which are generally referred to as products. Elementary aggregates may or may not be further partitioned/stratified into elementary product groups by location and/or outlet type. Where they are not, elementary product groups and elementary aggregates are the same. Elementary product groups/elementary aggregates are the lowest level of stratification in any given 5-digit sub-class and comprise a set of homogeneous products. In this section we focus on the sampling of products rather than partitioning.

Sampling strategies for products may differ according to the data source used (traditional data, scanner data, web-scraped data, administrative data). With reference to traditional price data collection, some of the main approaches are described below, noting that often there are at least two stages involved within each sub-class: (1) sampling of elementary product groups; and (2) sampling of detailed products (specifications) within elementary product groups. The final stage,

([48]) Benedetti, R., Bee, M., and Espa, G. (2010), 'A framework for cut-off sampling in business survey design', Jo*urnal of Official Statistics*, 26(4), pp. 651.

([49]) Dorfman, A. H. (2012), Inference in Cutoff Sampling, U.S. Bureau of Labor Statistics BLS.

([50]) ILO (2020), *Consumer price index manual: Concepts and methods*.

where specifications are transformed into a unique product offer, often occurs in outlets. That is discussed in Section 4.4.3.

Probability sampling is rarely involved in product sampling. Generally, various forms of purposive sampling are employed, such as cut-off and quota approaches. As a second step in their two-stage sampling process for collecting prices, France ([51]) applies a quota method. The outlets and the products for which the prices will be tracked are selected according to a quota method by asking the price surveyors to carry out a given number of collections by form of sales of the outlet from which the product is observed.

Two other examples referring to specific group of products are described below:

1. *Fresh or chilled fruit, ECOICOP 01.1.6.1.* Each type of fresh fruit (apples, oranges, bananas, grapes, etc.) is a detailed product and an elementary product group and can also be seen as an elementary aggregate. If seasonal products are sampled in an elementary aggregate, Member States shall use the seasonal imputation method or the seasonal weights method to compile a price index for that aggregate (Article 14 of Regulation 2020/1148). Often, practical considerations also play a role here, since the complexity of including strongly seasonal fruit that is not available throughout the year is greater than the routine measurement of non-seasonal fruit. Index compilers generally aim to keep the same sample of products for as long as reasonable quantities are sold. (For fruit and vegetables, this is more easily done than, for example, for clothing products.) Representativity has to be ensured according to a quota sampling approach, where consideration is given to potentially important price-determining factors such as domestic versus imported fruit. For example, small domestically produced fruit such as various berries (strawberries, raspberries, blueberries, etc.) could well have special price movements that should be captured based on their combined weight rather than on their separate weights. This could be done by assigning the total weight of berries to the most widely available type of berry. The treatment of seasonal products is described further in Section 7.1.
2. *Non-motorised small tools (for house and garden), ECOICOP 05.5.2*. Each tool type in this group (hammer, screwdriver, pincers, pruning shears, etc.), of which the universe is quite large, may be taken as an elementary aggregate, but the total weight of the whole group is relatively low. Within the group a sample of tools/segments needs to be selected. If the household budget survey or scanner data provides detailed expenditure data at the level of individual products to support a probability proportional to size sampling approach, then this method could be chosen. Where such detailed data do not exist, the most practical and perhaps best choice is to apply the cut-off sampling technique for those tools with the largest expenditure shares using aggregate household budget survey data (if it exists) for aggregated product groups such as garden tools, woodworking tools, tools for plumbing, etc. Samples can also be drawn from alternative data sources such as scanner data from do-it-yourself (DIY) stores or retail sales surveys. In the absence of any data, subjective judgement is the fall-back approach. At that stage, considerations of comparability and cost are important factors in the final selection of elementary product groups.

([51]) Traitement statistique − Consumer price index | Insee.

Detailed product sampling - traditional price collection

Within each sampled elementary product group, one or more product specifications are selected depending on the homogeneity and relative size of the elementary product group (in expenditure terms). Since a sampling frame of specifications is usually unavailable in traditional data collection methods, some form of non-probability or purposive sampling has to be used in this stage.

This procedure is usually referred to as the *representative item* (product) method. Therefore, several crucial choices are involved in this stage.

Firstly, an appropriate number of representative products must be defined to properly *represent the diversity of products that can be found within the category*. Therefore, a minimum number is needed for each ECOICOP sub-class in order for the ECOICOP index to have a minimum accuracy. Furthermore, the weight of the sub-class, the diversity and the variability of price changes within it have to be taken into account. Clearly, this depends on the total sample size; this issue is further discussed in Annex 4.1, at the end of this chapter, under *Optimising sample sizes per product*.

The sampling strategy within an elementary product group can take many different forms. One strategy would be to perform the whole sampling operation from elementary product group to product offer in the outlets without intermediate sampling steps. This corresponds to a strategy of loose specification, which is discussed in more detail below.

The product specification issue: tight versus loose specifications

The issue of tight or loose specification is relevant for products where a second stage of sampling is performed in outlets. A 100 % tight specification does not give any latitude for choice by the price collector once in the outlet, and is thus fully defined with respect to brand, size, etc., e.g. Vodka 75cl (unflavoured).

A loose specification gives the price collector some freedom in choosing locally popular product offers and to adjust the sample to match local conditions. Generally, it will normally lead to greater representativity of the sample, as it will reflect regional tastes and preferences. An extremely loose specification, e.g. vodka, on the other hand, allows all product offers that belong to the elementary aggregate to be selected on the basis of a sampling rule in the outlet such as most sold or well sold and lasts long. Moreover, in this case price collectors require training on how to select a product offer to be observed and how to describe it to ensure that the same product offer is observed over time. In between these extremes are various semi-tight specifications that reduce the scope for local choices without completely eliminating them.

It should be stressed that the tight/loose distinction refers to the central specifications, i.e. the general description that is often provided by the central office and within which a price collector is asked to select a product offer. A loose specification thus becomes tight in the outlet after the price collector has selected the product offer. It is worth noting that, according to this method, only product offers matching the specification are priced and no product offers falling outside the specifications will enter the index. Considering that prices belonging to the same representative product may be relatively homogeneous, both regarding price level and price change, it is also important to take into account the variability of price changes between the different representative products.

Neither tight nor loose specifications are universally superior (see Chapter 5 — Price collection). A tight specification allows better central control over the sample and may enable the use of centrally available market data that, for example, indicate that certain brands and models are currently popular, while a loose specification might run the risk of local price collectors missing (i.e. not selecting) important products. Tight specification may also enable stricter quality control, since prices can more easily be checked for accuracy, reliability, etc. by having more comparable prices available for validation purposes.

As already mentioned, a loose specification allows for easy adaptation to local conditions and to the range of available product offers in each given outlet while a tight specification will give rise to more missing price observations, since a number of products that meet the requirements dictated by the product description may not be found. Therefore, a tight specification could make replacements more difficult whereas a loose specification fits with an instruction to price collectors to find a replacement product offer with the same specification, which is more easily accomplished. The comparability principle should also be considered. Tight specification and thus less judgmental editing at the point of data collection can help to ensure the comparability of individual products, particularly where prices are variable.

Index compilers should be aware of the fact that tight product specifications may result in a loss of representativity with regard to the target universe. If product specifications are too tight, the price collectors may have difficulties in finding the product offers that meet the requirements dictated by the product description, and this will lead to fewer price quotes and a deficit in the sample.

Tight specifications therefore amount to a purposive sampling method in themselves (unless they are based on comprehensive datasets which allow PPS, e.g. scanner data ([52])). For both tight and loose specifications, care should be taken that, taken together, the specifications do not result in exclusion or misrepresentation of a significant market segment with common price-determining features such as domestic versus imported products, luxury versus standard quality, and the like. Ideally, the sample should be based on the market share, in value terms, of each of these features for a given product. Although such information is rarely available in detail, it is still possible to achieve a broadly correct representation with good judgement and a quota sample philosophy.

In general, it is often better to choose an option between extremely tight and extremely loose specification. For example, some generic features of a product may be specified, but not the brand or exact package size/type. However, it is generally good practice to specify the range of package sizes allowed (e.g. single can of beer, 33-50 cl, but not multipacks), along with instructions to record the size and price observed. This is because the unit value prices of products often vary with package size, not all of which are necessarily representative ([53]). Other factors play a role as well, such as the capacity of price collectors to act according to more or less complex instructions. In this context, investment in proper training of price collectors is essential. If specifications are loose, then price collectors need to provide additional notes and comments to

([52]) When scanner data are used, the first step is the individual product specification where the choice of a tighter or looser specification plays an essential role.

([53]) Representativity also depends on the elementary aggregate formula. If the Dutot formula is used, the price level will be part of the implicit weight. It should then be the quantities purchased that are representative. For example, luxury products should be included in their quantity proportions instead of their value proportions. If the Jevons formula is used, then the value proportions should be used (See Chapter 8).

head office on the selected product offer and to be able to judge comparability within clear national guidelines, etc.

A special problem in the case of tight product specifications (for which there is no easy solution) is that for certain categories of products, for example fashion clothing, furniture and technological products, it is more difficult to find prices over time than it is for others, depending on what counts as an essentially identical product ([54]). However, such products may be important in terms of expenditure share and may exhibit potentially different price movements. An example is clothing in particular women's/men's fashion clothing sold in specialised clothing boutiques. Clothes that are in fashion are typically sold for only a few months and are then replaced by new styles. Even the boutiques themselves may be short-lived. Excluding clothes that are in fashion would amount to a possibly severe representativity problem, but including them does necessarily lead to a comparability problem, not to mention the cost of the extra complexity of processing and compiling the HICP. In such cases, where a Member State judges that comparable product offers are impossible to price, exclusion is sometimes the least bad solution. But only in extreme cases should this argument be invoked.

4.4.2 Sampling of locations

Unless it is possible to sample outlets directly from a national sampling frame such as a business register (which often cannot identify small outlets or the precise range of products available in them), the sampling of outlets generally needs to be done in two stages. In the first stage, a sample of locations such as cities or shopping areas is drawn/selected in each region of the country, and in the second stage outlets are sampled. The first stage, which is referred to as cluster sampling, will be discussed in this section and the second stage in the next section.

When sampling locations, two major factors must be borne in mind: representativity and cost effectiveness. Areas where the bulk of consumer purchases take place need to be covered with certainty or by a probability sample to make the sample representative. In a large country divided into administrative areas (state, region, department, etc.) all of these regions are often included with certainty, after which there may be sampling of locations within each of them. This is conducive to representativity where price movements may differ due to different climates and/or transport costs. It is also a necessary requirement where there is a demand for separate price indices for each region.

A factor that complicates the sampling of locations is that, depending on how they are demarcated, they may cover different parts of the product spectrum. Ideally, locations need to be demarcated so that most products can be found in each location. Otherwise, it may be necessary to have separate sampling methods for some products — for example for new cars and DIY products, because car showrooms and large DIY stores are often located outside the main shopping districts. However, one must accept that not all products will be found in each location, and the sampling frame will need to be adjusted by drawing different location samples for different product groups.

Locations should then be listed together with a relevant size measure and a sample selected based on this list. This ideal size measure is total sales to private households, for which a proxy

([54]) This topic is discussed more in Chapter 6 — Quality adjustment and replacement.

could be the number of staff in the outlets or their ‘footfall’ — the number of people shopping in them.

In small countries it is common to select a few of the larger cities for price collection. This leaves out smaller towns and rural areas, but as consumers living in areas close to a city will go there for some of their shopping the effect of their exclusion will be smaller than might be inferred from population numbers, and a sufficient coverage may still be achieved. It is then important that the selected cities are such that their outlets are used by a large part of the population and that they are situated in different parts of the country for maximum coverage. Car-friendly shopping centres situated immediately outside a city should be included if they are significant.

Regarding small locations (villages, small high streets, etc.) situated far from regional offices, some cut-off approach to exclude such locations is acceptable on cost grounds.

Location samples are generally fixed for a long period of time, as they determine the whole organisation of work for the statistical office. This is probably the major reason why purposive location sampling has been the rule so far. However, probability sampling for locations is also possible and an example of this is provided below.

Example: Probability sampling for locations in France

The sampling plan adopted by Insee is based on two principles with the aim of maximizing the accuracy of the HICP: i) randomly select geographical collection areas (urban units); ii) determine an optimal number of surveys to be carried out in each selected geographical area and for each type of product. An estimator of the price index, based on a random sampling of the geographical areas, is derived from the exact expression of the index to be estimated. This index results from the aggregation of elementary local indices estimated at the level of each urban unit for a given type of product. The elementary indices are aggregated using as weights information obtained from the household budget survey. The details of the method are given in Jaluzot and Sillard (2016) ([55]).

The purpose of the location sample is to make it possible to construct tailor-made sampling frames in each sampled location. In the next section this is described in more detail.

4.4.3 Sampling of outlets

The objective of outlet sampling is to determine a representative set of outlets that sell the selected products. The sample also needs to reflect the diversity both of product varieties within the selected products and of types of outlets with different service and price levels.

For outlet sampling it is important to distinguish between probability sampling and purposive sampling. In addition, there is the separate process of matching the product sample with the outlet sample. The availability of scanner data has in many cases allowed the adoption of a probability sampling design for the selection of outlets. The Italian approach will be illustrated in Annex 4.3.

The outlet sample needs to be representative of both the location and types of outlets. Price levels and thus price change patterns may vary in both of these dimensions. Special attention

([55]) Jaluzot L. and Sillard P. (2016), *Échantillonnage des agglomérations de l’IPC pour la base 2015*.

needs to be given to internet retailers, which have increased their market share across most product groups over the last few years and especially during the Covid-19 pandemic. They should be included according to their approximate expenditure share for each product group.

Probability sampling

Where sampling frames exist for outlets, probability sampling could be considered. A sampling frame could be, for example, a central business register or another type of register with broad coverage. Coverage is crucial: the register should cover all kinds of outlets, large and small, and have systematic update procedures so that new outlets are regularly added to the register, and outlets that have closed are removed.

Example: Two-phase probability sampling for locations and outlets in Sweden

Statistics Sweden (SCB) has employed two-phase sampling of outlets from the Central Business Register. New samples are drawn each year to ensure maximum representativity of the current outlet universe. Samples are purposively rotated by 20 % annually by a permanent random number technique, thus spreading the response burden on outlets. Including new and closed outlets results in some 70–75 % of the sample remaining from one year to the next. Initially, small municipalities that are located far away from Statistics Sweden's price collectors, where the total commerce constitutes a maximum of 10 % of all commerce in Sweden, can be excluded from the sampling frame. Two-phase sampling is applied, somewhat different from two-step sampling. In the first phase, a sample of geographic areas (based on postal codes) is drawn with systematic probability to size sampling to concentrate travel for the price collectors. A reduced population register, frame, is extracted and the first phase selection probabilities are stored together with outlet information. In the second phase, retail outlets are sampled from the reduced frame using sequential Poisson sampling with sampling probabilities proportional to size (PPS sampling) ([56]) Size is now multiplied by the reciprocal of the selection probability from the area sampling in the first phase. In two-phase sampling there is no need to collect prices for all types of products in each area. In fact, there may be no selected outlets in several first-phase sampled areas.

Where a central sampling frame does not exist, a two-stage sampling procedure is needed if probability sampling is to be applied. In the first stage, a sampling frame can be created by enumerating all outlets in the selected locations. Potential sources for constructing such a sampling frame are the administrative records kept by local government or business associations (CPI Manual, 2020). Depending on the availability of information on size, these sources might provide a frame for PPS sampling. A sample can then be drawn from the tailor-made sampling frame by means of PPS if information on size is available (using as size variable a proxy of turnover, such as net retail floor space, number of employees, etc). In order to collect information on outlets where purchases are made, so-called point of purchase surveys can also be designed. A list can also be made by a survey of the area, although this may be expensive.

Sweden's method might, with some variation, be applicable in other countries. The other method, however, could be relatively resource-intensive. The use of probability sampling using either approach depends on the availability of the requisite data, which may not exist in all Member States.

([56]) Documentation on Consumer Price Index (CPI) (scb.se).

Non-probability sampling

Other strategies related to non-probability sampling are needed to achieve representativity. One such strategy is quota sampling illustrated in section 4.3.4. For outlets, this means selecting the sample so that the sample fraction corresponds approximately to the population fraction for certain variables that are considered important — for example, region and outlet type. In principle, this must be done for each product, or at least each product group.

A straightforward strategy is first to determine the sample size needed for each product specification in each city/location, and then to ask local price collectors, who may be assumed to know the local situation well, to find a representative outlet sample for each product based on their knowledge of which outlets are frequently visited. They should then be instructed to take diversity into account in the specification. For example, a 100 % cotton T-shirt represents a diverse product which can vary enormously in both price and quality, and which requires a larger sample than, for example, a packet of 20 cigarettes for which the price level and quality differences are less pronounced. For food products, the sample should, for example, include market stalls, local shops, discounter, supermarkets and hypermarkets, in proportion to their expenditure share and the elementary aggregate formula used. For clothing chains with markedly different price levels, the various price strata should ideally be represented in the sample based on their market share in expenditure terms (if such data are available) unless comparability problems are deemed insurmountable. For internet retailers, head office staff should carry out sampling centrally.

When sampling outlets, various factors should be considered. Firstly, the number of suppliers of the good or service in the city concerned: the larger the number of suppliers, the larger the sample. Another important dimension to consider is the degree of price dispersion among outlets. In general, the sample should be larger if the expected dispersion in prices is wide, assuming the dispersion in price changes is wide. For example, a large sample of fruit and vegetables outlets is usually needed. However, with newspapers, a small sample is sufficient because standard prices are generally adhered to. Moreover, the ownership of retail chains should be considered in selecting outlets in order to obtain a representative estimate of price movement for the various chains.

The outlet sample should also be up-to-date and include new types of outlets to avoid biases derived from distinctive pricing policies.

Matching the outlet sample with the product sample

In the end, an HICP sampling frame has to specify exactly which products are to be observed in which outlets.

In traditional price collection, it is not usually known in advance exactly which products can be found in each outlet. Ideally, compilers need to know where households buy each product and let this govern the allocation of products to outlets. There are several possible approaches to obtaining this information. Some are outlined below.

One approach is to use an *assortment survey* directed at the outlets (or outlet chains) where they provide the relative turnover share by type of product. This could guide the allocation of products to outlet types, leaving the actual products in a preliminary sample of outlets to be checked after that.

Another approach is to list (by outlet type & size) all outlets in the locations sampled, from which a sample of outlets can be randomly selected. To enable this, various product types are grouped together based on the likelihood of being sold in the same types of outlets; for example, food and non-durable household goods (cleaning products etc.) are observed in supermarkets/food shops, and medicines & beauty products are observed in chemists.

A third approach would be a *point-of-purchase survey*, where households are asked where they make their purchases of specific types of products. This information can then determine the type of outlets in which to price each product. This method is used in the US, but it is not common in Europe. With the aim of investigating the more frequent types of outlets (traditional shop, open market, hard discount, hypermarkets and supermarkets, department stores, farm or direct producer, internet) where Italian households purchase a set of widely consumed products (i.e. bread, pasta, milk, etc.) a specific question is included in the two-week Diary (Istat, 2021 ([57])). Households are asked to indicate the two places where they have purchased that specific good most often or to select the option 'not purchased'. Including a sort of point-of-purchase survey into an already existing survey may be a valid way; otherwise, carrying out a specific survey appears to be quite an expensive method, is subject to non-response problems, and the findings of such a survey cannot be expected to hold true for a long time. Alternatively, such data might be purchased from market research companies. In Germany, an extensive list of products can be checked regarding market shares of different retail chains/outlet types. This information is an important step for creating the sample frame in Germany. For goods, different market shares of the outlet types are taken into account by explicit weighting. All outlet types whose market shares amount to at least 5 % (on Laender level) for a certain type of good are covered. For price collection, the German territory is systematically divided into 16 Laender with 94 regions. In every region, outlets (assigned to relevant outlet types) with a high relevance for private consumption are selected. No outlet category is excluded ([58]).

In most countries, this process of matching products to outlets will be based on the informal local knowledge of price collectors, but care should be taken that the full range of outlet types is covered. If sample sizes in each location are small, not all outlet types can be included everywhere. In that case, central allocation is needed, for example to rule that location X will include a local shop but location Y will include a supermarket, to ensure the right balance in the overall sample.

Ultimately, it will still be necessary to visit each sampled outlet in advance of the first price collection for the new sample of locations, outlets and products to find out their exact assortment of products and which of the specified products are actually sold there. Note that in December, prices should be collected for both the old and new samples.

Generally, it is both reasonable and preferable (for efficiency reasons) to collect prices for all or most of the representative product specifications within the basket that are sold in a sampled outlet. This is because the extra cost of pricing one more product in a given outlet is small compared with having to collect additional prices (i.e. increasing the sample) by surveying prices from an additional outlet. Issues regarding administrative burden, efficiency and effectiveness are discussed further in Chapter 5. However, if this strategy is followed, then the prices recorded

([57]) Diario Blu Corrente italiano 2022.pdf [ISTAT - Indagine sulle spese delle famiglie], page 1-84 @ Apogee Preflight (in Italian).

([58]) See HICP metatadata.

have to be reconciled with the explicit or implicit self-weighting pattern within or between elementary aggregates with regard to outlets or products ([59]). Therefore, care must be taken to ensure that a sufficient number of outlets (as well as prices) are included in the sample to ensure that the sample is representative of where consumers shop. This is particularly important for larger outlets and outlet types such as hypermarkets that may stock many potential product offers which meet the product specification and for non-food retailers, restaurants, accommodation services, etc., where the range of outlets is diverse and where sales are not restricted to a few dominant retailers.

4.4.4 Sampling of product offers in outlets

In field price collection, once it is decided to price a product in a sampled outlet, a unique product offer must be defined. This is typically in the final sampling stage in a CPI or HICP, unless the product is already so tightly defined that no further sampling in the outlet is needed.

In Europe, purposive methods are used at this stage and the approach most often cited is to choose the *most sold* product offer in the outlet (cut-off sampling). Another criterion that is sometimes used is that the product offer should *last long*, i.e. be generally available over many months in order to minimise the frequency of replacements. Although both of these criteria make sense, they are not always compatible, and a compromise has to be found. When initially choosing the product offers, the knowledge of the shop assistants can be invaluable and their advice should be sought as necessary, if possible.

Where several similar product offers are differentiated primarily by brand, it may not always be possible to identify the *most sold* product. Likewise, expensive varieties may sell fewer units than cheaper varieties but account for a larger share of total revenues for the outlet in question. For some products, like electrical goods, sales data from market research companies or scanner data from the retailer can be used in order to sample the most sold products remotely from head office, thus removing the potential bias arising from the subjective choices that an individual price collector can sometimes make (see 4.4.5).

The *most sold* approach (to ensure representativity) amounts to a cut-off sample of one unit and is generally a sound sampling strategy. The *long-lasting* approach (to ensure comparability) is more dubious, since it may result in a sample that is less representative, by excluding popular sellers that exist in the market only for a short period. If comparability problems are deemed too difficult to overcome, the long-lasting approach may be unavoidable to some extent, but it should be applied with restraint.

([59]) When the weights of all sampled units are the same, the sample is referred to as self-weighting. Examples of self-weighted sampling designs are one stage, unstratified, simple random sample and one-stage stratified simple random sample using N proportional allocation across strata. However, samples are rarely self-weighting since sampling units are selected with unequal probabilities of selection both in traditional field price collection and when using scanner data. For a two-phase design, self-weighting is achieved by selecting a simple random sample or a stratified sample with N-proportional allocation at each phase. Using explicit weights for outlet types on the level of elementary product groups can be helpful to ensure the inclusion of outlet types balancing their impact on the overall index. In traditional price collection, when a quota sampling is used, price samples may be constructed so that they are self-weighting. For example, if there were a price sample for medium chocolate bars, and the major grocery outlets had 80 % of these sales and convenience stores 20 %, then the price sample would be selected so that for every price from a convenience store there are four prices from the major grocery outlets. Scanner data provides expenditure data at the elementary aggregate level, which could be used for weighting purposes and designing self-weighting sampling.

One of the pitfalls of the *most sold* criterion is how to deal with products that are often subject to sales prices or temporary price reductions. Such products have become more and more common in modern markets. For example, if a product offer has a temporarily reduced price in the week when price collection occurs then it may be the *most sold* that week but not over a longer period. If such product offers are disproportionally selected in the price reference period, i.e. in December of each year when a new sample is first priced, then price increases will be recorded in the following months once they return to their normal price level. This results in an upward bias in the index.

The problem with the most sold criterion can be overcome if the most sold reference period is longer than a week or even a month as it is the case when scanner data are used (4.4.5). In the field price collection, if a shop assistant is asked for the *most sold* it should be specified that it is the most sold over the last month or longer. On the other hand, for products with a short life cycle, one must consider if quite new products can be expected to be best-sellers and should be chosen.

Note also that a rule never to include a product offer with a temporary price reduction in the price reference period sample can also give rise to a bias. In that case, it is a downward bias, since future price changes will disproportionately be decreases, because price increases following the end of temporary price reductions will not be captured in all time periods. Ideally, the share of normal versus temporarily reduced prices in the sample should reflect their shares in the universe in each time period. One way to achieve this is by defining the selection criterion irrespective of the temporary price level at the time the price collector makes an initial sample selection. (Since prices have to be those actually paid by the consumer, excluding temporarily reduced prices is not an option.) Another way, however expensive, to manage this selection problem is to start price collection in new outlets in the outlet sample in September, say, but not make use of these collected data until base period December. For September to December the sample is ageing naturally to become comparable to next year. Statistics Sweden (SCB) has considered this problem for many years ([60]).

It is also possible to use probability sampling at this stage and this approach is used in the US. Basically, the expenditure share of each product offer that falls within the specification is estimated in the best way possible and a PPS sample of one product offer is drawn in each outlet. The exact procedure is described in BLS (2018) ([61]). Be careful, though, not to select 'too many' products with clearance sale prices if the expenditure on these is measured for the latest week or month only.

Possibly unconventional, but not strange, would be not to choose just one unique product offer within a product group in a sampled outlet. Rather, selecting two or more product offers and splitting the weights is easily manageable – and cheap. With this design it will be possible to analyse the contribution to CPI variance from all selection stages to find the best allocation of resources. Sweden selects four product offers for each product and outlet for clothing and two product offers for furniture.

([60]) Strandberg, K. and Norberg, A, 'Sample Selection Bias in the Swedish CPI'. Paper presented at the Joint UNECE/ILO Meeting of the Group of Experts on Consumer Price Indices, Geneva, May 26–28, 2014.

([61]) BLS (2018), 'The consumer price index', in *Handbook of Methods*, Chapter 17.

4.4.5 Product and outlet sample; central price collections

Central collection, either at the head office or in regional offices, can be cheaper and may be used for products where there are national pricing policies, as for rail fares, for products where scanner data are available or products and services where prices can be observed directly at the central office, such as for many professional services. In addition, central collection may be used for products whose price changes are better suited to be managed centrally, such as products with complex and constantly evolving qualitative characteristics (computers, smartphones, etc.) and services consumed within a wide area like those related to the tourism sector such as holiday packages. The head office may design specific sampling strategies and use different sources: manual price collection, web-scraping procedures, scanner data, administrative data or a direct survey of companies.

Manual price collection

The same general principles apply as with price collection in the field; outlets must be selected and representative individual products for regular pricing must be specified.

For products where the central office performs both the sampling and the price collection, the distinction between tight and loose specification is usually irrelevant. Instead, a sufficiently large sample of tight specifications is defined centrally to allow a price to be collected from the internet, by phone, from a catalogue of some kind or from another centrally available data source (see Chapter 5).

The application of transaction and web data may lead to a shift of costs and burdens but has the potential to increase cost efficiency. On the one hand, use of transaction and web data may reduce costs of NSIs since no manual price collection is needed. On the other hand, regarding transaction data, administrative costs for enterprises may increase in the short-term since enterprises must implement the regular data transmission to the NSIs.

Scanner data

NSIs may use scanner data in different ways. In some cases, scanner data are simply used as an alternative source for price collection, replacing collection in the stores, without changing the traditional principles of computing the price indices. Alternatively, scanner data can be used as universe from which samples of product-offers can be selected following different sampling methods (Nygaard, 2010; Norberg, 2014 ([62])).

However, when using scanner data, it is essential to consider that the product and the outlet sampling levels are closely related. Nevertheless, a two-stage sampling approach can be adopted where outlets are sampled first, possibly belonging to the different retail chain or outlet type, and then individual products, defined according to a tight (for example using the GTIN code/outlet type) or loose specification are selected within the sampled outlets. A probability sample design, such as a PPS, may be adopted for selecting outlets (see Annex 4.3 which reports an example for Italy).

The definition of individual products plays a crucial role for sampling in the context of scanner data, as it involves the calculation of unit price value (see Chapter 5 for classification issues). An

([62]) Nygaard, R. (2010), Chain drift in a monthly chained superlative price index, Workshop on scanner data, Geneva, 10 may 2010; Norberg A. (2014), Sampling of scanner data products offers in the Swedish CPI, Statistics Sweden.

individual product may be uniquely identified by its barcode GTIN-codes (also known as EAN-codes ([63])). The 'item' or GTIN specification, is the most granular product level available in the scanner dataset and contains the highest degree of homogeneity. However, individual products identified by different item codes could be grouped together to form homogeneous products with the aim of ensuring stability over time while avoiding unit value bias (see also Chapter 8).

The outlet dimension is also relevant for the definition of individual products, as quality differences between outlets can be associated with different opening hours and different assortments. A solution would be to specify the individual product at the level of an outlet and to keep the data as disaggregated as possible. In this case, the same item code or product identifier sold in different outlet types (i.e. supermarket, hypermarket, etc.) or outlets belonging to different retail chain is considered as a different individual product.

After having specified individual products, NSIs can choose to process all individual products (i.e., those that satisfy various filters) or sample individual products (items) from scanner data using either a static or a dynamic approach. The **static approach** closely mimics the traditional fixed sample including the treatment of relaunches. A probability sample of individual products is drawn from year t and used for 12 months following December of year t. The sample is kept and replacements are made as needed. If an individual product becomes less representative or disappears during the year, it is replaced. This all follows traditional methodology, but with the advantage of having full information on actual transactions on which to base choices about the initial selection of individual products and, if needed, their replacement during the year. This method has advantages, especially if scanner data are used on a limited scale and if it has to be combined with data collected in the traditional way. In such cases, it may be convenient and efficient to 'hand-pick' those individual products (product offers) that best fit the product descriptions used in traditional price collection. The method also has drawbacks since it makes limited use of available data.

An example is provided by the Swiss Federal Statistical Office, which uses scanner data following a static approach (Müller, 2010 ([64])). In order to identify individual products unambiguously, the in-store item numbers of the retail chain are used rather than the EAN codes. The individual products whose price changes are to be included in calculating the CPI/HICP are selected separately for each survey outlet. The number of individual products to be selected is predetermined and corresponds to that of the traditional survey.

For the correct selection of the individual products in the sample, the same selection criteria apply as under the traditional system:

i. Representativeness: For each elementary aggregate, those individual products are selected which are most representative of private household consumption. Representativeness is measured by the sales volume of the individual product.

ii. Continuity (last long): Except for seasonal products, those individual products should be selected which continuously generate high sales in the retail chains' product line.

([63]) Besides GTINs, Stock Keeping Units (SKUs) are used as product identifiers.

([64]) Müller, R. (2010), 'Scanner data in the Swiss CPI: An alternative to price collection in the field', Paper presented at the UNECE/ILO meeting of experts on Consumer Price Indices, Geneva, 2010.

This is meant to make it possible to track the price of the same individual product for as long as possible.

Statistics Sweden (SCB) adopts different sampling techniques for selecting individual products according to the product group to which they belong ([65]). Scanner data for daily products in the Swedish CPI and HICP have been used in production for over a decade. The methodological principles of the use of scanner data specify that: i) a PPS approach for sampling products is adopted; ii) the sample of individual products is chain specific but is symmetrically matched against specific stores. Regional differences in product assortment are therefore not taken into account in the product sample or in the product weights. Yet, for some product categories, such as fish, due to a high product churn different techniques are adopted. More specifically, a cut-off sample of products per store is used, instead of a PPS sample from the total supply of fish for each supermarket chain.

The **dynamic approach** automatically selects a representative sample of individual products for each consecutive set of two months (t and t+1, t+1 and t+2, t+2 and t+3 and so on) by selecting all matched individual products that have a turnover above a certain threshold and includes new and sufficiently important individual products while dropping individual products that are less important. The dynamic method should be preferred when substantial amounts of scanner data have to be processed because it can easily be automated. However, if relaunches and replacements occur frequently, it is necessary to deal with these issues separately to ensure quality adjustments are made.

As an example, STATEC has been using scanner data from participating retailers of Luxembourg in the CPI/HICP calculations since January 2018. Due to the drawbacks of the so-called ‘dynamic approach’, used from 2018 to 2020, such as its inability to incorporate all available products into price index calculations and above all its inability to directly incorporate the selected products’ turnover information into price index calculations, since January 2021 STATEC has adopted a multilateral method (see Radjabov and Ferring, 2021) ([66]).

Web scraping

For prices collected on the internet, a distinction must be made between prices collected centrally online, so that there is no need for a price collector to visit an outlet, and those prices that genuinely represent e-commerce transactions (online or web-based outlets with no physical location). In the latter case, it is possible to adopt the same sampling strategy as for price collection in the field, by first selecting appropriate websites and then selecting specific individual products to be priced (ILO, 2020).

Purposive sampling is usually adopted when choosing the appropriate web site for scraping since several important dimensions need to be considered. The first dimension is the coverage: it is important to verify if the coverage is representative, that is if online prices genuinely represent e-commerce transactions and if the assortments shown on websites are able to represent those in the stores. Another important dimension is the stability of the site over time. The long-term sustainability of the scraped data depends hugely on the steadiness of the web site. In order to fulfil the representativity requirement over time, it is preferred to scrape sites that are not subject

([65]) Quality declaration, Consumer Price Index, 2022 (scb.se) .

([66]) Radjabov, B., & Ferring, M. (2021), *The Implementation of a Multilateral Price Index Method for Scanner Data in the Luxembourg CPI*, STATEC.

to regular changes and that are not likely to disappear from the web (see Chapter 5 for further details).

Administrative data

In some cases, it is possible to cover the entire universe of transactions (i.e. there is a census of transactions). This is especially the case for certain administrative fees like TV licence fees, where an ECOICOP sub-index or an elementary product group weight may be represented by only a few prices or even a single price. For state-run monopolies (for example, alcohol sales in Sweden and Finland) it may be possible to gain access to the state-run retailer’s database and extract all or almost all of the prices from that source.

For some products, such as electricity, telecoms, cultural services and certain transport services, prices may take the form of tariffs with a limited number of prices within them. In other cases, national pricing structures may operate, in which case only a single price needs to be collected. In addition, there are some product offers, such as annual memberships of clubs or museums, where prices may only change infrequently or once a year. In such cases central sampling and price collection may represent a cost-effective solution. In many of these examples, it is often feasible to cover the entire universe of prices, although sometimes special methods are required.

It is worth noting that there are product groups in central price collection where specific sampling solutions are needed. In the examples below, the focus is on the sampling method and not the other aspects of index methodology. The examples demonstrate methods that might also be (partially) applicable to other product groups.

Package holidays — a case for quota sampling

The sampling unit for a package holiday is a completely specified holiday that occurs within a defined time period. The specification of a holiday typically includes at least the following variables: (i) destination, (ii) point of departure (airport), (iii) tour operator, (iv) hotel, (v) meals included, (vi) number of people travelling and (vii) other travel and (in some countries) cancellation insurance.

An ideal sampling frame would list each possible combination of these variables, but this is, of course, not practical. However, at least for some of these variables, the relative frequencies are known. The first three are sometimes available from official sources in the form of expenditure shares, and tour operators can be asked about relative frequencies of types of hotel and numbers of people sharing rooms, etc.

In this situation, quota sampling is the most practical choice. In a quota sample, it is possible to make a purposive sample such that all the known relative frequencies in the target universe are reflected, at least approximately.

Car insurance premiums — probability sampling feasible.

The target universe is all car insurance policies in a time period (year or month). Each insurance company will have a register of these policies including all price-determining factors such as type and age of car, age and location (residence) of the owner, etc. It may also be possible (as is done for example in Sweden) to ask each insurance company (they typically employ many statisticians), to draw a small random sample of policies from its own register and then note all price-determining characteristics of the policies selected (note: no personal data should be included). If that can be done, a probability sample is feasible. If companies are not willing to supply data, it may be possible to sample insurance providers statistically based on their relative expenditure share or number of policyholders. In terms of the actual policies priced, purposive methods based on the main price-determining characteristics are the only feasible approach.

New cars — PPS sampling

Many countries have a central car register with information on the brand and model, in which every new car is registered. Based on this, the index compiler could list all models, top-down according to total expenditure (the average price per model would have to be estimated), with the number of cars purchased. Care should be taken to distinguish between household purchases and other transactions. A PPS (Pareto, Sequential Poisson or systematic) sample could be drawn using expenditure per model as the size variable. An advantage of the Pareto method (see the CPI manual) is that an automatic method of excluding models that are out of scope (no longer sold or sold mainly to businesses) can be devised, guaranteeing that the final sample is still scientifically determined.

More detailed issues on coverage and other aspects of using a car register for sampling are discussed in Section 12.3.

4.4.6 Sampling of points in time

Each country has its own specific rules concerning the price collection period, within the limits set by Article 8 of Regulation (EC) No 2020/1148 on observation of prices for which observed prices shall refer to at least one working week at, or around, the middle of the month. Within these rules, the prescribed methods of sampling points in time are usually not very detailed and in field collection price collectors may be given a lot of leeway regarding when exactly to visit an outlet as long as they meet the deadline. For most products there is no problem with having less control over this aspect of sampling since few prices change within a week and the price collectors' choice of exact time will not have any noticeable effect on the result. Ideally, however, price collectors should aim to collect prices from a given outlet on the same weekday each month.

Spreading price collection across the week is best achieved by setting a schedule for the price collectors to visit outlets on different days of the month. Often, price collectors are given the option of deciding the day and hour of visits themselves within a given period, such as 1-2 weeks in the middle of the month. Where this occurs, care should be taken to ensure that price collection (as a whole) is not concentrated in just a few days.

Where prices for an individual product are known to be volatile within a month, the observed prices shall refer to more than one week (Article 8 of Regulation No 2020/1148). Examples of products that often show sharp and perhaps irregular price changes are fresh fruit and vegetables, fish, petrol, and some transport services (for example flights and train journeys). In the case of fresh product, it is not uncommon for market prices to fluctuate up or down by 50 % or more within a month. For transport services, prices can vary according to the day of the week or time of day and the timing of public holidays. (See also Chapter 5 and Section 12.5).

Prices for homogenous products for which many retailers have an inter-consistent pricing, such as for petrol and electricity, must also be collected over a long period.

For certain products, for example some travel services, the time of day and weekday are important price-determining factors. The sample will then have to be specified in terms of time so that it is representative of household purchasing patterns.

Scanner data offers the opportunity to process data relating to longer time periods than those gathered in the traditional way of collecting prices. Obviously, it is important to cover as much as possible of the reference month. Depending on the data supply arrangements and the production and publication calendar, the individual product observations typically cover the two or three (or sometimes the four) first weeks of the month. Diewert, Fox and de Haan (2016) ([67]) showed that aggregation over only one week of the month can be upwardly biased compared to aggregation over the full month. In principle, it is appropriate to calculate a unit value when an individual product is sold at different prices to different consumers, perhaps at different times within the same month. Conceptually, if all points in time during a certain time period are approximately equivalent to the consumer and there are no systematic price level differences between weekdays or hours of the day, then the whole time period (month or week) can be considered as homogeneous for the purpose of price aggregation.

When using web-scraped data, one of the important decisions to make is what the scraping frequency should be (temporal sampling). Prices collected on the internet can sometimes be highly volatile over time, with some websites applying dynamic or personalised pricing strategies (see Chapter 5).

The expected volatility of product prices could mean that more frequent extractions are made, but for most individual products it should be enough to do it on a daily or less frequent basis. If all points in time during a month are equivalent to the consumer, then as with scanner data, the whole time period can be considered as homogeneous (EU-Eurostat, *2020 Practical guidelines on web scraping for the HICP*).

([67]) Diewert, W. E., Fox, K. J., & de Haan, J. (2016), ‘A newly identified source of potential CPI bias: Weekly versus monthly unit value price indexes’, *Economics Letters*, 141, pp. 169–72.

Annex 4.1: Variance estimation and optimal allocation

Consumer price indices generally have a complex structure for data collection due to the different components which are mainly collected through surveys, although recent opportunities to use scanner data and web-scraped price information may potentially improve HICP accuracy (see Annex 4.4). Therefore, it is a significant challenge to produce estimates of HICP errors, even if the need for them has been acknowledged for a long time.

Errors in HICPs fall into two categories: sampling errors and non-sampling errors. This annex discusses sampling error.

Variance estimation can provide useful information at least for guiding decisions on sample sizes and allocating samples among the different products and outlets.

It might also be used to inform users about the likely margin of error of published index numbers. It is recommended that Member States show restraint until any particular variance estimation model has been analysed carefully.

Strictly speaking, calculating the sampling error in surveys by means of variance estimation requires probability sampling to have been used. Since probability sampling plays a relatively minor role in the compilation of most CPIs and HICPs, it is generally not possible to obtain reliable estimates of sampling error. Yet it is not entirely unreasonable to assume that samples are in many cases effectively random, i.e. the sample structure is such that it could have been generated by a random procedure.

Bearing in mind these initial disclaimers, this section discusses a simplified approach to analysing sampling errors that should be helpful in many countries. First, we discuss variance estimation and then we move on to the issue of sample allocation.

However, we should note that it is even more important to minimise biases that mainly arise from inappropriate treatment of quality change rather than sampling error. This has to be kept in mind when designing price samples — sometimes it is easier to keep control of quality change for complex products in a smaller sample.

Variance estimation

A very general form of HICP is $I = \sum_{i=1}^{N} w_i I_i$, where i denotes products, w_i the weight [68] of the product and Ii the product index. If the estimation of each product index were independent of each other the variance would be:

$$V(I) = \sum_{i=1}^{N} w_i^2 V(I_i), \qquad (4.1)$$

where $V(I_k)$ denotes the variance of the product index I_k.

However, product indices are not statistically independent. The main reason for this is that it is common practice to sample many products in the same outlet so that the same price-setting behaviour by an outlet can potentially affect many products. The sampling errors of the product indices are therefore correlated, which leads to equation (4.1) probably underestimating the total sampling errors.

(68) Here and below w denotes weights that are standardised so as to sum to 1.

As a first approximation and in particular for the purpose of allocating the sample, the simple equation (4.1) is still a useful starting point. The next step is to estimate the product variances $V(I_i)$. Note that these variances refer to variation in price change and not to price level.

If a product is represented by just one elementary aggregate, then $V(I_i) \approx \sigma_i^2/n_i$. Here σ_i^2 is the simple variance among the elementary aggregate's n_i product offer indices.(69) If instead the product index consists of several elementary aggregates (strata) the equation becomes $V(I_i) \approx \sum_{h \in i} w_h^2\, \sigma_h^2/n_h$, where now $h \in i$ refers to each stratum of the product index i. The elementary aggregate could for example be sub-products within a main product group or different cities/locations. Again, we assume zero correlations among elementary aggregates within the product.

For small countries with a simple sample design and without significant resources for analysing sampling error, the above approach could be a useful starting point for an analysis of sampling errors. Larger countries with more complex sampling design may well want to consider the peculiarities of their sampling designs and the various correlations that follow from them.

Optimising sample sizes per product

The number of products available to consumers is enormous and it is simply not possible or not affordable to collect prices for every product available in the market. Generally, for reasons of cost most countries' HICPs have between 500 and 1 000 product specifications in their basket of goods and services (even if this number increases with the use of scanner data). As some types of products have fixed national prices (e.g. utilities with a tariff) the number of product specifications required is low even though their weights within the HICP are high. Conversely, some products such as fruit are extremely diverse in both the range of varieties available and in price changes within a year, but their individual weights are generally very small. Given these factors, how can the sample of goods and services best (or optimally) be allocated among the ECOICOP categories with the limited resources available for price collection? This section describes how the sample size can be determined in an optimal way to reflect its relative importance in the measurement of overall inflation.

Optimal allocation of the sample aims either to minimise sampling error within a given budget or to minimise the cost of producing the index for a given sampling error. The natural starting point for an analysis of allocation is the Neyman allocation formula. For a CPI or HICP, if n is the total sample size, the optimal allocation can be written as:

$$n_i = n\frac{w_i\sigma_i/\sqrt{c_i}}{\sum_i w_i\sigma_i/\sqrt{c_i}} \qquad (4.2)$$

The new component in this formula is c_i which denotes the cost of measuring one sampling unit of product i.

Expressed in words, this formula states that the sample size for each ECOICOP product group should be proportional to its weight within the HICP and to the standard deviation of price relatives but inversely proportional to the square root of the unit cost of measurement.

(69) The ≈ symbol signifies that the expression is approximately correct when the Jevons (the ratio of the geometric mean of prices or the geometric mean of the ratio of prices) or the Dutot (ratio of arithmetic mean of prices) formulas are used.

Of these three components, the ECOICOP weight is straightforward and generally changes relatively slowly through time — normally once a year. Cost per unit requires detailed information on time spent in the field but rough estimates can still be helpful. For example, fast-moving electronic goods like smart TVs or computers are much more time-consuming to monitor than simple food products for which the quality features generally do not change. Note that only the relative cost of collecting prices is needed in the formula, not the absolute cost in monetary terms.

The most complicated factor to account for in the Neyman allocation formula is the standard deviation σ_i of the price relatives, i.e. how heterogeneous the price movements of all possible products within each ECOICOP 5-digit sub-class are. Three factors contribute to this complexity:

1. Equation (4.2) as it now stands is strictly valid only for a special form of probability sampling — simple random sampling (each sampling unit is drawn with equal probability). For stratified sampling, the formula can be modified fairly easily, but with other sampling designs it may prove more difficult. For non-probability sampling, an assumption that the sample is in some sense effectively random has to be made.
2. σ_i varies over time and the variation could be considerable (it depends on the target price change). For example, it may be different for a one-month change versus a 12-month change. Moreover, the standard deviation of price changes of a stratum is not necessarily constant over time. Furthermore, occasional price wars or the like may affect σ_i so that an estimate of σ_i for a historical period is not necessarily valid for the future. Since it measures the variation in price change across outlets, it depends on the intensity of competition activities in the market, which could change.
3. As discussed above, correlation between product variances also can make the estimate of $\sigma_i$difficult.

For this reason, a simplified strategy for the purpose of the optimal allocation of the sample is recommended for small countries with limited methodological resources. The strategy has two components:

1. As a first approximation, sample sizes for each product or stratum within the product should be proportional to the weight of the product or stratum. If the accuracy of the product index itself rather than only the overall HICP/CPI is considered crucial, then a minimum sample size per product is also needed.
2. The sample sizes are then modified, taking cost and standard deviations into account. Relatively crude estimates can be helpful here. For example, price collectors can be asked about how much time they normally spend on each product and calculations of standard deviations can be done for earlier time periods and for different time spans (1 and 12 months for example). The twelve-month price change from December to December is more important than change from December to other months. As described above, it is only the relative cost and the relative standard deviations that are needed in the formula, not the absolute values. A factor that also should be considered is that it is less expensive to sample an additional product in an already sampled outlet than to add another outlet to the sample.

Below are some examples of how to reason about sample sizes in a practical way for a number of product groups.

Petrol. Normally, petrol prices show little variation among outlets on the same day whereas they can vary considerably even over a month. It would thus make sense to have a relatively small sample of outlets but follow prices several times in the same month. However, the cost of price collection is normally small (telephone or email inquiries can often be used) and if so, a larger outlet sample could still be justifiable in order to be prepared for the rare occurrences of price wars between petrol stations.

Computers. Because of competitive pressures, prices for a specified computer model do not normally vary a lot among outlets, especially not within the same chain of outlets. At the same time, the cost and complexity of price collection are high because of the volume of information that needs to be collected along with the price. This situation calls for a relatively small number of outlets and models, with great care taken instead to be precise about the detailed specifications for each model (the product offer). This is the case irrespective of whether a hedonic or a matched-model (monthly chaining and replenishment or other overlap) approach to quality adjustment is used (see Chapter 6).

Fresh fruit and vegetables. Prices for fruit and vegetable are probably more variable over time (even over short time spans) than over outlets in the same day. If so, the number of outlets could be reduced to allow a larger number of observations to be distributed over the month.

New cars. Car prices do not usually vary much across outlets for the same model and specification ([70]). On the other hand, there are many models with different prices. One car retailer could easily provide prices for several models in the same collection period. As with computers, great care is needed to record all the detailed specifications of a model. This points towards an allocation strategy with perhaps only one retailer per model but several models per retailer.

Clothing. For each detailed clothing product, variation in price (in terms of both levels and change) can be great across outlets. There are outlet chains with markedly different price levels. However, prices across outlets in the same chain normally show little variation. If so, allocating the sample to one outlet per major chain and a sample of small independent outlets may prove to be the best strategy, especially for a small country or for each region of a larger country.

([70]) If price variation due to negotiation by individual customers is to be captured, a sample of customers per outlet/model is needed. However, practical difficulties normally rule out this approach.

Annex 4.2: An example from Germany

In Germany there exists something between the cases set out in Sections 4.4.3 and 4.4.4 and central price collection mentioned in Section 4.4.5.

As regards retail chains with a uniform pricing structure, a central survey is conducted by specially trained price collectors in one branch of the retail chain concerned. Therefore, in some chain stores, the prices in all stores (sometimes more than 100) are the same. In such cases, price collection in one store (maybe by well-trained price collectors) is more efficient than price collection in a sample of chain stores. But in that case the most sold approach is not appropriate. There is a need to collect more prices per product than with local price collection and to create a chain-specific sample. If such central price collection is combined with local price collection in one elementary aggregate without its own weight (e.g. in Germany taking big clothing chains as the centralised sample and small boutiques as the local sample — both are part of the elementary aggregate ‘specialist shops’), then the proportion between central and local price collection must be checked very carefully.

In Germany, for example, the sample fraction for outlets in local and in central price collection should be approximately the same. The number of prices collected for one product in each shop should also be the same. Yet, in local price collection, usually the (one ([71])) most sold product is selected for price collection while in central price collection a number of product offers — representing the range of goods of the product type — are selected. To avoid a disproportionate sample, explicit weights for the sample of one product in the chain stores with central price collection is created; these ‘multipliers’ sum up to 1 for each product per store.

([71]) For some product groups up to three.

Annex 4.3: Scanner data and consumer price survey sampling design: The Italian case

The availability of scanner data has, in the Italian case, allowed important improvements not only in terms of CPI/HICP monthly compilation but also in terms of sampling design at the basis of selection of outlets and, in particular in the first two years of usage of scanner data for Italian CPI/HICP (2018-2019), of the product offers (GTINs) for which the monthly price information within each outlet selected is required.

Indeed, thanks to the introduction of scanner data for the compilation of CPI/HICP, Istat had the opportunity to introduce a new sampling design for grocery products and large-scale retail trade distribution that covers most of the turnover of the market of this category of products (for which prices are no longer collected in the traditional retail trade distribution). Therefore, for grocery since 2018, the sampling design of the Italian consumer price survey is a two-stage design. The first stage is represented by the outlets of large-scale retail trade distribution (the PSUs, Primary Sampling Units), stratified by province (107) and type of outlet (hypermarket, supermarket, hard discount, small retail outlets, specialist drugstores), the second one by product-offers (GTINs that are SSUs, Secondary Sampling Units), stratified by the so called ‘markets’ that represent a low level of aggregation of GTINs in the ECR (Electronic Cashier Register) classification.

In 2018–19, the sample of outlets at the first stage of selection was extracted using a probabilistic design; at the second stage, the sample of product offers within each outlet was selected by a cut-off and adopting the static approach of the two ones recommended by Eurostat. Since 2020, the dynamic approach to select the sample of GTINs has been adopted at the second stage and within the strata represented by the ‘markets’.

The introduction of the new sampling design for the grocery products was made possible by the availability on the one hand of the information concerning yearly turnover of the outlets broken down by the main COICOP groups belonging to grocery and on the other hand of yearly turnover related to the strata (‘markets’). This information is made available, in the case of Italy, by the Nielsen company, but in general, they should be retrieved through statistical registers of enterprises and local units or directly from scanner data providers. It is worth noting that the availability in scanner data of information concerning the turnover and the quantities sold for each GTIN within each outlet allows the selection of the GTINs in case of adoption of a static approach.

Indeed, the index of an elementary aggregate in each Italian province, is calculated as the weighted arithmetic mean of indices of strata, compiled as the weighted arithmetic mean of outlet indices with weights obtained using the PPS (Probability Proportional to Size) approach.

Therefore, in 2021 the sample of outlets has been selected from the Nielsen universe, represented by 21 chains (out of 25) and about 29 000 outlets, covering more than 90 % of total turnover of the modern distribution in Italy. This universe is stratified by province (107) and outlet type (hypermarkets, supermarkets, discounts, small retailers and specialist drugstores). As aforementioned, the outlets represent the PSUs of the sample design (within which the selection of the GTINs, SSUs, is carried out by a dynamic approach) and their selection is made by using PPS, probability proportional to the (potential) turnover of the outlet. Evaluations have been carried out on the exclusion of strata with very low weight, in terms of potential, within the province ([72]).

As a result, about 526 strata were considered for the selection of the sample of outlets and within these strata a sample size of 4 000 outlets (each one with its own sampling weight that is the reciprocal of the selection probability, coherently with the PPS approach) was selected.

The number of outlets in the sample by province has been defined based on a compromise between three allocations criteria:

- a uniform allocation among the 107 provinces;
- an allocation proportional to the number of outlets in the provinces;
- an allocation proportional to the total turnover in the provinces.

Moreover, a compromise between two criteria of allocation was adopted to establish the number of outlets by type (discounts, small retailers and specialist drugstores) within each province. These criteria are the following:

- an allocation proportional to the total number of outlets;
- an allocation proportional to the total turnover of the outlets.

For the strata in which there are fewer outlets than those allocated, all units in the stratum have been selected.

The final sample of outlets in 2021 consists of 1 452 supermarkets, 1 023 small sales areas, 560 discounts, 496 specialist drugs and 472 hypermarkets.

Table 4.4.6 shows the distributions of the sample of outlets selected at the regional level.

Table 4.4.6

Sample of outlets by region and placement (within and outside the provincial town) – year 2021

Region	No of outlets in the sample	% of outlets within the provincial town	% of outlets outside the provincial town
Piemonte	310.0	30.3	69.7
Valle d'Aosta	23.0	8.7	91.3
Lombardia	537.0	22.9	77.1
Trentino Alto Adige	91.0	28.6	71.4
Veneto	278.0	29.9	70.1

([72]) Based on the analysis, a threshold equal to 0.005 (0.5 %) was decided, which at the same time allows limits on the number of excluded strata (and outlets) and the number of strata with only one outlet.

Region	No of outlets in the sample	% of outlets within the provincial town	% of outlets outside the provincial town
Friuli Venezia Giulia	129.0	35.7	64.3
Liguria	142.0	43.0	57.0
Emilia Romagna	327.0	41.6	58.4
Toscana	329.0	34.7	65.3
Umbria	78.0	34.6	65.4
Marche	166.0	19.9	80.1
Lazio	259.0	45.2	54.8
Abruzzo	130.0	29.2	70.8
Molise	53.0	39.6	60.4
Campania	235.0	26.8	73.2
Puglia	231.0	29.9	70.1
Basilicata	62.0	37.1	62.9
Calabria	141.0	30.5	69.5
Sicilia	313.0	28.4	71.6
Sardegna	169.0	27.8	72.2
Italy	**4 003.0**	**31.4**	**68.6**

In conclusion, the introduction of scanner data in the compilation of Italian CPI/HICP has further improved the quality of the survey design as a whole, opening the way to the adoption of a probabilistic approach to sampling that could in future allow the estimation of the sampling component of the measurement error that is a crucial aspect of the quality policy in official statistics.

Annex 4.4: Accuracy of HICP sampling and non-sampling errors: the role of scanner data

The accuracy and reliability of HICP estimates are of paramount importance due to the wide use of HICP as an economic indicator, which encompasses macroeconomic policymaking to uprating of costs and benefits. It is a widely scrutinised statistic, not least because of the effect it has directly on the lives and budgets of individuals (Smith, 2021 ([73])).

HICPs, like other official economic statistics, inherently carry uncertainties ([74]) or errors due to the way they are compiled as well as to the fact that the phenomena they measure are often latent and not directly observed. Due to the complex structure for data collection for producing HICPs, there are various types of potential errors that may arise from different sources when estimating a population HICP. Several data sources are used for producing the HICP both for weights (National Accounts data, Household Budget Survey data, administrative data, etc.) and prices (visits to local retailers and service providers and central collection via mail, telephone, e-mail, the internet, scanner data, web scraped data, administrative data).

Measuring HICP accuracy

NSIs generally do not publish numerical estimates of HICP errors, which are difficult to quantify due to the complexity of price index structures and the common use of non-probability sampling. From the sampling point of view, consumer price indices are published as point estimates (assuming that some of their components are random) therefore they do not incorporate the uncertainty inherent in the sampling process (sampling errors) as well as that related to non-sampling errors (measurement, choice of the formula, coverage, etc.). Consequently, no estimate for a HICP sampling error is available except for Sweden ([75]). The situation has not changed much since Morgenstern's remark on this issue *'In spite of the widespread use of government price indices, there has been little done in attempting to determine the error inherent in these indices'* (Morgenstern, 1963 ([76])).

However, measures of statistical errors for CPI/HICP have many uses: to inform on the quality for users of HICP, to guide HICP compilers in allocating resources for HICP compilation in the most efficient way and to detect possible serious errors in the data when output editing.

The interesting fact is that there has been very little assessment of the relative accuracy of the different approaches to sampling (Dorfman et al., 2006 ([77])). Indeed, it has not been clear if it is feasible to make such assessments. The underlying population price index, for even the smallest of countries, involves so many transactions on so many items in so many places as to be inaccessible. Moreover, the population of items on the market is dynamic, thus introducing

([73]) Smith, P. A. (2021), 'Estimating Sampling Errors in Consumer Price Indices', *International Statistical Review*, 89, 3, pp. 481–504.

([74]) This inherent uncertainty or error can be defined as the difference between the estimated and the true population value.

([75]) Statistics Sweden, *Quality Declaration Consumer Price Index*, 2021-02-18.

([76]) Morgenstern, O. (1963), *On the Accuracy of Economic Observations*, 2nd edition. Princeton, NJ: Princeton University Press.

([77]) Dorfman, A.H., J. Lent, S.G. Leaver, E. Wegman (2006), 'On sample survey designs for consumer price indexes', *Survey methodology*, Vol. 32, No. 2 (December), pp. 197–216.

additional difficult in the selection of an appropriate sampling design. Since HICP is not generally obtained from a single survey, the sampling and non-sampling errors, being related to all the surveys used for the construction of the index, cannot be easily specified by a single complex model. However, it is often possible to develop partial measures, in which only the effect of a specific single source of error is quantified.

In recent years, there has been a growing concern for a more explicit use of the concepts and tools of statistical inference to produce estimates of official CPIs/HICPs and, especially, to define the targets of the estimates following a framework typical of statistical survey methods. The so-called sampling approach in index theory is underlined by Balk (2005) ([78]) who considered for elementary aggregates the relation between the target index, the sample index, and the sampling design and analysed the index properties from the sampling point of view. Any actual price index, specified as a function that transforms sample survey data into an index number, can be considered as a stochastic variable, whose expectation ideally equals its target population.

De Gregorio (2012) ([79]) analysed aggregation effects and found that the optimal sample size depends crucially on the degree of relative variability and skewness of price changes and underlined the crucial role of stratification in reducing sample size. Empirical evidence showed that stratification may shrink sample size by 50 % to 70 % as compared to SRS design. The choice of the strata is of paramount importance, since it involves theoretical and microeconomic issues, including for example market criteria, to isolate possibly homogeneous product groups and clusters of pricing policies.

In this framework, NSIs try to reduce the sampling errors by using a sample of consumer prices that is representative of the target universe and as large as possible, under their resource constraints. In order to minimise the variance of the all-items index, the NSIs often use models that optimise the allocation of resources by indicating the number of prices that should be observed in each geographical area and each item category. Similarly, NSIs try to reduce non-sampling errors through continuous methodological improvements and survey process improvements, such as computer-assisted price collection that can help avoid coding and typing errors.

Sampling errors: the role of scanner data

However, the availability of new sources of data, such as scanner data and web-scraped data, have stimulated research for adopting more developed statistical techniques for constructing CPIs/HICPs and for assessing their accuracy (Fenwick and Ball, 2001 ([80])). Consensus has emerged on the fact that, besides reducing the administrative burden and cost for both statistical agencies and retailers, scanner data may allow the reduction of both sampling and non-sampling errors.

By using scanner data, it is possible to obtain probability samples for products sold in modern retail chains as well as to stimulate research on the various sampling methods. Various studies

([78]) Balk, BM (2005), 'Price Indexes for Elementary Aggregates: The Sampling Approach', *Journal of Official Statistics*, Vol. 21, No. 4, 2005, pp. 675-699.

([79]) De Gregorio, C. (2012), 'Sample size for the estimate of consumer price subindices with alternative statistical designs', *Rivista di Statistica Ufficiale*, vol 1, pp.19-47.

([80]) Fenwick, D., & Ball, A. (2001, April), 'Sampling in Consumer Price Indices: what role for scanner data?', In sixth meeting of the International working group on price indices, Canberra (pp. 2-6).

have evaluated whether and to what extent price indices are affected by differences in the sampling method and formula (Imai, Diewert, and Shimizu, 2015 ([81])). In addition, using repeated sampling techniques (Bootstrap and Jackknife methods) from a model, population variance estimation may be derived (Heravi and Morgan, 2014 ([82])).

As already mentioned, sampling uncertainty has been addressed on several occasions at Statistics Sweden. Recently, Tongur (2019) ([83]) focused on the case of scanner data for daily consumer products and their inclusion in the CPI, particularly regarding the issue of the trade-off between item related variance and the bias from disregarding explicit quality adjustments. Results show that the contribution to the variance from a randomly sampled item in the daily products survey is rather small and would tend to decrease with appropriate sampling, given that the samples are based on size-proportional sampling strategies. The sample size related variance is estimated by a Jackknife method.

In this context, another obvious advantage of scanner data is that the transactions of all individual products sold in outlets belonging to certain retail chains are available. With the aim of reducing sampling errors, scanner data can be used as a sampling frame for designing probability sampling and to replace traditional sample-based methods by methods that allow integral data processing, at least within some product groups. If all the stores from the various retail chains are covered, the scanner data set can be used as sampling frame for both the outlet and product dimension (see Annex 4.3). Revenue shares for each individual product can be used to determine the representativity / importance of each individual product within a product group. Individual products can then be selected for inclusion in the CPI/HICP 'basket' based on revenue share either through sampling proportional to revenue (i.e. PPS) or cut-off sampling. Recent research focuses on the evaluation of probability and non-probability samples drawn from scanner data with different schemes. Furthermore, different criteria of sample allocation both for outlets and elementary aggregates have also been considered (Bernardini et al 2016 ([84])).

Non-sampling errors: the role of scanner data

As an estimator, a CPI/HICP is considered accurate if both its bias and variance are small. Therefore, sampling variances are only one component of the accuracy of a CPI/HICP, and there is a general feeling among authors that sampling errors are generally small relative to the other types of error in a price index (Smith, 2021 ([85])). Attempts to classify and measure errors of a consumer price index date back to Edgeworth who discussed three types of errors: i) errors in weights; ii) errors in price relatives; iii) errors resulting from unrepresented product categories. After his pivotal study, several different taxonomies of bias have been introduced into CPI/HICP literature.

([81]) Imai, S., Diewert, E., & Shimizu, C. (2015), *Consumer Price Index Biases,* Ottawa, Group Meeting Tokyo 2015.

([82]) Heravi, Saeed and Morgan, Peter Huw (2014), 'Sampling schemes for price index construction: a performance comparison across the classification of individual consumption by purpose food groups', *Journal of Applied Statistics* 41 (7), pp. 1453-1470.

([83]) Tongur, C. (2019), 'Inflation Measurement with Scanner Data and an Ever-Changing Fixed Basket', *Economie et Statistique / Economics and Statistics*, 509, pp. 31-47.

([84]) Bernardini, A., De Vitiis, C., Guandalini, A., Inglese, F., & Terribili, M. D. (2016, May), Measuring inflation through different sampling designs implemented on scanner data, In UNECE meeting of the group of experts, Geneve.

([85]) Smith, P. A. (2021), 'Estimating Sampling Errors in Consumer Price Indices', *International Statistical Review*, 89, 3, pp. 481-504.

Specific studies on non-sampling errors have been carried out considering: (i) Formula error, which is a vexed question because there is no gold standard with which to compare a formula, but the general approach has been to try to approximate a superlative index formula as closely as possible (see for example Dorfman et al., 2006); (ii) Measurement error, which includes many of the kinds of errors, such as the failure to measure the price actually paid, new items and products (and quality adjustment error), and other measurement errors of the survey type resulting from the practical difficulties of the field operations; (iii) Non-response error which results from the collection of incorrect, inconsistent, or incomplete data. For example, new products can be a source of bias, a systematic under- or overestimation; (iv) Coverage error, which includes under-coverage (when elements in the target population are not included in the sampling frame used for sample selection) and over-coverage (when some elements are included in the survey that do not belong to the target population). These errors are mainly caused by the use of cut-off samples where parts of the population of interest are excluded.

By considering this framework for error classification, the various advantages of using scanner data in terms of CPI/HICP accuracy are illustrated below.

Firstly, regarding formula error (i), it is worth noting that scanner data offer the possibility of calculating more accurate price indices thanks to the use of weighted index formulae based on expenditure data at individual product level. This allows the computation of a superlative index in a situation where monthly scanner data are available to the NSIs for components of the CPI. However, as more experience with the use of chained indices has become available, it has been noticed that period-to-period chaining of a matched superlative price index leads to chain drift. Multilateral methods that are typically used in international spatial comparisons have been found to be a solution to this problem, even if a choice needs to be made among the several index compilation methods that can be applied to scanner data (Lamboray et al, 2017 ([86]); see also Chapter 8 for a detailed discussion on this issue).

Measurement error (ii) may be reduced thanks to the fact that the period over which prices are collected can be expanded in many cases, so that the number of observed product prices will increase. In general, the unit value price is a more accurate measure of the actual price of an individual product than an isolated price quotation, since it is a summary of an average of transaction prices over thousands of observations (Diewert, 1995 ([87])). Unit values contain discounts and the effects of these discounts on the quantity of varieties sold. Turnover data can be used to compute expenditure shares at GTIN level which further reduces measurement error.

Scanner data allow the reduction of non-response errors (iii) as itemised information is available from transaction data which can be used to replace field-collected prices (including a better treatment of sales, promotions, and discounts) and to expand pricing samples (or using all the data). Scanner data also offer an opportunity to examine the effect of product exclusions ([88]).

([86]) Lamboray, C. (2017, May), 'The Geary Khamis index and the Lehr index: how much do they differ?' In Paper to be presented at the 15th meeting of the Ottawa Group (pp. 10-12).

([87]) Diewert, W.E. (1995), 'Axiomatic and Economic Approaches to Elementary Price Indexes', Discussion Paper No. 95-01. Department of Economics, The University of British Columbia, Vancouver, Canada.

([88]) Brunetti et al. (2018) make such calculations for Italy, where sampling in the main CPI is restricted to the main provincial towns and uses only a sample of the most-sold products. They find only some differences, mainly due to sampling towns only, and concentrated in the south of Italy. Brunetti, A. Fatello, S. Polidoro, F., Simone A. (2018,), 'Improvements in Italian CPI/HICP deriving from the use of scanner data', in 50th Scientific meeting of the Italian Statistical Society.

Turning to coverage errors (iv), it is important to underline that when scanner data are used, the coverage of the price indices is also broadened, and the number of outlets and products increased. In this context, conceptual uncertainty can be also reduced by using unit value prices since they are more representative of prices paid by consumers over the reference period. The quality of price data increases given that directly observed prices are replaced by unit values from scanner data. Survey data merely contain shelf prices, which are not necessarily equal to the prices eventually paid by consumers. Information on numbers of individual products sold and turnover is not collected in traditional surveys. However, the market coverage of scanner data may vary between different retailer types and commodity groups and the amount and detail of data available can vary depending on the commercial source and on the individual product or product group.

5

Price collection

5 Price collection

5.1 Introduction

This chapter examines the definitions, rules, and procedures to be applied when observing prices in the HICP, the practicalities of price collection, and the processes of quality assurance and data editing. As a rule, prices have to be sampled, and the procedures involved typically entail collecting local prices from a sample of outlets in different locations. The sample is designed to represent the shopping habits of the population and their purchases within the scope of the HICP, as described in Chapter 4. However, prices can also be collected from central sources, such as utility companies or government bodies that set tariffs, online and from scanner data provided by retailers.

This chapter also covers alternative sources of price information; Section 5.4, in particular, discusses price collection on the internet, as well as more traditional methods of price collection. In considering new data sources, Section 5.4.3 illustrates the different approaches adopted by NSIs for processing scanner data, particularly focusing on the acquisition of scanner data and data characteristics (information available on products, GTIN ([89]), retailers, etc.). Section 5.4.4 describes how to retrieve data from other sources, focusing on Application Programming Interfaces with open access, which are intended to provide structured and controlled access to specific data or services on a server. In addition, Section 5.4.5 addresses the classification issues arising when these new forms of data are used for HICP computation, as classifying individual products/item codes to ECOICOP is the first step in processing scanner data as well as web-scraped data.

It does not cover the complexities that occur in some product areas, such as insurance, health

([89]) GTIN (Global Trade Item Number) is the name currently used for product code formerly known as EAN. GTIN is the nomenclature most commonly used when dealing with scanner data even if other codes may also be used, such as price look-up (PLU) and in-store and stock-keeping units (SKUs).

services and package holidays. Among the complications not dealt with are tariffs and the bundling of goods and services where, for instance, a customer pays a single price covering both the supply of a mobile telephone handset and a pre-specified amount of call time. These issues are covered in Chapter 7 and Chapter 12.

The collection and processing of prices must adhere to the basic concepts and rules underpinning the HICP. The HICP reflects the average change over time in the transaction prices observed, that is, the purchase prices of a representative fixed set of goods and services bought by households. Therefore, the HICP measures pure change in consumer prices that is unaffected by quality change. In order to ensure that the concept of 'price' is applied in a harmonised way by the Member States, it is necessary to establish rules on the treatment of prices.

Price collection should be aligned with the price definition underpinning the HICP. The target for the HICP is the actual prices paid by the HICP target population. However, it is worth noting that traditional price collection methods generally focus on shelf prices in physical outlets or on offer prices given in price lists, i.e. the displayed prices of *product offers*. Actual prices may deviate from shelf or offer prices if, for example, the purchaser negotiates with the retailer to obtain discounts on large purchases, or if a price is matched to that in another outlet, or if a seller negotiates for higher trade-in prices for used cars and other items.

When using scanner data, information on the actual expenditure for each individual product sold is provided by the retailer whose data are used; this information is used for calculating unit value prices. Automated internet data collection (web scraping) may also be implemented to collect online prices. However, listed prices or advertised prices may differ from prices actually paid by consumers for goods and services (transaction prices), if, for example, a discount (or personalised discount) is offered or due to the inclusion of shipping costs.

As illustrated in Chapter 4, sampling occurs on different levels (or dimensions): geographical (locations), outlet, product and time dimensions. Accordingly, multi-stage sampling designs are commonly employed. The geographical and outlet dimensions have been discussed in Chapter 4. The product dimension, also partially addressed in Chapter 4, will be further dealt with in the present chapter.

This chapter will cover both traditional and new data sources, detailing how price collectors use sampling methods to select a specific variety or model of a product to be priced in an outlet. This is particularly relevant when they have been provided with a vague product description by the head office. This chapter will also illustrate product specification in scanner data.

The time dimension is also covered in this chapter. HICP index numbers relate to a calendar month, and the index itself is calculated monthly with no retrospective revisions, other than those arising from errors or other revisions coordinated with the Commission (Eurostat) (see Chapter 10). As prices do not generally remain constant over a month, temporal sampling is applied. This involves spreading price collection over a representative period, particularly when collecting price observations for products with relatively volatile prices. Indeed, price collection needs to respect the temporal component of the HICP associated with the concept of a fixed basket. Thus, the aim is to collect prices each month for the same representative goods and services, in the same outlets, over the same period.

Within this context, an overview of manual price collection is provided in Figure 5.9.6 at the end of this chapter. It is presented as a flow figure, showing the different situations a price collector might face, and the decisions or referrals to head office they need to prepare for. The diagram should be considered an example of good practice in meeting legal requirements: the details are not stipulated by regulation or covered by recommendations.

5.2 Basic legal requirements

This section outlines the main legal requirements regarding price collection. The legal requirements concerning discounts are described in Section 5.3.3.

Article 5(3) of Regulation (EU) 2016/792 facilitates the collection of prices by stipulating that retailers must provide prices. It states:

> '*The statistical units that provide information on products included in household final monetary consumption expenditure shall cooperate in the collection or provision of basic information as required. The statistical units shall give accurate and complete basic information to the national bodies responsible for compiling the harmonised indices.*'

Subparagraph 4 of the same article refers specifically to the provision of electronic records:

> '*On request of the national bodies responsible for compiling the harmonised indices, the statistical units shall provide, where available, electronic records of transactions, such as scanner data, and at the level of detail necessary in order to produce harmonised indices and to evaluate compliance with the comparability requirements and the quality of the harmonised indices.*'

Commission Implementing Regulation (EU) 2020/1148 of 31 July 2020 provides the methodological and technical specifications for the HICP and states that the purpose of the HICP is to measure pure change in prices, unaffected by quality change. Therefore, it is also necessary to establish rules for replacements and quality adjustments (see Chapter 6).

Concerning the treatment of prices, Article 5 of EU Regulation 2020/1148 states that:

> *'1. Member States shall use observed prices to compile the HICP. They shall use estimated prices only for the purposes laid down in Articles 9, 11 and 14.*
>
> *2. Observed prices for health, education and social protection products shall be net of reimbursements.*
>
> *3. Changes in the observed prices or conditions of a tariff shall be shown as price changes in the HICP.*
>
> *4. If observed prices are index-linked, changes resulting from changes in the index shall be shown as price changes in the HICP.*
>
> *5. If household income is a condition determining the price, changes in the observed prices resulting from changes in household income shall be shown as price changes in the HICP.*
>
> *6. Observed prices for insurance shall be actual premiums.*
>
> *7. If an individual product has been made available to consumers free of charge and a price is charged subsequently, this shall be shown as a price increase in the HICP. Conversely, if a*

price has been charged for an individual product that is subsequently made available to consumers free of charge, this shall be shown as a price decrease in the HICP ([90])*.'*

Article 9 of EU Regulation 2020/1148, focusing on the estimation of prices, states that:

'1. If the price of an individual product in the target sample cannot be observed, an estimated price shall be used for no longer than 2 months, after which a replacement product shall be selected. This paragraph shall not apply to seasonal products or other individual products that are expected to become available again.

2. A previously observed price shall not be used as an estimated price unless it can be justified as an appropriate estimate.'

The focus of the above articles is on procedures for using *estimated* (i.e. imputed) prices in cases where it proved impossible to observe a price directly, rather than price collection as such.

There are no HICP regulations or official guiding principles relating specifically relating to observation (non-sampling) errors during price collection.

The price collection methods are chosen by the NSIs as long as they ensure sufficient quality, according to the legislative framework underlying the production of HICP. Data validation is conducted by the NSIs; additional quality and consistency checks are also carried out by Eurostat. The detection of outliers and errors, such as those attributable to errors in price collection, is part of the process of checking and correcting inaccurately observed prices.

It is important to verify, as operationally feasible as possible, that the prices entering the HICP are correctly observed and recorded. NSIs adopt different techniques to check data for internal consistency and completeness according to the source of data (see Section 5.9). In the context of price collection, reference is sometimes made to a distinction between *primary* and *secondary* data sources. Primary data sources include local price collection from price tags and outlet staff in the field. Prices can be collected by visiting in person, by telephone, or by checking vendors' websites, catalogues, or price lists (electronic or paper-based). Secondary data sources include scanner data and administrative sources, from which prices can be derived.

There is an intermediate grey area where the distinction is less clear-cut. For instance, it is unclear whether a tariff for the supply of a utility and the associated detailed figures on sales, obtainable from a regulatory authority, is a primary or a secondary data source. While the regulatory authority is a secondary source, it has access to information obtained directly for regulatory purposes from the utility company, the primary source.

Two important considerations when using secondary sources are whether prices correspond to the price definition used in the HICP, and whether they come from a trusted and neutral source with no interest in misreporting, relate to the correct period of time, and are verifiable. Due consideration must be given to checking secondary sources to confirm that they meet these conditions. It is not unreasonable to expect data obtained from a regulatory authority to be subject to quality assurance. However, such data are focused on the needs of the authority regarding timing, detail and so on, not those of the HICP. One of the main attractions of using secondary sources is cost-effectiveness, burden reduction and, in the case of regulatory

([90]) Examples of products (i.e. goods or services) that may change from zero to non-zero prices and vice versa are provided in Section 7.5.

authorities, for instance, the possibility of obtaining large quantities of quality-assured data from one source.

5.3 Principles

In general, a multitude of factors influence the choice of price collection methods adopted by NSIs, which should take into consideration efficiency, accuracy and representativity of consumers' purchasing patterns. Price collection is becoming increasingly multimodal with prices being sourced from the internet via web scraping or obtained from scanner data, as well as being collected manually from outlets and by telephone inquiry. The traditional method for gathering price data is the local price collection that involves collectors visiting individual outlets to collect prices for an assortment of goods and services. The following five principles express the general ideas that should guide index compilers in developing price collection strategies regardless of which data source is used:

1. The fixed basket at elementary aggregate level
2. The definition of a price
3. Discounts and inducements
4. The timing of price collection and of entering purchase prices
5. Frequency and period of price collection periods: volatile prices.

5.3.1 Principle 1: The fixed basket at elementary aggregate level

An underlying principle of price collection in the HICP is the fixed basket approach (at elementary aggregate level). As underlined above, the HICP is defined as an annually chain-linked Laspeyres-type index. Its purpose is to provide a measure of pure change in prices that is unaffected by quality change. The reference to a pure price index refers to the fact that it is only the changes in prices between the current (comparison) period and the price reference period that are reflected in the HICP (see Chapters 2 and 8). Comparing prices between months on a like-for-like basis is an underlying principle of the HICP and inflation measurement.

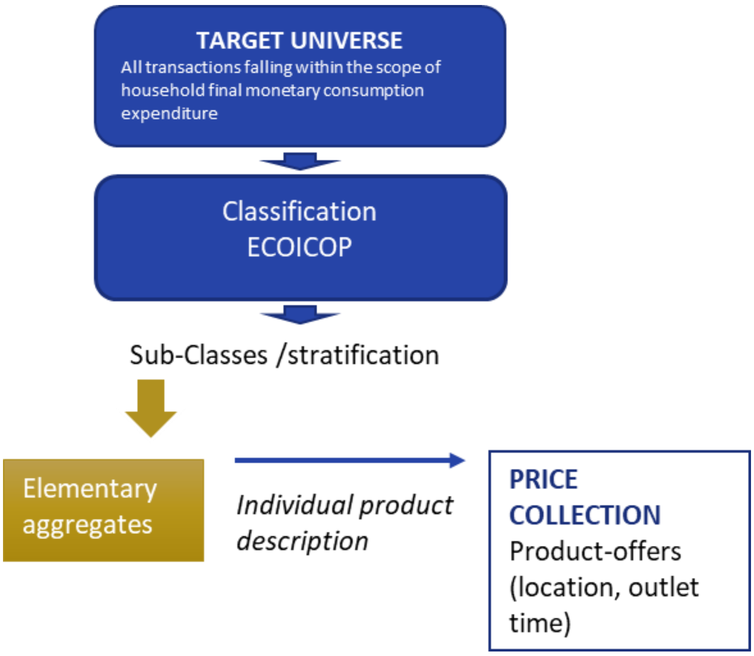
The fixed basket principle applies at the level of the elementary aggregate which is defined as the lowest level in a Laspeyres-type index (Article 2, Regulation No 2020/1148). Therefore, the HICP's fixed basket approach relates to holding elementary aggregates fixed over time (see Chapter 4), while individual products within the elementary aggregate should be identified according to the data sources and might be replaced where necessary or desirable, applying quality adjustment if the price-determining characteristics of the replacement differ from those of the product it has replaced (see Chapter 6). Elementary aggregates are defined according to the sampling strategy and to the methodological approach followed for compiling the HICP in each Member State (see Chapter 4). Generally speaking, an elementary aggregate can be defined as a partition of the product universe that is a disaggregation of a harmonised ECOICOP 5-digit sub-class level. This partition is determined by each Member State according to its needs and it is strongly related to the data sources. Figure 5.3.4 illustrates this structure for traditional price collection methods.

When price data are collected in a traditional manner in the field, within each elementary aggregate, individual product descriptions for which prices are collected in shops must be made The product specifications provided by the central statistical office may be relatively broad (e.g. jam, strawberry, 150 – 300 grammes) to ensure that one and the same individual product description can be used for a reasonably long period of time and across different retailers. On the other hand, a precise specification may be adopted for certain products by providing a fairly precise description of an individual product with the aim of narrowing the range of varieties from which a price collector or the central office might choose (see sub-section 4.4.1 and Section 5.5).

It is crucial to ensure that the priced products are representative and that the recorded monthly price movements within each elementary aggregate of the HICP reflect only price changes. The concept of a product offer is particularly important in this context. A product offer is an identifiable entity comprising a specific variety of a single good or service (individual product) offered for purchase at a stated price in a specific geographical area, location, place of purchase (an outlet or a shop) and point in time (Article 2(4) of Regulation (EU) 2020/1148).

Figure 5.3.4

Product offers: traditional price collection structure



Under stable market conditions it is advisable to collect prices that relate to the same product offer as in the preceding month. In other words, the same individual product offer should be priced in subsequent comparable periods. In the case of local price collection, that means collecting the prices of the same products, in the same shops and at the same point in time as in the previous period. With central price collection, it implies collecting the prices of the same representative goods and services offered by the same suppliers in the reference month (see Section 5.4.1). This makes it imperative to record any additional information available on product characteristics, to ensure that the same specific product continues to be priced.

When data are collected manually, it can be particularly challenging to identify a unique product offer if prices are being collected in a subsequent period by a different person who may be less familiar with the products and outlets. This is another reason why an adequate description of the product offer being priced in each outlet should be recorded, so that it can be uniquely identified at subsequent pricing. This description may be more detailed than the version of the product specification used for sampling, particularly if loose product specifications are used. In local price collection, various practices may be used by NSIs for checking that the price of the same product offer is being observed. For example the use of tablets for the local price collection provides the opportunity to check if the product characteristics are the same and to correct errors at the time of price collection (see section 5.9.1). In some instances, the use of photographs and the recording of audio descriptions can be an efficient way of doing this. For instance, photographs and audio recordings can be very helpful when collecting garment prices.

When using scanner data, prices for product offers are not typically observed, but rather unit values (sales value divided by quantities sold) pertaining to product identifier or item code (Eurostat, 2017 ([91])). Individual transactions of the target universe that fall within an elementary aggregate are directly observed. Therefore, a decision must be made on how to define the 'homogeneous products' for which sales data is aggregated within an elementary aggregate. According to Article 2 of Implementing Regulation 2020/1148 a 'homogeneous product' means a set of product-offers among which there are no significant quality differences and for which an average price is calculated. When specifying homogeneous products, quality differences must be evaluated with respect to three dimensions: the product dimension, the outlet dimension and the time dimension (see Section 5.5). Similarly, if web scraped data are used for HICP compilation, it is crucial to collect additional information for each scraped price, including the date/time when the price has been scraped, the name of the website from which the price has been scraped, a product identifier, a description of the product and possibly other meta-information on the product (e.g. a product category). In this way, each such data point corresponds to a 'product-offer'for which a price can be observed at a given time on a website. The operational meaning of homogenous products in the context of scanner data has been analysed, for example, by Dalèn (2017) ([92]) and Lamboray (2019) ([93]). Chessa (2018) ([94]) argued that, when constructing homogenous products, trade-offs must be made between homogeneity and stability over time. If items are defined too broadly, there is a risk of a unit value bias. If they are defined too tightly, there is a risk that relaunches are not captured (see also Chapter 4). Figure 5.3.5 illustrates the structure of homogenous product definition when scanner and web-scraped data are used.

([91]) Eurostat (2017), *Practical Guide for Processing Supermarket Scanner Data*. Available at: CIRCABC/Price Statistics/Library/Public/Manuals and Guidelines.

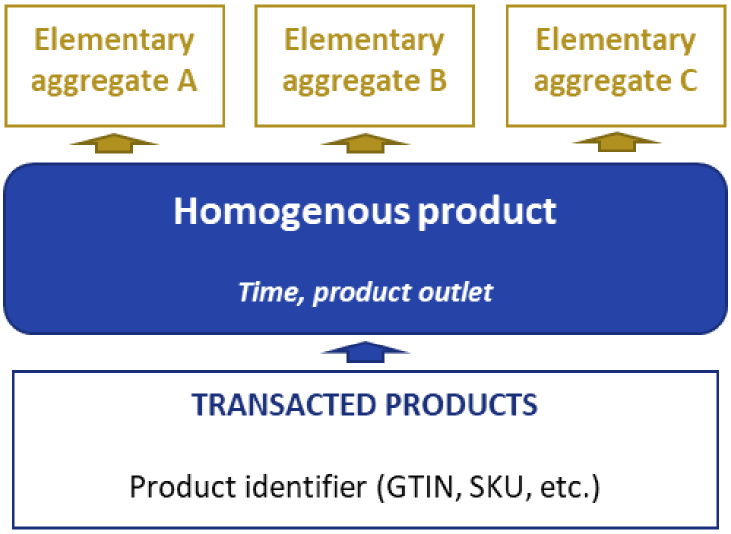
([92]) Dalèn, J., (2017), *Unit values in scanner data – some operational issues*, paper presented at the 15th meeting of the Ottawa Group, Eltville, Germany.

([93]) Lamboray, C. (2019), *Elementary aggregation: A not so elementary story*!, 16th meeting of the Ottawa Group May 7-10, 2019 Rio de Janeiro, Brazil.

([94]) Chessa, T. (2018), *MARS: A method for defining products and linking barcodes of item relaunches*, NTTS 2019 conference, Brussels, Belgium.

Figure 5.3.5

Homogenous products: new data source structure



Replacement of products

Detailed product information is also required to identify changes in quality when there arises a need for a product offer replacement. This occurs when the product offer being priced is no longer available or no longer representative. For instance, the outlet concerned may no longer sell the product, or the product is not available in any outlet, perhaps because its production was discontinued. If no replacements were made when product offers disappeared, the sample of product offers and prices would diminish and could become increasingly unrepresentative.

When a product offer is no longer available and is being replaced, the main price-determining characteristics must be listed to inform the choice of replacement and any necessary quality adjustment. It should be borne in mind that similar models (with different article numbers) may differ in ways that do not matter to consumers and do not affect the price (such as the exact position and size of a brand name label), so it would be fruitless to record such differences. But checks need to be carried out at each subsequent price collection to identify any modifications that could affect the price of products which appear unchanged. For instance, the same model number may be in use, but it may be discovered on enquiry that the detailed features have changed. For fruit and vegetables, weight, quantity information and packaging (i.e. whether the goods are pre-packed) should be part of the product specification. This also applies to a range of other products such as meat, fish and bread. This information is needed to adjust the nominal price in the price reference period of the new or replacement product, to make allowances for any change in quality (including quantity). It is important for price collectors to check pack sizes regularly, as it cannot be assumed that they never change.

Food producers and manufacturers of fast-moving consumer goods may pass on higher costs to consumers by reducing the package contents rather than increasing the package prices. This marketing technique, known as ‘shrinkflation’ or package downsizing, involves reducing the quantity of a product but selling it at the same price. The ‘shrink’ part of the term refers to the change in package size, typically a reduction, whereas the latter part of the word refers to inflation – the rise in the general price level. If products ‘shrink’ in size, inflation rises even if prices stay constant, as consumers pay the same amount of money for less of the good. This business practice is widely used across various goods (such as dairy, confectionery, and personal care products) and in many countries. A classic case of 'shrinkflation' is that related to a chocolate bar whose cost did not go up but it shrank from a net weight of 170 grams to 150 grams. Consumers are sensitive to price hikes, but they may pay less attention to how much a product weighs. In order to more accurately measure inflation, quality adjustment processes should be used to isolate price movements from the changes in product's weight or quality ([95]).

In the event of changes in product specifications, prices should be treated in accordance with the rules on quality adjustment set out in Regulation No 2020/1148, Article 1. How these rules are applied in practice is the subject of Chapter 6.

In traditional price collection, price collectors can have a pivotal role in the procedures for replacements and quality adjustment — how vital that role is depends on whether loose or tight product specifications are used (see Section 5.5). Price collectors have more influence on the reliability of the HICP when loose product specifications are used, as these leave them more discretion to choose what product offers they price. Where a replacement product offer has to be found, it often falls to the price collector, with guidance from the commodity and product experts at the head office, to find the most suitable replacement product, bearing in mind the need to avoid near-obsolescent products and products that are not representative of current purchasing habits. Price collectors need clear instructions on how to do this.

Similar considerations apply when prices are collected by the head office using scanner data and other sources. More specifically, a product defined by an item code (GTINs or SKU) can in practice be considered as homogeneous as item codes uniquely identify a specific article. However, different item codes may sometimes identify individual products that are almost identical or near perfect substitutes to each other from a consumer point of view. In addition, an item code may disappear from the market, but another item code may appear in the next period assigned to a product with slightly different characteristics that are not relevant to most consumers such as packaging. In such cases, in order to maintain comparability over time and measure pure price changes, it may be appropriate to use a product characterisation that is above the item code and allows for a price comparison of homogeneous products (see Section 5.4).

Identifying changes in characteristics

In some cases, the price-determining characteristics of products appear superficially to be exactly the same as in the preceding month but prove on enquiry to have changed. For instance, this may be the case where there has been a small reduction in the pack- size which will only be obvious by looking at the small print at the side of the packet or where certain fruits, such as berries, are sold by basket and not by weight.

In traditional price collection, price collectors should read the information given on the packaging, weigh the basket or ask shop staff whether the amount of fruit in the basket has changed. Before pricing, the price collector should always first check the product description on the price collection

([95]) Despite its prevalence, only few works examined consumers' response to downsizing. Examples are Çakır, M., & Balagtas, J. V. (2014), 'Consumer response to package downsizing: Evidence from the Chicago ice cream market', *Journal of Retailing*, 90(1); Çakır, M. (2022). 'Retail pass-through of package downsizing. Agribusiness', 38(2), pp. 259–278.; Kim, I. K. (2022), *Consumers' Preference for Downsizing Over the Package Price Increase*. Available at SSRN 4044401.

form — which should include all price-determining characteristics — with the description on the article sticker. If the sticker does not provide the full description, shop staff should be asked to provide the missing information. It is impossible to be prescriptive about what follow-up questions should be asked, but they should focus on confirming the price-determining characteristics.

In the case of scanner data, the availability of additional characteristics of the products, such as brand, material, package size, etc. that are given may be useful for identifying changes in product characteristics. When web-scraped or internet data are used, several practical strategies have been proposed to specify individual products and to identify changes in product characteristics which are primarily focused on extracting characteristics information (for example, brand and shirt type) from text strings (see Sections 5.4.5 and 5.5).

Replacement strategies

When selecting replacement products in accordance with the HICP regulation, the principal strategy is to replace the disappearing product with the *most similar individual product*. Section 4.4.4 discusses the strategies that can be employed for the initial sampling of individual products, i.e. in the case of non-probability sampling the individual product that is *most sold* or those products that may be expected to *last longer*.

Replacing the product with the one *most similar* to it reduces the role of quality adjustment, as the more similar a replacement product is the less the price-determining characteristics will differ. However, the disadvantage of this strategy is that the sample of individual products in the elementary aggregate may become increasingly unrepresentative, as the replacement product may be less likely to be typical of what is currently being sold. Replacing the product with another product that is *most representative* resolves this issue by keeping the sample up-to-date and relevant but will result in the need for more quality adjustment. The HICP regulations offer no detailed advice on this issue.

However, one of the main legal requirements of the HICP is that it should represent the average change in prices over the target universe. Moreover, replacement products must not be selected on the basis of a similar price (Article 10(2)). Statisticians should weigh up the pros and cons of various approaches to replacing individual products. In so doing, they need to take into account:

- the dynamics of the market, particularly the rate of product development,
- the capacity and capability of the statistics office to adopt satisfactory quality adjustment procedures, and, most importantly,
- the need to ensure that a representative sample is maintained. (See Chapter 4).

The point to note in this chapter is that in manual collection the price collector needs to be given clear instructions on which rules to follow when choosing a replacement and which information to record when doing so.

Generally, product offers in the sample should be replaced when they are no longer representative, not just when they can no longer be found in outlets. This is particularly important for high-tech products, which are subject to rapid technological development and a high replacement rate for models. Quality adjustments and replacements are discussed in depth in Chapter 6.

When scanner data are used, replacements will be considered in different ways by NSIs depending on the approach adopted. If the static approach is used, which closely mimics the traditional fixed sample, the treatment of relaunches follows the traditional methodology. For example, a semi-automated method may be used in which listings of new and disappeared products may be based on text mining analysis and manual verification using metadata online (Van Loon, 2019 ([96])). However, the volume of data to be processed may preclude human expert input into the choice of replacement products. In this case an automated decision-making process should be developed (Leclair et al., 2019 ([97])).

With internet price collection, if an item is permanently unavailable the detailed product information needed to select a replacement and make any necessary quality adjustment is generally readily available on websites, can be copied with relative ease, and automated using web scraping.

5.3.2 Principle 2: Price definition

Regulation 2016/792, Article 2, provides a definition of price. This states in clauses (2) and (4) respectively:

‘2. ‘Consumer prices’ means the purchase prices paid by households to purchase individual products in monetary transactions.’

4. ‘Purchase price’ means the price actually paid by the purchaser for products, including any taxes less subsidies on the products, after deduction of discounts from standard prices or charges, excluding interest or services charges added under credit arrangements and any extra charges incurred as a result of failing to pay within the period specified at the time of purchase.’

The above definition broadly follows the concept of the purchaser’s price as defined in the European System of Accounts (ESA) 2010.

The prices used to compute the HICP are the transaction prices agreed at the time of purchase between households and retailers of goods and services within the scope of the index. The transaction price is defined to include sales taxes such as Value Added Tax (VAT) less any subsidies (e.g. subsidised prices charged by government) and allowable discounts.

The overall position is that expenditure and prices included in the HICP should relate to payments made to purchase goods or services. The fact that the prices paid may be subsidised is of no consequence (examples of subsidised prices are given in Section 12.1 Health, education and social protection). Similarly, the price recorded for the HICP should be net of reimbursements, i.e. net of any payments made by the vendor of the good or service to the purchaser — whether they are an outlet, a government agency or some other vendor — as a consequence of purchasing a good or service.

Supplementary interest or service charges associated with consumer credit arrangements are excluded from the price, as are additional charges arising from failure to pay within a stated period, e.g. when using a credit card at the time of purchase. These latter charges are not part of

([96]) Van Loon K. (2019), *Redefining what products are in the context of scanner data and web scraping*, experiences from Belgium. Paper presented at the 16th meeting of the Ottawa, group, 08–10 May 2019, Rio de Janeiro, Brasil.

([97]) Leclair, M., Léonard, I. Rateau, G. Sillard, P. Varlet G. and Vernédal P. (2019),’ Scanner Data: Advances in Methodology and New Challenges for Computing Consumer Price Indices’, *Economie et Statistique / Economics and Statistics*, 509, pp. 13–29.

the purchase price and should be excluded. Services incurring unavoidable charges that are not part of the basic advertised price (such as a delivery charge for large household appliances or furniture) and which are either compulsory or which most customers choose to use as a discretionary service, may be treated as an inseparable bundle of a good and a service and thus as a single product (see Section 7.6 on the treatment of bundles).

Tips for services, e.g. in restaurants, should be included in the purchase price if the service charge is shown in the price list as a standard component of the total price to be paid and is itemised in the bill. For example, in some restaurants there is a non-discretionary service charge for parties of, say, six or more people dining together. The service charge should relate to the product offer being priced and should exclude charges for any additional services not specified in the product offer. Non-compulsory tips or gratuities are gifts that fall outside the scope of the HICP.

Prices are thus defined in the HICP as the prices that purchasers pay, that is, the acquisition prices. Acquisition prices are what consumers actually agree to pay when they purchase goods and services to satisfy their consumption needs. As previously stated, in manual price collection, local collectors generally focus on shelf prices in physical outlets or offer prices in price lists. This deviation from the target measure is often admissible, but where there is any doubt, the price collector should preferably check that the offer price is the price most commonly paid. As Section 5.4.3 will illustrate, NSIs may use scanner data as an alternative source for price collection, replacing collection in the stores, without changing the traditional principles of computing the price indices. However, the definition of price differs from that used in manual collection and it is more similar to the price actually paid by consumers. Indeed, in the context of scanner data, unit price values are computed as the ratio between total sales and quantity sold for that product offer. In this context, an individual product should be uniquely identified by using for example its barcode or GTIN-codes (also known as EAN-codes).

By convention, individually negotiated prices do not fall within the scope of the HICP, although priced quotations given by builders, decorating services and service providers for specific jobs are covered, subject to a representative sample of such quotes being drawn.

5.3.3 Principle 3: Discounts and inducements

‘Inducement’ means a change, often temporary, in the characteristics of an individual product by increasing the quantity of the product, attaching another individual product free of charge or offering other benefits to the consumer. Inducements shall be treated in accordance with Articles 10 and 11 (Replacements and Quality Adjustment).

Discounts fall within the scope of the index if they:

- are applicable to individual goods or services
- are provided at the time of purchase.

The discount offered or the special-offer price displayed must refer to a particular defined product and must be provided to the consumer at the time of purchase. The existence of a true discount price can usually be substantiated, e.g. where the consumer and the price collector can see both the standard and the reduced price displayed.

Before designating a price as a *sale* price, care should be taken to ascertain that it represents a genuine discount and has not been assigned to shop-soiled or damaged goods, products close to their expiry date, or items that are similarly perceived as being different in quality from the corresponding products that are normally on sale.

Discounts offered to pensioners for public transport are an example of discounts available to specific sub-groups of the population. Discounts of that kind should enter the index calculation if deemed significant.

However, bonuses and free gifts are not universally treated as discounts, that is, they should not be deducted from prices in the index, unless they are likely to have influenced consumer behaviour, i.e. they provide an effective inducement for the customer to purchase the good or service in question (see rule 3 below).

The objective is to use prices that reflect actual transaction prices including any tax and reflecting any discounts, sales, or promotions. Therefore, the treatment of discounts in the framework of the HICP should:

- represent a *practicable* solution;
- ensure, to the best extent possible, equal *solutions* regardless of data sources in the HICP;
- ensure, to the best extent possible, *consistency* with Article 6 of Regulation 2020/1148 mentioned earlier.

More specifically, as deviations may exist between data sources, discounts that are exclusively available to a limited consumer group (discriminatory discount) or other types of discounts (e.g. lower prices associated with loyalty cards) should be taken into account if allowed by data characteristics. With scanner data, the prices (unit values) typically include the discounted prices in proportion to their sales, namely discounted prices that are only available to loyalty card holders. In traditional price collection however, it may not be feasible to estimate the proportion of a specific group of households that benefited from a discounted price and therefore such types of discounts are often ignored by NSIs.

In this context and against a background where discounts have become more prominent and where various data sources for prices are being used (including scanner data and web-scraping), five general rules can help to guide the index compiler. These do not necessarily form part of a regulation, but they can provide guidance for applying regulation rules in practice.

Rule 1*: General principle*. Price reductions (i.e. discounts) should be taken into account in the HICP as long as they are applied to an individual good or service and are known to the purchaser at the time the purchase is made. In addition, rebates or refunds should be taken into account only if they are linked to the purchase of an individual product and granted within a short period of time after the actual purchase such that they are expected to have a significant influence on the quantity purchased. The difference between discounts and rebates can be hazy and is perhaps best drawn according to timing: a discount takes effect at the time of purchase, whereas a rebate becomes operative some time later (CPI Manual, 2020 ([98])). Discounts are typically applied at the point of purchase to reduce the buying price. The discounted price is visible as of the precise moment that the purchase would have been made. Rebates are a retrospective payment, which

([98]) ILO (2020), *Consumer price index manual: Concepts and methods*.

eventually reduces the overall cost of a product or service at a later date. This makes rebates different to discounts, as consumers pay for the full amount then, at some point later in time, part of the amount may get returned to them. Rebate agreements can take many complex forms. Rebates may be made in respect of a single product (for example, air miles), or may be more general (for example, supermarket loyalty programs where a 10-euro voucher is awarded for every 200 euro spent). A simple example of a rebate is a volume incentive, where a customer could receive a rebate for buying a certain volume of a certain product over the life of the deal. For example, if a customer purchases over 10 units of paint (priced at 10euro a unit) from a paint store, then they can receive a 5 % rebate. Once the consumers purchase their 11th unit of paint, then they can get the rebate, which would mean that they actually spent 9.50 euro on each unit. Loyalty rebates are offered on condition that the consumer engages in a loyal purchasing behaviour, by repeatedly purchasing from the same seller and refraining to purchase from other suppliers. One-off rebates are limited to a single time or occasion, such as a one-off rebate to assist households with the rise in energy costs. According to Article 6 of Implementing Regulation 2020/1148 Member States shall take account of these type of discounts when they can be attributed to an individual product and can be claimed at the time of purchase. It may be virtually impossible, however, to take account of all discounts and rebates in practice (CPI Manual 2020).

Rebates should be treated in the same way by the HICP and the national accounts. The latter point is particularly pertinent for some services provided by government or state agencies. For example, where the consumer pays in part for health services, the prices should be net of direct refunds made as a direct consequence of the individual purchasing the service in question.

Rule 2*: Discriminatory discounts*. Discounts available only to a restricted group of households should be considered as they may affect consumer behaviour. They are likely to have such an impact if they are available to a significant proportion of households and the associated expenditure is relatively high in percentage terms. However, it may not always be possible to know the exact share of discounted prices that are charged to a specific group. Under such circumstances, it may be acceptable to ignore discriminatory discounts.

Rule 3*: Inducements*. Inducements in the form of extras may be disregarded if the value to the consumer of the inducement (normally taken to be the retail price of the inducement if purchased) is insignificant and has little impact on whether a potential customer makes a purchase. The market value of the inducement may be deducted if known, but it should then be added back if the offer is withdrawn. Where such inducements are included, they should be sampled according to their relevance. An inducement could be treated like any other replacement product or quality adjustment.

Rule 4*: Credit and payment arrangements*. Credit and payment arrangements involving interest, service charges or extra charges incurred as a result of failing to pay within the period stated at the time the purchases were made should be disregarded. These charges are not part of the purchase price.

Table 5.3.7 below uses examples to provide more detailed guidance on forms of reduced prices in HICP according to Regulation 2020/1148.

Table 5.3.7

Guidance on treating reduced prices in the HICP according to the data source

Form of price reduction	To be reflected in the HICP	Not to be reflected in the HICP
Rules from the Regulation		
1 When the reduced price can be linked to an individual good or service		
2 When the reduced price is available to all consumers as well as to a restrictive group of consumers (1)	1–3 to be fulfilled in combination	
3 When the reduction is known to the purchaser at the time the transaction takes place		
4 When the reduction can be claimed at the time of purchase and it is expected to have a significant influence on the quantities sold	X	
5 Inducements	X	
Other rules not explicitly written in the regulation		
6 Stock clearing sales prices if no specification changes are identified	X	
7 Closing-down sales prices if no specification changes are identified	X	
8 Seasonal sales	X	
9 Goods which are in end-of-range or line sales		X
10 Damaged, shop-soiled or defective goods or stock purchased for the sale		X
11 Goods close to their expiry date		X
12 Prices which include zero-interest loans		X
13 Prices which include positive interest loans		X
14 When the price for more than one piece is lower than the price for one piece (2)	X	

Form of price reduction	To be reflected in the HICP	Not to be reflected in the HICP
15 Free product B provided with purchase of product A		X
16 Prices in connection with money off coupons		X
17 Lower price for a restricted group of persons	X	
18 Deposit for money back bottles	X	
19 Deposit included in the price of a new car if the old car is destroyed		X
20 Loyalty rebates not attributed to an individual products		X
21 Prices in connection with loyalty cards ([1])	X	
22 Incentive schemes to replace old products by new ones (e.g. cars)	X	
23 One-off rebate in next year's bill		X

Note:
([1]) With traditional field data it may not be possible to consider these types of discounts.
([2]) Scanner data allow to consider these types of discounts

Advertised prices in *stock-clearing sales* and *closing-down sales* should be taken into account if no specification changes are identified, as the prices are non-discriminatory and apply to individual goods (rule 1).

However, *discount cards* which are only available to people who have joined an organisation such as a trade union and which entitle the holder to discounts at certain shops are allowed even if they require the shopper to perform a specific action before shopping, subject to specified terms and conditions (rule 2).

Cash-back discounts should be disregarded (rules 1 & 3) as any cash back or points accruing from a purchase which can then be used to obtain free gifts or cash backs on purchases are associated with the use of the credit card and are not linked with the purchase of an individual product. The same applies to store cards.

Similarly, any annual fee for the use of the card or interest charges incurred are not part of the purchase price of a product (rule 4).

An inducement, which helps sellers to persuade consumer to purchase a product or a service, shall be treated in accordance with Articles 10 and 11 of Regulation (EU) 2020/1148. When the inducement has monetary value for the consumer, is associated with a particular sale, and is large enough to influence whether a purchase takes place, it is needed to verify the existence of quality differences between the good and services in question and then quality adjustments methods may be used to correctly consider product prices. Judgement is required, and perhaps some market research or discussions with the retailer, to ascertain whether an offer by a retailer will influence shopper behaviour. Insignificant inducements should be ignored as no quality adjustments are needed.

An example of what may be considered an insignificant inducement is providing a free tank of petrol when a new car is purchased. While the petrol may have considerable monetary value, it is unlikely to be significant compared with the price of a new car. Moreover, it is impossible to assess whether such an offer increases sales. But if five litres of petrol were provided free for every 10 litres purchased, that would probably be a major incentive for drivers to buy their petrol at the petrol station advertising the offer. This would be an example of a significant inducement and would therefore fall within the scope of the HICP (rule 3).

5.3.4 Principle 4: Timing of price collection and of entering purchase prices

The timing of price collection is chosen purposively in most cases. The main principle is that the prices of each individual product should be collected each month at the same time, during the same week (weekdays excluding holidays) or the same day of the month. If there is some price variation within a day, it is important that prices are collected always at the same time of the day (ILO 2020).

As already mentioned in Section 5.2, Article 8 of Commission Regulation No 2020/1148 lays down detailed rules as regards the timing of entering observed prices into the HICP. Prices for goods shall be entered into the HICP for the month in which transactions can take place at that price while the price for a service shall be included in the HICP for the month in which consumption of the service can commence.

Some products have a time-dependent component that should be incorporated into the product specifications. This has an impact on the scheduling of price collection and on the individual product being priced. For example, prices for airfares or other transport services can be highly dependent on the day of the week, the time of the flight, and how long in advance the ticket is purchased. Such timing elements should be held constant to ensure the comparability of the collected prices over time. This has a bearing on the collection and treatment of prices for other services, e.g. on the treatment of package holidays concerts and season tickets for football, which are usually purchased some months before the holiday, concert or football season.

Regular price collection to a fixed timetable is an important aspect of price collection related to sampling (see Chapter 4). Price collection days (and sometimes the time of collection) need to be set in advance. The interval between successive price collections from each retailer, in traditional price collection, must be kept constant by collecting prices at a set time each week or month. This is regardless of the frequency of price collection and is especially important when collecting prices for products with volatile prices (see the next section).

When scanner data are used, depending on the data supply arrangements and the production and publication calendar, the information typically covers the two, three (or sometimes the four) first weeks of the month. It is important to cover as much as possible of the reference month. The time period over which scanner data is aggregated should align with the retailer’s pricing policy, thus allowing price changes to be monitored (ILO, 2020). Commonly scanner data are aggregated over a week and delivered and processed per week. When web-scraped data are collected, attention should be paid to the scraping frequency as prices collected on the internet can sometimes be highly volatile over time with some websites applying dynamic pricing strategies. The expected volatility of the observed prices could mean that more frequent extractions are made but for most items, it should be enough to do it on a daily or less frequent basis (Eurostat, 2020a ([99])).

5.3.5 Principle 5: Frequency and period of price collection periods.Volatile prices

The HICP recognises that special arrangements may be needed for products whose prices tend to be volatile over time.

If prices for an individual product are known to be volatile within a month, the observed prices shall refer to more than 1 week. This rule could apply for example to:

- energy products;
- fresh food, such as fruit and vegetables.

The HICP legal framework does not set out all the practical details of implementation. This enables individual EU countries to choose the approach that best suits their needs. The important point is that the average prices should be representative of the average price for that month, i.e. they should be based on a dense enough sample over time to deal with price volatility and should also be representative of sales periods.

How the price collector deals with volatile prices depends on the nature of the volatility. Thus, if prices are volatile due to regular changes over the week – for instance, peak prices for restaurant meals could be on a Saturday, when demand is particularly high, with lower prices on other days of the week – then collecting prices on the same *representative* day of the week should prevent artificial volatility in the index as long as the price pattern remains stable. On the other hand, if price volatility is irregular, then averaging of daily prices over an extended period may be warranted. An example is retail petrol prices, which can change daily in response to fluctuations in the price of crude oil.

5.4 Price collection methods

5.4.1 Local and central price collection

While HICP regulations define the set of prices to be covered by the index and also the price concept, the regulations are not prescriptive about data sources. They leave it to individual countries to decide on the appropriate sources for gathering prices and the sampling methods to be used. This is because the most appropriate sampling and survey methods and the best data

([99]) Eurostat (2020), *Practical Guidelines on Web Scraping for the HIC,* European Commission, Eurostat, Available online: Practical guidelines on web scraping for the HICP (europa.eu).

sources for the HICP price survey depend on local circumstances. These include the structure of retailing in terms of the characteristics of outlets, their geographical spread and the range of goods and services available to purchase.

In recent years, traditional price collection has been replaced by increasingly automated digital data sources, such as web scraping data from web pages and direct collection from enterprises and government agencies via register and transaction data. In this case data are collected centrally. Nevertheless, traditional methods for gathering price data, involving collectors visiting individual outlets to collect prices for goods and services, continue to be used in many Member States with the help of local statistical offices across the country. Therefore, various data sources are incorporated into HICP production.

Local price collection

As regards *local price collection*, consideration must be given as to how best to collect prices with regard to efficiency, accuracy and representation of consumers' purchasing patterns. Replacement strategies and the application of quality adjustment methods can also be a consideration. For example, more complex and data-intensive quality adjustment methods, such as hedonic methods, are applied centrally because they require highly technical skills and relatively large and detailed data sets that go beyond what many local data sources can provide.

For many kinds of products, prices are collected locally by price collectors visiting a sample of retail outlets — either selected by the head office or coordinated by it using a prescribed sampling scheme — and recording the current price of a sample of product offers. This approach is referred to as *local* price collection (see Section 5.8.1). The products to be priced are usually selected by head office, but there may be some leeway in the exact characteristics, such as the brand or specific product model to be priced.

The use of tablets for local price collection makes it easier to gather prices in the field in real time, improves quality assurance and increases the scope for better quality control by head office. It also obviates the need to copy prices from paper to computer, which is inefficient and avoids the associated risk of transcription errors. Local price collection can be costly, and consideration needs to be given to the most efficient way of collecting prices while also ensuring accuracy and proper representation of consumers' purchasing patterns. There are other options which are less expensive (see below in this section).

Despite the cost, there are also advantages in local price collection. In particular, regular visits to the shops in their price collection area mean price collectors can physically check that the same product offer is being priced from one month to the next, and they will also be better informed about local retailing. They can raise queries and ask retail staff questions that might not appear relevant or be feasible in the same timescale if they were doing this at a distance. Such questions might include, for instance, whether there have been hidden changes in product characteristics, whether the product offer being priced is still representative, and whether staff think a missing product is likely to be re-stocked.

Conversations with retail staff also make it easier to put follow-up questions straight away. The knowledge and expertise that local price collectors gain can also be used more generally, benefiting the continued development and relevance of the HICP. For example, local price collectors can inform their head office about newly significant products found on retailers' shelves and about new shopping centres or outlets. Such information can be used when reviewing the HICP basket of goods and services priced and the outlet sample.

Local price collection can be outsourced to a private company for financial or practical reasons, although most statistical agencies do this work in-house. Local price collection is a specialist activity requiring special skills. Outsourcing enables statistics agencies to exploit the price collection expertise of market research companies and others, and to focus on more familiar statistical data-gathering exercises, thus reducing average unit costs and using their professional skills in the most effective way. However, outsourcing depends on having effective and well-managed contracts.

Central price collection

Collecting prices centrally, without visiting local outlets, can offer a good alternative to local price collection. Often it is the only feasible method, particularly for some services, such as health, education and social services, which, in most countries, are provided almost exclusively by government institutions or public bodies. Several Member States have introduced internet price collection (see Section 5.4.2) and scanner data into production covering various product aggregates (see Section 5.4.3). Central price collection can also provide the best option for services like utilities and public transport, where prices are set nationally or regionally by the public or private sector supplier, and it is the only option where there are no outlets as such (see Section 5.8.2).

Prices set centrally may change infrequently and at pre-determined times of the year, making price collection relatively less laborious. However, statistical offices should avoid making unwarranted assumptions that there have been no price changes between one collection period and the next. In principle, central prices can also be collected centrally in any situation where a retailer advertises prices online, for instance, or from a retail chain with centralised pricing and where prices can be obtained from a central source.

Centrally collected prices may be obtained from scanner data, internet, by email, by postal enquiry, telephone, or fax. It is not usually necessary to visit the head office of the retailer or service provider on a routine basis, although it is advisable to maintain regular contact, e.g. by email. Where retail chains claim to set prices centrally for all their outlets, the price collector should check that there are no local variations in prices, and that the central pricing policy has not changed since the last time prices were collected. The head office of the retail chain should be asked to confirm regularly that prices are set centrally, and independent checks should be carried out where possible, e.g. informally when doing family shopping. If the prices advertised by a retailer online are, in reality, different from those charged in those retailer's shops, then online purchasing should be treated as a different outlet-type and should be placed in a different elementary aggregate. Prices can also be collected from publicly available price lists, provided that these lists are up-to-date and accurately reflect the price a customer would actually pay. The main challenge with these sources is validating the prices by reference to an alternative source. Setting up arrangements to compare prices quoted in price lists from central sources with those in a sample of outlets undermines the benefits of central price collection. That is often the case for purchases of cars where the price actually paid is a bargain price.

It should be noted that consistency issues arise when combining price data from different types of outlets, that is, different channels for purchase. In these cases, it is important to have a properly balanced sample of prices from the whole range of outlet channels that accurately represent the purchases of the target population. Constructing separate elementary aggregates for each data source — where the latter represents different outlets or outloutlet-types — and aggregating the elementary aggregates using explicit weights relating to the respective turnovers can help to ensure a balanced sample, but may not entirely resolve the problem.

There are several considerations when deciding whether to use central or local price collection. An assessment has to be made as to whether there is a central source of relevant information, such as a public utility provider or a government agency, with a pre-established list of products, prices and purchase conditions that has been established centrally by the supplier or by government. In many cases, the service provider may provide a full price list or tariff from which prices can be extracted, either in their entirety or on a sample basis.

If there are a very small number of prices, sampling may not make sense or may be unreliable. For example, no sampling would be involved if an electricity tariff simply consisted of a standard standing charge for service provision and a standard charge per kilowatt of electricity used that was the same for all customers, regardless of location and varied only with total usage. See Section 7.4.

Other prices may be obtained centrally, either for convenience or to maintain a representative sample, where this mode of purchasing is increasingly used.

The general issue of sampling is addressed in more detail in Chapter 4.

5.4.2 Internet price collection

The internet is a major price collection source for the HICP. For some time, EU countries have been using it to observe prices centrally, instead of sending price collectors to physical outlets. However, changes in households' purchasing habits, with more and more purchases now made online, reducing visits to physical stores, have prompted countries to review their use of the internet for data collection. The COVID-19 crisis accelerated an expansion of e-commerce towards new firms, customers and types of products. This has provided customers with access to a significant variety of products from the convenience and safety of their homes (OECD, 2020 ([100])). Some of these changes in purchasing patterns will likely be of a long-term and structural nature, as more recent studies are demonstrating (Jensen et al, 2021; Pollák et al, 2022 ([101])). Therefore, EU countries increasingly include online outlets (even when physical stores exist in parallel) as a separate outlet-type in their index compilation systems. They are developing their price collection methods to reflect this change in the market.

Consequently, the internet today has three roles in price collection:

- First, it is an important outlet-type where consumers actually buy goods and services.
- Second, it is a significant source of price information on goods and services bought by consumers elsewhere (i.e. in other physical or non-physical outlets).
- Third, it is a relevant source of information on product characteristics and meta data.

([100]) OECD (2020), *E-commerce in the time of COVID-19, Tackling coronavirus (COVID-19) Contributing to a global effort*, October 2020.

([101]) Jensen, K., Yenerall, J., Chen, X., and Yu, T. (2021), 'US Consumers' Online Shopping Behaviors and Intentions During and After the COVID-19 Pandemic', *Journal of Agricultural and Applied Economics*, 53:3, 416–434. Pollák, F., Markovič, P., Vavrek, R., & Konečný, M. (2022), 'Return to the new normal: Empirical analysis of changes in e-consumer behavior during the COVID-19 pandemic', *Behavioral Sciences*, 12(3), 85.

It is important for price statisticians to know the role and type of prices observed on the internet. The first type of price relates to transactions that are *actually undertaken* on the internet. These prices from internet outlets should enter the HICP in proportion to the underlying transactions' market share. The second type of price may be used to replace the prices collected in the field in physical outlets. The main advantage of collecting prices from the internet is that it is generally much cheaper than collecting prices by visiting outlets in person. One website may even show both sets of prices charged when buying goods at the physical outlet or through other traditional channels (catalogues), and the prices charged when purchasing online, as well as special online-only offers.

Price collection from online retailers shares certain features with traditional price collection. Member States need to check that the prices collected are in line with the HICP price concept. Also, as visiting an online retailer's website should be seen in some sense as similar to going to a physical store, internet price collection should be done in accordance with the national laws and practices applicable. For example, retailers could be informed in advance that they are part of a sample and that the country is planning to collect prices for the HICP, if that is the national practice.

What is more important is that the internet era brings new opportunities and challenges for price collection. As already mentioned, the opportunities are linked to the digital nature of the internet, which makes automated price collection possible. This in turn enables a larger amount of data to be captured and the frequency of data collection to be increased. These factors have the potential to improve the quality of the HICP. The challenges are linked to managing increasing amounts of data, retailers' new pricing strategies, blurred national boundaries, the inclusion of the sharing economy ([102]) , and the complexity of the internet as a potential data source. Another feature of the internet is its propensity for rapid change. EU countries are currently developing strategies and technologies to address these challenges.

Prices can be collected from the internet using the traditional method of central price collection, i.e. statisticians visit web pages to observe the prices of a sample of products considered to be representative. However, the internet also offers promising new options. Some EU countries are using ready-to-use commercial internet data extraction websites and software tools, which provide easy access to web-scraped internet price data.

Third-party applications, such as cloud services, can be used to collect prices and do not require programming environment or prior programming experience. However, practice has shown that using third-party applications is rarely free of charge and may also cause legal problems because the scraped data could be stored in a foreign country.

Moreover, many countries are developing web-scraping tools tailored to specific HICP requirements. Such tools can collect large numbers of prices for a wide variety of online products and automatically feed them into structured datasets, using web-crawling software. The use of web-scraping is common for individual products for which it is known that online purchases are getting more and more representative (Eurostat, 2020a).

Collecting prices online involves a number of technical and practical issues that do not affect traditional price collection in physical outlets or are less important in that context. IT automation

([102]) A definition of 'sharing economy' can be found at The Sharing Economy - What It Is, Examples, And How Big Data, Platforms And Algorithms Fuel It (forbes.com).

techniques and scraping technologies allow the quick and relatively effortless collection of large amounts of data available on the web. Indeed, over the past years several NSIs across European countries, including, for example, the Netherlands (de Haan and Hendriks, 2013 ([103])), Italy (Polidoro, Giannini, Lo Conte, Mosca, and Rossetti, 2015 ([104])), and Romania (Oancea and Necula, 2019 ([105])), have significantly improved data collection methods through the use of automated digital data sources.

Developments in this area are ongoing and appropriate solutions have not yet been found in all cases. The issues concerned have to do with technical innovations used by retailers in the area of pricing strategies, and with the globalisation of online retail. Some examples are outlined below.

Statistic Belgium has been web scraping data for several product groups for computing the CPI/HICP, including consumer electronics, footwear, hotel reservations, books, using R (mostly using the rvest and Rselenium packages ([106]). In addition, web scraped data allow the coverage of new segments, such as second-hand cars and renting a student room, thanks to specific analyses carried out by StatBel ([107]).

As online outlets can record all visits and purchases by using cookies, monitoring IP addresses or requiring registration, they can target their marketing, with different products and prices for different customers. For example, a price collector surfing from one online store to another might be offered a reduced set of products or prices adjusted in line with the search carried out in the first internet outlet, as relevant information might have been saved by way of cookies.

Another technique used by online retailers is *dynamic pricing* by which retailers automatically and continuously change their prices in the light of current market demand, identified consumer profiles, competitors' pricing and other external factors in the market. This is already common practice in several market segments, such as travel, entertainment, electricity and public transport. As online retailers are increasingly using dynamic pricing, the frequency of price collection and the methods used also need to be adapted to online stores' pricing policies.

Online outlets can also use geo-blocking and other geographically based restrictions to prevent customers from other countries from making purchases. And this may only become apparent once the would-be customer reaches the final step of entering payment details. While cross-border purchases should be included in the HICP of the country where the products are delivered (see Section 7.2 on the treatment of cross-border internet purchases), the prices of products that are not available for purchase in a given country must be excluded. The Recommendations in Section 7.2 give additional guidance on the need to include unavoidable extra costs incurred solely through the purchase of an individual product. Delivery charges, booking fees and credit/debit card fees are typical examples.

([103]) de Haan, J., and Hendriks, R. (2013), *Online data, fixed effects and the construction of high-frequency price indexes*, In 13th economic measurement group workshop (pp. 1–31).

([104]) Polidoro, F. et al. (2015), 'Web Scraping Techniques to Collect Data on Consumer Electronics and Airfares for Italian HICP Compilation', *Statistical Journal of the IAOS*, 31:2, pp, 165–176.

([105]) Oancea, B., & Necula, M. (2019), 'Web scraping techniques for price statistics: the Romanian experience', *Statistical Journal of the IAOS*, 35 (4), 657{667. DOI: 10.3233/SJI-190529.

([106]) Integrating big data in the Belgium CPI.pdf (unece.org).

([107]) Le webscraping, la collected et le traitement de données en ligne pour l'IPC.pdf (fgov.be).

In general, establishing a contact with the website owners in advance is recommended as more efficient solutions can be found. Retailers might even agree to provide statistical offices with scanner data, which is preferable for having information on the actual sales and quantities and defining product weights. A stable relationship with the web page owners enables a direct communication which helps solving specific issues or avoiding being blocked. In addition, webpage owners may provide information regarding web sites policies, large website changes and even information on their pricing algorithms.

The issue of internet purchases and their implications for the HICP is constantly developing, and updates to this section in the manual can be expected.

5.4.3 Scanner data

The term 'scanner data' refers to transaction data that specify turnover and numbers of 'items' sold and are gathered by large retailers when consumers go to pay for their goods in store.

Involving much larger volumes than traditional survey data, these data are a real opportunity for improving price statistics as they contain complete transaction records, including information on prices and quantities, thus allowing the use of weights for calculating price indices at the lowest level of data aggregation (item codes or individual products). Nevertheless, scanner data also raise new questions in terms of access, reliability, compilation methods to use and from an IT point of view. Scanner data will typically not cover the entire universe that is in scope of the HICP (see also Chapter 4). For example, in most countries, scanner data do not cover services, rents, automobiles, restaurants, or cafes.

A growing number of EU countries have been using scanner data for compiling CPI/HICP using different approaches for data acquisition, classification and price index computations (Eurostat, 2017; Eurostat, 2022 ([108])). Therefore, the list of countries adopting scanner data for official CPI/HICP computation is continuously updated. For information regarding the official use of scanner data, see the metadata on Harmonised index of consumer prices (HICP) (prc_hicp) (europa.eu). From here each national metadata can be accessed and the use of scanner data checked under point 18.1.

Thanks to the pioneers in using these new data sources, there are now best practices for collecting scanner data and using them to produce CPI/HICP even if work on the treatment of scanner data continues, especially regarding developing elementary aggregate formulas appropriate for compiling an index using scanner data (see Chapter 8).

Eurostat published a practical guide for Processing Supermarket Scanner Data to help NSIs to accelerate the process of using scanner data and to ensure comparability among national HICPs (Eurostat, 2017). The scanner data sets can be used in the following ways:

1. for data validation and quality assurance;
2. to replace field collected prices;

([108]) Eurostat (2017), *Practical Guide for Processing Supermarket Scanner Data*. Available at: CIRCABC/Price Statistics/Library/Public/Manuals and Guidelines.
Eurostat (2022), *Guide on multilateral methods in the Harmonised Index on Consumer Prices (HICP)* — 2022 edition - Products Manuals and Guidelines.

3. to expand pricing samples;
4. to update index structures and apply weights;
5. to implement new compilation methods.

The availability of scanner data provides NSIs with the opportunity to validate and quality assure the data used to construct the CPI/HICP. Prices collected in the field can be compared to the unit values calculated from the scanner data by dividing the individual product turnover by the quantity sold (see also Section 5.5 for product specification). In this way insights into any biases introduced to the CPI/HICP from point-in-time pricing compared with unit values can be provided (CPI Manual, 2020). In addition, scanner data allow the exclusion of items not actually sold and includes certain types of discounts (see Section 5.3.3). They provide a more reliable source of information for the inclusion of new items in the HICP than reliance on price collectors.

Replacing field collected prices by unit values from scanner data generally results in NSI resource savings and reduced measurement errors. Indeed, price collection costs may be reduced as NSI field price collectors are no longer required to visit shops and outlet where prices were collected. In addition, unit value represents an average price experienced by consumers over long period of time and are computed from thousands of observations (Diewert, 1995 ([109])).

The traditional approach to sampling, based on non-probability or purposive samples for both outlets and products, can be replaced by probability sampling since scanner data can be used as a sampling frame for drawing and updating pricing samples (Sammar et al 2012 ([110]); ILO, 2020).

Besides changing the sampling procedure, NSIs may reconsider the index structure by defining the combination elementary aggregate-chain as separate strata in the index compilation process (see Chapter 4). If the service levels are different across outlets belonging to the same retail chain, due, for example, to the different type of outlet, such as supermarkets and hypermarkets, it may be worth considering an additional stratification and calculate unit values for the sampled individual products at the store level.

Information on sales provides the opportunity for NSIs to weight price indices more frequently using more timely data. Moreover, the individual products' economic importance may be explicitly included using a weighted index number formula at elementary aggregate level. Knowledge of the precise quantities of each individual product sold may also help in identifying which index formula should be adopted from a theoretical point of view (see Chapter 8).

Acquisition of scanner data

Scanner data have been used for market study purposes for many years while their value in the compilation of official statistics has become more and more evident over time.

Switching from traditional surveys to electronic data delivery reduces the burden for both statistical agencies and retailers while the availability of expenditure data in scanner datasets can be leveraged to increase the accuracy of HICP figures (see Annex 4.4). However, the transition from traditional survey data to scanner data may be a lengthy process, which entails different

([109]) Diewert, W.E. (1995), 'Axiomatic and Economic Approaches to Elementary Price Indexes'. Discussion Paper No. 95-01. Department of Economics, The University of British Columbia, Vancouver, Canada.

([110]) Sammar, M., Norberg, A., & Tongur, C. Statistics Sweden (2012), Scanner Data – A Collection Method for the Future, Paper presented at the Meeting of the Group of Experts on Consumer Price Indices.

stages from establishing the first contact with a retail chain to evaluating a method for calculating price indices in a HICP production environment.

How NSIs can obtain scanner data depends on the legal and institutional arrangements in each EU country and on the relationship between the NSI and retailers.

Two main options are available for obtaining scanner data sets: NSIs may seek the supply of scanner data directly from retail businesses or from third-party data providers. It is recommended to collect scanner data directly from the retailer if possible, as they concern retailers' economic activities.

With scanner data, the dependence on the retailer increases substantially. Scanner data can be obtained from a variety of retailers: supermarkets, pharmacies, do-it-yourself stores, home electronics or clothing shops, and many others. However, in some cases scanner data may only be available for large retail chains but not for small independent stores or other types of outlets.

Commonly NSIs, firstly, improve the relationship with the retailers and, secondly, enter legal contracts with the retailers. Indeed, the details of the provision of scanner data should be laid down in a formal agreement since, given the relevance of the HICP, the delivery of important input data should not be left to verbal agreements. The information contained in the dataset is also highly confidential, and retailers will want to have guarantees on the confidential treatment of their data and their uses (Eurostat, 2017).

For example, in France the use of private scanner data followed various steps to overcome several difficulties. After consultation with distribution retailers, Insee presented a study of the feasibility and advisability of using scanner data for the CPI/HICP to the French National Council for Statistical Information (CNIS) at the end of 2016. Having received a positive endorsement, a decree was signed by the minister, making the transmission of certain private data mandatory (for non-specialist stores over 400 m2). Since January 2019, all scanner data from major food retailers, apart from hard discounters, have thus been received daily by Insee (Leclair, 2019) ([111]).

When third parties, such as market researcher companies, are involved in the delivery of scanner data, this should be seen as a service to the NSI and the retailer, and it should be clear what processing steps the third parties undertake. It is obvious that NSIs are responsible for ensuring that the relevant price indices are correct.

The amount of data that has to be processed and for which the appropriate IT structure and staff needs to be available may be a challenge for the NSI. This means that more IT-oriented skills are required for staff and, depending on how the traditional price collection is done, there may be a need to have more staff in-house.

Characteristics of scanner data

All scanner data come in the form of sales values and quantities for a coded product, for example the Global Trade Item Number (GTIN) or other codes.The content and structure of scanner data differ across countries and is one key factor that will influence the approaches that are possible

([111]) 'Using Scanner Data to Calculate the Consumer Price Index', *Courrier des statistiques*, Published on: 22/06/2021.

and actually chosen by countries to include these data into CPI/HICP production (Dalen, 2017 ([112])).

Ideally, the NSI would have the following information at its disposal for each barcode:

i. The time period to which the transactions data pertain (day, week, or month). Indeed, sale values and quantities sold are usually aggregated across some time period by the data supplier. Frequently, scanner data are collected weekly, i.e. all transactions taking place during a week. Statistical agencies themselves can convert weekly prices into monthly prices aggregating them over time.

ii. An outlet indicator. Transaction data are preferably specified at the individual store level, allowing NSIs to choose the appropriate level of aggregation across outlets. If the data cannot be supplied for individual outlets, at least a distinction by retail chain and/or type of outlet should be available.

iii. Descriptive information. A short textual description of each item is usually part of the scanner data sets. Although these descriptions contain information on the characteristics of the items, it may be difficult to extract it in an automated way. In addition, the available information may not cover all details needed, including brand, content, unit of measurement, colour, etc. Thus, information on the most important characteristics, preferably given in a format that enables automated processing, would be highly beneficial. In some cases, NSIs may use a dictionary of barcodes provided by retailers or third-party companies, describing in detail the characteristics of the product associated with each barcode.

iv. Other information. Itemised information on the unit of quantity (pieces, kg, litres etc.); content of the package; and tax rates. It is recommended that data be collected at the most detailed product level, that is at item code level, which is often the GTIN. If the retailer uses other codes, such as stockkeeping units (SKUs), these should be provided in the dataset. SKUs are retailer specific codes which are used by retailers to track the inventory of their own products. Nevertheless, it is recommended that the GTINs should still be supplied so that the composition of SKUs can be checked and SKUs may be considered as items' primary identifier, because they may be more stable than a GTIN. For instance, StatBel uses SKUs to identify products in scanner data segments even if GTIN are provided in the dataset. These codes are typically at a level above the official barcode or GTIN and can combine multiple GTINs that are similar to the consumers (Van Loon, 2019 ([113])).

The more information is provided, the easier it is to identify items and thus classify the item codes and identify replacements (see section 5.4.5). This is the reason why including a retailer-specific classification is very useful, especially if this can be linked to ECOICOP. Information that could link temporarily discounted items that have a different item code from their regular counterparts is useful; often a SKU is used for this purpose.

([112]) Dalén, J. (2017, May), *Unit Values and Aggregation in Scanner Data — Towards a Best Practice*, In Fifteen Meeting of the International Working Group on Price Indices, Eltville am Rhein, May.

([113]) Van Loon, K. (2019), Redefining what products are in the context of scanner data and web scraping, experiences from Belgium. In 16th Meeting of the Ottawa Group. Rio de Janeiro: Statistics Belgium.

A further consideration is how the delivery of the data fits into the HICP production cycle, if office staff have to make replacements and quality adjustments. Processing data per week at weekly intervals is granular enough to monitor developments in prices and check whether new item codes are relaunches or replacements. Using weeks – and receiving data by week – will allow a NSI to use the first three full weeks of the month for the HICP, while the fourth week will often include days of the next month. Similarly, the first few days of the month may often be included in the scanner data from the last week of the previous month. However, this depends how NSI have asked retailer to deliver data. When the retailer has to send weekly data so that only days belonging to each month are included, the first and last week (could also be fifth) may be full or not. Receiving data at least per week also adds an element of safety. If data cannot be delivered for a particular week, the index could still be calculated with the other weeks. At the same time, collecting data for every week may be easier for the retail chain because the delivery follows a fixed cycle.

5.4.4 Other sources

NSIs may retrieve data through Application Programming Interfaces (API) with open access whose purpose is to provide structured and controlled access to specific data or services on a server. Indeed, the owner of the website might be open to providing an API rather than block the statistical office's IP address if they understand who uses their data for which purposes. APIs facilitate the exchange of information between data suppliers, programmers and app developers. API collection requires advanced programming skills but is very cost-efficient. Using an API enables even more solid technical solutions as it involves reading prices directly from a central database which is generally a more stable solution compared to a website that can change within a year. APIs can be publicly available or locked by an API key. Some retailers may have a structured database that can be approached through such a web-based API, which would return exactly the data of interest. A well-known example is the Amadeus API from where one can frequently retrieve thousands of air flight prices. Amadeus can serve as a good starting point to master using APIs.

Statistics Finland has experimented using web scraping with Amadeus API to collect information on flight prices. Using Amadeus via API allows collecting more prices compared to traditional price collection with less time spent on the collection (Eurostat, 2020a ([114])). Web scraping is done using Python programming language. The packages (datetime, numpy, pandas, sys) are needed for extracting data from Amadeus application programming interface. These Github packages that allow hosting software packages are publicly available at: https://github.com/amadeus4dev/amadeus-python. The GitHub site also includes examples and other guides to help the starting of web scraping with Amadeus. Using these packages Statistics Finland is able to send the request with parameters on wanted flights to the API. The API returns information on prices and additional characteristics (e.g. which company operates the flight) to be used for HICP.

([114]) Eurostat(2020a), *Practical Guidelines on Web Scraping for the HICP*, European Commission Eurostat.

5.4.5 Classification issues

Classifying individual products/item codes to ECOICOP is a fundamental and partly new aspect in the production of the HICP, as the classification system provides the weighting and aggregation structure as well as the basis for stratification of products in the sampling frame, at least down to a certain level of detail.

Commonly, scanner data and web scraping data have the disadvantage of not being labelled according to the ECOICOP classification system, thus requiring that they need to be pre-processed and classified. The classification of individual products is probably the most important challenge to process bulk web scraped and scanner data efficiently. All the price observations that enter the index compilation each month must be grouped into homogeneous products and assigned to product categories that are part of the index stratification. This is important because web and scanner data are typically characterised by being ‘dynamic’. Every period, new products enter the market and old products are not available anymore. This suggests the implementation of classification rules to be maintained in the long-term.

Given the large numbers of price observations derived from the use of scanner data and web-scraped data, it may be impossible to classify every single product manually. Therefore, other techniques taken from semantic technologies, artificial intelligence and machine learning are used to classify codes to ECOICOP.

Since these data comprise a variety of different product categories, including goods such as groceries, clothing and laptops, and services such as rail fares, air fares and package holidays, a different choice of classification strategy may be adopted as each category (and the data collection method for each category) has different characteristics that can affect how classification should be performed. Therefore, different classification strategies may be used according to different scanner data properties. For example, a largely automated approach may be necessary for clothing because of the sheer volume of data, while a different method, for example a machine-assisted manual classification, may be more suitable for working with grocery scanner data.

For the classification of data, each observation must be mapped to the classification structure used in the HICP. As a minimum requirement, the data needs to be mapped to ECOICOP subclasses, but very often more detailed national or retailer-specific classifications are used. Indeed, the level of product classification to which the item code is mapped will be the lowest level of classification used by the NSI, often the 6- or 7-digit level of ECOICOP.

Often the data provider – either retail chain or website owner – uses its own detailed product classification system, which might be helpful in this respect, as long as this system can be linked to ECOICOP. But even these strata will generally contain different product varieties.

The main strategies that are available for classification, which are mainly based on the vendor’s division of the products and product information, are the following:

a. Manual labelling and mapping;

b. Key word classification or text string searches and category mapping;

c. Supervised machine learning algorithms.

When manual classification is adopted, a compiler looks at the description string and visually examine the item description. This method is a feasible option for small data sets containing fewer unique products or a lower product churn rate. A manual-based approach is maintainable for these datasets and provides additional reassurance in the accuracy of our classifications.

In addition, the presence or absence of keywords in the description string may be checked for classification. This means that certain keywords are extracted from the product descriptions. One could also do a mapping of the product categories used by the website or by the retailer to the product categories used in the index. Some datasets may contain an attribute which can be directly used to break the dataset up into elementary aggregates or product groups. Some of the data sets (or parts thereof) contain retailer categories for each product; if one of these categories sits within a classification, the category can be mapped to the classification. The information is linked to the ECOICOP categories by means of link tables and rule sets.

The design of classification rules is time consuming and needs to be repeated many times, because products and product codes differ between vendors and differ in time. In these cases, coding efforts should instead be focussed on machine-assistance techniques that improve the efficiency of manual classification and the quality assurance procedure.

Supervised machine learning ([115]) allows the production of an algorithm that learns from training data and can create filtering rules automatically, so that there is no need to specify new inclusion or exclusion terms every time a new product appears. Supervised methods differ from unsupervised methods, as they assume the data is labelled and parameters are learned using the labelled data. In other words, a supervised classifier attempts to learn rules to divide the data into provided categories. However, to learn how to perform the splitting, the algorithms need data that are already labelled into the desired categories. In other words, using supervised machine learning methods to automate a classification task of this type requires a large amount of labelled training data and labelling by hand is very time consuming as it needs to be done for every language individually. Moreover, all the texts (product names, descriptions and categories) have to be represented by numerical features or feature vectors, which leads into the field of natural language processing (NLP).

This can be done by providing training data to a statistical learning algorithm that identifies patterns between text and training decision for automatic classification. There are various algorithms that can be used for this purpose, including the Support Vector Machine (SVM) that separates the classes by maximizing the distance to the closest items of each class. These closest items of each class on each side of the line are called support vectors.

The performance of the various classification methods should be tested to verity if it is high enough to produce reliable and unbiased indices while also maximising homogeneity of the product groups. Indeed, erroneous classifications can be a result of both manual and automatic methods. Automatic classification algorithm can make a prediction which should be manually inspected and corrected if the prediction is wrong. Mehrhoff (2019 ([116])) observed that around

([115]) Several other NSIs are experimenting with the use of machine learning techniques for classification purposes. Puts and Daas (2021). *Machine Learning from the Perspective of Official Statistic. The Survey Statistician, 84, 12–17*. give a general overview about the possibilities for machine learning in official statistics while Beck, Dumpert, and Feuerhake, (2018). *Machine learning in official statistics. arXiv preprint arXiv:1812.10422.* provide an overview of which NSIs are using machine learning and for what purpose.

([116]) Mehrhoff, J. (2019), ‘Demystifying big data in official statistics–it’s not rocket science!’ (Vol. 49). Bank for International Settlements.

20 % of products were misclassified by a classification algorithm and therefore recommended that machines are used to offer reasonable suggestions with assistance from humans.

Machine learning methods are particularly promising where there is a mismatch between the product classifications used by retailers and the classification used for HICP compilation. As with all classification methods, ongoing maintenance is required to ensure that items with new features that have not previously been identified are classified appropriately.

With the help of supervised learning algorithms which classify individual products it is expected that automatic classification techniques may appear in time which will further reduce significantly the cost of price collection (Eurostat, 2020a ([117])).

In this context, it is worth noting that large grocery stores use some sort of classification standard for goods which can be used by NSIs to implement classification rules. For example, Statistics Norway refers to the ENVA-codes to obtain rough information on what the items are and, using a mapping catalogue specially created, to correctly classify many of the items (Myklatun, 2019) ([118]). However, the ENVA-codes have some limitations, as they do not follow the COICOP structure and they are not detailed enough to be used directly. This means that a rule-based approach with a text search must be added to be able to classify items. This text search had to be continuously updated with new words that help split the ENVA-groups to maintain the classification in the long-term.

Statistics Netherlands has explored several kinds of supervised machine learning models to classify individual products (Harms and Spinder, 2019) ([119]), including the traditional supervised approach, such as Naive Bayes, Random Forest, SVM and Logistic Regression, that have been implemented efficiently in the Python package scikit-learn. As an addition to the traditional approaches, Statistics Netherlands used a boosting technique, XGBoost, that is based on iteratively updating a decision tree and explored deep learning approaches, which refer to the use of multi-layered neural networks.

Regardless of which technique is chosen, an important step in the classification process is the initialisation of a new retailer, when all the data needs to be mapped. The initialisation consists of an in-depth study to understand the churn of item codes, identifying items and groups of items that are to be excluded. For each retailer, a separate initialisation is required to fully understand the type of codes (GTIN, PLU, SKU, etc.), the descriptions (the meanings of abbreviations, etc.) and other metadata linked to the codes. Classifying item codes is partly unique to each retailer, as the data each of them provide differ and descriptions for the same item code may not be the same across all retailers. However, with thousands of GTINs per retailer, finding an efficient solution specific to each retailer may turn out to be a complex quest over the years, which may be

([117]) Eurostat (2020a), *Practical Guidelines on Web Scraping for the HICP*. European Commission Eurostat. Available at : https://ec.europa.eu/eurostat/documents/272892/12032198/Guidelines-web-scraping-HICP-11-2020.pdf/

([118]) Myklatun, K. H. (2019), *Utilizing Machine Learning in the Consumer Price Index*, Statistics Norway, In 28th Nordic Statistical Meeting, Helsinki.

([119]) Harms, A., & Spinder, S. (2019), *A comprehensive view of machine learning techniques for CPI production*, Statistics Netherlands.

reflected in a range of different methods across retailers and consumer goods (Chessa, 2016 ([120])).

NSIs should also monitor changes in the retailer classification, such as item codes that move to another group and verify if item codes retain the same retailer-specific/ECOICOP classification.

As already mentioned, the quality of the classification needs to be checked by randomly selecting a sample of item codes and checking the correctness of the classification. It is advisable to provide a performance threshold that a classifier will need to exceed in order to be used and understand the impact of classification inaccuracies on CPI/HICPs. At least two quality checks should be made: i) Checks on whether individual products have been correctly mapped to ECOICOP. This is valid for both the static and the dynamic approach (see Chapter 4). Errors should then lead to improvements in the classification procedures; ii) Checks on whether replacements have been included correctly (see Section 5.6). This is particularly relevant for the dynamic approach. A quality control system that is independent of the production system should be used to offset the risks involved in using highly automated systems for the monthly production in which filters and algorithms make the choices.

5.5 Product descriptions and product specifications

An essential question that needs to be answered when compiling price indices is how to define items that will be 'homogeneous enough' for making price comparisons.

In traditional price collection, to compare prices on a like-to-like basis from one period to the next, price collectors must record all the additional information needed to ensure the unique identification of the product offer in each outlet. The same principle applies to the new data sources which require the specification of the individual product for which prices are compared between two periods. The main idea of creating broader individual products is to increase the matching over time. On the other hand, if a grouping is too broad, this can lead to unit value bias (and high volatility) as the individual articles are not strictly comparable.

The way in which transactions or product offers are aggregated matters from both a theoretical and a practical perspective. Therefore, it is necessary to develop a workable definition of homogeneity that takes the theoretical ideal as well as practical circumstances into account. From the point of view of economic theory, a product is homogeneous if all product offers/transactions within its specification are equivalent to the consumer. This implies that there is full substitution between the transactions/ product-offers that belong to the same homogeneous product (Silver, 2009 ([121])). In scanner data the quantities purchased per item are simply added, thereby forcing the additivity property to the data. The interpretation is then that each quantity unit is of the same utility to the consumer. If this is not the case in practice a unit value bias will occur (Dalèn, 2017 ([122])).

([120]) Chessa, A. G. (2016), 'A new methodology for processing scanner data in the Dutch CPI', *Eurostat review of National Accounts and Macroeconomic Indicators*, 1(2016), 49–69.

([121]) Silver, M. (2009), 'An Index Number Formula Problem; The Aggregation of Broadly Comparable items', *IMF Working paper* 9/19.

([122]) Dalén, J. (2017), *Unit Values and Aggregation in Scanner Data—Towards a Best Practice*, In Fifteen Meeting of the International Working Group on Price Indices, Eltville am Rhein, May.

Manual price collection

As regards manual price collection, the product characteristics that significantly determine the product price and which are not part of the general product offer specification should be recorded, particularly when loose item descriptions are used (see also Chapter 4). This information is helpful when a product with a relatively loose specification is first introduced into the HICP and an operational decision is being taken about what model or variety of a product should be priced in a particular outlet, i.e. the specific product offer. It is also necessary to determine what allowances need to be made for quality changes if the product characteristics change as a result of a change in the manufacturer’s specifications or the introduction of a replacement product offer with different characteristics. Product information can also help the price collector assess whether a model (product offer) is likely to be available for pricing over a reasonably long period, as well as whether it is typical of what is sold. More generally, product information can help the price collector identify the same product offer in consecutive months.

As regards product specifications, there are no firm rules on the use of *loose* or *tight* product specifications to suit price collection, but certain considerations come into play.

Specifying a TV set of a particular brand and model is an example of a tight specification, while *TV sets*, which allows for all kinds, is a loose specification. Naturally there is a range of possible options between the two opposite ends of the spectrum (extremely tight and extremely loose). An intermediate option in the TV example might be to specify the most important price-determining features, which in this case might be a TV of a particular screen size, with ultra-high definition (4K-ready).

Clothing and furniture often require loose specifications because the existence of so many brands, styles and models can mean that different outlets rarely sell exactly the same range of products unless they are part of a retail chain.

Chapter 4 on sampling discusses in more depth the issue of loose versus tight item specifications.

It is good practice to test product specifications by piloting the collection of new product offers a few months before they are included in the calculation of the HICP. This will allow the detection and correction of errors in the wording of the product specifications, to ensure that local and head office price collectors and retailers completing questionnaires and the like have understood the specifications correctly.

An important consideration, particularly relevant to local price collection, is that loose specifications give price collectors a more important role and more influence, as they have greater discretion over what to price. This means placing greater reliance on them. However, loose specifications can broaden the range of product offers in the sample and increase the sample size achieved, particularly if there is a wide range of product types in the marketplace, i.e. if the market is relatively diverse and outlets do not stock all brands and varieties. Naturally, tight specifications are of limited use if the specified product can be found for sale in a small number of retail outlets only, or if it is only available infrequently in the outlets surveyed.

Scanner data and web scraped data

When new data sources are used for HICP computation, after the data have been received, treated, and classified, before applying any index calculation method, the individual product to be priced must be defined. The basic principle is to compare like with like and to track the price of the same individual product over time. However, product specification has been recognised as a critical step that could endanger any gains in bias reduction that we would typically expect from using new sources of data (see Annex 4.4 and 5.4.3).

NSIs face a trade-off in balancing homogeneity and stability over time when defining how tightly the individual product should be specified. The individual product can be defined more broadly or more narrowly with different impacts on the results. Tightly specified products may cause a bias as new and disappearing products in the two comparison periods are not considered if a matched price index is adopted. Broadly specified products may cause a bias as the underlying transactions that make up the product may not be of the same quality (Lamboray, 2022) ([123]). In this respect, Chessa (2019) ([124]) developed the MARS method as an operational tool for finding a compromise between homogeneity and product match. Metrics are given for these two criteria that allows finding the 'optimal' product stratification.

When specifying individual products, NSIs must consider the product, the outlet (physical shops and websites) and the time dimensions (period covered by scanner, date/time of scraping). The aim is to create homogeneous groupings so that consumers are indifferent between the different individual products within these groupings (Eurostat, 2022 ([125])).

There are different strategies that can be used to treat the **product dimension** and cope with a dynamic product universe. In many cases, the article code level (GTIN, SKU, product identifier ID, etc.) represents the most detailed level of homogeneity in the data both for scanner and web-scraped data (see Section 5.4.3). With such a strategy, item codes are considered if they are available in two comparison periods. However, the practical construction of homogeneous products is usually data driven and largely depends on product characteristics (e.g. type of product, availability of product characteristics, retail chain pricing policy, etc.). The construction of homogeneous individual products may be based on a list of variables and their modalities which can be used for grouping. For instance, article codes can be grouped according to brand, product type or some other specific product characteristics. Once the data have been pre-classified, price levels may be used as auxiliary criteria (e.g. to distinguish between high-end and low-cost products). In some cases, the item codes level may be too detailed for price index calculation. In some product categories, such as clothing and footwear, the article codes frequently appear and disappear, making it difficult to match them across time and therefore price changes are not adequately measured. More specifically, existing individual product may receive a new GTIN, for instance, to fit it into a new product line, or small changes to packaging and product formulation may give rise to a new GTIN, even if the product remains the same from the consumer's perspective. Sometimes product IDs can change without any change in the quality of the respective product-offers (Eurostat, 2020a ([126])). In this respect, the use of GTINs that contain the highest degree of homogeneity may be hampered by the occurrence of so-called 'relaunches'. This term refers to existing items that re-enter the stores with a new GTIN. The old and new

([123]) Lamboray C. (2022), 'What impact does product specification have on a Fisher price index?' Paper prepared for the 17th Meeting of the Ottawa Group on Price Indices, 7-10 June 2022, Rome, Italy

([124]) Chessa A. (2019),' MARS: A method for defining products and linking barcodes of item relaunches', paper presented at the 16th meeting of the Ottawa group, Rio de Janeiro, Brazil.

([125]) Eurostat (2022), *Guide on multilateral methods in the Harmonised Index on Consumer Prices (HICP)* — 2022 edition - Products Manuals and Guidelines.

([126]) Eurostat (2020a). *Practical Guidelines on Web Scraping for the HICP*.

GTINs need to be linked in order to capture possible price increases after relaunches. This may be achieved through retailers' own product codes, such as the SKU, or otherwise through item characteristics. In addition, as part of the monthly production cycle, a classification algorithm should be used to map new item codes and item codes with changed meta-data (description, classification etc.).

As regards the treatment of the **outlet dimension**, different approaches may be adopted by NSIs. The most detailed outlet level available in the data may be considered for defining an individual product in very narrow terms, referring for example to an item code in an outlet for a given time period. Following this approach, NSIs can consider differences in prices of the same item across outlets, which reflect product differentiation embodied in the range and/or quality of services offered by different retailers, both across chains and across stores within the same chain. Indeed, consumers value not only the physical product but also the shopping experience. This includes for example long opening hours including weekends, nearness to shop from workplace or home, a large assortment (but also ease of finding what you are looking for), access to service staff in the shop etc. (see Ivancic and Fox, 2013). However, there may be reasons to combine outlets of the same retail chain or brand. The impact of aggregating (or not) across outlets on the final index is an empirical matter that can be assessed through specific analyses. Outlets may also be grouped based on some geographical criteria if for instance regional price indices are compiled. Another reason for aggregating across outlets is that it significantly reduces the number of individual products which will be used in the index compilation. An extensive discussion on whether aggregation across outlets is warranted or not can be found in Ivancic and Fox (2013) ([127]).

The **time dimension** may be an issue for homogeneity only to the extent that it is related to different service levels. Conceptually, if all points in time during a certain period are approximately equivalent to the consumer and there are no systematic price level differences between weekdays or hours of the day, then the whole time period (month or week) can be considered as homogeneous for the purpose of price aggregation (see also Section 5.3.4). Since in scanner data product-offers and their shelf prices are not observed it is necessary to calculate the unit value price by dividing total expenditure by the related total quantity for an individual product. Diewert, Fox and de Haan (2016) ([128]) showed that aggregation over only one week of the month can be upward biased compared to aggregation over the full month. They suggested that unit values should be constructed over the same period as the index to be constructed, rather than over an incomplete sub-period. Quantities and weights are typically not available for individual products with web scraped data even if there is an increasing number of studies addressing the issue of estimating proxy variables for weights (see for example Willenborg, 2017 ([129])). The price for a homogeneous individual product is usually obtained as an unweighted arithmetic or geometric average of the prices of the article codes which fall under the definition of the homogeneous product in given month. If feasible, it could be helpful to try out different homogeneous product definitions and estimate the impact of these choices on the results.

([127]) Ivancic, L., and Fox, K. J. (2013), 'Understanding price variation across stores and supermarket chains: Some implications for CPI aggregation methods', *Review of Income and Wealth*, 59(4), 629-647.

([128]) Diewert, W. E., Fox, K. J., & de Haan, J. (2016), 'A newly identified source of potential CPI bias: Weekly versus monthly unit value price indexes', *Economics Letters*, 141, 169-172.

([129]) Willenborg L. (2017), 'Elementary price indices for internet data', *CBS, Discussion Paper August, 2017.*

5.6 Missing prices

5.6.1 Treatment of temporarily and permanently missing prices

As a fixed-basket index, the HICP should ideally follow the price development of a fixed representative sample of product offers. However, given the dynamics of the markets for consumer goods and services, this can be challenging due to the disappearance of goods and services. Indeed, as with many surveys, a missing price is generated when a quote-price is not attained for the month from a specific outlet. As part of the maintenance of representative samples, items and locations for which prices are missing can be examined. An increasing number of missing prices can, for example, be an indication that the outlets or the product specifications are no longer appropriate, and action must be taken to update the samples (see Chapter 4).

However, it may not immediately be possible to find out whether the products whose prices are missing are only temporarily unavailable. If an individual product or a product offer is permanently unavailable, this may be because the outlet has decided to stop stocking it or because the supplier no longer supplies it, perhaps because it is no longer manufactured.

According to Article 9 of the Implementing Regulation 2020/1148, if the price of an individual product in the target sample cannot be observed, an estimated price shall be used for no longer than 2 months, after which a replacement product shall be selected. This does not apply to seasonal products or other individual products that are expected to become available again (see Section 5.2).

In traditional price collection, the price collector plays an important role in collecting information and should be encouraged to identify the real causes for missing prices.

Where a product is temporarily missing, price collectors only need to note this on the return sent to head office and then check in the next price collection period whether the product is in stock or temporarily or permanently out of stock. Head office will then impute a price, or in rare circumstances carry forward the price if this can be shown to be an appropriate estimate).

The price collector faces a bigger challenge if the product offer is no longer available in the outlet or has been out of stock for 2 consecutive months. In both instances, a replacement product offer needs to be found. If the product offer is only temporarily absent, a replacement needs to be made in the third month.

As regards prices observed at less frequent intervals (e.g. quarterly or annually) because they are known not to change at monthly intervals, estimated prices can be used only on the first occasion on which price observation fails. However, price collectors should make every attempt to avoid such situations by anticipating when prices are unlikely to be available. They can do this by checking with the store manager, observing when the stock on display is running low, and asking whether the product will continue to be sold. When a replacement has to be made, it is important to have operational rules on product replacement, e.g. on whether to choose the product that is most similar to the one being replaced, or the most representative product offer. Moreover, the person making the replacement must have a detailed specification of the price-determining characteristics of the product to be replaced. The price collector's role in choosing a replacement product offer will depend on whether tight or loose item specifications are used.

Where loose product specifications are used for local price collection, it is up to the price collector to find a replacement, following the operational rules supplied by head office. The latter then determines whether the selected replacement meets the specified criteria. It is up to head office, however, to replace missing products based on tight specifications. This can be more challenging in terms of later attaining an adequate sample of prices, as the limited leeway of tight specifications may mean that some shops in the sample may not sell the specified product, thus increasing the non-response rate. Alternatively, head office may change the tight description and perform quality adjustment centrally, possibly on the elementary aggregate index itself.

In scanner data, prices of unsold items are not observed. The aim of imputation is however broader than estimating missing prices. Scanner data typically show substantial item attrition: many new items appear and many other 'old' items disappear. Item churn can be substantial, especially when individual products are identified by barcode or GTIN.

When scanner data and the dynamic approach are used, as for example in Italy, prices of temporarily missing products (due to seasonal or accidental reasons) are estimated using the monthly growth rate of the other products in the same stratum or of the higher-level index according to the aggregation rules (ISTAT, 2022) ([130]) .

The imputation of missing prices and alternative strategies for choosing replacement product offers are discussed in more detail, along with quality adjustment, in Chapter 6.

Separate rules apply to products subject to strong seasonal patterns, such as fresh food products or garments that are temporarily unavailable in certain months (see Section 7.1).

5.6.2 Treatment of missing prices due to atypical events

Price collection can fail because of restrictions that do not allow price collectors to visit sampled outlets, because outlets have been closed down or because certain services (e.g. flights) cannot be offered. In general, missing prices often occur seasonally – as for fruit, vegetables or clothing - but also when shops are closed due to holidays or in the event of catastrophes such as floods. In addition, the recent COVID-19 pandemic led to an increase in missing prices and restricted on-site surveys in shops.

Possible sources to replace the missing prices in case manual price collection activities are restricted are outlets' websites and telephone and email enquiries. Some NSIs may also have access to scanner data that, although not yet integrated into the HICP production system, could be used for the replacement of the missing prices. However, the replacements using scanner data should be done with care as this could entail a change of outlet to a different category or market segment.

In the case where the outlets have physically closed their doors, the internet and on-line trade may also be sources for the temporary replacement of missing prices. In this situation, consumers may have the possibility to continue purchasing the same products using online platforms or from the websites of outlets that have closed their physical outlets. In such cases,

([130]) ISTAT (2022), Consumer Prices.

prices from websites should be used only if the products can possibly be purchased at displayed prices. However, if none of these replacement solutions are possible, the product-offer has to be treated as a missing product and an imputation needs to be done.

Depending on the situation, NSIs may employ different methods to arrive at a notional price for these goods and services in compliance with the guidelines drawn up by Eurostat in collaboration with all of the member states of the European Union and the European Central Bank (Eurostat, 2020b; 2020c ([131])).

The compilation of the HICP in the context of the COVID-19 crisis has been guided by the following three principles:

- Stability of the HICP weights (see Chapter 3);
- Compilation of indices covering the full structure of the ECOICOP;
- Minimising the number of imputed prices and sub-indices

The second principle means that all sub-indices for the full ECOICOP structure will be compiled even when no products are available on the market for some categories. In such cases prices do not exist and they should be replaced with imputed prices. Sub-indices consisting of both imputations and observed prices should be compiled and aggregated using the standard HICP compilation procedures.

The third principle underlines the idea that, whenever possible, missing price observations should be replaced by price quotes obtained from other sources. The solutions adopted enabled NSIs to continue to publish the HICP in full and to ensure that in due course the price development calculated between the post-corona and pre-corona period will reflect reality.

In those cases where prices cannot be replaced but products continue to be transacted, a price must be imputed. In practice, the imputed price is obtained by multiplying the previously collected price by an appropriate price change. The imputation rules apply both to cases in which it is not possible to detect the price of a product, and to cases in which the absence of the price derives from its unavailability in the market. The recommendation is to impute the missing prices using the price changes of similar products or of the nearest higher aggregate (‘nearest aggregate estimation’). This approach is analogous to the one used to impute price changes of seasonal products when they are out-of-season. It is based on the idea that such products and product groups can be considered the closest substitutes for the unavailable products; and they are therefore next to each other in the classification structure used for the HICP (Eurostat, 2020b; 2020c). For example, it may be possible to collect prices of the same or similar commodities in other outlets or other areas of the country to use as a basis for the imputation. The prices of missing product-offers should be imputed by multiplying the previous price with the average price change of the available product-offers of the same elementary aggregate. If an entire elementary aggregate is missing, its prices should be imputed based on the average price change of similar elementary aggregates. If an entire ECOICOP sub-index cannot be observed due to limitations on price collection, one should impute with the price change of the sub-index of the nearest higher aggregate in the classification. For example, imputations for a subclass could be based on the next class to which the subclass belongs.

([131]) Eurostat (2020b), *Guidance on the compilation of the HICP in the context of the COVID-19 crisis*, April 2020; Eurostat (2020c) *Guidance note on HICP issues emerging from the lifting of lockdown measures*, July 2020.

When products are not transacted anymore, the methods suggested by Eurostat (2020b) are similar to usual imputation procedures when products are temporarily missing. In the COVID-19 crisis, however, there were large segments of consumption expenditure that no longer take place due to national restrictions. Although choices regarding imputations must be made on a case-by-case basis, two alternative approaches may be followed:

a. Impute with all reliable price indices
b. Carry forward.

According to the first approach an index based on all reliably estimated sub-indices, for which products are available on market and a sufficient number of prices were observed, could be used as a basis for imputation. In practice, the ECOICOP categories (5-digit subclasses) that are considered reliable need to be identified. The aggregate monthly price change of these categories is used to estimate the monthly price change for a subclass for which no better imputation could be made. The advantage of this approach is that, if applied to all sub-indices for which there is no market, the monthly price change of the all-items index is driven only by the price changes of all reliable sub-indices.

An alternative way of imputing the missing prices is to carry forward the last observed prices. Although carry forward is a transparent method that is easy to explain, its use will make the index converge towards no price change. Unlike the imputation method based on reliable sub-indices, the carry forward method is not neutral to the monthly price change at the all-items level. The more sub-indices are imputed with carry forward, the more the all-items monthly price change converges to zero. For some products (e.g. social or cultural services, restaurants, etc.), where there are reasons to expect that their prices will remain unchanged, carry forward is an acceptable imputation method.

5.7 Closing outlets: outlet substitution and closing-down sales

Chapter 4 discusses the outlet dimension of sampling for surveys of prices for the HICP and describes the various approaches potentially available to the compiler. This section focuses on the operational aspects of price collection. Outlet bias is a sampling issue that is also addressed in Chapter 4. It arises from surveying retailers who are no longer representative, owing to reduced sales volumes. This may result from low competitiveness because of high prices, unpopular stock products or customer dissatisfaction stemming from low levels of customer service etc.

Retail outlets close regularly, and the phenomenon should be dealt with by following the general principles for replacing product offers. Essentially, outlet closures are handled through one-to-one resampling. This means replacing an outlet by another of the same type, in the same or a similar location, and selling the same or a similar range of products to similar customers. The replacement decision may be taken by a local price collector or by head office.

As with product offers, a more proactive approach to sample renewal is needed to cope with the natural turnover in outlets, which means keeping replacements and sample ageing to a minimum. This can be done by sample rotation, which involves full or partial resampling of the outlet sample at regular intervals. The resampling method can follow methods similar to those used for selecting the initial sample. Re-sampling involves an overlap period (December of each year) where the first period of the new sample overlaps with the last period of the preceding sample. This provides for chain-linking of the preceding sample and the newly selected one (see Chapter 4). The point to note here is the possibility of involving price collectors, who have first-hand knowledge of both new outlets in their localities and those that are on their way out. It can be very helpful to head office staff, who may have a more limited knowledge of the local market situation, for price collectors to be involved in the replenishment of the outlet sample.

When outlets are closing down, final sales prices may drive the index down. A problem may occur if the disappearing product offer is replaced by a product offer in another outlet which is not holding a sale. By linking the closing-down price to the price of the replacement outlet, with the use of direct overlap pricing, or when chain-linking, the index may drift away from the correct mid-term price development, resulting in a downward bias. In principle, price falls prior to closure should be reflected in the HICP, as long as the price reduction is not associated with shop-soiled or damaged goods. The subsequent price in a replacement outlet should ideally be introduced either by direct comparison or by some other method that does not lead to downward drift, if practicable. One such method, to be applied in the first month after the outlet closes down, could be to make an estimate of the price that reflects the *normal* price level in the closed outlet, based on the price history in the outlet and, where relevant, by reference to movements in the product's price in other comparable outlets. This estimated normal price can then be used when introducing the price of the replacement product. This is similar to the recommended treatment for out-of-season and in-season, seasonal products (see Section 7.1). Price collectors have a key role in determining what is happening on the ground by, for example, recording whether an outlet is soon to close (indicated by, for example, a closing-down sale or a rundown in stock levels) and whether a price in an outlet soon to close is a genuine sale price or not.

5.8 Practical price collection procedures

5.8.1 Local price collection

No substantive advice is given here on the planning and organisation required for successful local price collection. The *Practical Guide to Producing Consumer Price Indices* (United Nations, 2009, ECE/CES/STAT/NONE/2009/2) provides guidance on good practices that countries might wish to adopt as part of their price collection procedures. With regard to traditional price collection, tight price collection and production schedules should allow sufficient time for a collector to travel to all required localities and obtain all the necessary prices from each specified outlet at the appointed time of day. The price collector should also have enough time to conduct all the necessary checks and re-pricing before submitting the prices to the head office. There should be effective audit trails covering all aspects of price collection, including those involving the head office.

5.8.2 Central price collection

Efficiency considerations can lead to prices being collected centrally by staff based at the head office or regional offices, without monthly visits to retail outlets. Central collection can also be useful for products and services that are difficult to observe directly, such as utility tariffs; those not sold from physical outlets; and products subject to national pricing policies, either imposed by the government or established by a retail chain for all its outlets, for example. Prices can be collected from catalogues, from retailers' price lists for their outlets, by telephone, fax, letters, emails, postal and electronic questionnaires or by querying websites. Scanner data, containing itemised information on turnover and quantities, are increasingly being used by NSIs in place of traditionally collected price data (see Section 5.4).

All these methods can be cost-effective and, equally important, can help to ensure the sample is balanced, for instance, by ensuring the inclusion of mail order and internet purchases in the HICP. Central price collection also has the potential advantage of increasing the sample of prices collected at minimal cost, as it eliminates the variable costs of employing local price collectors, which otherwise increase proportionally to the sample size. The most common data sources used in central price collection are discussed below.

Prices may be obtained from mail order catalogues and their internet equivalents, to represent a certain type of retail outlet, or where high street catalogue stores have nationwide coverage with uniform pricing policies. Increasingly, mail order suppliers are offering their own internet services. In the case of both mail order and internet shopping, care must be taken to treat delivery prices and sales taxes consistently and correctly (see the earlier definition of a price and also Section 7.2). Catalogue or list prices provided by the supplier to the retail outlet are in many cases identical to the transaction price. However, the catalogue or list price may only be the recommended price and not the actual price at which the item is sold.

Prices may be collected online either for convenience (where major stores offer the same prices online and in their outlets) or to maintain a representative sample in areas where online selling is increasingly utilised. It is worth noting that while some retailers have an online presence with up-to-date prices reflecting those charged in their outlets, others publish online prices which may differ from their in-store prices. For instance, there may be lower basic prices online, but with a delivery charge or special offers for online customers only.

Some retailers have national pricing policies with no individual pricing discretion, even for sales and special offers. In such cases, a single store can be visited or the retailer’s head office may agree to supply a single price list (covering all products or prices of specific selected products).

Prices may be obtained by telephone or fax, offering no ambiguity, since the product being priced is standard and the contractor will quote a standard charge (for example, electricians may be phoned to enquire about the charges for providing a new single electricity socket). Moreover, asking about prices by phone reflects common consumer behaviour. A further factor is that many service providers (e.g. plumbers or window cleaners) do not work from retail outlets. Even where they do, visits are problematic, given their variable and sometimes erratic working hours off-site at customers’ premises.

Prices may be obtained by letter, or email, accompanied by relevant head office forms for completion and returned in cases where central collection is considered more efficient or where local price collection is not possible (for example, tariff prices). Examples include prices collected from a sample of local authorities, insurance companies, public utilities and telephone companies. However, these days, email has generally replaced letters and faxes.

Prices may be obtained from other government agencies or regulatory authorities, which can act as intermediaries, i.e. secondary sources, in the price collection process. In some countries this would be the case for electricity prices.

Some outlets or institutions have only one outlet. Examples include historic sites, museums, art galleries and theme parks. Often admission prices are published on their websites, so collecting prices online is the most practical solution. Alternatively, prices can be collected by phone, by fax or through a postal enquiry.

While customers still use traditional high street travel agencies to purchase both holidays and flights, in many countries such services are now purchased mainly online. Compilers should include both online price collection and prices collected from high street travel agents, in proportion to their market shares (see Section 12.5).

Prices can also be obtained from a variety of administrative sources. The use of administrative sources will be covered in some detail in chapters covering specific measurement issues such as the pricing of education, health and social services and areas such as public transport where regulatory authorities may be involved. In these instances, there can be a reliance on administrative data for both prices and expenditure. An example of the latter is where the expenditure associated with different tariffs is needed.

It is important to ensure that compilers of administrative data sources understand the significance of their data for the HICP and the extent to which the countries concerned rely on them. Service-level agreements on data coverage, definitions and deadlines for data delivery can be useful in making the relationship between data source and the country concerned more explicit.

When using other sources such as catalogues or the internet for prices, special care must be taken to ensure that the prices are correctly recorded and that they adhere to HICP conventions. See also Section 5.3.2 on the definition of a price and Section 7.2 on internet purchases. Procedures should also include a check that the prices are relevant to the index period, as the reference periods could vary, particularly for catalogue prices.

Importantly, all the usual price collection principles and quality assurance concerns remain relevant for prices collected online, including the need for detailed descriptions, immediate availability of the product for purchase, etc. One possible source of difficulties is retailers' propensity to regularly change the format and content of their web pages. Print screens are a possible way to retain proof of the price, or web-scraping can be used.

Finally, to reiterate an earlier point, exploiting different data sources through central price collection can help keep the HICP representative of the various outlets used by customers, but only if product offers are sampled in proportion to sales per outlet-type.

5.9 Detecting pricing errors

5.9.1 Checking and editing data in the field

Data validation should be carried out throughout the entire process of compilation of the HICP, from the collection of individual prices to their aggregation into indices. Several tests can be carried out on price data collected in the field, especially if those data are entered into hand-held computers or tablets. The tests can be carried out at the time of price collection and errors can then be corrected without any need for a follow-up visit to the retail outlet.

Some basic tests include whether a price has been collected and whether it has shown any change. The most useful tests to detect outliers are the *price change* test and the *minimum-maximum* (or min-max) test. In both cases, the thresholds used to identify outliers that may be worth investigating can be determined by the number of outliers detected and the proportion subsequently proven to be price collection errors. Thresholds will vary according to product type (ILO, 2020).

Price change test

The price collected is compared with the price for the same product in the same shop/outlet in the previous month. It is subject to further checking if the change is outside pre-set percentage limits specific to the product and determined by the month-on-month variance in previously recorded prices, excluding sale prices (ILO, 2020).

Minimum-maximum test

This identifies cases where the price entered is above a maximum or below a minimum pre-set indicative threshold price for the product of which the particular product offer being priced is representative. The range is derived by applying a scaling factor to the validated maximum and minimum prices for product offers observed for that product specification in the *previous* month. The scaling factor is chosen so that an appropriate number of price observations are marked for checking, based on past experience of the number of incorrect prices encountered.

In both the above tests, it is important to identify sales prices and any changes in the price-determining characteristics of the product whose recorded price is being checked, to identify whether it is an outlier.

Other tests can include the number of months for which a price has remained unchanged, and whether a price has been collected and, if not, why not. The price collector may conceivably have forgotten to collect a price.

Where hand-held computers or tablets are used, these tests can be programmed so that if a test fails, a warning message appears.

For example, in Italy, the use of Tablets for the local price collection provides the opportunity to check if the product characteristics are the same and to correct errors at the time of price collection. The software 'desktop' (named P1J) installed on PC Tablets provides a set of automatic checks on inputted data which helps price collectors to detect and avoid possible mistakes and to validate prices. These automatic checks are based on tolerance range of price change (comparison of the currently observed price quote with the previously observed one).

Ranges are set independently for group of products, taking into account if products are seasonal, if they have volatile prices (for example the ranges are set ± 50 % Fresh fruit and vegetable, and ± 30 % Fresh fish).

In Germany, the use of mobile data capture devices with integrated plausibility checks prevents measurement or data entry errors during the process of data compilation. Inconsistent entries are rejected by the processing program. Warning messages are displayed if, for instance, atypical price or quantity changes occur. If a warning message is ignored, the relevant case will be automatically shown to a specially qualified staff member of the competent statistical office for final assessment or clarification ([132]).

The same tests can be carried out on the central computer system at head office, though not in real time.

It is important to note that prices should not be automatically excluded if they fail the above checks. The onus is on the price collector to identify and distinguish between outliers and errors and to justify the decision to exclude a price.

Further details are given in The Practical Guide to Producing Consumer Price Indices ([133]).

5.9.2 Data checking and editing at the head office

Price collectors and head office have different but complementary roles in the quality assurance of price quotes. The price collector focuses more on whether a price looks reasonable compared with previous prices collected in the same shop for the same product offer. Head office, on the other hand, has access to all price quotes submitted by collectors at a given point in the monthly production cycle. This means that checks can be carried out on, for example, whether the price quote for a particular product in a particular outlet looks reasonable when compared with all price quotes submitted for all retail outlets for that particular product, or with all price quotes submitted for that product by outlets of a similar type or located in the same region.

Checking can be carried out by manual inspection (non-statistical checking) or by applying statistical algorithms (statistical). Non-statistical checking includes the price change and minimum-maximum tests referred to above, which rely on some form of automated analysis to identify price quotes warranting more detailed inspection and tests of logic, for instance if a sale price is higher than the non-sale price. An example of statistical checking is the use of the Tukey Algorithm which overcomes the problem of validating data when there are many observations with no price change (that is, where many price relatives are equal to one, indicating no price movement).

Verifying that the calculated index movements are plausible is another important part of data checking and validation. Using plot charts is helpful to spot the outliers on the collected data and focus validation on these. For visual data validation, it is easy to use plot charts that are readily available in spreadsheet software tools or can be programmed on the information technology (IT) system (CPI Manual, 2020).

([132]) Destatis (2023), Quality Report - Consumer price index for Germany - 12/2023 - 12/2024 (destatis.de).

([133]) *Practical guide to producing consumer price indices*, United Nations, Economic Commission for Europe, 2009.

Further details on data validation and editing are given in the ILO Manual and The Practical Guide to Producing Consumer Price Indices.

The central collection of high-frequency data, such as scanner data and web scraped, requires the adoption of check systems, composed by systematic and automatic checks, both formal and quality checks on the data flow. Formal checks have to ensure completeness of data collected at territorial level, distribution chains, outlets, products and weeks. Quality checks introduce editing rules which identify inadmissible values on the main variables of interest (quantities sold, turnover and prices).

These scanner data checks can be classified as either global checks or detailed checks. Global checks occur when the data enter the production process and are part of the acceptance procedure. Detailed checks typically occur toward the end of the production process (CPI Manual, 2020).

Global checks, generally applied at the time the NSI receives the data set, aim at ensuring the data set is broadly consistent with data sets received by the NSI from the same data provider in previous periods. The checks may relate to the format of the data set, the total number of items within the data set, and the total revenue by outlet. These global checks should highlight significant errors with the data set.

Detailed checks (micro-editing of price data), generally applied at the item group level, aim to disclose significant changes in the quantities sold, sales, and the prices of the items within the data set. Unexpected changes in prices, turnover, or quantities will trigger these checks.

Even if new data sources such as transaction and web-scraped data may be subject to existing quality control standards, it is important that specific procedures are implemented to check the quality of the received data, monitor the number and nature of mistakes and errors, and ensure that the automated systems are improved.

The completeness, accuracy and consistency of every data set should be checked by using formal and quality checks. A first dimension to be considered is coverage which consists in checking if the automatically extracted website data or the received scanner data has the right number of records. Any serious deviation from that benchmark should be monitored and checked upon. In addition, it is necessary to verify completeness, which is about checking if the right number of results (cells with the right data in them) have been returned (Auer and Boettcher, 2016).

In Italy, formal checks have been studied and implemented on the flow of scanner data both during and after the data loading (Bernardini et al, 2016) ([134]). The formal checks during the data loading ensure that all occurrences (a product identified by EAN sold in an outlet in a week) have full numeric code for the outlets and products, with numeric and valid decimal values for turnover and quantities and related to the period of interest.

The formal checks after the data loading concern:

- the presence of duplicates for outlets, products and weeks;
- the presence of a product not included in the list updated every two months;

([134]) Bernardini, A., Guandalini, A., Inglese, F., & Terribili, M. D. (2016), 'The Scanner Data In The Consumer Price Survey: The Data Processing', *Rivista Italiana di Economia Demografia e Statistica*, 70(4).

- the absence of an outlet among the required outlets;
- the presence of null fields of turnover and quantities;
- the presence of unauthorised data such as outlets which do not belong to the authorised provinces or to the allowed chains, or outlets not classified as a hypermarket or supermarket.

These checks must ensure that data always refers to the same population (locations/provinces, chains, outlets and products) for each week.

The quality checks follow the phase of formal checks with the aim of introducing editing rules for identifying inadmissible values among the variables of interest (quantities sold, turnover and unit prices). First-type quality checks are implemented to identify and eliminate the problematic occurrences (outlet, EAN code, week) in which: i) quantity lower than 1 or decimal values on quantities greater than 1 are not motivated by unit of measurement; ii) unit prices are lower than EUR 0.01.

Subsequently, in order to maintain an accurate and stable price index over time, a second type of quality check has been implemented. The prices of each product are validated considering the price labels, during the relevant weeks of every month at provincial level. To identify inadmissible unit prices of occurrences, several methods – more or less sophisticated – may be considered.

In principle, all individual products in scanner data could be included according to their importance when multilateral methods are used for compiling elementary indices (see Chapter 8). However, in practice, observations can still be excluded because important information is missing (e.g., turnover) or through application of filters, such as (Eurostat, 2022 ([135])):

1. Outlier filter: an observation is excluded if the price change compared to the previous month (or any earlier period), the price, or the quantity is unusual (too high or too low) as this may point to coding errors or other mistakes in the data sets. Thresholds for identifying outliers should be set very carefully so that the number of outliers remains low. Any outliers detected during this phase should best be followed up.
2. Dumping filter: an observation is excluded if both the price and the quantity goes down considerably compared to the previous period. This is an indication for clearance sales. The observation could be removed as such observations may inadequately influence the resulting indices. Products identified as a dumping in a month should also be excluded in the following months if price and quantity remain similar.

In order to illustrate the various procedures used for explicitly and systematically assesses data quality against requirements, a quality report for scanner data may be compiled (Daas and Osses, 2017) ([136]). See Chapter 11 for more details.

5.9.3 Rejection of price observations

The HICP regulations do not address editing, data processing or validation procedures. Individual EU countries are responsible for determining the practices that best suit their indices.

([135]) Eurostat (2022), Guide on multilateral methods in the Harmonised Index on Consumer Prices (HICP) — 2022 edition - Products Manuals and Guidelines – Eurostat..

([136]) Daas, P. J., and Ossen, S. J. (2011), Metadata quality evaluation of secondary data sources, Center for Quality.

However, a common framework for the rejection of price observations should secure the comparability, reliability and relevance of the HICPs.

The following guiding principles are useful:

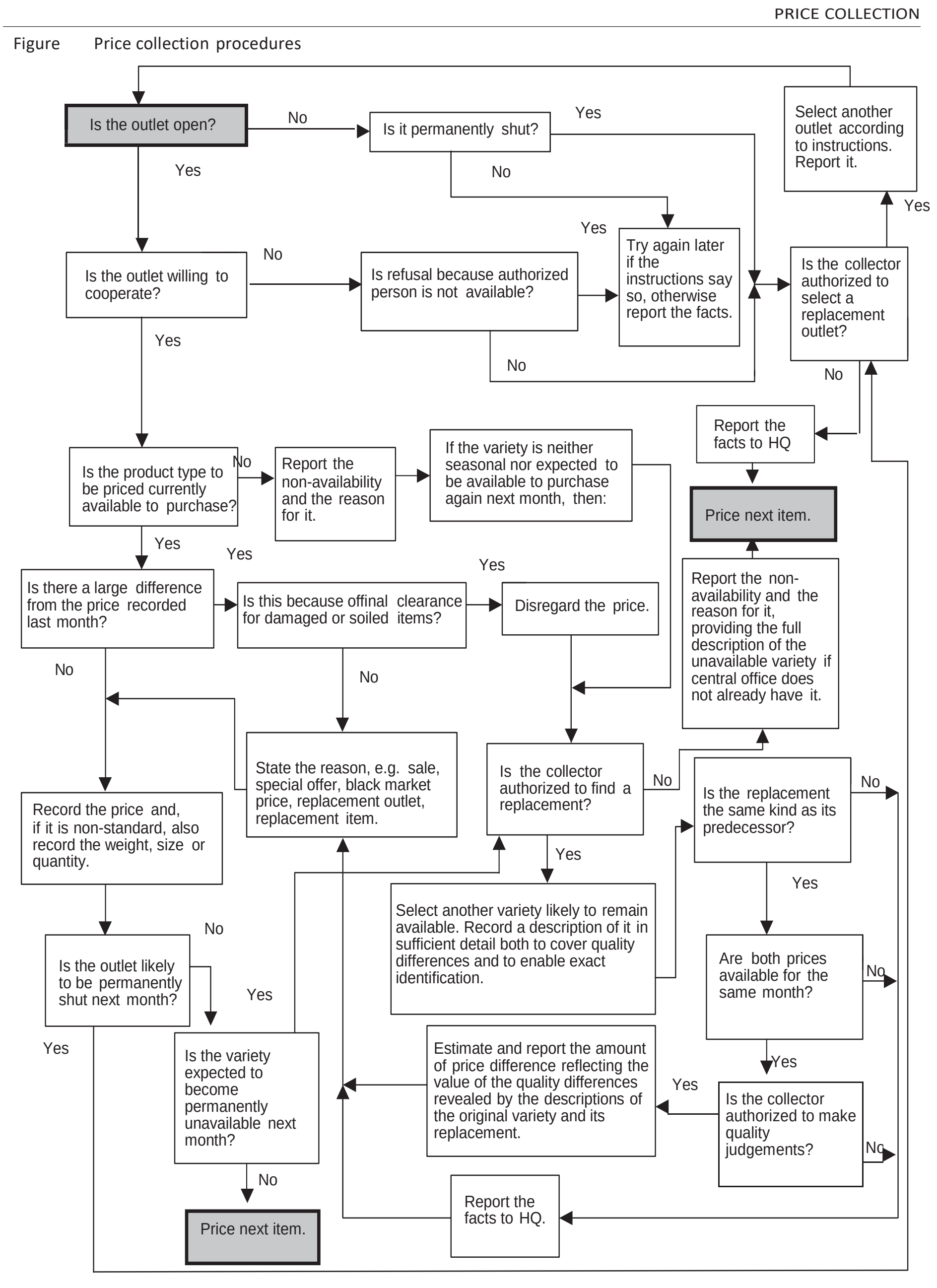
- Reported prices should normally be accepted.
- Prices should be rejected or adjusted only by reference to specific information relating to the individual price observation concerned.
- When, as a result of validation procedures, reported prices have to be rejected and new observations cannot be established, rejected prices should be treated as missing observations.
- Other methods may be used. In this case, Eurostat may request that the methods used must be shown not to result in an HICP that differs systematically from an HICP constructed in line with HICP Regulations by more than 0.1 percentage points on average, taking one year against the previous year.

Annex 5: An overview of price collection

The following diagram (Figure 5.9.6 Planning and Organising Price Collection from the CPI manual, p. 105) summarises good practice with regard to price collection. The procedure described is a way to meet HICP legal requirements, but it is not prescribed in detail by any regulations or other agreements.

Figure 5.9.6

Summary of price collection practice



6

Replacements and quality adjustments

6 Replacements and quality adjustments

6.1 Introduction

The HICP tracks the price developments of a representative sample of individual product. To this end, a matched (or like-for-like) sample strategy is applied. As stated in the Consumer Price Index Manual: Concepts and Methods (2020, para. 6.10), the matching of models facilitates the measurement of constant-quality price change. However, because the market for consumer goods and services is in a constant state of flux, maintaining a sample of identical and representative products over time is impractical (see Section 4.3.2).

There are generally two approaches that are used to keep the sample current in a changing market environment. The first consists of periodic comprehensive revisions of the sample of products using the procedures described in Chapters 4 and 5 (i.e., pre-programmed annual basket updates). The second consists of replacing, between the planned periodic revisions, those single individual products as they disappear from the market or when they are no longer representative of consumers buying habits. This chapter describes the procedures to apply when the latter case, i.e., in cases when individual products need to be replaced between scheduled basket updates.

To reflect the price changes experienced by consumers, the index compares the change between two price observations taken over two adjacent periods. Under matched sampling, the assumption is that these two individual products are comparable. However the reality, however, the reality is that some products go missing and the replacing individual products are not always strictly comparable with those that were previously sampled, as their quality characteristics (or features) may differ.

As the HICP is a measure of *pure price change,* it should be unaffected by quality differences when a new product replaces an old one. As such, these quality differences need to be identified and addressed before computing the index.

Quality in general can be understood to mean the characteristics or features of an individual product. These features will often determine a consumers' willingness to pay for a product. For example, a television with a larger screen (all else equal) will typically command a higher price than one with a smaller screen because consumers value the larger screen size more and thus their willingness to pay is higher.

Quality adjustments are applied to modify prices between replaced individual product and replacement individual product to enhance their comparability so that an accurate estimate of price change can be calculated. Such modifications are common when replacements are needed because the price-determining characteristics of the replacement individual product differs from those of the replaced one. In practice, either the new price or the previously observed one can be quality adjusted without affecting the outcome; the choice is often a matter of computational convenience.

Two broad quality adjustment methods exist that are both typically applied across the product spectrum:

- *Explicit* methods estimate the value of quality change by evaluating changes in product characteristics.
- *Implicit* methods estimate the value of quality change from other observed price differences between similar individual product that are available at the same time.

Various methods for both explicit and implicit quality adjustment are described in this chapter.

Statisticians need to make some important choices among the various quality adjustment methods available, in addition to the strategy for selecting the replacement individual product. Both dimensions to quality adjustment have traditionally varied across Member States, which presents a challenge for harmonisation.

Replacement and quality adjustment can have an important impact on the HICP. While only a minority of individual product are replaced in a single month, over a year a large share of the sample can be subject to replacement (e.g., electronic goods such as mobile phones, cars, computers, clothing, etc.). This requires a significant effort in developing and maintaining a strategy for quality adjustments and replacements. Replacements and quality adjustments are intrinsically linked and should be treated together.

This chapter starts with the legal requirements and some general principles behind replacement and quality adjustment, followed by a description of the various methods that can be used for quality adjustment.

The chapter draws on earlier work done in the European Statistical System (ESS) such as the project under CENEX ([137]) on quality adjustment for the HICP.

([137]) Centres and Networks of Excellence.

6.2 Legal requirements, definitions, concepts and supporting material

Concepts and definitions of replacements and quality adjustments

Article 2 of Commission Regulation (EU) 2020/1148 of 31 July 2020 laying down the methodological and technical specifications in accordance with Regulation (EU) 2016/792 of the European Parliament and of the Council as regards harmonised indices of consumer prices and the house price index provides the following relevant definitions for this chapter:

> *3. 'target universe' of the HICP means all transactions included in household final monetary consumption expenditure;*
>
> *4. 'product-offer' means a product specified by its characteristics, the timing and place of purchase and the terms of supply, and for which a price is observed;*
>
> *5. 'homogeneous product' means a set of product-offers among which there are no significant quality differences and for which an average price is calculated;*
>
> *6. 'individual product' means a product-offer or a homogeneous product;*
>
> *7. 'target sample' means a set of individual products that pertain to transactions from the target universe and for which price data are to be used for HICP compilation;*
>
> *8. 'quality difference' means a difference between the characteristics, timing, place of purchase or terms of supply of two individual products, where this is relevant from the consumer's perspective;*
>
> *9. 'replacement product' means an individual product that replaces another individual product in the target sample;*
>
> *10. 'quality adjustment' means a procedure of increasing or decreasing the observed price of a replacement product or the replaced product by the value of the quality difference between them;*
>
> *11. 'observed price' means the consumer price of an individual product, as used by the Member State for the HICP compilation; and*
>
> *12. 'estimated price' means a price based on an appropriate estimation procedure;*

More legislative definitions about sampling are found in Chapter 4. Additional (non-legislative) definitions dealing with quality adjustment methods are provided in Sections 6.7and 6.8 of this chapter.

Articles 4(3), 9(1),(2), 10(1),(2), and 11(1),(2) of the Implementation Regulation state the following requirements for replacements and quality adjustments:

Article 4

Sampling and representativity

3. Member States shall ensure that the target sample remains representative of the target universe over time by conducting at least an annual review and update of the target sample and selecting replacement products.

Article 9

Estimation of prices

1. If the price of an individual product in the target sample cannot be observed, an estimated price shall be used for no longer than 2 months, after which a replacement product shall be selected. This paragraph shall not apply to seasonal products or other individual products that are expected to become available again.
2. A previously observed price shall not be used as an estimated price unless it can be justified as an appropriate estimate.

Article 10

Replacements

1. Member States shall select a replacement product that is like the disappearing product, while ensuring that the target sample remains representative.
2. Member States shall not select replacement products based on a similar price.

Article 11

Quality adjustment

1. If there is no quality difference between a replaced product and its replacement, Member States shall compare the observed prices directly. Otherwise, Member States shall make a quality adjustment.
2. Member States shall make a quality adjustment equal to the whole price difference between the replaced product in month m-1 and its replacement in month m only if this can be justified as an appropriate estimate of the quality difference.

6.3 Principles

The following seven principles should guide the index compilers in developing and implementing strategies for quality adjustment and replacement:

1. Replacements should maintain representativity.
2. Replacements should be timely.
3. Characteristics of the replacement individual products should be similar to the replaced individual product.
4. The consumer perspective is primary.
5. Fashion variation, in the sense of variations in prevailing style, is not a quality change.
6. Quality change from all relevant causes should be recognised.
7. Specified recommendations apply for quality adjustment in specific product areas.

6.3.1 Principle 1: Replacements should maintain representativity

Article 10(1) of Implementing Regulation (EU) 2020/1148 states that Member States shall select a replacement product that is like the disappearing product, while ensuring that the target sample remains representative.

This rule follows standard index number construction approaches by ensuring that the price observations used for the HICP are representative of current purchaser transactions and that the index is not influenced by prices of obsolete products.

However, considering that an individual product may be only temporarily unavailable and soon return to market; the rule allows an imputed price to be used for a period of two months (see Article 9(1)). For a more in depth discussion about missing prices, the reader is referred to Chapter 5 of this manual.

6.3.2 Principle 2: Replacements should be timely

Article 4(3) of Implementing Regulation (EU) 2020/1148 stipulates that keeping the sample representative need not be limited to that time of the basket update. Timely replacements should be made at every opportunity, and this is a continuing exercise between basket updates. This ensures that the sample remains representative, irrespective of the timing of the comprehensive sample revision.

Introducing a replacement need not be delayed only in situations when the original individual product is no longer available. A replacement should be made when it can be shown that the market share of the individual product has significantly decreased while another one has gained importance. This practice ensures that the sample remains representative.

Annual sample revisions and within-year replacements are two complementary exercises that contribute in keeping the sample representative. In other words, annual sample revisions can be interpreted as a long-term strategy while within-year replacements are more akin to a short-term strategy for ensuring sample representativity. It is important that replacements be carried out as frequently as required, even if it is towards the end of the year and nearing that time of the basket update. This allows for any quality change to be reflected in the index in a timely fashion, thus ensuring that the index accurately estimates the latest price developments.

Price collectors can play a critical role in this area by monitoring their products for any change in market share (or changes in sales volumes) that may disqualify them from the sample because they are no longer representative. The same practice extends to any prices that can be collected centrally (see Chapter 5 for further details).

6.3.3 Principle 3: Characteristics of the replacement product should be similar to the replaced product

According to Article 10(1) of Implementing Regulation (EU) 2020/1148, a replacement individual product must be selected from a similar individual product and in such a way that target sample remains representative. Moreover, the chosen replacement product should be functionally like the old product; similarity of price should not be the criterion when choosing the replacement product (see Article 10(2)).

Product specifications define the products to be priced within target samples and are in effect instructions used by price collectors so that they can select individual product to price within the sampled outlets. These product specifications delineate the product categories (i.e., sampling frame) within which replacement individual product should be selected. They are not to be confused with the actual product descriptions recorded by price collectors when selecting a particular individual product or variety when pricing in the sample of outlets (see Section 5.4).

Replacement strategies: most similar or most representative

Price collectors need some guidance and principles on which to rely on when selecting replacement individual product for a given product specification. There are basically two options available to the compiler: 1) either to select an individual product that is *similar* to the replaced one; or 2) to select the *most representative* (i.e., most sold) individual product that satisfies the pre-established product specifications. Although the compiler should strive to achieve both objectives, they can sometimes be mutually exclusive.

The approach of replacing with a *similar* individual product has an advantage of generating more sampling precision because this leads to less variability in the index since the quality adjustment is minimised. However, it has an important drawback in as much it may not reflect the overall quality developments within the specified product type if this development is significant (e.g., technology products). Annual resampling will mitigate this problem, but cannot eliminate it altogether. This is because there is a risk that price changes are not properly captured if models change in between the annual resampling, which can often be the case for some types of products with frequent turnover (see below).

The second option of replacing with a *representative* individual product (while respecting the product specification) has the advantage of reflecting the changing market environment and thus maintaining the representativity of the sample. This option is less attractive because of the uncertainty involved in selecting replacements and in applying quality adjustments.

Whichever strategy is followed, there will always be some uncertainty and some random volatility, both in the replacement situations and when applying quality adjustments.

To some extent some judgement is always needed because of the trade-off between sampling accuracy and the need to maintain representativity of the sample. Article 10(1) of Commission Implementing Regulation (EU) 2020/1148 stipulates that a replacement product should be like the disappearing product, while ensuring that the target sample remains representative. Similar does not necessarily equate with identical, otherwise the new product would likely not be representative of the current state of the market and true price changes would be unlikely to be reflected in the index.

For example, a furniture company may have a policy of not changing the prices of its current line-up of furniture, but introduces instead new models at higher prices. In such a case, the preferred strategy is to choose the representative approach. Namely, the price changes that consumers observe will not be appropriately reflected in the index unless the newly available models that are preferred by consumers are selected as the replacements. In such situations, appropriate quality adjustments must be applied.

In the end, when replacing products, the compiler should strive to satisfy both objectives: similarity and representativity. However, there may be cases where the most similar product is not the most representative product or *vice versa*. In such cases, representativity should then be privileged, and the required quality adjustments made as needed.

The option of replacing between outlets

Practices vary among countries as to whether replacement individual product should be selected only from the same outlet as the replaced one or if it can originate from a new outlet altogether. The choice between these two options is allowed to reflect country-specific conditions and ensure comparability of results.

Occasionally, there can be reasons to choose a replacement individual product from a different outlet when the sampled outlet closes or no longer stocks individual product that satisfy the products specification. For example, if a hardware store used to sell garden equipment but does not do so anymore, then a solution may be to price the products in another outlet. However, this solution is possible only if the reference prices are comparable or can be reliably observed retrospectively in the replacement outlet.

A replacement between outlets can potentially lead to a need for a quality change adjustment, e.g., if the replacement outlet is not entirely comparable to the replaced one in terms of user functionality of products or the quality of the customer service. Such quality differences should, in principle, be accounted for if they are deemed important to consumers and can be estimated.

6.3.4 Principle 4: Consumer perspective is primary

In accordance with Article 2(8) of Implementation Regulation (EU) 2020/1148, a quality difference means a change in the characteristics, timing, place of purchase or terms of supply of two individual products, where this is relevant from the consumer's perspective.

In other words, there is a quality difference when the replacement individual product differs from the replaced one in some product characteristics that matter to consumers. In the language of the CPI Manual (2022, paragraph 6.73), if variety A is better than its old version, variety B, it is because it delivers more utility to the consumer who in turn is willing to pay more.

The HICP has adopted a purchaser approach rather than a user approach for its conceptual framework. This means that the relevant product characteristics are essentially those that consumers are aware of when they decide to purchase the product. According to basic consumer choice theory, it is assumed that consumers think and behave rationally and are well informed when making their choices, although this is possibly only partly true. It is thus assumed that consumers are cognizant of all those features of a product that have consequences for them.

However, this means that the expected use of the product is also a relevant issue in the purchase approach, as consumers have the use in mind when deciding on the acquisition of a product. Below are some examples on this point.

Energy efficiency rating labels for electric appliances, and *life expectancy for light bulbs:* for household appliances like refrigerators or for light bulbs, the energy rating label provides information about the product's energy (electricity) consumption. Any change in the information content of a label is a quality change, analogous to a change in fuel consumption for cars in the preceding example. Namely, the energy label is there to inform consumers, and they are not indifferent to the information provided on the label. In fact, manufacturers often use this same information when promoting their product to consumers.

Product modifications arising from regulatory changes: the features of a product may change because of a new legislation that is introduced for reasons of health, safety, or environmental protection. However, it is not obvious if such regulatory product changes should or should not be treated as quality change. Take for instance the case where new legislation stipulates that the material used and the tread design for automobile tyres needs to be changed to reduce the maintenance costs of highways. Let's further suppose that this change adds to the manufacturing cost of tyres, thus leading to higher tyre prices, but there is no effect ontheir durability, ride comfort or other utility changing features. This price increase would be reflected in the HICP since this is not considered a quality change. Now, if the new mandated tyre design had led to a change in some utility inducing characteristic such as lengthening the expected life of the tyre, then the price of the tyre would be adjusted for the estimated additional value to consumers of that quality change.

Renovations for rental dwellings: major renovations of rental dwellings (e.g., a new and improved heating system or a renovated bathroom) entail a quality change to the extent that they *improve* (or worsen) the functionality of the dwellings to the tenants and any rent increase that results should be adjusted for the value of the additional satisfaction that renters derive from such renovations. In contrast, other types of renovations, such as replacing the water pipes, which are typically needed after many years of use to *maintain* the rental unit's functionality but do not change it, are not considered quality change. Consequently, rents should not be quality adjusted for such types of renovations. But if other measures that lead to a quality change that improves the comfort for the tenant, such as the addition of new heated flooring, are made at the same time as the installation of the new piping, then these should be quality adjusted (see Section 12.4).

6.3.5 Principle 5: Fashion variation, in the sense of temporarily varying consumer preferences, is not quality change

Fashion variation, in the wider sense of variation in prevailing style or temporarily varying consumer preferences, occurs not only for products like clothing (see Section 12.7) but also for many other products which are affected by temporary trends in consumer preferences, such as electronic goods, cars and appliances. The point is to decide what product characteristics need to be accounted for when deciding to adjust for quality or not.

Take the case of clothing for example, a product which is known for its propensity for fashion changes. The CPI Manual (2020, paragraph 11.48) recognises that making like-for-like comparisons for clothing can be difficult when fashion comes into play and states that for fashion items, only changes in compositional and material characteristics, if significant, should be treated as quality changes. As for controlling for quality in the case of fashion items, the CPI Manual recommends collecting prices for the same (or equivalent) brand in the sample since this is the primary characteristic of most fashion items and is therefore key to measuring the fashion element of clothing (or any other fashion-centric product).

It is crucial for the quality of the index that fashion variation can be identified as such and not be quality adjusted for. This can be challenging at times.

6.3.6 Principle 6: Quality change from all relevant causes should be recognised

Generally, a symmetric treatment must be applied between treatments of improved versus deteriorating quality of a product. For example, it may occur that a replaced TV model happened to have some unusual luxurious feature that the replacement model does not possess. Then the quality change is to be treated analogously with changes in the opposite direction, i.e., improvements. This symmetry is crucial for preventing the index bias to grow over time.

Another kind of quality change is where there is a change in contract conditions (other than by legal requirements, see Section 6.3.4) associated with the use of a product. An example is change over time in the conditions of a car warranty. Warranties are valued by car buyers and can potentially influence their decisions on which car brand to buy. Thus, modifications from one year to the next in the coverage of a warranty (e.g., length of coverage from 2 years to 3 years) should be treated as a quality change and calls for a quality adjustment by the compiler.

Likewise, a replacement insurance policy may become subject to a change in conditions that makes it less valuable or more valuable to the policyholder. For instance, there may be a change in the amount of the deduction when a claim is paid out. Then a quality adjustment should be made to the insurance premium (see Section 12.2) so that comparability is ensured.

It should be noted that quality adjustments should be applied to all observed quality changes in the sample.

6.3.7 Principle 7: Specified recommendations apply for quality adjustment in specific product areas

Between product groups there are differences in the need for, feasibility of and relevance of approaches to be applied for quality adjustment. Therefore, guidance has been developed for specific product areas (e.g., clothing and footwear, etc.), which is elaborated in other chapters of this manual.

Some methods (these methods will be discussed in detail below) are more suitable for certain product groups then others. For example, many NSIs have found that hedonic methods are the best option for quality adjusting electronic goods such as computers and other digital-type equipment. The option cost approach is often used to adjust for quality change in cars. Changes in package sizes are mostly adjusted by NSIs by assuming a linear relationship between price and quantity. Finally, bridged overlap is a very popular method, and it is frequently used for many of the other product groups such as, furniture, appliances, clothing. However, care must be taken when using bridge overlap ([138]). Recommendation 1 of the *HICP recommendation on bridged overlap* states the conditions under which this method should be avoided as follows:

(138) HICP recommendation on bridged overlap - June 2021 (europa.eu).

‘*It is recommended to avoid applying bridged overlap in the following situations, unless duly justified:*

1. The last price of the replaced (old) product-offer is a reduced price.

2. The first price of the new product-t-offer is a reduced price.

3. The first price of the new product-t-offer is unusually high.

4. The matched sample of product-t-offers includes reduced or atypical prices or shows a downward price trend during the product life cycle’.

6.4 General remarks on quality adjustment

Simplistic approaches

Article 11(1 and 2) of Implementing Regulation (EU) 2020/1148 states the following:

1.’If there is no quality difference between a replaced product and its replacement, Member States shall compare the observed prices directly. Otherwise, Member States shall make a quality adjustment.’

2. ‘Member States shall make a quality adjustment equal to the whole price difference between the replaced product in month m-1 and its replacement in month m only if this can be justified as an appropriate estimate of the quality difference.’

Article 11 presents two options for the price statistician:

In Article 11(1), it has been judged that the features of the replacement individual product are very similar to those of the replaced individual product and consequently there is no observable quality difference and therefore no quality adjustment is needed. In such a situation, any price difference between both products will be recorded as a pure price change when compiling the index. However, if the replacement product is perceived as being sufficiently different compared to the replaced product, the compiler must quality-adjust. For instance, if the standard size of a box of breakfast cereal increase from one month to the next, then some adjustment for the larger size needs to be accounted so both prices are comparable. Under no circumstances should both prices be compared without any adjustment since the features of the boxes of cereal have clearly changed over these two months. The methods and techniques for applying estimating quality change are discussed below. The choice of the technique varies according to the nature of the product.

Article 11(2) describes an extreme case whereby the entire price difference between the replacement and replaced product can be explained by their quality difference. In other words, the monetary value to consumers of the quality improvement (assuming it is a quality improvement) equals the price difference between the old and the new product. For example, take the case of a new car with a price this month of 30 000 euros and then for the following month the price rises to 30 500 euros. However, the latest model now incorporates an integrated GPS as a standard feature (which was not available with the previous model). If the compiler has reason to believe that the entire difference of 500 euros is accounted for by the new feature, then 500 euros should be deducted from the latest price of 30 500 euros and the index shows no change.

As noted in Section 6.3.7, choosing the first option is not generally considered the ideal option, particularly when there are clearly perceived quality differences; however, this option can, in some limited cases, be acceptable. The second option is to be avoided for most situations as it introduces inertia into the index, thus often supressing true price changes. This second option is based on the often inaccurate and simple assumption that the difference in price between the old and the new individual product is entirely explained by their quality differences. In fact, Article 11(2) stipulates that option 2 can be applied but only in the limited cases when it can be justified; it should never be applied automatically or as a short-cut solution in situations when a product is being replaced; otherwise, this can seriously bias the index.

Pitfalls

Generally, quality adjustment must be applied with caution. This is because over- or under-adjusting for quality differences can potentially bias the index:

- Neglecting to quality adjust could overstate inflation over periods of large and rapid quality improvements.
- Unnecessarily adjusting for quality by inaccurately considering fashion trends as a quality change would likely generate a downward bias in the index; and
- Quality adjustments that are not applied in ways that are mutually consistent could yield incomparable results.

Naturally, all such pitfalls should be avoided.

Elements of judgement

Quality adjustment procedures rely on both observed physical attributes of a product, such as the screen size of a television, and some judgement. Judgement involves making decisions with regards to quality adjustment other than strictly applying automatic procedures or rules. For example, one uses judgement when choosing quality adjustment methods and replacement individual product; sometimes also judgement is used when assessing the monetary value of the quality change for individual replacements. Also, and not least, when quality adjustment uses hedonic regression techniques, a judgement must be made when deciding which relevant characteristic variables to use in the model, the frequency for which the coefficients need to be updated, and the functional form of the regression model.

The basis for making judgemental decisions should not however be arbitrary. They must be supported by knowledge of the product and applied with due diligence, following clear instructions and documentation.

6.4.1 Criteria for quality adjustment methods

Five general criteria are useful to assess the applicability of quality adjustment methods.

1. *Acceptance.* Methods should be widely accepted among the price statistics community; this includes the requirement that they should avoid obvious bias.
2. *Justifiability.* Methods should be justifiable to users with respect to the explicit and implicit assumptions on which they are based.

3. *Maintaining representativity.* Rules for replacements, etc. should ensure that high-volume selling products are always represented in the sample (must-takes), unless measurement problems are deemed insurmountable (this is rarely the case). This is consistent with Article 10(1) of Implementing Regulation 2020/1148, which states that similar replacements products to the replaced product should be used in such a way that the sample remains representative.
4. *Applicability.* The application of the methods should be straightforward in most of the replacement situations.
5. *Sustainability.* Methods should be expected to be applicable for several years. For instance, the chosen methods should not depend on the individual who is applying them, who may eventually be replaced over time.

Whatever method is used, due competence and training are essential for staff working on quality adjustment to ensure that the best methods is applied given the resources available.

6.4.2 Quality control

Quality adjustment can be challenging for compilers and the methods used rely on judgements with generally a small number of observations for use in auxiliary calculations. Potentially, this means that a considerable degree of uncertainty can plague the index.

A quality control strategy should be implemented to collect and monitor the performance of the chosen quality adjustment method. This is the responsibility of Member State and should be done at their own initiative. Basic indicators include at least a count of the frequency of the quality changes and a record of the types of quality adjustments that are made per product group. The latter record can be reported in a database with other summary statistics.

A useful summary statistic for monitoring quality adjustments is an implicit quality index (IQI). It is calculated by dividing a hypothetical HICP, called standard reference index (SRI), a version of the HICP where no quality adjustments are made, by the published HICP.

The SRI is usually based on simple averages of prices calculated at the elementary aggregate level and then weighted according to the same weighting scheme as in the official HICP. However, because of their special nature, if package-size adjustments are applied (see Section 6.7.2), these should also be used when estimating the SRI too.

The calculation follows this formula:

$$IQI = SRI / HICP.$$

It should be noted that IQI can provide useful information at any aggregate level (i.e., from the level of the elementary price indices to any of them at the higher levels all the way to the all-items HICP).

IQI can be interpreted as the estimated average development of quality change. When quality adjustment works as it is supposed to, the SRI will typically increase faster over time than the actual HICP assuming the quality of the products has generally improved on average over time (which is mostly the case).

For example, the price of computers may have remained unchanged during a year, while quality adjustments made to the HICP sub-index for computers results in a 30 % decrease in the index (from December of the preceding year when the index is 100, to December of the current year). In other words, the prices of computers have been adjusted to reflect their quality improvement during the year. The IQI would be in this case expressed as a per cent to the amount of

$$IQI = 100/(100 - 30) \times 100 = 142.9$$

From this result it is found that the quality of computers has improved by 42.9 %.

The calculation of IQI for product groups or for other levels of aggregation can help identify any potential biases caused by the quality adjustment methods that have been applied. For example, some apparently substantial quality improvements may show up unexpectedly in some product area like as bath towels, where no noticeable quality improvements have been identified. Such a result may call for a review of the quality adjustment practices. Standard reference indices for higher levels of aggregation can indicate such issues occurring in broader areas while those for low-level aggregates can pinpoint problems occurring in narrowly defined product areas.

6.4.3 Computation of the quality adjustment

Quality adjustment makes allowance for quality change by increasing or decreasing the observed current or reference prices by an amount equivalent to the value of that quality change perceived by consumers.

In the practical computation of the index, the quality adjustment can be applied in various ways; either the current price or the reference period price is adjusted ([139]), and either by multiplying the price by a factor, or by adding or subtracting a monetary amount to that price. The choice between these alternatives in practice is basically a matter of convenience based on computational routines and the data sources available. It is not a matter of principle for proper quality adjustment, although the different approaches can lead in some cases to different outcomes.

Without loss of generality, the following descriptions of quality adjustment methods are given for one of the computation choices described above. This is the form where the *reference price* is *multiplied with a factor*, which is known as the quality adjustment factor (denoted g).

The descriptions below illustrate how a single product is quality adjusted when a replacement occurs. However, quality adjustments can also be applied for entire strata or elementary aggregates at the same time. This can occur when a quality difference results from a change in a product specification. The treatment is then analogous to the quality adjustment of a single individual product, the only difference being that a quality adjustment is simultaneously applied to more than one individual product at the same time.

A case with replacement individual product — the setting for quality adjustment

Assume for the rest of this chapter that between months $(m\text{-}1)t$ and mt, individual product 4 and 5 where replaced by individual products 4’ and 5’, respectively.

([139]) Note that price statisticians usually favour adjusting the reference period price for ease of computation. If the adjustment is applied to the current price, then all prices in subsequent periods for that product will need to be corrected, which can be burdensome.

For most methods of quality adjustment, the quality-adjusted index may be written in the following form for the Jevons index (see equation 8.9):

$$I^{mt} = \left(\frac{p_1^{mt}}{p_1^{0t}} \cdot \frac{p_2^{mt}}{p_2^{0t}} \cdot \frac{p_3^{mt}}{p_3^{0t}} \cdot \frac{p_{4\prime}^{mt}}{p_4^{0t} \cdot g_4} \cdot \frac{p_{5\prime}^{mt}}{p_5^{0t} \cdot g_5}\right)^{\frac{1}{5}} \quad (6.4.1)$$

Here g_4 and g_5 are *quality adjustment factors*, computed by one of the methods described below. They express the estimated price value of the quality difference between individual products 4 and 5, and individual products 4' and 5', respectively. The factors are applied to a reference price or to the price at the reference period of the replaced products.

The quality adjustment factors g_4 and g_5 are thus scale factors by which a reference price or the price reference period prices are multiplied (or rescaled) to account for quality differences. They are used here mainly as a technical device to conveniently describe how the quality adjustment is used computationally in the index calculation, for a given quality adjustment method.

For the Dutot index formula the quality-adjusted index becomes:

$$I^{mt} = \frac{(p_1^{mt} + p_2^{mt} + p_3^{mt} + p_{4\prime}^{mt} + p_{5\prime}^{mt})/5}{(p_1^{0t} + p_2^{0t} + p_3^{0t} + p_4^{0t} \cdot g_4 + p_5^{0t} \cdot g_5)/5} \quad (6.4.2)$$

$$I^{mt} = \frac{p_1^{mt} + p_2^{mt} + p_3^{mt} + p_{4\prime}^{mt} + p_{5\prime}^{mt}}{p_1^{0t} + p_2^{0t} + p_3^{0t} + p_4^{0t} \cdot g_4 + p_5^{0t} \cdot g_5} \quad (6.4.2)$$

where the quality adjustment factors $g_4$and g_5 are used.

The quality adjustment factors g_4 and g_5 have a straightforward interpretation. If the number g_4 is equal to one, it means that the quality is unchanged. If the number is greater than one it means that quality has improved, and if less than one then the quality has deteriorated (g is always greater than zero). So, the index Imt computed by equation 6.4.1 (or equation 6.4.2) will show the pure price change, not unduly biased by quality changes.

A remark on notation: the notation for the quality adjustment factor *g* has varied in the literature, as sometimes *g* is interpreted as the inverse of what it is in this manual.

An alternative form: Imputed price reference prices

Alternatively, equation 6.4.1 may be written as:

$$I^{mt} = \left(\frac{p_1^{mt}}{p_1^{0t}} \cdot \frac{p_2^{mt}}{p_2^{0t}} \cdot \frac{p_3^{mt}}{p_3^{0t}} \cdot \frac{p_4^{mt}}{\hat{p}_4^{0t}} \cdot \frac{p_5^{mt}}{\hat{p}_5^{0t}}\right)^{\frac{1}{5}}$$

without the explicit use of the quality adjustment factors g_4 and g_5, but instead using *imputed* reference period prices:

$$\hat{p}_4^{0t} = p_4^{0t} \cdot g_4, \hat{p}_5^{0t} = p_5^{0t} \cdot g_5 \,.$$

Alternatively, in the case of the Jevons index, the price index can be expressed as the index in *t*–1 compared to the reference period 0*t*, multiplied by the quality adjusted price change between *t*–1 and *t*.

A decomposition of this type is not possible with the Dutot price index.

6.4.4 Quality adjustment with transaction data

The product universe usually changes over time. Consequently, each new transmission of transaction data to the statistical office contains new product offers and misses old ones. In general, individual products are identified with its barcodes. The barcodes are matched over time and that guarantees that like is being compared with like.

When using the static sampling approach ([140]), replacements and quality adjustments can be done as explained before. However, any other option for processing transaction data entails the development of an appropriate methodology to deal with this issue. So far, the work developed on this matter has not reached an ideal solution, and research is ongoing.

Based on framework of the dynamic sampling approach, bilateral methods, and multilateral methods, some techniques to reduce the bias caused by product churn have been implemented by statistical offices.

The dynamic sampling approach estimates the price change between two periods using the products available in both periods only. This matched-model sampling strategy thus consists in discarding information of new and disappearing products. This approach often uses price estimations to include the price movement of reappearing products. Also, this method is sensitive to downward bias when products leave the market under clearance prices (dumping filters can be used to avoid the bias in the index). Nevertheless, since new and disappearing products are not matched one-to-one (replacements), quality adjustments are not made. *The same holds true for all bilateral methods. However, in the case of multilateral methods, the quality differences may be accounted for when combined with hedonic regression or the quality adjusted unit value method.*

Multilateral methods (see Guide on Multilateral Methods in the Harmonised Index of Consumer Prices) use information from multiple periods. Some techniques have been applied to deal with this, such as the use of the quality adjusted unit value method (QU method) introduced into the Dutch CPI in January 2016 (see Chessa and Griffioen, 2019, Comparing Price Indices of Clothing and Footwear). The family of quality-adjusted unit value methods encompasses the prominent Geary-Khamis method as well.

An interesting approach has been used by Statistics Belgium (Statbel) for several consumer electronics (laptops, smartphones, etc.) and household appliances (washing machines, refrigerators, etc.). For supermarket scanner data, Statbel uses the GEKS-Törnqvist (or CCDI) method with a window length of 25 months and a half-splice on published indices as an extension method (see also Guide on Multilateral Methods in the Harmonised Index of Consumer Prices for further information on the technicalities). However, Statbel asserted that this method could not be used for the aforementioned product segments due to the relative short lifecycle of the products, products leaving the market at lower prices compared to their entry price, and usually there is also a quality difference between new and disappearing products caused by technological progress. These factors emphasized that a different method had to be used.

Consumer electronics and household appliances data were included in the Belgian HICP from January 2021 and the method that was settled on was the Imputation Törnqvist GEKS method (ITGEKS). Instead of traditional Törnqvist indices, the ITGEKS method uses bilateral time dummy

([140]) For a thorough discussion about the static and dynamic sampling approaches, please consult a Practical Guide for Processing Supermarket Scanner Data (Chapter 8).

hedonic indices as inputs in the GEKS formula. These indices are estimated using weighted least squares with the mean expenditure shares for matched items and half expenditure shares for the new and disappeared items as weights. When there are no new or disappearing items, the index will be equivalent to a traditional GEKS-Törnqvist index.

In the ITGEKS method the quality differences between the new and disappearing items can be captured. The window length was reduced to 13 months instead of the 25 months tha is usually used for supermarket scanner data. This was done because of the relative short life cycle of the products, limiting the window length to 13 months therefore reduces the imputations. As an extension method the window splice on published indices was chosen.

6.4.5 Metadata for users

It is important that index users are provided with metadata, i.e., information on the quality adjustment methods that are used by the Member State. The choices and performance of methods and conventions in quality adjustment and replacements can crucially affect the comparability and interpretation of results. Simple descriptive statistical tables on the frequency of quality adjustment by product category and the choice of quality adjustment method that is used can be informative and helpful for the users.

The methods used to adjust specific product groups should be fully described in the HICP metadata.

6.5 Quality adjustment methods

Quality adjustment may be carried out as a modification of either the current price or the price reference period price. Furthermore, various methods of quality adjustment exist.

As described in Section 6.1 above, there are two main approaches or types of methods for quality adjustment. These are: (i) *explicit methods*, which estimate the quality difference based on observable (and measurable) product characteristics, and (ii) *implicit methods*, which estimate the value of quality change based on differences between observed prices of other individual product.

For both methods, the aim is to adjust prices for quality change for the replacement individual product, so that the index reflects *pure* price change (i.e., unaffected by quality change). Generally, *explicit* methods work in two stages: first, they estimate the value of the quality change, and second, they modify the current price or reference period price to reflect the quality change. According to the CPI Manual (2020, para. 6.42), an explicit quality adjustment is described as follows: If a replacement variety is non-comparable (that is, there are identifiable quality differences) estimates of the impact of the quality differences on the price enable quality-adjusted price comparisons to be made between the old and the new varieties.

As an example of an explicit method, consider the option pricing approach (an explicit quality adjustment method). This approach consists of estimating the value of the quality difference between the old and the new models by using the list prices of available characteristics (i.e., options). For most products, option pricing is used when a certain feature of a product, like air conditioning in a car, which was previously available only as an option, now becomes a standard feature of the car, hence the name ’option pricing‘.

The value to the consumer of this quality change is explicitly assessed as a proportion of the market price for the same feature when purchased separately as an add-on for a similar car, but for which this feature is not included with this model.

In contrast, *implicit* (or overlap) methods are applied in cases when obtaining information on the value of the quality difference between the replacement and replaced individual product is almost impossible. According to the CPI Manual (2020, para. 6.42) an implicit quality adjustment method is described as follows: if a replacement variety is non-comparable and no information is available, or resources are too limited to allow reasonable explicit estimates to be made of the impact of a quality change on the price, the price difference between the old variety and its replacement in the overlap period is then taken to be a measure (or proxy) of the quality differential.

The better known and widely applied *bridged overlap* method is an implicit quality adjustment method. It will be described in more detail below.

Compatibility with the legal framework

Article 11(1, 2) of Implementation Regulation (EU) 2020/1148 does not recommend using one of these two methods over the other one. In fact, Article 11(1) states that if there is no difference between the replaced product and its replacement, then the prices should be compared directly. This makes sense, given that both products are deemed comparable. Moreover, Article 11(1) adds that if the two products are indeed different, then a quality adjustment must be made; there is no recommendation as to which method should be used and therefore it is left to the Member State to choose what they believe is the appropriate method to meet their goal. The absence of a recommendation reflects the fact that the decision to use one method over another often depends on several factors including resource and data availability, which will differ from one country to another.

Theoretical basis for implicit methods

Implicit methods assume that in case of a replacement individual product the price development of other individual product within the same aggregate may be used to estimate that of the replacement. Economic theory explains why this assumption has some merit. In a free market where prices converge towards their equilibrium, any price differences that may persist among products that are considered close substitutes at any point in time must be explained by the product’s quality differences. This implies that price differences at a given point in time can confidently be used to assess the value of the quality differences among the replacement and replaced product.

Cases where the implicit quality adjustment method may not be appropriate to use, thus leading to spurious results, is when a new individual product replaces one that has been available in the market for some time. In such a scenario, the price of the product can be deeply discounted to clear the remaining stock to make room for the new line of products. At this point, it is likely that supply and demand are not in equilibrium and therefore basing the value of the quality difference on this abnormally low price will bias the index.

6.5.1 Definitions

No quality differences

- *Direct price comparison* means that the value of the quality change is zero.

Explicit methods

- *Package-size adjustment* means that the value of a change in package size, as a proportion of the price, is assessed as the relative change in package size.
- *Single-variable adjustment* means that the value of the quality change between a replaced and a replacement individual product, as a proportion of the price, is assessed as the relative change in some function of one characteristic of the individual product (example: a change in excess for insurance policies; see Section 12.2).
- *Option pricing* means that the value of the quality change between a replaced and a replacement individual product is assessed as some fixed proportion of the market price of features by which the two individual products differ.
- *Supported judgement* means that the value of the quality change between a replaced and a replacement individual product is calculated by using supplementary information sources.
- *Hedonic regression methods in general* means that the quality adjustment is in some way based on a regression equation, which expresses the price as a function of product characteristics. This model estimates coefficients for each product characteristics which are proxies of the implicit prices of these characteristics, often referred to as ‘shadow prices’.
- *Combined quality adjustment methods* means that the value of the quality change between a replaced and a replacement individual product is assessed using a combination of methods (see Section 6.7.7.).

Implicit methods

- *Bridged overlap* is when the relative price change in a replacement since the preceding period (last month) is assessed as the relative price change since the preceding period for other individual product which were available in both months being compared.
- *Monthly chaining and replenishment* is when the aggregate relative price change between any two adjacent periods is assessed as the aggregate relative price change for the set of all individual product that are available in both those periods.
- *Backcasting* (or base price imputation) is when the relative price change in a replacement since the price reference period is assessed as the relative price change since the price reference period for individual product that are not replaced.
- *Link-to-show-no-price-change* this method is mentioned in Article 11(2) in Implementation Regulation (EU) 2020/1148 which states that Member States shall make a quality adjustment equal to the whole price difference between the replaced product in month m-1 and its replacement in month m only if this can be justified as an appropriate estimate of the quality difference.

6.5.2 Applicability of methods

The choice of an appropriate quality adjustment method varies by product type. This is elaborated on other sections of this manual. Table 6.5.8 gives a summary of the various methods including their pros and cons.

Table 6.5.8

Summary of aspects on quality adjustment methods

Method	Explicit (E)/ Implicit (I)	Advantages	Limitations	Remarks
Direct price comparison	(Explicitly decided)	Transparent	Overlooks quality change	For convention where needed
Package-size adjustment	E	Straightforward	Assumes linear proportionality	Applicable for modest differences
Single-variable adjustment	E	Transparent	Assumes form of variable impact	Example: Excess in insurance (14.2)
Option pricing	E	Transparent	Needs prices of options	Assumption of fraction of option price needed
Supported judgement	E	Flexible	Lack of control	Lack of criteria for ‘supported’
Hedonic regression methods	E	Strong theory	Data intensive	
Combined methods (Not strictly a separate method)	E and I	Adapts to individual conditions	Complex	E.g., to split major/minor changes
Bridged overlap	I	Flexible. Easier than hedonics	Assumes free stable market, etc.	Not suitable for clothing or similar products
Monthly chaining and replenishment (MCR)	I	Flexible. Easier than hedonics	Assumes free stable market, etc.	Similar Comparable to bridged overlap
Backcasting	I	Computationally fits to December link	Slightly less accurate (than bridged overlap)	Other methods often considered better

Method	Explicit (E)/ Implicit (I)	Advantages	Limitations	Remarks
Link-to-show-no-price change	I	Straightforward to apply	Assumes that the price difference between the old and the new products is all explained by the quality difference.	This method should not be used as the 'default' for measuring the price change between the replacing and replaced products. See Article 11(2) of the Implementing Regulation.

The above table is a simplified overview of the main quality adjustment methods. There are many different views by experts on the above methods, and it is therefore not possible to present them all here.

In general, the list of characteristics, particularly those identified as 'price-determining', can potentially provide a concrete instrument to support replacements and quality adjustment decisions in a consistent way. More specifically, by focusing on the information taken from the list on critical variables, it would be possible to formulate two minimum replacement and quality adjustment rules. The first rule states that replacements should be done within the same type of product or a very similar product. This takes us to the second rule that states that a direct comparison should never be applied when more than two critical characteristics of the product description change.

An example of the application of the second rule would be an iPhone 8 replacing an iPhone 7 when considering mobile phone equipment. The Table 6.5.9 lists the top four characteristics of the two products for the list of attributes identified as critical 'price-determining' characteristics.

Table 6.5.9

A hypothetical replacement situation with the top 4 price-determining characteristics

Critical characteristics	iPhone 7	iPhone 8
Operating System	iOS 10.0.1	iOS 10.0.1
Processor speed, in GHz	2.34 GHz	2.39 GHz
Memory, storage capacity in GB	128 GB	128 GB
Screen size,diagonally, in inches	4.7 inch LCD (1334x750)	4.7 inch LCD (1334x750)

In this (fictitious) replacement situation, only one out of the four characteristics identified as critical changes (processor speed), meaning that it would be possible to apply the direct comparison method. It should be borne in mind that this is not the same as saying that the rule could be applicable automatically but that it could be admissible to apply a direct comparison. However, if more than two critical characteristics had changed, then it would not be advisable to apply the direct comparison method and one of the other methods shown below would have likely been a better choice.

Life cycle of product models

A complicating issue is how quality adjustment methods perform in relation to life cycles of product models. For example, in various product areas, product models often go on sale at sometimes substantially discounted prices for stock clearance just before disappearing from the market. Under such circumstances, implicit methods generally cannot be used unless certain precautions are taken, as these methods assume a stable market which is not present here, particularly for products like clothing, where models are often available for only a few months, and largely at falling prices over the life cycle of the product. Consequently, this means that implicit methods are not an option in such cases.

but when dealing with product model life cycles, care must be taken also when using explicit methods, including hedonic regression techniques. For example, for some hedonic methods the timing and choice of data to refresh the estimates of the regression coefficients must be planned appropriately.

6.6 Explicit quality adjustment methods

6.6.1 Direct price comparison

The method of *direct price comparison* means that the value of the quality change is assessed as zero.

Aliases: direct price comparison is also known as unadjusted price comparison i.e., individual product which are judged to be essentially equivalent. It means that the index is computed without any quality adjustment.

Basic usage: direct price comparison is applicable when disregarding any quality change does not yield unacceptable bias, or it is acceptable by convention (see Section 6.3.7).

Underlying assumptions: the applicability of the method rests on the assumption that quality differences between the new and old products are negligible.

Examples of use: a red cotton T-shirt is replaced by a blue cotton T-shirt, the only significant difference between the two being the colour. As such, the replacement product is deemed to be essentially equivalent to the replaced product. Another example: a hammer is replaced with another very similar hammer, which does not differ in any way affecting its functionality, and thus the hammers are essentially equivalent. This method is often applied to various kinds of services.

The method can be viewed as appropriate for products that are normally without notable distinguishing features. It is an acceptable method in cases where this estimation would be too demanding in practice.

Computation: for direct price comparison, the index is computed by equation 6.4.1 or equation 6.4.2 with the quality adjustment factors taken as:

$$g_4 = 1,\ g_5 = 1$$

For the geometric mean index, the formula for the index computation becomes:

$$I^{mt} = \left(\frac{p_1^{mt}}{p_1^{0t}} \cdot \frac{p_2^{mt}}{p_2^{0t}} \cdot \frac{p_3^{mt}}{p_3^{0t}} \cdot \frac{p_4^{mt}}{p_4^{0t}} \cdot \frac{p_5^{mt}}{p_5^{0t}}\right)^{\frac{1}{5}}$$

and for the ratio of arithmetic mean prices, it becomes:

$$I^{mt} = \frac{(p_1^{mt} + p_2^{mt} + p_3^{mt} + p_4^{mt} + p_5^{mt})/5}{(p_1^{0t} + p_2^{0t} + p_3^{0t} + p_4^{0t} + p_5^{0t})/5} I^{mt} = \frac{p_1^{mt} + p_2^{mt} + p_3^{mt} + p_4^{mt} + p_5^{mt}}{p_1^{0t} + p_2^{0t} + p_3^{0t} + p_4^{0t} + p_5^{0t}}$$

Comment on applicability: disregarding quality change by using the direct price comparison approach may be adequate in product areas where quality changes are deemed to be generally small or random in nature. It may also be an acceptable approach as a convention in areas where it is almost impossible to assess the quality features of a product.

An example: the use of direct comparison for clothing material.

In month *m*-1: price for 1 metre of fabric, 90 % cotton, EUR 16.5

In month *m*: price for 1 metre of fabric, 96 % cotton, EUR 16.8

Quality adjusted monthly price change: 16.8 / 16.5 = 1.018

6.6.2 Package size adjustment

The method of *package size adjustment* means that the value of a change in package size, as a proportion of the price, is assessed as the relative change in package size.

Aliases: package size adjustment is also known as quantity adjustment or quantity augmenting.

Basic usage: package size adjustment is applicable for adjustment of price per package in cases of modest changes in package size, where the size of the replacement package is approximately between half and double the size of the replaced package.

Underlying assumptions: the applicability of the method rests on the assumption that the consumer value of the product is proportional to the size of the package (in the sense of the quantity of contents).

Comment: strictly, package size adjustment is not a method of quality adjustment, as it consists of rescaling of quantity units and does not concern quality characteristics of the product itself. However, package size adjustment is in a way more transparent and less problematic in terms of relevance and accuracy than quality adjustment in a proper sense. For convenience, the method is listed here among quality adjustment methods, as in practice it has a similar use in rendering observed prices comparable.

Examples of use: the weight of a branded confectionary bar originally of 50 grams is reduced to 48 grams, as such a quantity adjustment is required to reflect the underlying price change. Another example: a beer can of 33 centilitres is replaced with one of 50 centilitres of the same kind of beer. The replacement can be taken as comparable if a quantity adjustment is made.

Computation: assume here that in the replacement for price (individual product) 4 in the sample, the size of the package, in e.g., kilogrammes or millilitres, changes from u^{0t} to u^{mt}.

Package size adjustment in the index is then computed by equation 6.4.1 or equation 6.4.2 with the quality adjustment factors taken as

$$g_4 = \frac{u^{mt}}{u^{0t}} \qquad (6.6.1)$$

Comment on applicability: the package size adjustment is generally straightforward and justifiable for modest changes in package size, as the value to the consumers essentially consists in the contents of the package, measured by the size. However, the method is not adequate for very large changes in package size, as very different quantities of a product can have notably different uses. In such cases, the method would not ensure sufficient comparability. It is important that a symmetric rule is used for increases and decreases in size. If for example a 50 % (3/2-1) increase in size is allowed, then the threshold for decreases should be 33 % (1-2/3).

Alternatives to the method are to use prices expressed on a per quantity unit (this information is usually available from the outlet), or to apply a broad product specification which allows a wide range of package sizes.

Numerical examples

Example 1: Sodas, a change in bottle size

Assume that the following prices have been collected.

Table 6.6.10

Observed prices for sodas

No	Period	
	0*t*	m*t*
1	1.59	1.59
2	1.25	1.25
3	1.25	0.99
4	1.10	1.49
5	0.99	0.99

Assume that between month *m*-1 and month *m*, for price (individual product) 4, a 33 cl bottle of soda was replaced by a 50 cl bottle of soda, while for price 5, a 33 cl bottle of soda was replaced by a bottle of the same size.

Then for the method of direct price comparison calculated using the geometric mean index formula, equation 6.4.1 with g_4= 1 and g_5= 1 generates I^t= 101.42.

For the method of package size adjustment, equation 6.4.1 gives:

g_4 = 50/33 = 1.5151, g_5 = 1

Inserting this value into equation 6.4.1 generates I^{mt} = 93.33

Example 2: Products for personal care, a change in package size

In month *m*-1*:* liquid soap, brand X, variety *sensitive*, 300 ml EUR 2.39

In month *m:* liquid soap, brand X, variety *sensitive*, 250 ml EUR 1.95

Quality adjusted monthly price change: 1.95 / 2.39 × 1/(250/300) = 0.979

6.6.3 Option pricing

The method of *option pricing* means that the value of the quality change between a replaced and a replacement individual product is assessed as some fixed proportion of the identifiable market price of the features by which the two individual products differ.

Aliases: none.

Basic usage: option pricing is applicable in product areas where quality changes often consist in changes of specific product features for which their prices can be identified and collected separately.

Underlying assumptions: the applicability of the method rests on the assumption that the difference in consumer value between similar individual product is equal to some given or previously estimated proportion of the price for separately purchased features by which the individual product differ.

Examples of use: the method is often used for new cars that are subject to minor changes, i.e., changes in features within the same car model. It has also been used for desktop computers. The method is also applicable to services that are characterised by various components, such as package holidays and restaurant menus.

Computation: assume that the value of a quality difference is to be taken as the given proportion of the market price for the different features, where ρ is a positive number no larger than one. Then assume that, in the price of the replacement individual product 4 in the sample, the replacement individual product (but not the replaced individual product) has features with a market price of *c.* The price *c* is stated in euros, or in monetary units in the currency of the country in question, and it pertains to the price reference period.

With option pricing, the index is then computed by equation 6.4.1 or equation 6.4.2 with the quality adjustment factors calculated as:

$$g_4 = 1 + \frac{\rho \cdot c}{p_4^{(m-1)t}} \tag{6.6.2}$$

and similarly, for g_5 .

If, instead, features were present in the replaced individual product but have been removed from the replacing individual product, then the prices of those features will be negative once computed.

A critical issue for this method is the choice of the proportion. This number $\rho \leq 1$ works as a *reduction factor* by which the value of the added or subtracted features is scaled down from their observed market value.

The reduction factor ρ is very often fixed to one half. This means that 50 per cent of the market price of the option is taken as the value of the corresponding quality difference. With this 50 per cent reduction, it is assumed that probably not all buyers of, for example, a car, necessarily value a particular feature and would be willing to pay the full market price for it. In other words, some consumers value the now standard feature less than the value of the same feature when it is bought separately by those consumers who specifically desire that same feature.

The choice of the reduction factor ρ is a judgement, even if some empirical support may be available for making a more precise assessment. In particular, the choice of a factor of 50 per cent seems to be a widely established convention by practitioners. There is some logic behind this choice. In addition to this being a midway compromise, the timing for including a new feature (option) in the price of the car could be when the car manufacturers are confident that most buyers are now willing to pay for it.

Comment on applicability: in the case of new cars, the method is useful to quality adjust for minor changes such as the addition of features like additional airbags, a higher quality sound system, climate control or changes to the warranty conditions. Changes in such features are to be treated as quality changes to the extent that they are of lasting consumer value and not a temporary fashion issue (see Section 6.3.5). However, features like colour, special alloy wheels and leather seats can probably be perceived to be more fashion oriented and thus quality adjustment can be a questionable decision in such cases (see Section 12.3).

Usually, market prices can be collected for the features (options) in question when bought as extras for a similar car model that does not include them. The prices for these options can be used as a basis for quality adjustment according to the option pricing approach.

Example: assume that the following prices have been observed for five car models:

Table 6.6.11

Observed prices for cars

No	Period		
	0*t*	(*m*-1)*t*	mt
1	14 900	14 900	14 900
2	26 990	26 990	26 990
3	20 900	19 900	19 900
4	17 900	17 900	19 690
5	19 000	19 000	19 000

Assume that for price (individual product) 4, the replacing individual product has two features that were unavailable with the previous model. For the previous model, those features were, however, available as separate options at the prices of EUR 298 for one of them and EUR 699 for the other. For price (individual product) 5, there were no differences in terms of distinguishing features between the replaced and the replacement model.

Then for the method of direct price comparison, equation 6.4.1 with g_4=1 and g_5 =1 generates the index I^{mt} = 100.93.

For the method of option pricing, with reduction factor ρ = 0.5, equation 6.6.2 gives:

$$g_4 = 1 + \frac{0.5 \cdot (298 + 699)}{17\,900} = 1.027849, g_5 = 1\,.$$

Inserting these numbers into equation 6.4.1 generates the index I^{mt} = 100.38.

6.6.4 Supported judgmental quality adjustment

The method known as *supported judgmental quality adjustment* means that the value of the quality change between a replaced individual product and the one replacing it is calculated by using supplementary information sources.

Aliases: expert judgement is a term for one form of supported judgmental quality adjustment.

Basic usage: supported judgmental quality adjustment is applicable in product areas where more formal methods are not available, and where supporting instructions and information are available, so that a quality adjustment strategy can be applied.

Underlying assumptions: the applicability of the method rests on the assumption that the difference in consumer value between individual product can be calculated by using supplementary information sources in one way or another.

The method is in some ways like that of option pricing just described. However, in contrast to option pricing, the supplementary information is here not restricted to the prices for options taken from observable prices. The value of the quality difference can be calculated with more flexibility — using a broader source of supplementary information, as described below.

The examples below use calculation procedures that are designed for specific kinds of quality change in certain product areas. Somewhat more controversial is whether the supplementary information sources may involve assessments involving the judgement of product experts or the judgement of price collectors. For the success of this method, it is critical that the assessments are supported by quality information, instructions, calculation templates and validation procedures to control the process properly and avoid any subjectiveness. Ideally, the supporting material could make the process work somewhat like option pricing.

Not considered the ideal method, but nevertheless acceptable for complex products where the required supplementary information sources are available and other methods are not easily applicable in practice.

Computation: the computation is basically the same as for option pricing as described above, by equation 6.4.1 or equation 6.4.2 and equation 6.6.2. The computations can be adapted to product-specific conditions as required.

Comment: no criteria have been agreed for the requirements of supported judgements.

The following three examples show how calculations can be used for supported judgement.

Example 1: Energy consumption

An example of the value of a quality change expressed in monetary terms is if a replacement individual product of an electric appliance, for example, has lower power consumption than the replaced one. The monetary benefit caused by the lower power consumption can be calculated by multiplying a current average price of the energy saved per year by the anticipated duration of use of the appliance. In practical application, the change in the energy label can be used (see Section 6.3.5).

Example 2: Comparable models

An example of the use of comparable models (to determine the value of the quality change) is where a manufacturer markets two models simultaneously that differ in one characteristic only — the net capacity of two otherwise identical freezers, for example. If it can be assumed that prices have been set in a competitive market, it would in this case be justified to take the price difference between the two freezers as an estimate of the value of the quality difference — because the price difference can be attributed to the characteristic in question. This means it is possible to determine the price for a certain amount of additional capacity. The assumption here of a proportional relationship between capacity and consumer value in monetary terms can probably be taken as acceptable.

6.6.5 Hedonic regression methods

In general, the *hedonic regression method* means that the quality adjustment is in some way based on the ’shadow prices‘ estimated with a regression equation, which expresses the price as a function of product characteristics. Hedonic methods are often used to process web scraped data and scanner data.

Aliases: There are two main hedonic methods; the hedonic imputations method and the dummy hedonic method. The first has some variants namely the hedonic re-pricing method addressed, and the characteristics hedonic method. The latter has two main variants, the time dummy hedonic method and the product dummy hedonic method. Hedonic methods are highly regarded for their strong scientific basis and well-controlled accuracy.

Basic usage: hedonic regression methods are applicable in product areas where detailed data on product characteristics can be collected in the price collection, and where a regression function can be assumed to adequately describe the dependence of the price on product characteristics.

Underlying assumptions: generally, hedonic methods assume that a regression function expresses how the prices of different models (product variants) depend on characteristics of the models.

Specifically, the price *p* is assumed to depend on some variables $z_{\text{char.1}}, z_{\text{char.2}}, \dots, z_{\text{char.}k}$ corresponding to quality-related product characteristics, which can be expressed by an equation like this:

$$ln\, p = b_0 + b_{\text{char.1}}\, z_{\text{char.1}} + b_{\text{char.2}}\, z_{\text{char.2}} + \cdots + b_{\text{char.}k}\, z_{\text{char.}k} + \varepsilon \qquad (6.6.3)$$

Here *ln* stands for the natural logarithm, $b_{\text{char.1}}, \dots, b_{\text{char.}k}$ denote parameters to be estimated from data, and ε denotes a *residual* term capturing a component of the price that cannot be explained by observed product characteristics. The parameters $b_{\text{char.1}}, \dots, b_{\text{char.}k}$ are known as *regression* *coefficients* or *hedonic coefficients* and express the consumer value of the corresponding product characteristics.

Comment on applicability: the quality-related variables $z_{\text{char.1}}, z_{\text{char.2}}, z_{\text{char.3}}$ may be of two different kinds, continuous variables, and categorical variables which can be either numerical or text. Continuous variables are very rare, but an example is the floor area of a dwelling. The size of a TV screen for example, although numerical, is not continuous. Normally, categories are created for intervals of screen sizes, and these *are* transformed in dummy variables for processing. Dummy variables are equal to 1 or 0 to represent whether a particular characteristic is present or not, such as Dolby surround sound in a TV set, a hard cover for a book, or a lining in a jacket.

There are several intricate decisions to be made in the design of a hedonic application. Decisions and assessments must be made on issues such as:

- How many and which quality-related variables to include in the regression equation.
- Whether to use another (finer or coarser) stratification when estimating the regression coefficients than when computing the index.
- How frequently to re-estimate the regression coefficients.
- Whether to weight the prices when estimating the regression coefficients.
- Which functional form to use: semi-logarithmic, double-logarithmic or other.
- Whether valid or spurious results are generated.
- Whether the method improves the accuracy of the index so much that it outweighs the often relatively higher resource intensive work involved in applying this approach.

These decisions require both sound knowledge of the product area and advanced statistical skills. Running a regression analysis on the computer is not difficult but ensuring that the procedures and results are satisfactory can be demanding.

Examples of use: for the HICP, hedonic methods are often used for electronic goods like computers and cameras (see Section 12.9), and for appliances such as washing machines, and for clothing (see Section 12.7). It is also applied for used cars (but not for new cars, see Section 12.3) and could be useful for books, primarily to reduce the variance caused if the sample is limited to the list of bestsellers.

Comment: While the hedonic methods are potentially useful, it is still of limited use in the HICP since it requires a reasonably large and detailed data set. Hedonic methods are widely used for house price indices (see Technical Manual on Owner-Occupied Housing and House Price Indices, Chapter 6).

Computation:

As an example, a simple form of the time dummy method may be mentioned. The regression equation is analogous to equation 6.6.3 and may be written as:

$$ln\, p = b_0 + b_{\text{char.1}} z_{\text{char.1}} + b_{\text{char.2}}\, z_{\text{char.2}} + \cdots + b_{\text{char.}k}\, z_{\text{char.}k} + b_{\text{time}} D + \varepsilon$$

In contrast to equation 6.6.3, this equation is assumed to hold for both the reference period and the current period simultaneously, not just in each period. Therefore, this equation involves an additional dummy variable D, called *time dummy*, which can take the values 0 or 1 to indicate whether the price was collected in the reference period b or in the current period t. Here b_{time} is a regression coefficient to be estimated from the collected data.

A regression analysis is carried out in one single run over data from both the reference period and the current period simultaneously. The regression analysis produces an estimate of the regression coefficient b_{time} for the time dummy variable. The index is obtained directly by exponentiation, that is,

$$I^{mt} = e^{b_{\mathrm{time}}}$$

Usually, this method uses a rolling time window of 12 months, thus a dummy variable for each of the periods contained in the time window is included in the regression. For further practical computational details see Residential Property Price Index (RPPI), IMF 2020.

Given the richness of the data available through bulk web scraping, these data can lend themselves very well to hedonic quality adjustment models ([141]). This is because such data often come with detailed information about a product's characteristics. The greater volume of data will likely generate better hedonically estimated results than those that could be obtained from the traditional approach with smaller sample sizes. Among the types of products for which this approach has shown much promise are electronic goods such as computers and major appliances. Technically, the product characteristics, once obtained through web scraping, could be loaded into the hedonic modelling program to generate quality-adjusted price indexes. A study by Statistics Canada uses web-scraped data to produce hedonically adjusted price indexes for Laptops, Desktops, Monitors, and Printers ([142]).

Re-pricing hedonic methods

Assume that there are three quality-related product characteristics to be adjusted for, i.e., $z_{\mathrm{char.1}}, z_{\mathrm{char.2}}, z_{\mathrm{char.3}}$, so that the equation 6.7.3 takes the form:

$$\ln p = b_0 + b_{\mathrm{char.1}}\, z_{\mathrm{char.1}} + b_{\mathrm{char.2}}\, z_{\mathrm{char.2}} + b_{\mathrm{char.3}}\, z_{\mathrm{char.3}} + \varepsilon \qquad (6.6.4)$$

The computation is carried out in two steps:

Compute estimates $\hat{b}_{\mathrm{char.1}}, \hat{b}_{\mathrm{char.2}}, \hat{b}_{\mathrm{char.3}}$ of the regression coefficients. . This is typically done at an early stage, in the reference period or earlier, using data available then.

In the subsequent replacement situations, use the coefficient estimates $\hat{b}_{\mathrm{char.1}}, \hat{b}_{\mathrm{char.2}}, \hat{b}_{\mathrm{char.3}}$ to compute the quality adjustment factors g_4 and g_5 to be used in the index computation by equation 6.4.1 or 6.4.2.

In step (a) the coefficient estimates $\hat{b}_{\mathrm{char.1}}, \hat{b}_{\mathrm{char.2}}, \hat{b}_{\mathrm{char.3}}$ are usually computed using a statistical estimation technique such as ordinary least squares. This computation of the coefficient estimates is based on observed price data and quality-related variables for sampled models available, for example, in the reference period.

(141) Note that the discussion here refers to bulk web scraping. However, in the case of targeted web scraping (i.e., when specific products are selected for estimating the index), the same replacement and quality adjustment strategies as those used for traditionally collected data can be used.

(142) Estimating computers and peripherals price indices using web-scraped data. Roobina Keshishbanoosy and Lance Taylor, Statistics Canada | UNECE.

For step (b), assume that by the replacements for the prices (individual product) 4 and 5, the values of the quality-related variables changed from $z_{\text{char.2,model.4}}$ to $z_{\text{char.2,model.4}'}$ etc. The quality adjustment factors are then computed as:

$$g_4 = e^d, \text{ where}$$

$$d = \hat{b}_{\text{char.1}}\left(z_{\text{char.1,model.4}'} - z_{\text{char.1,model.4}}\right) + $$
$$+ \hat{b}_{\text{char.2}}\left(z_{\text{char.2,model.4}'} - z_{\text{char.2,model.4}}\right) + $$
$$+ \hat{b}_{\text{char.3}}\left(z_{\text{char.3,model.4}'} - z_{\text{char.3,model.4}}\right) \quad (6.6.5)$$

and similarly for g_5 .

A hedonic regression equation such as equation 6.6.4 is said to be of semi-logarithmic form, as the equation uses the logarithm of the price. Alternatively, a double-logarithmic form is often used, where the equation uses logarithms of the price and of the continuous quality-related variables.

The estimated hedonic coefficients can be given an independent interpretation. Let z_1 be a dummy variable, being equal to 1 when a certain product feature is present and equal to 0 when it is not. Then a product model having the feature is expected to have a $e^{\hat{b}_{\text{char.1}}}$ times higher price than an otherwise similar model without the feature. For continuous variables, there is a corresponding interpretation. The interpretation of regression coefficients is useful in procedural tests and data validation, to highlight potentially unrealistic outcomes. This way, the regression coefficients express the value of the characteristic.

Now note that according to the procedure in this method, the coefficients were estimated in an earlier period, while they are applied in quality adjustment for replacements in the current period. This means that the method inherently assumes that the consumer value of various product features does not change noticeably between the earlier period and the current period.

However, the consumer value of product features may indeed change over time, at least progressively or sometimes perhaps rapidly, as consumer preferences change. For this reason, the regression estimates must be re-estimated at regular intervals.

Remarks on wording: ‘regression equation’, of which equation 6.4.2 is an example, is often referred to as a *regression model or a hedonic model*. The word model is then used in the sense of a *statistical model*, which is an assumed mathematical representation of the defining magnitudes (parameters) to be estimated from observed data. This use of the word *model* should not, of course, be confused with 'model' in the sense of product variety.

Numerical examples

Example 1: Observed prices and quality variables

Assume that the following prices and quality-related data have been observed.

Table 6.6.12

Observed prices and quality variables

No	Period							
	0t				mt			
	Price	$z_{char.1}$	$z_{char.2}$	$z_{char.3}$	Price	$z_{char.1}$	$z_{char.2}$	$z_{char.3}$
1	390	23	0	0	390	23	0	0
2	480	39	0	0	519	39	0	0
3	700	51	1	0	650	51	1	0
4	550	39	0	1	598	39	1	1
5	490	45	0	0	690	53	0	0

Here, there are three quality-related variables, of which one is continuous, i.e., $\mathbf{z_{char.1}}$, and two are dummy variables, $\mathbf{z_{char.2}}$ and $\mathbf{z_{char.3}}$.

Here, for the method of direct price comparison, equation 6.4.2 with g_4 = 1 and g_5 = 1, gives the index I^{mt} = 108.98.

Now assume that equation 6.6.4 has been considered adequate for the situation. Then first compute the coefficient estimates $\hat{b}_{\text{char.1}}, \hat{b}_{\text{char.2}}, \hat{b}_{\text{char.3}}$ from the observations for period 0t. A standard computer program for statistical analysis yields:

$$\hat{b}_{\text{char.1}} = 0.01091$$
$$\hat{b}_{\text{char.2}} = 0.27232$$
$$\hat{b}_{\text{char.3}} = 0.16210$$

It must be stressed that in an actual application the estimation of the regression coefficients from such a small data sample is not recommended because the precision of the model then becomes unacceptably poor. The computation of the coefficient estimates here presented is for illustrative purposes only. For the remainder of this example, it could of course be imagined that the coefficient estimates were computed from a larger dataset.

For the interpretation of e.g., $\hat{b}_{\text{char.2}}$, note that $e^{\hat{b}_{\text{char.2}}} = e^{0.27232}$ = 1.313. This means that a model that has the feature indicated by zchar.2 = 1 is expected to have a price 31.3 per cent higher than a model without that feature (i.e., with z2 = 0). This type of interpretation is useful to check that the hedonic regression analysis works in a way that makes sense.

To apply the coefficient estimates for the actual quality adjustment in the replacement situation, use equation 6.6.5 to compute:

$$g_4 = e^{0 + 0.27232 \cdot (1 - 0)} = 1.313007$$
$$g_5 = e^{0.01091 \cdot (53 - 45) + 0} = 1.091202$$

Inserting these values into equation 6.4.1 generates the index I^{mt} = 101.42.

Example 2: Rents, the use of the hedonic re-pricing method when replacing dwellings

Using *all* the data* from a rent survey, the following hedonic regression has been estimated:

Table 6.6.13

Rents data

Variable	Categories	Comments	Coefficient
Constant			5.01
	1 = West		-0.168
	2 = East		-0.293
Location	3 = Centre	Reference category	
	4 = North		- 0.448
	5 = South		- 0.258
Floor area		Transformed into logarithm	0.475
	<= 2000		-0.363
Year of the signature of the contract**	2001-2005		-0.209
	2006-2010		-0.124
	>= 2011	Reference category	
	<= 1960		-0.192
Year of construction	1961-2000		-0.080
	2001-2014	Reference category	
Type of dwelling	Apartment		-0.063
	House		
Number of rooms			0.314

* *It is not possible to present the underlying data due to the size of the dataset.*
** This variable is used in the regression to improve the model, but it will not be used to calculate the adjustment factor, as it is not a characteristic of the dwelling.

In month *m*-1: apartment in the south, 60 m², year of construction 1961-2000, 2 rooms, rent EUR 900 per month.

In month *m:* replacement apartment in the west, 50 m², year of construction 2005, 1 room, rent EUR 700 per month.

Estimation of the dwelling in *m*-1:

$5.01 - 0.258 + \mathit{ln}\,(60) \times 0.475 - 0.080 - 0.063 + 2 \times 0.314 = 7.1818$

Estimation of the dwelling in *m*:

$5.01-0.168+\mathit{ln}(50) \times 0.475-0.063+0.314 =6.9512$

Monthly price change with *no* quality adjustment: 700/900 = 0.777

Quality adjusted monthly price change*:* $700/900 \times 1/[\exp\,(7.1818)/\exp\,(6.9512)]=0.98$

6.6.6 Combined methods of quality adjustment (a mainly explicit method)

Occasionally, two or more quality adjustment methods are combined in practice. A frequently used approach is to make a distinction between minor and major quality changes. For example, option pricing may be applied for minor changes and bridged overlap for major changes. This solution is used in many countries for new cars.

In this solution, an explicit quality adjustment method is combined with an implicit one. In a way, the approach is primarily explicit, as the final choice of method for a specific product is governed by characteristics of the latter. The definition of minor and major changes depends on the product area and can be determined by product-specific guidance and conventions. The approach is adaptive, in the sense that the final choice between optional methods depends on observed characteristics of the sampled products, following pre-specified criteria.

Another kind of combined method is the direct comparison in bestseller lists. This is used for products like books. Optionally, hedonic regression can also be involved to reduce the variance caused by basing the sample on the bestseller list.

6.7 Implicit quality adjustment methods

The variants among implicit methods may look partly like each other, but they have distinguishing features making them suitable under different conditions. The following table summarises the main implicit methods.

Table 6.7.14

Overview of main implicit methods

Method	Section	Source of price change ('bridge')	Comment	Use
Bridged overlap	6.7.1	Individual product in the same elementary aggregate (EA)	Generic implicit form	Competitive market
Overall mean imputation	6.7.1	All individual products in the same EA	Special case of bridged overlap	Homogeneous EA
Targeted mean imputation	6.7.1	Selected individual products in the same EA	Special case of bridged overlap	Heterogeneous EA
Class mean imputation	6.7.1	Quality adjusted replacement individual products in the same EA	Special case of bridged overlap	For rich supply of price data

Method	Section	Source of price change ('bridge')	Comment	Use
MCR	6.7.2	All individual products in the same EA	In effect like overall mean imputation	Homogeneous EA
Backcasting	6.7.3	All individual products in the same EA, price change since December	Less up-to-date	Where computationally fit
Link-to-show-no-price change	6.7.4	Selected individual products in the same EA	Only applicable under some very restrictive conditions.	When price difference between the old and new product is fully explained by its quality difference.

6.7.1 Bridged overlap

The method of *bridged overlap* means that the relative price change in a replacement since the preceding period (last month) is estimated as the relative price change since the preceding period from other individual product. In fact, with the bridged overlap method, the quality difference is implicitly measured by the ratio of prices of the old and new products in the common, overlapping period.

Aliases: bridged overlap is in some forms also known as mean imputation, sometimes further specified as overall mean imputation versus targeted mean imputation ([143]).

Basic usage: bridged overlap is applicable in product areas where the underlying assumption is deemed not to yield unacceptable bias.

Underlying assumptions: the applicability of the method rests on the assumption that the aggregate used for imputation has price changes representative of pure price changes. In addition, according to the HICP recommendation on bridged overlap, the bridged overlap relies on the idea that the prices of the product-offers that are sampled within an elementary aggregate react to each other instantaneously, and that when a price difference is observed it must arise from a difference in quality, such as product characteristics, timing, location, or conditions.

Comment: the underlying assumptions can be violated where sales discounts occur, as they disrupt the market equilibrium and are liable to create a downward bias in the index. The problem becomes apparent when a discounted individual product is replaced by one with a *normal* higher price. Then an imputation with an aggregate with mainly unchanged individual product can result in an obvious downward bias, as the price increase due to the return to normal price level is eliminated.

([143]) In Triplett, J. (2006), Handbook on Hedonic Indexes and Quality Adjustments in Price Indexes: Special Application to Information Technology Products, Paris: OECD Publishing.

As such, where sales discounts occur particular care must be taken to prevent them from disturbing the method. A solution could be to adjust the price of the replaced individual product to its pre-sales level before performing the quality adjustment, or instead to allow for direct comparison with a sufficiently similar replacement. Moreover, sales prices may disrupt the computation of the bridge. A possibility could be to apply targeted mean imputation (see below), in such a way as to exclude discounted prices from use in imputation.

A related drawback of the method is that it does not capture the *hidden* price increases which may be present when a new model is introduced.

Examples of use: the method is useful in a wide area of goods and services, including electronic goods, household appliances, new cars (in cases of major changes) and apartment rents (if they are free market prices).

Computation: in the case of the geometric mean index (the Jevons formula), use of bridged overlap means that the index is computed by equation 6.6.3 with the quality adjustment factors taken as:

$$g_4 = \frac{p_{4'}^{mt}}{p_4^{(m-1)t}} \cdot \left(\frac{p_1^{(m-1)t}}{p_1^{mt}} \cdot \frac{p_2^{(m-1)t}}{p_2^{mt}} \cdot \frac{p_3^{(m-1)t}}{p_3^{mt}}\right)^{\frac{1}{3}} \qquad (6.7.1)$$

and similarly for g_5.

It may be practical to use an alternative recursive computation which here takes the simple form:

$$I^{mt} = I^{(m-1)t} \cdot \left(\frac{p_{1)}^{mt}}{p_1^{(m-1)t}} \cdot \frac{p_{(2)}^{mt}}{p_2^{(m-1)t}} \cdot \frac{p_{(3)}^{mt}}{p_3^{(m-1)t}}\right)^{\frac{1}{3}} \qquad (6.7.2)$$

and gives the same result as equation 6.7.1.

To use the bridged overlap method in the case of the ratio of arithmetic mean prices (the Dutot formula), it is most practical to apply a corresponding recursive computation, which here becomes:

$$I^{mt} = I^{(m-1)t} \cdot \frac{p_1^{mt}+p_2^{mt}+p_3^{mt}}{p_1^{(m-1)t}+p_2^{(m-1)t}+p_3^{(m-1)t}} \qquad (6.7.3)$$

Remark: it may be noted that the quality adjustment factors corresponding to equation 6.7.3 become rather complicated to express and are dependent on all prices.

The method of bridged overlap exists in various alternative forms.

Alternative forms, option (i) — use of both non-replaced and replaced individual products for the bridging: in the form of bridged overlap described in the computation above, the non-replaced individual products are used for bridging. An alternative form of the method bridges by using both the non-replaced individual product and some replaced individual product. Namely, in the alternative form the bridge also includes replacement individual product treated with direct comparison or possibly with an explicit method of quality adjustment.

Assume that the replacement individual product 5 is treated with direct comparison, so that $g_5 = 1$. Then, the use of this alternative form of bridged overlap gives for replacement individual product 4, instead of equation 6.7.1, the quality adjustment factor:

$$g_4 = \frac{p_{4'}^{mt}}{p_4^{(m-1)t}} \cdot \left(\frac{p_1^{(m-1)t}}{p_1^{mt}} \cdot \frac{p_2^{(m-1)t}}{p_2^{mt}} \cdot \frac{p_3^{(m-1)t}}{p_3^{mt}} \cdot \frac{p_5^{(m-1)t}}{p_5^{mt}} \right)^{\frac{1}{4}}.$$

It may be noted that this form of the method is less automatic than the form using only non-replaced product-offers for the bridge. Namely, this form of bridged overlap involves individual judgements on how to treat each replacement individual product: whether to adjust by bridged overlap, or to use direct comparison or some other method.

Alternative forms, option (ii) — use of a single individual product for bridging: an alternative form of bridged overlap uses the price of just one non-replaced individual product for the computation of the quality adjustment factor g_4, and not all non-replaced individual product as equation 6.7.1 does.

Assume that the non-replaced individual product 3 has been chosen for this.

In this alternative variant of bridged overlap, the index is then computed by equation 6.4.1 or 6.4.2, with the quality adjustment factors taken as:

$$g_4 = \frac{p_{4'}^{mt}}{p_4^{(m-1)\mathrm{t}}} \cdot \frac{p_3^{(m-1)t}}{p_3^{mt}} \qquad (6.7.4)$$

and similarly, for g_5

Alternative forms, option (iii) — targeted mean imputation: other alternative forms may be a type of compromise between equation 6.7.1 and equation 6.7.4, by bridging using a restricted subset of individual product that are like the replaced individual product and the replacement individual product. This is a targeted mean imputation, in contrast to the overall mean imputation of equation 6.7.1, which bridges by use of all (non-replaced) individual product in the sample.

Comment on applicability: the different forms of bridged overlap are all based on the same logical premise. The price change since the last period for a replacement individual product is imputed from the price change for a bridge of other individual product. Thus, other individual product bridge over the break in the price series of a replaced one. Different forms of the method may define the bridge by using a broader or narrower class of other individual product in the bridge. For example, in equations 6.7.1 and 6.7.3, all non-replaced individual products in the elementary aggregate are used for the bridge, while in equation 6.7.4 just one non-replaced individual product is used.

There is an inherent assumption that the value of a quality difference between individual product available in the same period are equal to the price difference between them. In bridged overlap this condition is inherently used both for the quality difference between the replaced individual product and the bridge in the preceding month (m — 1)t, and for the quality difference between the bridge and the replacing individual product in the current month (mt).

The applicability of bridged overlap requires that the assumption to be true, or possibly be acceptable by convention. This issue must be evaluated for each product area. More loosely, the method can also be defended on the grounds of *neutrality,* in that, where applicable, it yields no obvious or unacceptable bias.

Design in practice: the suitable choice between variant methods, such as between overall mean imputation and targeted mean imputation, varies between product areas. Targeted mean imputation has the advantage of possibly giving imputations that may be more suitable for replacements in heterogeneous aggregates. Overall mean imputation, in turn, has the advantage of being more stable in small aggregates. In small aggregates, it is also possible to use a higher aggregate for imputation, for adequate stability.

Example 1: Bridged overlap ([144])

Assume that the following prices have been observed.

Table 6.7.15

Price observations used in bridged overlap

No	Period		
	0*t*	(*m*-1)*t*	m*t*
1	390	390	390
2	480	480	519
3	700	650	650
4	550	550	598
5	490	490	690

Then for the method of direct price comparison, equation 6.4.1 with g_4 = 1 and g_5 = 1 generates I^{mt} = 108.98.

For the method of bridged overlap, equation 6.7.1 gives g_4 = 1.059326, g_5 = 1.371969. Inserting these numbers into equation 6.4.3 generates I^{mt} = 101.13.

Similarly, the alternative variant of the method using equation 6.7.4 gives g_4= 1.087273, g_5 = 1.408163, which generates I^{mt} = 100.08.

Variants: simple overlap, overall mean imputation, targeted mean imputation, class mean imputation.

Example 2. Refrigerators, the use of bridged overlap

In month *m*-1*:* fridge freezer, brand X, energy label A+, EUR 499

In month *m*+1*:* fridge freezer, brand Y, energy label A++, EUR 599

Monthly price change with no quality adjustment: 599/499 = 1.20

Quality adjusted monthly price change based on the average price change of the other fridge freezers in the sample: 1.007.

(144) See the document: HICP recommendation on bridged overlap for more examples of the bridged overlap method. Other examples on the Bridged overlap method can also be found in the CPI Manual (2020); note that bridged overlap in the CPI Manual is known as Overall mean or Nonclass mean imputation.

The following recommendations for applying the bridged overlap method can be found in the HICP recommendation on bridged overlap:

1. It is recommended to constantly monitor and identify replacement situations in which the underlying assumptions of bridged overlap are either significantly or systematically not satisfied and modify the replacement and quality adjustment procedures where feasible.
2. To avoid biases caused by the bridged overlap method, the following alternative treatments have been suggested:
   a. Apply direct comparison.
   b. Apply explicit quality adjustment methods.
   c. Apply class-mean imputation.
   d. Apply targeted imputation.

Furthermore, the Report suggests that to avoid the possibility of a downward bias in the index caused when the last observed price of the old product is a reduced price then the practitioner should consider the following:

1. Go back to the last ’normal price’.
2. Optimise the timing of the replacements.
3. Apply bridged overlap between the current period and the period prior to the price reduction.
4. Adjust bridged overlap by correcting the bridge for the price decrease of the replaced product-offer.

6.7.2 Monthly chaining and replenishment

The method of *monthly chaining and replenishment* means that the aggregate relative price change between any two adjacent periods is assessed as the aggregate relative price change for the set of all individual product that are available in both periods. It involves a complete resampling of available individual product each month.

Aliases: monthly chaining and replenishment is also known as monthly chaining and resampling, or multi-period overlaps.

Basic usage: monthly chaining and replenishment is mostly used in product areas where the underlying assumption is deemed not to yield unacceptable bias.

Underlying assumption: the method assumes that, on average, the prices of competing individual products move in the same direction and magnitude as their quality difference as perceived by consumers.

Comment 1: using chaining within the year might technically seem to deviate from the principle of a fixed-basket index. However, a distinction must be made between the target of the index and the means to accomplish this. The target is a fixed-basket index with the elementary aggregate being the level at which the basket as fixed. The method of monthly chaining and replenishment is proven to be an efficient means to achieve this target under suitable conditions.

Comment 2: in its original form, the method of monthly chaining and replenishment involves a complete monthly resampling of available individual products in sampled outlets. A simplified form of the method involves a fixed number of currently popular individual products instead of a complete resampling in each of the outlets from which prices are collected. Note that a downward drift in the index may occur if the individual products systematically exit the market at a discounted price.

Examples of use: the method can be used for products like electronic goods.

This method should be avoided and when need following the Eurostat recommendations on Bridged overlap.

Computation: the computation is the same as the recursive form for bridged overlap — that is equation 6.7.2.

However, assume now that a model not previously available, labelled 6, is introduced at time (m-1)t and is still available at time mt, at prices $p_6^{(m-1)t}$ and p_6^{mt} .

In the case of the geometric mean index formula (the Jevons formula), use of monthly chaining and replenishment means that the index is computed using the following recursive formulation:

$$I^{mt} = I^{(m-1)t} \cdot \left(\frac{p_1^{mt}}{p_1^{(m-1)t}} \cdot \frac{p_2^{mt}}{p_2^{(m-1)t}} \cdot \frac{p_3^{mt}}{p_3^{(m-1)t}} \cdot \frac{p_6^{mt}}{p_6^{(m-1)t}} \right)^{\frac{1}{4}} \qquad (6.7.5)$$

Comment on applicability: as may be noticed, the method of monthly chaining and replenishment is in a way very similar to a bridged overlap. Essentially, the difference lies in the way the sample is maintained. In using monthly chaining and replenishment, the sample is continuously renewed not by one-to-one replacements of previous individual products with new ones, but instead by taking in new models as they become available, disregarding the previous sampled models.

This is a practical method that is very similar to bridged overlap, but with the advantage of a continuous updating of the sample. The simplified form without full monthly resampling is particularly convenient. But like bridged overlap, it depends on market conditions; it may fail for products where discounts are a common occurrence. For small sample sizes and under some circumstances, the method may possibly give the index series a larger random variation than is the case with usual one-to-one replacements and the bridged overlap.

6.7.3 Backcasting (base price imputation)

The method of *backcasting* means that the relative price change for a replacement product over the period between the price reference period and the time of replacement is estimated by imputing from the relative price change over the same period but for those individual products that are not replaced in the sample.

Aliases: retropolation. Backcasting is sometimes known as base-price imputation, a somewhat vague term which might also be used in a more general case.

Basic usage: Backcasting is applicable in product areas where the underlying assumption is deemed not to yield unacceptable bias.

Underlying assumptions: the applicability of the method rests on the assumption that individual products of different kinds are expected to have on average the same price development.

Examples of use: the method is sometimes used for various product areas as a simple proxy when other methods are not practically available. However, bridged overlap and monthly chaining and replenishment are preferable and should in general be just as feasible and practical.

Comment: the method may look somewhat like bridged overlap, except that instead of going back to the previous month, it goes back to the price reference period (the previous December) for imputing the price change from other individual product. The imputed price changes in the bridge of bridged overlap methods extends over a shorter time span only and are therefore based on recent price observations; in contrast, with backcasting the imputed price movement spans a longer period and relies on using older price observations. Thus, backcasting may in a way sacrifice some accuracy in exchange for some possible computational convenience where the production system is not easily adaptable to month-to-month imputations.

Computation: in the case of the geometric mean index (the Jevons formula), use of backcasting means that the index is computed by equation 6.6.3 with the quality adjustment factors taken as:

$$g_4 = \frac{p_4^{mt}}{p_{4\prime}^{0t} \cdot I^{(m-1)t} \cdot \left(\frac{p_1^{mt}}{p_1^{(m-1)t}} \cdot \frac{p_2^{mt}}{p_2^{(m-1)t}} \cdot \frac{p_3^{mt}}{p_3^{(m-1)t}}\right)^{\frac{1}{3}}} \tag{6.7.6}$$

and similarly for g_5.

In the case of the ratio of arithmetic mean prices (the Dutot formula), use of backcasting means that the index is computed by equation 6.6.4, with the quality adjustment factors taken as:

$$g_4 = \frac{p_4^{mt}}{p_4^{0t} \cdot I^{(m-1)t} \cdot \frac{p_1^{mt} + p_2^{mt} + p_3^{mt}}{p_1^{(m-1)t} + p_2^{(m-1)t} + p_3^{(m-1)t}}} \tag{6.7.7}$$

and similarly for g_5.

A simplified approximate form of the computation is:

$$g_4 = \frac{p_4^{mt}}{p_4^{0t} \cdot I^{(m-1)t}} \tag{6.7.8}$$

Comment on applicability: where replacements are infrequent and generally random, the method in effect works in a way like that of bridged overlap. But, where replacements are more frequent, backcasting has a disadvantage due to its less controlled statistical inference properties.

Furthermore, the underlying assumptions of bridged overlap have a more transparent interpretation, although they can and should be critically assessed on a case-by-case basis. For backcasting, the underlying assumptions appear to be more problematic.

6.7.4 Link-to-show-no-price-change

The method of *link-to-show-no-price-change* means that the value of the quality change is assessed as the change in price since the preceding period.

Aliases: link-to-show-no-price-change is also known as automatic linking, Price change taken as quality change, or price difference equals quality difference.

Basic usage: link-to-show-no-price-change should only be used in cases where there is a clear reason to believe the price difference between the old and new product is fully explained by its quality difference. This is an agreement with Commission Implementation Regulation (EU) 2020/1148 and is generally banned by Article 5(5) of Regulation No 1749/96: Member States shall make a quality adjustment equal to the whole price difference between the replaced product in month m-1 and its replacement in month m only if this can be justified as the appropriate estimate of the quality difference.

Underlying assumptions: the applicability of the method rests on the assumption that true price changes in conjunction with quality changes either do not exist or are negligible, and that the difference in consumer value (i.e., quality) between the replacement and replaced individual product is equal to the full difference in price. The assumption is logically circular as it is based on a prejudice about the outcome of the measurement to be made. There are good reasons to use the link-to-show-no-price-change with some caution as its application can potentially hide true price change.

Examples of use: generally, not to be used as a first-choice option for quality adjustment unless it can be justified as generating the appropriate estimate. The option of justifying its use is probably not very applicable in practice, as a justification would generally have to be based by applying some other method for quality adjustment, which should then be the one used in the first place.

Comment on applicability. Only applicable under some very restrictive conditions.

7

The treatment of special cases

7 The treatment of special cases

This chapter deals with several different types of products in which the usual methods of index construction must be modified because of their unusual characteristics.

The chapter is divided into six parts, each addressing a specific problem area. They are:

7.1 Seasonal products

7.2 Cross-border internet purchases

7.3 Service charges proportional to transaction values

7.4 Tariffs

7.5 Zero prices

7.6 Bundles.

7.1 Seasonal products

This section deals with seasonal products, which, according to the CPI Manual *Concepts and Methods* (2020) ([145]) (hereafter the CPI Manual) are defined as those products that are either not available in the market during certain seasons or periods of the year or are available throughout the year but with predictable cyclical fluctuations in their quantities and prices that are linked to a season or time of the year. Climate, social and cultural traditions, and institutional arrangements are the main causes of seasonal patterns for some products found in the HICP basket.

The CPI Manual identifies two types of products that can be qualified as seasonal:

1. 'Weakly' seasonal products are those products that are available throughout the year but for which their prices and availability to consumers fluctuate significantly with the time of year;

([145]) CPI Manual Concepts and Methods 2020, International Monetary Fund (ilo.org).

and

2. ‘Strongly’ seasonal products are those products that are available only part of the year when ‘in season’.

In contrast to strongly seasonal products, weakly seasonal products present a different set of issues and require a different treatment by index compilers. For instance, a weakly seasonal product, while being available for most of the year, will usually display a seasonal pattern of its sales volumes with corresponding changing prices; these weakly seasonal products do not normally disappear from the market when they are qualified as out-of-season. Practitioners seeking to smoothen fluctuations in the index resulting from the presence of such products for which their prices follow a seasonally cyclical pattern will use well-established seasonal adjustment techniques to achieve this objective. Note, that Eurostat does not currently publish a seasonally adjusted version of the HICP.

This section of the manual will deal exclusively with strongly seasonal products. These are typically more conceptually challenging compared to weakly seasonal products and require a more complex methodological treatment. Moreover, any allusion to these products in the European Regulations pertains to those that are strongly seasonal in nature. In fact, the HICP does not qualify weakly seasonal products as being seasonal, and they are thus not subject to the rules laid down in Regulation (EU) 2020/1148 (see below).

The growing importance of imports and new food production technologies, such as the greenhouse cultivation of fruits and vegetables, have now extended the availability of certain products to the entire year, though their prices, quality and quantities may vary over the period. This may affect both the identification of strongly seasonal products and the choice of the measurement approach. Moreover, in some cases, a country may very well find that the imported version of a particular product is so different from its domestic counterpart, both in quality and price, that they are considered as distinct products for the purposes of index construction. However, if consumers perceive the imported version of a product to be similar in quality to the one produced domestically, and prices can be observed in every month, then these products are not treated as seasonal as per the definition above. Fresh and frozen fruits are good examples of similar products but can be deemed as distinct products given their perceived (or real) quality differences; moreover, the former could be qualified in some countries as being seasonal if they are unavailable during certain months of the year while the latter is likely available throughout the year.

Commission Implementing Regulation (EU) 2020/1148 does not distinguish between seasonal goods and seasonal services: seasonal products apply to both product categories. It may be pointed out, however, that there are certain differences in the treatment of goods versus services regarding the timing of the recording of their acquisition (i.e., the time that the observed price enters the index) and practitioners need to be aware of these differences.

Paragraph 3.118 of ESA (2010) states that:

> *‘Goods and services are acquired by institutional units when they become the new owners of the goods and when the delivery of services to them is completed’.*

In the case of services, the time of acquisition is, for the purposes of the HICP, the month in which actual consumption of the service takes place. Take for example the purchase of a season ticket to a sporting event whose starting date can be several months after the day the ticket was purchased; for the purposes of the index, for the compilation of the HICP, this transaction should be recorded in the month of the opening game. This principle applies equally to seasonal and non-seasonal services.

It has been observed that the existence of seasonal products in the price sample is often the leading cause of missing price observations when compiling the HICP. In practical terms, the issue with seasonal products can be described as follows. If it is known that a product will return to market after a predictable period (i.e., its usual in-season period) then there is no reason to justify a replacement for it when it disappears from the sample. However, a decision must be made about how best to treat the missing price until the product returns to market. Temporarily carrying the last observed price forward is not a viable option as this will likely distort the inflation estimate the HICP is designed to measure. For example, if most prices in the HICP sample are rapidly rising at the same time as a seasonal product disappears from the market, then temporarily replacing its price with the last recorded one would have the effect of dampening the true rate of inflation.

The treatment of seasonal products contrasts with that used when accounting for missing prices in the index under different conditions. For instance, if a product disappears from the market but is expected to return within a short time (e.g., it is temporarily out-of-stock), its price can be estimated (or, perhaps more precisely, *imputed*) for the period when the item is missing (Regulation 2020/1148, Article 9.1). In other cases, a product may have permanently disappeared (e.g., discontinued model) and is *not* expected to return; here, the index compiler must find a replacement item with similar features to the one which has disappeared (Regulation 2020/1148, Article 10.1). (See Section 5.6 for a more thorough discussion about missing prices and their treatment).

The solution to the seasonal product problem consists in applying the best possible imputation strategy for the missing price during the entire period for which the product is out-of-season. This is not always intuitively straightforward given the conceptual basis of the HICP, which is to measure the month-to-month changing cost of a ‘fixed basket’ of goods and services (i.e., cost of goods price index) over time; to this end the HICP uses a (fixed-basket) Laspeyres-type price index formula.

Many solutions exist for handling seasonal products when compiling a price index under a fixed-basket environment such as the HICP with annually updated weights. None of them can be regarded as ideal but they remain nevertheless a superior option to that of disregarding seasonality altogether. Each one leads to different outcomes whereby some are sometimes viewed as better to others. Therefore, to ensure a consistently measured HICP across countries, Implementing Regulation 2020/1148 was put in place. It contains provisions for the treatment of seasonal products, and this will be discussed below.

In the sections following 7.1.3, details are provided regarding the methods to be used in the compilation of price indices for seasonal products according to the current HICP legislation. The topics covered are as follows:

7.1.3 Scope of seasonal products

7.1.4 Compilation techniques for seasonal products

7.1.4.1 General approaches to computing price indices for seasonal products

7.1.4.2 Seasonal imputation method: basic approach

7.1.1 Legal framework, definitions, and terminology

The compilation of the HICP is, as previously mentioned, governed by Framework Regulation (EU) 2016/792, which lays down a common framework to produce the harmonised index of consumer prices and other major price indicators. This framework regulation is complemented by Commission Implementing Regulation (EU) 2020/1148 (hereafter Regulation 2020/1148), laying down the methodological and technical specifications in accordance with Regulation (EU) 2016/792 of the European Parliament and of the Council as regards harmonised indices of consumer prices and the house price index. This section is based on the rules and recommendations currently in force for the HICP.

Article 2 of Regulation 2020/1148 provides the following definitions related directly or indirectly to seasonal products. These provide guidance for compilers to first identify seasonal products more conveniently, and second to then apply the best methodology for treating them in the HICP.

‘4. Product-offer means a product specified by its characteristics, the timing and place of purchase and the terms of supply, and for which a price is observed.’

‘6. Individual product means a product-offer or a homogeneous product.’

‘9. Replacement product means an individual product that replaces another individual product in the target sample.’

‘11. Observed price means the consumer price of an individual product, as used by the Member State for the HICP compilation.’

‘12. Estimated price’ means a price based on an appropriate estimation procedure.’

‘13. Elementary aggregate means the smallest aggregate used in a Laspeyres-type index’

‘14. ‘Elementary price index’ means an index for an elementary aggregate or an index for a stratum within an elementary aggregate.’

‘22. Seasonal product means an individual product that is available for purchase or purchased in significant amounts only part of a year in a recurring pattern. In any given month, the product is considered to be either in-season or out-of- season. The in-season period may vary from one year to another.’

‘23. Typical price means an estimated price for a seasonal product that is not exceptional such as an end-of-season sales price.’

‘24. Seasonal imputation method means a treatment whereby prices of out-of-season seasonal products are estimated using counter-seasonal or all-seasonal estimation.’

> *'25. Counter-seasonal estimation means a procedure to obtain an estimated price for a seasonal product so that:*
>
> *(a) in the first out-of-season month, a typical price from the previous in-season period is used.*
>
> *(b) in the following out-of-season months, the estimated price is equal to the previous month's price adjusted by the average change in observed prices over all in-season seasonal products in the same ECOICOP group, class, subclass or the same aggregate at any level below the subclass.'*
>
> *'26 All-seasonal estimation means a procedure to obtain an estimated price for a seasonal product so that:*
>
> *(a) in the first out-of-season month, a typical price from the previous in-season period is used.*
>
> *(b) in the following out-of-season months, the estimated price is equal to the previous month's price adjusted by the average change in observed prices over all individual products in the same ECOICOP group, class, subclass or same aggregate at any level below the subclass.'*
>
> *'27 Seasonal weights method means a treatment of seasonal products in which weights for out-of-season seasonal products are zero or set to zero.'*

Articles 9 and 14 of Regulation 2020/1148 lay down the following rules on the treatment of seasonal products in the HICP:

As previously stated at the beginning of the section, not all products disappearing from the market are deemed as seasonal in nature. In this case, Article 9 of Regulation 2020/1148 provides guidance when identifying seasonal products so that the proper treatment can be applied.

Article 9

Estimation of prices

> *'1. If the price of an individual product in the target sample cannot be observed, an estimated price shall be used for no longer than 2 months, after which a replacement product shall be selected. This paragraph shall <u>not apply to seasonal products</u> or other individual products that are expected to become available again.'*

As for the treatment of seasonal products in the HICP, Article 14 of Regulation 2020/1148 provides the methodological treatment of these products.

Article 14

Seasonal products

> *'If seasonal products are sampled in an elementary aggregate, Member States shall use the seasonal imputation method or the seasonal weights method to compile a price index for that aggregate.'*

The rules on the treatment of seasonal products pertain exclusively to products that are *not* continuously available for purchase every month. Consequently, during these months, their prices cannot be observed. Moreover, a substitute product can usually be purchased from within the same ECOICOP category and for which a price is available.

The distinguishing feature of a seasonal product is that it follows a predictable cyclical pattern during the year. It disappears from the market and then reappears for a certain time to disappear again then later. The unavailability of any product during a given month is not however a sufficient condition for it to be qualified as a seasonal product. In fact, many products in the HICP sample disappear for reasons other than being out of season. Take for example the case of a monthly pass to access public transportation which happens to be unavailable for purchase in March because of a strike by transit workers. The unavailability of the pass does not in itself mean that it is a seasonal product. Because the strike will likely end, passes are expected to become again available sometime in the future. Hence, the pass does not follow an infra-annual predictable cyclical pattern of availability and is not considered a seasonal product. The treatment of such missing prices falls under Article 9.

Conceptually, the HICP measures the average monthly price developments for a fixed basket of goods and services consumed by households. Within the HICP's ECOICOP hierarchy, it is at the elementary aggregate (EA) level (and higher) for which the basket is fixed as per the spirit of the Laspeyres formula on which the compilation of the HICP is based. Below this level, the expenditure shares of the sampled items can be adjusted to improve the accuracy of the estimated elementary aggregate (EA) price index.

Assume for example that there is an apple EA and it is comprised of a representative sample of two varieties: A and B. Let us further assume that in June the shares of varieties A and B within the EA are respectively 40 % and 60 %; these shares could have been obtained through market intelligence including possibly scanner data. If it is known that in a subsequent month the shares of these varieties have changed say to 25 % and 75 % respectively, then the sampled price observations used for each variety can be re-weighted accordingly. By changing the share of apple varieties within the EA, the price statistician can improve the statistical accuracy of the estimator of apple prices (i.e., its elementary price index).

Therefore, the hierarchical structure of the HICP can be viewed as being made up of two distinct parts: 1) The upper part which starts at the level of the EA and for which expenditure weights are fixed for the duration of the basket as per the Laspeyres formula; and 2) the lower level of the structure (below the EA) where the weightings (or market shares) can be adjusted inside the basket's reference period if so chosen by using currently available market intelligence information. Regulation 2020/1148, Article 14, is not meant to introduce rules for varying expenditure shares of products at the EA level or above (e.g., the case of apples above). Rather, it sets out rules on how to deal with individual product varieties within the EA when they go temporarily missing because of seasonal events.

7.1.2 The definition of in-season and out-of-season periods

In-season and out-of-season periods usually follow a stable pattern, which for year *t* must be determined before the weighting scheme is established, i.e., by December of year *t*–1 at the latest, reflecting the HICP rules on weight reference periods (see Chapter 3).

The out-of-season period of a seasonal product includes the months in which no prices are observable for the purpose of compiling the index. The in-season period in year *t* should *not* be adjusted because of observations on product supply during the current year *t.*

Note that the in-season period may vary to some extent from one year to another. If, for example, it is observed during the current year that the annual availability of a product is changing, the separation into in-season and out-of-season periods can be adjusted and then applied to next year's index compilation exercise. This may happen exceptionally, for example, because of climate change or new cultivation methods, some seasonal fruits become available earlier in the year, or if the period of availability is extended by the increased demand for imported products.

As the in-season period must be defined prior to the current index year, there is always a possibility that prices may, exceptionally, be unavailable in the first or the last month of their normal in-season period. In such cases prices must be estimated, regardless of the method used for the treatment of seasonally disappearing prices (these methods are described in Section 7.1.4.). A new product may also be identified as seasonal, but this is not likely to be determined until its pattern of availability has been observed over time.

7.1.3 Scope of seasonal products

The current Regulation 2020/1148 (Article 2 (22)) defines a seasonal product as *an individual product that is available for purchase or purchased in significant amounts only part of a year in a recurring pattern. In any given month, the product is considered to be either in-season or out-of-season. The in-season period may vary from one year to another.*

No specific products are explicitly identified as seasonal according to this Regulation. They need only to satisfy the above definition to qualify as such. Clearly however, the product's availability must be characterised by a seasonal pattern. Some products unambiguously fulfil this condition such as Christmas ornaments, certain fruits and vegetables, and certain clothing and footwear items. It can also be beneficial to have access to a large database of prices including expenditures or quantities (e.g., scanner data) to determine if by treating a product as seasonal it has a significant effect on the official sub-index or even higher. The CPI Manual 2020 (paragraphs 11.47-49) provides a discussion on the treatment of two seasonal products groups which are Fruits and vegetables, and Clothing. These products are often found to be seasonal in nature for many countries.

7.1.4 Compilation techniques for seasonal products

7.1.4.1 General approaches to computing price indices for seasonal products

The principle underlying the sampling approach to the HICP is that the observed prices for constructing the price relatives must be drawn from identical products that respect the scope and coverage of the index. This approach results in a matched (or like-for-for) sample of products, thus ensuring that the HICP is indeed an estimate of ‘pure’ price change. To this end, prices for identical products are compared monthly so that an elementary aggregate price index for a given aggregate can be generated. These elementary price indices are then combined with their corresponding expenditure weights, which represent the consumption patterns of households for a given reference period (see Chapter 3), to arrive at higher level price indices in the HICP’s classification hierarchy). Alternatively, multilateral aggregation methods can also be used for estimating the elementary aggregates; this is discussed in Section 7.1.6.

In practice, during some months prices for seasonal products cannot be observed and this needs to be addressed given the matched sample approach used for compiling the HICP. Note that given that the HICP is an index measuring monthly developments in the price of a basket of goods and services consumed over a 12-month period, therefore for non-seasonal products, seasonal fluctuations in availability (and hence consumption) are irrelevant.

However, in an environment with seasonally missing prices the compiler must decide on how to best treat this situation. Regulation 2020/1148 provides two options for this end:

1. The seasonal imputation method

   Treat seasonal products, when possible, in a similar way as when the prices for non-seasonal ones are unavailable, i.e., missing price observations are imputed. To accomplish this, estimate out-of-season prices by following changes in the prices of the most similar products within the same ECOICOP subclass, class, or group. With this method, the weights of all the HICP component indices, regardless of the level of aggregation, remain unchanged month after month. For those months where the product is out-of-season, a price is imputed for the purpose of calculating the index. The index so calculated is known as a ‘seasonally imputed index’ (or sometimes also known as the fixed-weights index).

2. The seasonal weights method

   With this second strategy, it is accepted that the price of a seasonal item cannot reasonably be observed during its out-of-season period, and therefore the only logical option is to set the expenditure weight of that product to zero during its out-of-season months. When the product is in-season, the weights vary during those months to reflect the corresponding consumption pattern. The resulting index is known as the ‘seasonally weighted price index’. (In some circles this method is known as the variable weights method). The term 'seasonal weights' refers to the fact that the weights are based on estimates of actual monthly availability.

The *seasonal imputation method* has the advantage of being theoretically consistent with the treatment of certain other products when they go missing. Moreover, it is easier to implement. A major drawback, however, is that it remains an imputation and the assumption that the seasonal products are available through the year results in the estimated monthly consumption pattern differing from the observed pattern. For instance, cherries might only be marketed during the summer months, but the seasonal imputation method implies that they are available throughout the year. This leads to the use of fictitious prices (those that are imputed) in the compilation of the HICP, based on products for which their price behaviour is often of limited comparability with that of the missing product.

The *seasonal weights method* has the advantage of allowing the consumption patterns to vary thus reflecting market realities while minimising the need to impute for missing prices. There is a drawback to using the seasonal weights method, however. Most data sources for the seasonal weights (e.g., HBS, retail trade data) use information that relates to the base period of the index, hence the weights reflect only the base year consumption pattern. (i.e., the weight reference period). Consequently, if for some reason the usual seasonal pattern should be different in a period beyond the base year, or if the prices happen to be unusually high or low at the beginning or end of the season, then the measured rate of inflation will be affected. For example, if unusual weather conditions delay the arrival of peaches on the market, an estimation is needed for the period for when peaches are unavailable. If more timely seasonal weights data are available such as for example from scanner data, then more recent seasonal consumption patterns could be reflected in the index, thus avoiding the issue that arises from using base period weights.

Yet another disadvantage in terms of the transparency of the seasonal weights method is that monthly changes in the index will be a mixture of price and quantity changes under certain conditions which includes the choice of the index formulae (see Chapter 8 on the possible formulas that can be used). Hence, interpreting the monthly (sub-) index movements for seasonal products in this case can be ambiguous when the seasonal imputation approach is applied([146]). This problem is not however present when an index number formula that does satisfy the proportionality test is used. Superlative index number formulae will, by the way, pass this test.

It is important to note at this stage that with the seasonal weights method, and contrary to what is often believed, that this approach does not violate the Laspeyres framework on which the HICP is compiled. This is because in the hierarchical structure of the HICP, whereby the fixity of the basket starts at the level of the elementary aggregate (and above). Below this level (and the level where seasonal weights are used) the expenditure weights can indeed vary.

For example, assuming that Fresh Fruit and Vegetables is qualified as an elementary aggregate, while its total expenditure weight is fixed, the composition of that basket can vary within the year; in other words, the weight of fresh peas can change according to varying monthly consumption habits of households for the various fresh fruit and vegetable items. So, under the seasonal weights method, while the composition of the basket of fresh fruit and vegetables can change monthly, the proportion of household expenditures for fresh fruit and vegetables remains fixed across all months.

Regardless of the choice of approaches, no perfect solution exists; the advantages and disadvantages of each method should be recognised and, if possible, measured or assessed

([146]) For instance, the following weighted average of prices formula: w(t)*p(t)/w(0)*p(0) does not satisfy the proportionality axiom. More precisely, the ratio of two consecutive index numbers built upon a variable weight's framework does not respect the proportionality axiom of a price index. This axiom states that if all reference prices are multiplied by a positive scalar ***k***, the result will be a new price index which is ***k*** times the price reference period index. This property is often regarded as a natural one for an index number since it makes a composite index analogous to a price relative (price ratio). The relevance of this property for the purpose of constructing an accurate index is not unanimously supported by index number experts.

before implementation. The two methods should generate approximately the same result. The final choice likely lies on efficiency grounds. Table 7.1.16 summarises the main pros and cons of the two approaches.

Table 7.1.16

Advantages and disadvantages of seasonal weights and seasonal imputation methods for the treatment of seasonal products in price indices

Approach chosen	Advantages	Disadvantages
(a) Seasonal imputation method	It is easy to implement, and the price-imputed seasonal items are treated as regular products found in the index. Consistent use of weights across all items in the basket.	Annual fixed weights may not be representative of true monthly consumption patterns. For certain groups of products (e.g., fresh fruits) the incidence of imputations can be quite high in each month. The incidence of imputed prices can be large for certain products leading sometimes to more imputed prices than observed prices in a year.
(b) Seasonal weights method	Seasonal availability patterns are consistent with observed consumption behaviours. Price imputations are kept to a minimum.	Month-to-month price change reflects not only changes in price relatives, but also changes in consumption patterns. Undesirable impact on inflation in cases of unusually late availability or early unavailability of some seasonal products. Obtaining the monthly weights data can be challenging. (With the increased availability of scanner data, this disadvantage is likely not as pertinent anymore). Inconsistent use of variables weights for seasonal items while using fixed weights for the other non-seasonal items.

7.1.4.2 Seasonal imputation method: basic approach

Following Regulation 2020/1148 (24 to 26), under the seasonal imputation method, out-of-season prices of seasonal products can be estimated by either one of two approaches. These two approaches are as follows:

1. *Counter-seasonal estimation* means a procedure to obtain an estimated price for a seasonal product so that:
   a. In the first out-of-season month, a typical price from the previous in-season period is used; and
   b. In the following out-of-season months, the estimated price is equal to the previous month's price adjusted by the average change in observed prices over all in-season seasonal products in the same ECOICOP group, class, subclass, or the same aggregate at any level below the subclass.
2. *All-seasonal estimation* means a procedure to obtain an estimated price for a seasonal product so that:
   a. In the first out-of-season month, a 'typical' price from the previous in-season period is used; and
   b. In the following out-of-season months, the estimated price is equal to the previous month's price adjusted by the average change in observed prices over all individual products in the same ECOICOP group, class, subclass, or same aggregate at any level below the subclass.

Recall from above that Article 2 (23) from Regulation (EU) 2020/1148 defines a typical price as an estimated price for a seasonal product that is not exceptional such as an end-of-season sales price.

It is clearly important that the initial out-of-season estimates are not biased by using atypical prices, which are often observed for many seasonal products in the last month of their availability. This is particularly true for seasonal clothing and footwear, where at the end of each season unsold products are heavily discounted at clearance prices. To avoid any downward bias in the index, the *typical price* used in the first month of unavailability could be the modal price, or the mean of the in-season prices. If end-of-season sales are held, the last observed in-season price should not be used when establishing the *typical price* otherwise this will probably bias the index by generating in that month an unrepresentative price increase.

See also Section 12.5 on the treatment of flights and package holidays, and Section 12.7 on clothing and footwear. Both sectors present unique challenges for estimating typical prices. Section 7.1.4.3 below discusses the treatment of fresh products such as fruit; the same treatment applies to other fresh seasonal products, including vegetables and fish.

Under this approach, when a new product is first included in the sample, there must be a price available in December of *t*–1. If the product is known to be out of season in December, then a typical price from the in-season period in the previous year should be used when estimating the December *t*–1 index. Prices for the index for January onwards for year *t* should then be imputed as described above until the product returns to market (i.e., until it is in season). Under this approach, the coverage of sample products needs to be reviewed well before the annual resampling exercise, to collect any prices required to estimate a typical price for the first December index.

Note that this method is not designed for ECOICOP sub-classes, classes, or groups in which all products have the same seasonal pattern, resulting in months when expenditure on the entire class or group falls to a very low level. Examples include heating energy and heating gas. The general rules for the treatment of missing prices and replacements items for non-seasonal products apply in such cases.

It is also worth noting that Regulation 2020/1148 lays down no specific rules on product definitions. Some countries may define a summer coat and a winter coat as two distinct seasonal products, while other countries may define a year-round *coat* that encompasses both winter and summer coats. This is permissible and reflects variations in climatic conditions. However, quality-adjustment issues may need to be addressed.

7.1.4.3 Seasonal imputation method: counter-seasonal estimation and all-seasonal estimation

Article 14 of Regulation 2020/1148 allows for two methods for estimating the prices of out-of-season products when using the seasonal imputation method: *counter-seasonal estimation* and *all-seasonal estimation*. The Regulation does not recommend or favour one method over another.

Counter-seasonal estimation

This method involves estimating the index for out-of-season products using only the prices of *seasonal products* in the ECOICOP group, class, subclass, or the same aggregate below the subclass. An ECOICOP group, class, or subclass or the same aggregate below the subclass containing seasonal products may consist entirely of such products — though their out-of-season and in-season periods may not necessarily be identical. A common example is fresh fruit. Quite often, however, the ECOICOP category also includes non-seasonal products for which prices can be observed during the entire year. This may be the case for clothing where some types of apparel in a given ECOICOP category are available throughout the year (e.g., jeans, socks, and underwear), while linen pants may be available only in summer.

The reasoning underlying counter-seasonal estimation is that both in-season and out-of-season products serve a similar broad purpose, although in a different climate. In contrast, non-seasonal products within the same ECOICOP group, class, subclass, or the same aggregate below the subclass may have different uses. For instance, formal dinner suits are available all year round to comply with a dress code for example, so they cannot be replaced either by an informal winter suit or a lightweight suit, regardless of weather conditions. In contrast, warm and lightweight clothes serve the same purpose of protecting the body and are substitutable according to the climatic conditions.

Counter-seasonal estimation may not always be practical to implement. For example, certain fruits in some countries may be available either all year round or only in the summer. In such cases the price for summer fruits in the out-of-season period cannot be estimated using only *winter fruits* that are unavailable. In this case, the all-seasonal estimation method should be used. However, the growing importance of imports in recent years means that some fruits, such as apples, bananas, and oranges, may be available all year round, but a judgement needs to be made as to whether sufficient price observations are available for the counter-seasonal approach to be used. If not, the all-seasonal estimation method will likely be the best option.

All-seasonal estimation

With the all-seasonal estimation method, the index for out-of-season products is estimated using the prices of *all available products* in the ECOICOP group, class, subclass, or the same aggregate below the subclass. For example, the prices of fresh summer fruits during the out-of-season winter months are estimated using data for all fruits available in winter (including tinned, and dried and frozen fruit) assuming this ECOICOP category includes such diversity of fruits.

All-seasonal estimation implicitly assumes that in-season, out-of-season, and all-season products are near-substitutes from the consumer's perspective. All types of fruit provide (similar) nutrition throughout the year. Seasonal availability, which leads to changing consumer preferences, will affect purchasing patterns.

Note that, with this approach, higher-level aggregates, e.g., ECOICOP divisions (2-digit level), should not be used for estimation purposes. The reasons for this are twofold:

- Inflation rates of higher-level aggregates are likely to be influenced to a large extent by factors unrelated to the seasonal products concerned.
- Using products from the same ECOICOP class or group improves comparability with class confined seasonal weights indices.

Choice of method

Although Regulation 2020/1148 does not favour one of the two approaches, under certain circumstances one approach may be more practical to implement than the other. For instance:

Counter-seasonal estimation can be easier to apply when the calendar year is characterised by only two clearly distinct seasons, e.g., where summer products are replaced by winter products and vice versa, and where in each month of the year sufficient seasonal products are available to apply this estimation procedure, e.g., clothing is a good example here.

All-seasonal estimation will likely be restricted to situations where the seasonal pattern is not as obvious and where the number of available seasonal products is limited for certain months of the year, e.g., some fruits.

7.1.4.4 Seasonal weights method: data sources and methods for estimating weights

For the HICP, it is annual and not monthly weights that are the target. This explains in part why household budget surveys are designed in a way that the expenditure data obtained are annualised. For non-seasonal products in the HICP the weights are fixed annually. Usually, this information is derived from National Accounts, household budget survey data and other sources (see Chapter 3).

In the case of seasonal products, if the plan is to use the seasonal weights approach, then infra-annual weights (e.g., monthly, quarterly, or other) will be needed. To this end, the compiler will need additional complementary data sources for estimates of the monthly weights required to successfully apply the seasonal weights method.

For instance, in the case of seasonal products in the food category, a dedicated food survey that is conducted over the course of the year would provide the necessary detailed information to generate monthly weights. Now with the availability of scanner data (and other high frequency data) and the move towards multilateral methods for compiling the HICP, timelier seasonal weights are available, and this information can be used for applying the seasonal weights approach.

Note that during the in-season period, the weights can vary to reflect the expected monthly availability of products, but only to the extent necessary to reflect changes in the composition of the basket.

Regardless of the source for the seasonal weighting data, aggregate weights for ECOICOP sub-classes, classes, or groups, remain according to regulation, fixed for the entire year, just as for non-seasonal products. This means that weights must be constant (i.e., fixed) down to the lowest published level of ECOICOP (by Eurostat), ideally this would be the 5-digit sub-class level when possible.

Using the seasonal weights index method, variations in weights may serve two purposes. Firstly, they allow for out-of-season periods in which products are not available and prices cannot be directly observed. Secondly, they allow for variations in the composition of the basket during the year.

Fluctuations in the weights can be minimised by applying the following steps:

1. Determine the yearly average weight per product within the ECOICOP group, class, or subclass or the same aggregate at any level below the subclass of seasonal products;
2. The out-of-season months should be clearly defined; and
3. The monthly weights of the in-season period should then be determined, ensuring that:
   a. monthly weights of ECOICOP group, class, or subclass or the same aggregate at any level below the subclass are equal each month;
   b. weights are zero if and only if the product in question is expected to be out of season;
   c. the average product weight during the year represents the product's annual weight; and
   d. the weights of seasonal products do not vary during periods when the set of in-season products is constant.

In practice, to calculate monthly weights fulfilling these requirements, the following method is recommended. A worked example is given in Table 7.1.17.

Section A shows the annual expenditure on each product. Section B shows each month’s proportional shares of the products’ annual volumes. These two sections are given data. Sections C and D are based on these data. Section C combines data from sections A and B to give estimated monthly expenditures on each product, plus the class total. Section D calculates the weights of each product for each month, using data from Section C. The formulae used are shown at the foot of the table.

This method ensures that the weights of seasonal products are treated like other products as far as possible, and that the impact of changing weights on the monthly change in the HICP is reduced to a minimum. The method is explained in more detail in the following section.

7.1.4.5 Example of method for determining monthly weights in a seasonal weights index

Three products, A, B and C are considered.

Product A is a winter product, in season from September to April. Products B and C are summer products: B is in season from April to August, while C is in season only from May to August.

Data on monthly expenditures are unavailable — only estimates for the annual totals are produced (Rows 1-4 in Table 7.1.17). However, it is necessary to estimate the monthly shares when using with the seasonal weight method. This is shown in rows 5–7. These estimates are based on rough approximations by the Member State or trade or other sources. The figure of 12.5 % for product A in row 5 indicates that 12.5 % of the annual sales of A (EUR 96 m) fall in each of the 8 months from September to April. In row 6 we can see that 20 % of the annual sales of B (EUR 60 m) are in April, with a further 20 % falling in each of the 4 months from May to August. Row 7 shows that 25 % of the annual sales of C (EUR 72 m) fall in each of the 4 months from May to August. This is a simple example, and in practice estimated figures may vary month by month.

Next, using these estimated proportions, we can estimate the sales price of each product in each in-season month. These are shown in rows 8 to 10. For example, the monthly sales of product A are estimated at EUR 12 m, 12.5 % of the annual total of EUR 96 m. The other figures are calculated in the same way. Row 11 shows the total monthly sales of all three products, totalling the known figure of EUR 228 m.

The final step is shown in rows 12–14. These are the monthly class weights for each of the three product groups. For example, from September to March the only product in season is A, so it accounts for 100 % of the weight. Between May and August, however, A has no sales and hence a weight of zero. Product B has sales of EUR 12 m out of a monthly class total of EUR 30 m, a proportion of 40 %, while product C has sales of EUR 18 m from the same class total of EUR 30 m, a proportion of 60 %. Row 15 shows, as a check, that the class weights add up to 100 % each month.

Table 7.1.17

Seasonal weights index, an example of a method for determining monthly weights

A	Annual expenditures (mio EUR)														
1	Product A	96.0													
2	Product B	60.0													
3	Product C	72.0													
4	Class Total	228.0													
B	Estimated monthly availability estimates (shares of annual total expenditures) (%)														
			J	F	M	A	M	J	J	A	S	O	N	D	Year
5	Product A		12.5	12.5	12.5	12.5	0.0	0.0	0.0	0.0	12.5	12.5	12.5	12.5	100.0
6	Product B		0.0	0.0	0.0	20.0	20.0	20.0	20.0	20.0	0.0	0.0	0.0	0.0	100.0
7	Product C		0.0	0.0	0.0	0.0	25.0	25.0	25.0	25.0	0.0	0.0	0.0	0.0	100.0

C	Estimated monthly expenditures (mio EUR)														
8	Product A		12.0	12.0	12.0	12.0	0.0	0.0	0.0	0.0	12.0	12.0	12.0	12.0	96.0
9	Product B		0.0	0.0	0.0	12.0	12.0	12.0	12.0	12.0	0.0	0.0	0.0	0.0	60.0
10	Product C		0.0	0.0	0.0	0.0	18.0	18.0	18.0	18.0	0.0	0.0	0.0	0.0	72.0
11	Class Total		12.0	12.0	12.0	24.0	30.0	30.0	30.0	30.0	12.0	12.0	12.0	12.0	228.0
D	Relative class weights (%)														
12	Product A		100.0	100.0	100.0	50.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0	100.0	
13	Product B		0.0	0.0	0.0	50.0	40.0	40.0	40.0	40.0	0.0	0.0	0.0	0.0	
14	Product C		0.0	0.0	0.0	0.0	60.0	60.0	60.0	60.0	0.0	0.0	0.0	0.0	
15	Class Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
KEY:															
Rows 1-3, 5-7		Source data													
Row 8		Row 1 * Row 5 /100													
Row 9		Row 2 * Row 6/100													
Row 10		Row 3 * Row 7/100													
Row 12		Row 8 / Row 11*100													
Row 13		Row 9 / Row 11 *100													
Row 14		Row 10 / Row 11*100													

The set of weights obtained in this way is not unique in fulfilling the requirements mentioned in Section 7.1.4.4. Alternative algorithms — or, indeed, estimates of monthly expenditures — may reduce the variation in the monthly weights, if this is considered desirable. However, standard approaches of iterative proportional fitting, which is sometimes suggested in the literature, are not directly applicable to the HICP because of the zero prices issue.

7.1.4.6 Price-updating of weights

At each level of publication, the HICP is compiled as a yearly chain-linked index, as described in Chapter 8. The weights used for the annual chain links of year *t* have to be price-updated to reflect expenditures expressed in the price level of December of year (*t*–1), using the procedure described in Chapter 3. As regards to seasonal products, special care is warranted for products which happen to be out of season in December. The general rule is that annual weights should always be price-updated to the price reference period of the index, i.e., the corresponding month of the price that appears in the denominator of the price relatives. This is needed to yield a Laspeyres-type index as required with the HICP, which is equally true for seasonal products and for the other products. Thus, weights must usually be price-updated to December of the preceding year.

However, the situation is special for a summer season expenditure category where the season ends before December. Here, the price-updating procedure to be used depends on whether the seasonal imputation approach or the seasonal weights approach is used (as defined in Section 7.1.4.1):

- With the seasonal imputation approach, the price-updating exercise corresponds to the imputed December price level.
- In the seasonal weights approach, price-updating is made to the observed price level of the last in-season month for the product, e.g., August, instead of December.

Again, this gives the correct Laspeyres-type index.

As mentioned in Chapter 3, price-updating is mandatory for weights of ECOICOP categories, and optional for the weights of aggregates at lower levels where weighting data may or may not be available. Where price-updating for seasonal products at lower-level aggregates is used, this should be done following the same procedures as described above.

For example, consider a summer-season product category with an annual expenditure of EUR 200 m, where the seasonal weights approach is used. Suppose that the HICP sub-index is 105.22 for the last in-season month of the preceding year (t–1) and 101.57 is the mean value of the index over the weighting reference period. The price-updated annual weighting expenditure is then calculated as:

$$200 \times 105.22 / 101.57 = \text{EUR } 207.19 \text{ m.}$$

The monthly weights in the seasonal weights index approach are determined from the price-updated annual expenditures as described in Section 7.1.4.4.

7.1.5 The interpretation of monthly and annual inflation rates

a. Monthly inflation rates (*m*/(*m*-1))

Interpreting monthly inflation rates in the presence of seasonal products may be challenging for both the seasonal imputation method and the seasonal weights method.

In the seasonal imputation method, neither the monthly rate in the first out-of-season month nor that in the first month of the new season depends solely on observed price changes in the latter month, because one or other of the prices is imputed.

In the seasonal weights approach, the monthly rate is determined not only by price changes in the observed month, but also by changes in the weights distribution between these months.

When using the seasonal weights method, the non-zero weights for the in-season products are on average higher than the corresponding product weights with the seasonal weights method. This implies that a seasonal product has more impact on inflation during its in-season period, but, on the other hand, in the seasonal imputation method the product may additionally influence inflation through an out-of-season product, where its price is estimated. Over a twelve-month period, these differences may cancel out, but there is no assurance that this will indeed be the case.

b. Annual inflation rates (*m*/(*m*-12))

When using the seasonal imputation method, annual inflation rates for seasonal products can be calculated entirely from observed prices during in-season periods. They will, however, be calculated entirely from estimated prices during out-of-season periods. Such estimates must have some justifiable meaning.

This is achieved by estimating the index in the first out-of-season month to the average or typical price for the just-ended in-season. Then the year-on-year inflation in this first out-of-season month equals the average of the year-on-year inflation results that were estimated during the in-season period, or the difference between the typical prices in the two seasons compared. Otherwise, the last measured in-season prices may have too great an impact on the out-of-season inflation estimates.

For the remaining out-of-season months, year-on-year inflation will follow the trend of inflation measured by the prices of in-season products.

In the case of the seasonal weights method, the annual rates of change for ECOICOP sub-classes, classes or groups with seasonal products are determined solely by comparing the observed prices of the in-season products.

7.1.6 Seasonal products and multilateral methods

Section 7 of Eurostat's Guide on Multilateral methods (2022) deals with the treatment of seasonal products and multilateral indexes. It states that: 'In principle, multilateral methods can be applied to seasonal products.' A more in-depth discussion about the treatment of seasonal products and price indexes can be found in Chapter 9 of the CPI Theory Manual ([147]).

Ideally, the goal would be to calculate a matched Fisher price index (fixed base or chained) over two periods (i.e., a Fisher price index calculated with products that are available in the two comparison periods). However, neither of these two options is deemed as satisfactory when seasonal products are involved. On one hand, the choice of the base period may have too much influence on the fixed base Fisher index. On the other hand, a chained Fisher price index can be subject to some (usually downward) chain drift. Multilateral methods can help avoid these two problems.

Conceptually, multilateral methods can be viewed as an application of the 'seasonal weights method'. When an individual item is out-of-season, its weight is given a value of zero. In contrast, when a product is in-season, its weight corresponds to the observed quantities during that season. More details on this subject are available in the Guide on Multilateral methods, which also includes a link to a dataset with corresponding examples of already-calculated multilateral indices ([148]).

Section 7 of the Guide concludes by offering three recommendations:

1. Seasonal products do not need to be explicitly identified in the data.
2. To have a good coverage of two successive in-season periods, it is important to have time windows longer than 13 months. (This is to ensure that the window includes the last month of the previous in-season period and the first month of the new in-season period).

([147]) CPI - Chapter 9 – Seasonal products.pdf (ilo.org).

([148]) Circabc – Multilateral methods guide – Seasonal products – example 2.xls (europa.eu).

3. The impact of splicing should be closely examined with seasonal products as some splicing methods may produce indices that are biased compared to (i.e., deviate systematically from) benchmark indices compiled without splicing.

7.2 Cross-border internet purchases

7.2.1 Introduction

The world economy has changed significantly since the HICP was first launched in the mid-1990s, driven by the twin forces of globalisation and the internet (e-commerce). The latter has revolutionised the way in which consumers make many of their purchases. In 2019, online purchases accounted for 12 % ([149]) of the value of all purchases in Europe, and the volume of these purchases has rapidly been rising in recent years. More businesses' turnover has come from e-commerce. It has now become the norm for airline, train tickets and package holidays to be purchased online rather than through travel agencies.

Given the increasing importance of internet purchases for EU consumers, this relatively new type of outlet cannot be overlooked in the computation of the HICP. It must be within scope when designing the outlet samples and included in national HICPs, according to their significance. Some categories of goods and services, such as flights, package holidays, books, music and movies, are now typically purchased online. Accordingly, online retailers selling these products should be included in HICP sample of outlets, with a weight that reflects their respective significance. Moreover, there are good reasons for specifying online shopping as a new type of outlet, as price changes for online outlets may differ from other outlets. This is easy to demonstrate. Two of the reasons given by consumers for using the internet are price related. Firstly, online prices — even including delivery charges — are frequently lower than prices for the same products sold in physical outlets. Secondly, price comparisons are often easier to make for products sold online. In addition, delivery charges for bulkier items may be just as competitive when bought online compared to having them delivered from a traditional outlet.

The Recommendation on the treatment of cross-border internet purchases borrows from the VAT rules ([150]) that came into effect in January 2015 in all Member States. The new VAT rules recognise that a growing number of products are electronic in nature (e-books and movie streaming are two examples) and have largely replaced their physical counterpart.

The new VAT rules draw a distinction between goods, digital services, and other services. For goods ordered online, the delivery destination determines the VAT rate. Usually this will be the country of residence. For digital services, the VAT rate is determined by the country where the purchaser normally resides. For non-digital services such as airline tickets and package holidays — even if booked online — VAT is determined by the country where the tangible service is provided. Following the new VAT rules, the HICP Recommendation on the treatment of cross-

([149]) Source: The Centre For Retail Research: Estimate applies to Western Europe only.

([150]) VAT explanatory_notes_2015_en.pdf (europa.eu).

border internet purchases has been developed to ensure harmonisation among all Member States — see Section 7.2.2.

These same recommendations also cover purchases ordered by phone or from mail order catalogues, which are treated in the same way as online purchases because of their transactional similarities.

7.2.2 HICP Recommendation on the treatment of cross-border internet purchases

Although Eurostat recommendations have no formal legal status, they have been developed in the belief that Member States will abide by them. Eurostat considers them applicable for the purposes of monitoring the quality of individual Member State HICPs.

The Recommendations on the treatment of cross-border internet purchases are the following:

Recommendation 1: Purchase of goods

The expenditure and the prices for goods purchased online shall be recorded in the HICP of the country where the product is delivered.

Recommendation 2: Purchase of services of a tangible nature

The expenditure and the prices for services of a tangible nature purchased through the internet shall be recorded in the HICP of the country where the service is provided.

Recommendation 3: Purchase of digital services

The expenditure and the prices for digital services (communication, broadcasting, and electronic services) shall be recorded in the HICP of the country where the consumer usually resides.

Recommendation 4: Extra costs

The price to be recorded should be the full price, including any compulsory additional costs, provided that these costs can be attributed solely to the purchase of the product concerned.

Recommendation 5: Other distance purchases

The expenditure and prices relating to other distance purchases, for example by phone or mail order, shall be treated in the same way as internet purchases with regard to extra costs and for determining the country from which expenditures and prices shall be accounted for.

7.2.3 Definitions and terminology

The following definitions have no legal status, but may be regarded as working definitions:

Additional costs: any costs charged by an internet supplier over and above the cost of the product itself, such as delivery charges, booking fees and credit or debit card fees.

Digital services: all electronic services (including downloading and streaming of software, music and on-demand TV, social media — Facebook, Instagram and dating sites, etc.), TV and radio broadcasting and telecommunication services.

Domestic concept: defines the scope of the HICP as all household final monetary consumption expenditures on the economic territory, regardless of the nationality or normal residence of the consumer (see Chapter 2).

Electronic services: services supplied online (or through another electronic network, e.g., cable TV, gaming services and services accessed via mobile telephone networks) which, given their nature, are supplied by essentially automated means, involving minimal human intervention, and cannot be supplied without information technology. The VAT rules give the following list of electronic services:

- Website supply, web-hosting, distance maintenance of programmes and equipment.
- Supply of software and software updates, e.g., MS Office, security software and photo-editing software.
- Supply of images, texts, and information and the making available of databases, e.g., e-books, online newspapers and news sites, and other electronic publications.
- Supply of music, movies and TV episodes, and games, including gambling and other games of chance, and broadcasts of political, cultural, artistic, sporting, scientific and entertainment events, streaming or downloading of movies, receiving television programmes online for viewing at the convenience of the user, based on a catalogue of programmes selected by the media service provider, such as TV or video on demand.
- Supply of distance learning services including automated online distance learning the supply of which requires limited or no human intervention, such as online training courses.

Tangible services: services linked with immovable property, passenger transport, services involving admission to cultural, artistic, sporting, scientific, educational, entertainment and similar events, and restaurant and catering services.

7.2.4 Explanatory text

The domestic concept (see Chapter 2)

The domestic concept determines the geographical coverage of the HICP. It is set out in Regulation (EU) 2016/792 of the European Parliament and of the Council of 11 May 2016 on harmonised indices of consumer prices and the house price index, which states that:

> '*the HICP[…] shall be based on the price changes […] of products included in the household final monetary consumption expenditure'*.

Article 2(20) defines household final monetary consumption expenditure (HFMCE) as expenditure incurred by households on the economic territory of the Member State. Article 2(18) stipulates that households must be included irrespective of nationality or residence status.

Treatment of cross-border internet purchases in the HICP

In the case of cross-border internet purchases, there is a need to give the domestic concept underlying the HICP an unambiguous and operational interpretation. The aim is to ensure consistent geographical coverage of the related prices used for the HICP across Member States.

The traditional — non-internet — case of households buying goods and services while abroad is a tourism expenditure. Households are physically outside the economic territory of their country of residence when goods and services are acquired and will often consume them there. Both the seller and the place where the good or service is delivered are in the same country, which is not the purchaser's country of residence, and this is the country which includes both expenditure and prices in its HICP.

Cross-border online purchases are somewhat more complicated. The internet offers virtually unrestricted access to a myriad of products found abroad, and transactions can be made from almost anywhere using an Internet connection. A person residing in country X orders/purchases products from a foreign website, and they may be delivered to country X or Y, or even to a non-EU country.

Clear rules are needed to define the geographical coverage of country cross-border online purchases. The rules should take account of the conceptual framework of the HICP. They should be practical and robust; even if that means that a simplified treatment would apply to certain special cases.

Using the *country of delivery* criterion for the geographical allocation of the cross-border online purchases meet these requirements. It reflects the fact that the full price which the consumer must pay for a good is known only once the country of delivery is established. Only then can delivery charges and the appropriate VAT rate be determined. In the case of services of a tangible nature, it is the country where the service is provided. Furthermore, the country of delivery or provision of the service is where the consumer and the product or service *come together*, which is in the spirit of the domestic concept.

Hence, the general rule should be:

- For goods purchased online, the expenditure and price should be covered by the HICP and recorded in the country where they are delivered.
- For services of a tangible nature, it is the country where the service is provided, and for digital services it is the country where the consumer usually resides.

In complex cases, appropriate proxies to the delivery criterion are to be used. See Section 7.2.4.3 for some complex examples.

7.2.4.1 Country of purchase of goods (Recommendation 1)

For online purchases of *goods* both the expenditure and the price should be assigned to the HICP of the Member State where the good is delivered. The rationale for this is that the final purchase price of the good itself and the associated delivery costs can only be determined once the shipping address has been determined. This also corresponds to the country where the VAT usually applies.

This approach aligns with the recommendations in the latest CPI Manual 2020, paragraphs 11.67 and 11.68 whereby:

> *‘As discussed in Chapter 2, the treatment of purchases made online requires special consideration … In many cases, however, internet-based outlets may be based (registered) abroad and this expenditure would be considered cross-border shopping’*.

For those countries following the national concept, the approach is clear. Strictly speaking, under the domestic concept, this expenditure would not be included because it would be defined as an expenditure abroad; in practice, this requires a broader interpretation. The nature of Internet purchases, therefore, require a different strategy and special consideration, about the domestic concept. Additionally, internet purchases continue to grow in importance.

Many countries have carefully considered how to include the expenditure (and prices) made on goods and services via the internet. For the purchase of goods, the expenditure and prices should be reflected in the country where the goods are delivered. Therefore, the country of delivery is normally the country where the purchaser resides, regardless of the residential status of the seller and/or supplier. This approach is consistent with the guiding principle in the HICP behind such purchases, whereby the domestic concept of consumption is to be adopted, which means that all expenditures on goods and services that are delivered to households on the domestic territory are within the scope of the index. Of course, this would include goods and services delivered from abroad.

This should include imports of goods delivered directly to the purchaser, which, in the national accounts, are excluded from consumption expenditures made on the domestic territory.

For example, an Italian consumer purchases sunglasses on Amazon's Italian website (Amazon.it) but the seller of the sunglasses is at an undisclosed location. The order is shipped from say France and delivered to the Italian consumer's residence where the purchase is subject to the Italian VAT rate. Both the expenditure and price should, in this case, be assigned to the Italian HICP.

It is important to note that this rule avoids the two extreme (and undesirable) cases of double-counting or the non-inclusion of these purchases altogether. At the same time, it ensures consistency in the treatment of online purchases and respects the scope of the HICP (i.e., the domestic concept), as defined in the Framework and Implementing Regulations.

7.2.4.2 Services of a tangible nature booked online (Recommendation 2)

An expenditure on a *tangible service* (services linked with immovable property; passenger transport; services involving admission to cultural, artistic, sporting, scientific, educational, entertainment and similar events; and restaurant and catering services) *booked online*, and its price, should be assigned to the country where consumption first commences. This is because the consumer must be at the location of the service provider to start consuming the service, and the place of consumption determines the applicable VAT rate to be paid.

For example, a ticket booked online for a live concert in Paris will include the French VAT rate, regardless of the residence of the consumer at the time of purchase. Both expenditure and price belong to the French HICP. In contrast however, a ticket booked online to watch an opera live concert streamed from Paris to a cinema in Luxembourg will include in its price the Luxembourg VAT. Both expenditure and price belong to the Luxembourg HICP. Under both scenarios, the country where the service is first supplied equates to the place where VAT is levied, which in turn determines the country to which the expenditure and prices are assigned.

Recommendation 2 is particularly relevant to airfares, package holidays and holiday accommodations booked online (see Section 12.5).

For all services (tangible and digital) even when they are purchased online, Regulation

2020/1148, Article 8(2), on Observation of prices, still applies. This Regulation states that 'An observed price for a service shall be included in the HICP for the month in which consumption of the service can commence.'

7.2.4.3 Digital services (Recommendation 3)

Digital services are supplied over the internet and the nature of which renders their supply essentially automated and involves minimal human intervention and cannot be delivered without the use of information technologies. Digital services also include the costs of installing servers and other similar service-related equipment. The availability of a helpdesk does not change the fact that all these services are essentially digital.

Digital services are electronic services. This includes all broadcasting and telecommunication services. Section 7.2.3 and Annex 1 of the VAT rules regarding broadcasting and telecommunication services defines electronic services and provides examples.

Under the 2015 VAT rules, all digital services are taxed according to the residence of the consumer and not the residence of the supplier ([151]), as it is the consumer's country of residence that determines the VAT rate. For example, an e-book downloaded by a Luxembourg resident from Amazon.fr is subject to the Luxembourg VAT rate, and both expenditure and price are assigned to Luxembourg's HICP.

Under current VAT rules, it is the principle of residence of the consumer rather than the residence of the supplier, or the country in which the service was accessed, which determines the applicable VAT.

> '*Special rules may apply when you buy* ***goods from another EU country for delivery*** *to your country of residence. If the company you buy from sells goods over a certain value to your country, where the goods are delivered, they cannot charge VAT in the country where you make your purchase*.
>
> *Instead, they have to apply* ***VAT in the country where the goods are delivered*** – *VAT of destination. The maximum amount for these cross-border sales is set by each EU country at either EUR 35 000 or EUR 100 000. This means that most major online retailers delivering within the EU will have to apply the VAT of destination rule.'* ([152])

This includes *all* telecommunication, broadcasting, and electronic services, not just those purchased for download and streaming. It clearly makes sense for telecommunication and broadcasting services to be covered by these rules because the relevant service providers may be in the country where the consumer resides is located and where the service is ultimately consumed. Examples include Skype, Movie streaming services such as Netflix and Apple TV, and satellite (television).

In the case of online purchases, the rules determining the country of residence have been laid down in such a way that most payments, many of which involve small sums of money, can be handled automatically. Generally, the consumer's account settings (e.g., within an iTunes

([151]) Before 2015, it was the service provider's location that determined the rate of VAT levied on the purchase.

([152]) See section on Buying online from another EU country at: VAT – Value Added Tax - Your Europe (europa.eu).

account) and the location information automatically provided by the internet connection (IP address) are sufficient to determine the country of residence and hence the applicable tax rate.

The VAT rules allow suppliers and retailers to make several assumptions to simplify their application:

- If a digital service (telecommunications being the foremost example) requires physical presence at a particular location to access the internet, e.g., a Wi-Fi hot spot, an internet café, a restaurant or hotel Wi-Fi network, or a telephone kiosk, the VAT for using such services is payable in the Member State where those places are located.
- If the service is bought via a mobile operator's network using a device such as a smartphone or tablet, then the expenditure and price are assigned in accordance with the SIM card country code. For example, if a French resident uses a French SIM card to buy an e-book while on holiday in Germany, French VAT applies.
- If the service is supplied through a decoder or a telephone landline, the location of the landline or decoder determines the VAT rate.

In these cases, it is clear where the service is being provided. If none of the above three assumptions apply, the retailer needs to keep two pieces of non-contradictory information as proof for the location and residence of the customer at the time of purchase. This evidence includes:

- the billing address of the customer (normally country of residence),
- the Internet Protocol (IP) address of the device used by the customer (this address can be linked to a country),
- the customer's banking details (the IBAN code contains a country identifier, normally that of the country of residence),
- the country code of the SIM card used by the customer (again, the SIM card code includes a country code),
- the location of the customer's fixed landline through which the service is supplied (again, this includes a country code).
- any other commercially relevant information, e.g., gift cards unique to a specific Member State, the consumer's trading history with the retailer.

A service purchased *locally* while abroad such as Wi-Fi access in a hotel, or the use of the computer in an internet café, includes the local VAT rate and should be assigned to the HICP of the country where the service is provided and consumed.

Purchases of broadcasting and telecom services are included in the HICP based on the consumer's place of residence, which would be the country where the service contract has been signed between both parties. If a consumer while away on holidays in a foreign country buys additional data for their mobile phone, it is purchased from their original provider and is recorded as if it was purchased domestically (i.e., his or her country of residence).

For electronic services – especially over-the-top services, provided by a third party and delivered to a consumer, with the internet service provider simply acting as the intermediary between the service provider and the consumer (e.g., purchasing an e-book on a mobile phone using a hotel's Wi-Fi service) — the retailer must keep any two pieces of non-contradictory information (as listed above) as evidence of the customer's location. Assuming the tourist does not change SIM cards, bank accounts and billing addresses, the VAT rate will most likely still be that of the consumers' country of residence.

Such services should therefore be assigned to the HICP of the purchaser's country of residence, as the country of regular delivery which is also the economy where the product is consumed.

The alignment of the HICP Recommendations for the treatment of cross-border online purchases with the VAT rules should also make it possible to improve the weightings for digital services and internet purchases in the HICP.

7.2.4.4 Extra costs (Recommendation 4)

Buying goods and services online may involve unavoidable costs over and above that of the product's posted price. Examples include:

- delivery charges;
- credit/debit card fees;
- administration/booking fees; and
- charges for supplementary services.

These extra or additional charges usually result in the final price paid for the product being higher compared to what would have been paid had the person bought the same item in a physical outlet. For airline tickets bought online, the additional charges can sometimes represent a significant proportion of the final price. These charges are generally unavoidable when making an online purchase, in contrast with the previous scenario, where purchases can be made from traditional outlets therefore avoiding delivery charges and/or credit charges and service (or sometimes known as convenience) fees if the payment is charged to a credit card.

The price which should be recorded for the HICP is the full (or final) price, *including* any complementary charges provided that these additional charges arise solely from the purchase of the product in question. This is consistent with the intentions underpinning the definition of a product offer drawn from Regulation 2020/1148, Article 2(4):

> *'product-offer' means a product specified by its characteristics, the timing and place of purchase and the terms of supply, and for which a price is observed.'*

The rule on the treatment of additional costs is based mainly on issues of practicability. If such costs can be assigned to a specific purchased good or service, they should be included in its price. However, if several products are purchased simultaneously and the additional costs cannot be assigned to each individual product, they should be recorded elsewhere. Explicitly invoiced credit card fees, for example, should be assigned to the financial services category.

Note that charges for using debit or credit cards to make purchases made using the internet are charged by the seller and are therefore unavoidable since paying with cash is not an option. Charges incurred by a consumer while on holiday abroad when making purchases in physical outlets or withdrawing local currency from ATMs are applied by the consumer's bank. They are in fact financial service fees and are not to be included in the product's purchase price. Section 12.8 makes it clear that any card fees charged by the card provider in connection with such purchases are to be assigned to the purchaser's country of residence.

Under ECOICOP, separately invoiced delivery charges are included in the same category as the product being transacted (i.e., delivery charges are included in the price paid for the product). With this approach, the delivery charge for a book ordered online, for example, would be included in the observed and reported price of the book and classified accordingly. The same applies to deliveries of larger goods, such as durables, where ECOICOP explicitly includes delivery and installation charges. The CPI Manual sections 11.78 and 11.79 discusses such delivery charges in the context of the CPI in general.

7.2.4.5 Other distance purchases (Recommendation 5)

This category covers purchases made by mail order and over the phone. Although these types of transactions have long been in existence, they have not always been treated as separate outlets in the HICP. However, they do share some of the same features as online purchases. Firstly, the customer has no physical contact with the merchant. Secondly, customers usually pay as they do when they make online purchases: by credit card, debit card, or bank transfer. Additionally, such purchases may also be subject to separately invoiced delivery charges which are often unavoidable when ordering from a distance. These unavoidable charges should be included in the final price of the item.

It has been decided that these other distance purchases should be treated in the HICP in the same way as online transactions, although they are not classified per se as e-commerce. Accordingly, the same rules and procedures should be followed. These include rules on the country to which the purchase is assigned, the way in which services are dealt with, and how extra/additional costs (such as delivery) are to be treated.

7.2.5 Weights and sampling

No specific recommendation has yet been made on the issue of weighting for Internet purchases. Currently, it is often difficult to obtain appropriate weights for online purchases. The obvious source at the appropriate ECOICOP level is the National Accounts and household budget surveys. It is important that the household budget survey include specific questions on the volume of online purchases, broken down by product groups. VAT records from tax authorities should be useful for estimating weights (to what level of detail is currently not yet clear). They may also be able to distinguish to some extent between household and business expenditures. Currently, some statistical agencies are showing growing interest in harvesting such weighting information from credit card, debit card and other types of electronic-type transactions (e.g., ATM and point-of-sales transactions). Some care should however be applied when multiple sources of data are used for obtaining weighting data since double (or more) counting some overlapping expenditures can be a real issue that needs to be addressed.

As regards outlet sampling, the usual procedure for non-internet outlets is to construct a target universe of outlets and then use an appropriate sampling method (see Chapter 4). With online purchases, the target universe of sellers is often unknown and can, in theory, be large, as goods can be shipped from almost anywhere. This means more subjective sampling methods must be used based on information from e-commerce surveys or organisations with knowledge of that sector. A characteristic of the online retail trade is that some markets (books, clothing, music downloads, etc.) are dominated by a small number of large retailers. A subjective sampling of the major retailers in these market sectors should be acceptable in most cases to accurately reflect the behaviour of prices in these markets. Product suppliers that have both physical and internet outlets should normally be allocated separate weights according to outlet type.

Online prices can be conveniently collected by manually retrieving this information available on merchants' websites. Alternatively, the use of web-scraping tools and techniques, which have been growing in popularity within NSOs, can be used to collect prices *automatically* (see Chapter 5, Price collection). In all cases, care should be taken to ensure that the proper VAT rate is applied.

The prices of some products available online may, because of lower 'menu costs', change more frequently than their equivalents sold in traditional physical outlets. In such cases, price collection and weights estimation methods may also need to be more flexible. Finally, it should be noted that web scraping offers an economical way of collecting prices by offering the opportunity to increase the sample while simultaneously lowering the cost of collection. Web scraping is not without its challenges. For more information on web scraping, the reader can consult annex 5.6 or paragraph 11.57 in the CPI Manual and Eurostat's Practical guidelines on web scraping for the HICP, November 2020 ([153]).

7.3 Service charges proportional to transaction prices

7.3.1 Introduction

Many services have, as with goods, stated prices payable for a specific service such as a bus journey, a haircut, or a theatre ticket. But there is a separate class of services whose prices are given as a proportion of the value of the associated product.

The fee charged by an estate agent for arranging a rental contract will often be a fixed proportion of the rental price. It may, for example, be one month's rent or a percentage of the monthly or annual rent. Many fees for financial transactions are similarly presented (see Section 12.8). But even with transactions relating to saving rather than consumption (such as the purchase of shares or stocks, which are outside the scope of the HICP) some fees for related services, e.g., stockbroker fees, are still included in the HICP.

This method of charging for a transaction, sometimes referred to as *ad valorem* charges, raises the question of how these charges can best be reflected in the measured inflation rate. If rents are rising, there is no question that this contributes to inflation, and indeed rental prices are covered in the HICP. But if an estate agency keeps its proportionate fee fixed, the fee will nevertheless rise as rents increase. Should this increase contribute to inflation? According to Regulation 2020/1148, Article 7(2), an increase in a fee resulting from an increase in the price of the underlying product should be included in the HICP.

> *Changes in the service charge that result from changes in the price of a representative unit transaction shall be shown as price changes in the HICP.*

([153]) Practical guidelines on web scraping for the HICP.pdf – 2020 - Eurostat (europa.eu).

The price index for this type of charge may be driven by changes in either one or both components: the price of the underlying product (e.g., rises in actual rents) and the *price* of the specific service charge (e.g., the agency's commission rate). The base price must therefore comprise two components: the underlying price of the product; and the price (or rate) of the associated commission or charge.

A practical difficulty is that the price for an *ad valorem* transaction is usually not directly observable. Where a service charge is expressed as a proportion of the transaction price, it must be valued (modelled) for the HICP using a representative unit transaction from the price reference period (December of each year). That is, applying the observed fee proportion to the price of the representative unit transaction gives a price in monetary terms for the service; this is the price that is relevant for the HICP.

The specifications of a representative unit transaction may change during the current period, just as the specifications of an ordinary product offer may change. In such cases, a quality adjustment may be needed to preserve the comparability of the transaction before and after the change. (See Regulation 2020/1148 Article 5(3), which describes how a change in a condition of a tariff should be treated in the HICP).

Examples of various types of calculation are given in Section 7.3.4. These cover stockbroker fees, foreign currency fees, and estate agency fees. The commonality among these examples is that representative transactions should be typical of consumer purchases; just as representative items are selected for the pricing of products within elementary aggregates. The amounts involved should be large enough to capture changes in both fixed and *ad valorem* fees.

It should be noted that FISIM (Financial Intermediation Services Indirectly Measured) is not included in the HICP because it is not considered as part of Household Final Consumption Expenditure (HFCE).

Situations where fees for certain services are income-dependent have some similarities with proportional charges. An example is nursery school fees that are established according to household income. Such situations are covered in Section 12.1.

This part of Chapter 7 continues with the legal requirements (Section 7.3.2) followed by definitions (Section 7.3.3). These are followed by a detailed explanation of the methods to be used to calculate the appropriate prices and weights for the HICP.

Annex 7.3 contains details of the algebra involved in calculating proportional service charges.

7.3.2 Legal framework

The subject of service charges proportional to transaction prices is addressed in Commission Implementing Regulation (EU) 2020/1148 of 31 July 2020, Article 7 (1) (2), and (3), laying down the methodological and technical specifications in accordance with Regulation (EU) 2016/792 of the European Parliament and of the Council as regards harmonised indices of consumer prices and the house price index.

The Regulation deals with how the HICP should treat service charges which are proportional to transaction prices.

Article 7 of the Regulation states:

> *'1. The HICP shall include charges that are levied directly on consumers in exchange for the service provided and can be expressed as a flat fee or a proportion of the transaction price. If the price of a service is determined as a proportion of the transaction price, the proportion multiplied by the price of a representative unit transaction shall be used as an observed price'.*
>
> *'2 Changes in the service charge that result from changes in the price of a representative unit transaction shall be shown as price changes in the HICP'.*
>
> *'3. If a change in the price of a representative unit transaction cannot be measured, it shall be estimated using an appropriate price index'.*

7.3.3 Definitions

Note: the following two definitions have no legal status; they are given purely for information purposes only.

Representative unit transaction: a typical transaction nominated for pricing in the price reference period, for which the price can be estimated.

Revaluing index: an index chosen to represent changes in the *price* of a representative unit transaction.

7.3.4 Methodological guidance

Service charges proportional to transaction values are mostly found in financial services — ECOICOP 12.6.2, Other financial services not elsewhere classified. Section 12.8 discusses the detailed methodology dealing with financial services (both flat fees and proportional charges) in detail, giving specific guidance on how to treat foreign currency transactions, the purchase and sale of investment funds, stockbrokers' services, and financial advisers and tax consultants' fees.

Three examples are given below to illustrate the procedure for measuring proportional services charges:

- stockbroker fees;
- foreign currency exchange; and
- estate agency fees.

Stockbroker fees

The following example illustrates the application of the Article 7.1 of Regulation 2020/1148. It concerns the stockbroker fees charged for a purchase of a block of shares of stock or other securities. Stockbrokers buy or sell shares of stock or other securities on behalf of clients. The service provided consists of arranging for a transaction to take place on conditions specified by the client, i.e., a given block of shares of stock is bought or sold. Usually, clients are charged a fee in proportion to the value of the block of shares traded. The proportional charge is often combined with a minimum or flat fee.

The first step is to determine the weights of this service. In principle, weights are obtained from the household budget survey, but as is well-known, response rates from higher-income households (those households that tend to buy and sell shares of stock) tend to be relatively low and is likely to lead to an inaccurate weight for this service. Consequently, other sources of information may need to be used as weights for this product such as national accounts data. If the estimated weights fall below the threshold for inclusion in the HICP, then no further action need be taken to obtain prices. If this is however not the case, the next step is to determine one or perhaps several *representative unit transactions*.

For stockbroking, purchasing or selling of shares, unit trusts or other securities, the representative unit transaction should be the charge payable by consumers in exchange for trading a given basket of securities (expressed in value terms). This transaction is representative for the base or reference period.

The amount invested in stocks during the price reference period (i.e., the value of the investment) should also be kept constant. The all-items HICP should be used to adjust the transaction values so as reflect percent changes. Price indices relating to the stock market or other securities should not be used. This approach thus maintains expenditures constant in real terms during the reference period ([154]).

The representative unit transaction should be the trading of a basket of shares of stock (or other securities). The value of this basket should be adjusted by the overall (all-items) HICP as the revaluing index (see Section 12.8.6 for further explanation). In other words, the representative unit transaction is the trading of shares of stock of a given value in real terms, that is, in constant euros (or other national currency).

The choice of the representative unit transaction is dictated in a similar way to other products to be chosen and priced *as representative products* within the HICP basket. They must be typical examples of the given product, and likely to be available for pricing for a reasonable length of time. They must also, of course, be capable of being priced. In this example, a representative unit transaction could be the trading of shares within one's portfolio with a value of EUR 7 500. For the price reference period, the service charge could comprise of two components:

- a flat standard fee of EUR10 regardless of the number of units transacted, and
- a proportional fee of 5 % of the total value of the shares transacted.

Total charges for this transaction equals EUR 385 (= EUR 10 plus EUR 375 = 0.05 x EUR 7 500). This amount is the base amount to be used for the price reference period of the representative unit transaction (product).

Suppose now that in some later period the flat fee has risen to EUR 15, while the proportional fee remains at 5 %. However, over time, the value in real terms of the unit transaction in the reference period will likely decline because of inflation. To maintain this value in real terms so that the change in the service charge can be properly estimated ([155]), the base value of EUR 7 500 must be recalibrated annually by an appropriate index, which, as stated above, should be the all-items HICP. If, for instance, the all-items HICP has risen by 17 % between the price reference period and this subsequent period, then the initial value of the portfolio should also be increased by 17 % (= EUR 8 775 (= EUR 7 500 x 1.17). The total transaction would then be priced at

([154]) See Annex 7.3.

([155]) This exercise is necessary to reflect the increased value of the transaction due to inflation and does not affect the result in terms of the units of shares transacted.

EUR15 plus 5 % of EUR 8 775, which comes to EUR 453.75. The index for this representative transaction is thus 453.75/385 x 100 = 117.9.

Without the fixed stockbroker fee, the index for the proportionate fees will always be identical to the all-items HICP. In the above example, it is slightly higher because the flat fee has risen faster (50 %) than the increase in the HICP.

It might be thought that to replicate the usual method for pricing goods in retail outlets, the basket of shares of stock would have to be identified as, say, 1 000 Class A shares in Company X. But this is irrelevant, as company and share class do not normally determine brokerage fees, and the unit transaction is a fixed investment expressed in monetary terms — in this case EUR 7 500.

Foreign currency fees

The output of any financial intermediary can, in principle, comprise two components:

a. financial intermediation for which there are no explicit charges (FISIM); and
b. financial services for which commissions or fees are explicitly charged. In some Member States, no explicit charges are applied to the purchase or sale of foreign currency. Instead, the financial institution, to generate income, will widen the spread between the selling and buying quotes for the purchase of foreign currency. Consumers pay only an implicit charge for the services in such cases, and since they are classified under Financial Services Indirectly Measured (FISIM), these types of transactions are excluded from the HICP.

The weight for acquiring foreign currency may thus be either very small or negligible in these Member States. Regulation 2020/1148 covers only those financial services for which explicit charges are made. Annex (Household final monetary consumption expenditure) states:

'In further specifying the quality of weights, the final monetary consumption expenditure shall include the following examples of household final consumption expenditure as defined in the following points in paragraph 3.95 of Annex A to ESA 2010:

- the part of point (e) that relates to financial services directly charged…'

Commission for the exchange of foreign currency is usually expressed as a proportion of the value of the foreign currency received in exchange for a given amount of national currency (or vice versa). There may also be an additional flat-rate fee, for example where foreign currency is acquired through a bank machine. Services related to currency exchange for which proportional charges are levied must be defined based on specific transactions. Charges in connection with selling or buying foreign currency correspond to two distinct services and should be dealt with separately in the HICP.

The representative unit transaction should be expressed as the charge payable by consumers to exchange a specified amount of foreign currency considered representative at the reference period in the economic territory of the a given Member State. An example is the charge associated for exchanging EUR 200 into its equivalent in pounds sterling.

The revaluing index should in theory be based on an official exchange rate whose values can be easily observed. However, given that exchange rates fluctuate daily, a moving average of one or more months might be considered a more appropriate approach. Calculations may then be made in the same way as those described in the previous example. Section 12.8.6 discusses the measurement of foreign currency exchange in more detail.

Estate agency fees

Estate agents who deal with the purchase and sale of properties by households usually charge a fee by reference to the purchase price of a property when it is sold. However, the HICP does not currently cover transactions involving sales and purchases of dwellings. Estate agents also charge proportional fees for their services when finding tenants for a rental unit. These fees are usually tied to the rental cost of unit, and there also may be additional one-off fees at the start of a rental period. For example, a particular agency may charge a flat fee of EUR 150 for a new tenancy in addition to a fee equal to one month’s rent, so the higher the rent, the higher the agent’s fee.

The method is like that described above for stockbroker fees. Firstly, the weight must be determined; this should normally be obtainable from the household budget survey or the national accounts, provided that the questions is designed in a way that a distinction can be made between the expenditure for the actual rent from the expenditure for the agency fee. Secondly, a representative unit transaction must be selected; this could be based on the average rent for a property in the base or reference period. Here it may perhaps be suitable to select more than one property, to represent different types and sizes of properties whose price developments may differ.

Some estate agencies may simply charge one month’s rent as commission on letting a property. Others may use a different approach by charging a flat fee. Assume that one of the representative unit transactions that has been chosen is the letting of an apartment with an annual rental of EUR 3 600. Agency A charges the tenant a fee equal to one month’s rent, i.e., EUR 300, plus a flat-rate fee of EUR 350. Agency B charges two months’ rent, but with no flat-rate fee. The base period fee for Agency A is EUR 650, while that for Agency B is EUR 600.

Twelve months later, survey data shows that Agency A has changed its fee structure: the flat-rate fee has been increased from EUR 350 to EUR 400. No other changes are recorded.

It has been decided to use the HICP for rental prices (ECOICOP, 04.1.1/2) as the revaluing index. This shows an increase of 6 % over the year in question.

The fee charged by Agency A is now based on a revalued rent of EUR 3 600 plus 6 %, which comes to EUR 3 816. The flat-rate fee is now EUR 400 and the proportionate fee EUR 318, totalling EUR 718. This is an increase of 10.5 % over the original fee.

The fee charged by Agency B is also based on a revalued rent of EUR 3 816 and amounts to EUR 3 816/6 = EUR 636. This is an increase of 6.0 % — identical to the revaluing index, as there is no flat-rate fee.

Just as with sub-elementary aggregate indices for most product offers, there are no weights available for the above indices. The treatment is the same as usual for ordinary product offers: the observed prices are aggregated, using the appropriate unweighted formula for aggregating prices at the elementary index level.

Annex 7.3: Modelling charges proportional to transaction values

This technical introduction sets out the algebra used for the HICP for estimating charges proportional to transaction values.

The changes in a proportional charge resulting from changes in transaction values to be captured by a given HICP sub-index *j* can be modelled as follows:

The proportional service charge *c* equals the percentage rate *r* applied to the value *v* of a unit transaction — which is the price of the transaction unit — times the quantity or number of transactions q in the base or reference period.

$$c = r * v * q = r * V \tag{7.3.1}$$

where $V = v * q$.

If ${}_0i_t$ is an index that appropriately reflects the movement in the value of the unit transaction (i.e., the price of the service) from period ***0 to t***, i.e., ${}_0i_t = v_t/v_0$, the price-updated proportional charge c at time t for the same set of transactions sampled at *b*, i.e.:

$$V_t = v_t{*}q_0 \tag{7.3.2}$$

can be written as:

$$c_t = r_t{*}V_t = (r_t{*}{}_0i_t){*}V_t/{}_0i_t$$

$$= (r_t{*}{}_0i_t\,){*}v_t{*}q_0{*}v_0/v_t = (r_t{*}{}_0i_t\,){*}(v_0{*}q_0\,) \tag{7.3.3}$$

The HICP sub-index j is then

$${}_0j_t = \sum[(r_t{*}{}_0i_t\,){*}(v_0{*}q_0)] / \sum[\, r_0{*}(v_0{*}q_0)] = \sum[(r_t/r_0){*}\,{}_0i_t\,{*}w] \tag{7.3.4}$$

with

$$w = (r_0{*}v_0{*}q_0) / \sum[r_0{*}v_0{*}q_0] = (r_0{*}V_0) / \sum[\, r_0{*}V_0] \tag{7.3.5}$$

The price change in the proportional service charge is thus given by

$$(r_t/r_0){*}\,{}_0i_t \tag{7.3.6}$$

i.e., the change in the percentage rate times the estimated change in the value of the representative unit transaction.

Once the base or reference period weight has been estimated according to (7.3.5), expression (7.3.6) reduces the estimation problem to:

- constructing an appropriate elementary aggregate and the corresponding elementary aggregate index to capture the movement (r_t/r_0), and
- choosing an index ${}_0i_t$ which appropriately reflects the change in the value of the representative unit transaction. Although a monthly price updating of the base or reference year expenditure is not necessary, the criterion for selecting this index is its ability to price-update the base or reference period expenditure for the transactions connected to a given service.

7.4 Tariffs

7.4.1 Introduction

The formal definition of a tariff is given in Regulation 2020/1148 Article 2(28):

> *'means a list of prices and conditions for a product that is differentiated according to the quantities purchased, the timing of consumption or the characteristics of purchasers.'*

This definition is consistent with the one found in the CPI Manual 2020, paragraph 11.211: 'A tariff is a list of prices for the purchase of a particular kind of good or service under different terms and conditions.'

One example of what can be considered a simple case of a tariff is illustrated in this fictitious example of domestic electricity prices for which the data is presented in Table 7.4.18 below.

Table 7.4.18

Price of electricity for domestic households

Monthly standing charge	EUR 3.00
First 200 units of energy (kWh) consumed: cost per unit	EUR 0.20
Subsequent units (kWh) consumed: cost per unit	EUR 0.10

A *component* (see definition below) would be any one of the above three elements of the tariff. The price of each component can change independently of the others: the electricity company can change the standing charge, or the price of the first 200 kWh consumed, or the price of units consumed above 200 kWh. It can also change the 200-unit threshold (which can be the most difficult aspect for the price statistician to deal with).

The following example is provided to illustrate the concept of a particular tariff in the case of electricity. Assume a household consumes 350 kWh, under the conditions presented in Table 7.4.18, its monthly cost for this service would be EUR 58 (= EUR 3.00 + (200 x EUR 0.20) + (150 x EUR 0.10)). Similarly, a household that consumes 150 kWh would pay EUR 33. And in the extreme case where a household uses no electricity it would pay only the standing charge of EUR 3 that month. This type of tariff pricing, which may be said to be based on quantities supplied, is often known as a *block pricing*. Other approaches to tariffs exist, such as those based on types of consumers (child/adult/pensioner, season ticket holder/non-season ticket holder), and *on demand* conditions, such as time of consumption (day-time fares, night-time fares). These various types of tariffs can sometimes coexist depending on the market environment.

Although many tariffs relate to the sale of services rather than goods, a tariff may, for example, be applied to the sales of goods at different unit prices, depending on the quantity being bought at any one time: e.g., buying larger quantities of a good in bulk usually translates into a lower unit price.

The treatment of tariffs for services is affected by several price index problems associated with service that compilers should be aware of when faced with situations of tariff pricing:

- Tariffs are subject to the same pricing rules as any other product in the HICP basket. As a first step in compiling the aggregate price index for a product that is subject to tariff pricing, a homogeneous product needs to be defined (e.g., electricity or public transit passes). These are often recognised as representative products or more specifically in the case of tariffs, 'representative unit transaction' or simply 'unit values' from which elementary price indexes are calculated. The second step then consists in aggregating the group of elementary price indexes of similar products into an elementary price index using either one of two index formulae discussed in Implementing Regulation (EU) 2020/1148, Article 12.1 (a) and (b).

- Charges for services can be subject to such complex pricing schedules that it is difficult to select the appropriate prices for inclusion when constructing a price index.
- Identification or specification of individual products or units of consumption themselves can be difficult, particularly when they are offered as bundled packages consisting of several smaller types of expenditure that may be priced separately but are typically only available as a part of a package. (See Section 7.6 — bundles).
- Services are often provided under long-term contractual arrangements, which may include different types of customer loyalty rebates, clauses for the minimum duration of contracts, surcharges for the provision of services not provided for in the contract, etc.
- There are often difficulties in accounting for substitution between different providers of the same type of service, and in accounting for quality differences in the services provided. Tariffs may be structured in such a way as to prevent direct comparison with other providers operating in the same markets. When different companies' tariffs are compared, the elements of the pricing schemes and details in the contents of the plans provided often turn out to be somewhat different. This is particularly marked in the field of mobile telecommunication services (see Section 12.6.).
- There may also be difficulties in accounting for customers moving under their own volition from one tariff structure to another under the same service provider. For instance, when a mobile telephone company or internet provider offers several different pricing packages targeting different patterns of use, existing customers may review the conditions of their agreement during which they may decide to move to a different package (with a different tariff) that better reflects their needs. The treatment of tariff prices must be consistent with the treatment of other prices in the HICP.

7.4.2 Legal framework

The treatment of tariffs in the HICP is addressed in Commission Implementing Regulation (EU) 2020/1148, of 31 July 2020, laying down the methodological and technical specifications in accordance with Regulation (EU) 2016/792 of the European Parliament and of the Council as regards harmonised indices of consumer prices and the house price index ([156]).

> '*Article 5*
>
> *3. Changes in the observed prices or conditions of a tariff shall be shown as price changes in the HICP.*'

([156]) Note that the legal provisions for tariffs have been significantly reduced since the last edition of this manual.

7.4.3 Definitions

Definitions included in Commission Regulation 2020/1148

Tariff: a list of prices and conditions for a product that is differentiated according to the quantities purchased, the timing of consumption or the characteristics of purchasers.

Other definitions

Tariff price: a price within a tariff that applies to a component or unit of consumption of the good or service in question.

Component: one of the elements of a tariff list which carries its own price.

Homogeneous: tariff elements which are of a similar type and are measured in the same units..

Homogeneous product: means a set of product-offers among which there are no significant quality differences and for which an average price is calculated..

7.4.4 Methods of treating tariff prices in the HICP

7.4.4.1 General procedure

The electricity example in Table 7.4.18 demonstrates the situation if the standing charge or the unit price for electricity usage were to change either below or above 200 kWh (or both). For each level, there is a measurable price change, and these price changes must be reflected in the HICP. The problem is how to weight these changes together.

To put this another way, using the above example, if one of the tariff components were to change (say, the 200 kWh threshold was increased to 250 kWh), the cost of electricity to the household could be re-priced on the assumption that consumers are insensitive to changes in the tariff structure, i.e., they do not adjust their consumption pattern in response to the tariff change. Thus, the consumer who used 350 kWh per month before the change, under this scenario, would continue to use 350 kWh per month after the change. Under the new tariff, the customer above would therefore pay EUR 63 (= EUR 3.00 + (250 x EUR 0.20) + (100 x EUR 0.10))..

The circumstances described in Regulation 2020/1148 Article 5(3), would include the situation mentioned above where the 200 kWh threshold has changed. (*The specifications* of the second and third elements of the tariff would then have changed, since 200 kWh is replaced by 250 kWh.) The Regulation also covers another situation, for example, if a second threshold were added to the tariff: *units consumed between 200 kWh and 500 kWh*. (This would also affect the top threshold, which would now be units over 500 kWh.) The new component does not constitute a *newly significant product*; the product remains the same: electricity consumed..

Moreover, under the new regulation, the price index for electricity can change under the more realistic scenario whereby a change in the price structure leads to changes in the levels of electricity consumption. Turning again to the example above, the new threshold for the first tier can potentially result in households who are now potentially facing a higher total cost for electricity adjusting their consumption downward. This change in consumption, combined with the new thresholds, should be accounted for in the compilation of the index, for example, by assuming that following the new threshold, the consumption of electricity declines to 300 kWh in the month. Then the cost of electricity for that month would be EUR 58 (= EUR 3.00 + (250 x EUR 0.20) + (50 x EUR 0.10)), and this is the estimate that would be used in the index..

Given that most electricity companies (and many other ones involved in supplying markets with products that are sold at tariff prices), operate in a regulated environment, current data on consumption patterns should be accessible to the compiler and therefore accounting for changing consumption patterns when compiling the index is likely possible..

Another possible compositional change in a tariff structure that should be monitored is when an existing tariff structure changes to include a newly significant product or more precisely a new service element. Although such occurrences are not as common, they can still have an impact on the index when they happen. An example might be the addition of on-demand movies or a live sports channel to an existing subscription TV service package, or a move from providing these options free of charge to explicitly charging for them. The methodology for dealing with newly significant products is covered in Chapter 4. (See also Sections 7.5 – zero prices and 7.6 – bundles for other relevant discussions on this topic).

Some types of service, such as transport, have only one tariff, and when a component changes, all or nearly all consumers are affected by that change at the same time. Such changes should be dealt with as described in this section. However, for some other types of services, most notably telecommunication services, many different tariffs co-exist on the market. When new tariffs replace old tariffs, a frequent occurrence in this sector, only new customers pay the new tariff price. Existing customers are often bound by contract to the replaced tariff, and do not move to the replacement tariff until their existing contract expires. To capture the correct price change facing all consumers, it is often preferable to phase in new tariffs over time, to reflect the changing proportion of consumers who are subject to the replacement and the replaced tariff respectively. These changes between tariffs are referred to as *migration rates*. Migration rates, and how they should be applied, are discussed in detail in Section 12.6 (telecommunication services). The principles discussed in Section 12.6 can be applied to other types of services if the market situation is like that of telecommunications services.

In the above example, a quality adjustment may be required if a new service element, such as a live sports channel which was previously available only as an option, is added to a standard subscription TV service/package at no additional charge. This applies also to the inverse, whereby such an option was included as part of a package but now an additional charge applies see Section 7.4.4.6..

7.4.4.2 Types of tariffs

It is helpful to distinguish four broad types of tariffs, which cover most tariffs in general use:

a. Tariffs based on demand conditions, which are in fact tariffs that are differentiated by the timing of consumption according to the definition of a tariff above (e.g., peak-load pricing; limited availability).

b. Tariffs dependent on the type of customer, which are in fact tariffs that are differentiated by the characteristics of the purchasers. (e.g., children, adults, students, pensioners).

c. Two-part tariffs:

   i. charge for the right or permission to use a product; and

ii. charges for actual usage (e.g., landline telephone services which often comprise a line rental charge plus usage charges).

d. Block pricing (e.g., units charged at different prices depending on the volume of consumption, e.g., coal or fuel oil, which may attract different unit prices depending on the quantities purchased).

Each Member State should determine which of the four broad categories of tariff exist in their country, under which category they fall and carefully analyse which tariffs are significant enough to be included in their HICP.

Examples of the four categories or types of tariffs are provided below.

a. Tariffs based on demand conditions

Tariffs based on demand conditions may be created because of the need to ration or smooth out the consumption of a service which has limited availability. Thus, electricity companies may have a cheap night rate to encourage consumers to shift as much as possible of their electricity consumption to the night-time (a time of day when demand is generally low). This reduces overall demand during the day when it is normally higher. This approach is sometimes called *peak-load pricing* or *congestion pricing*. Another example, also dependent on the time of day, is a bus company tariff: fares between, say, 6.30 a.m. and 9.30 a.m. may be higher than at other times. This is because there are more passengers at these peak travel-to-work times. After 9.30 a.m., prices may be adjusted downward to encourage travel outside the rush hour.

b. Tariffs dependent on the type of customer

This type of tariff may sometimes appear indistinguishable from *discount prices*. (See Chapter 5). Typical types of customers include pensioners, students, young children, families, foreigners (*dual pricing*), unemployed people, and annual subscribers (e.g., to magazines).

c. Two-part tariffs

Many examples of this type of tariff exist. A simple case is metered taxi fares: it is often the case that the taxi meter starts charging even before the journey has started; this is a *standing charge* which must be paid before the charge per distance (and/or time) travelled is levied. It is a pre-condition of travelling in the taxi.

The concept of a standing charge is also applied to many other types of tariffs. For example, with utilities such as electricity, gas, landlines, water and sewerage, customers often must pay a certain set fixed amount separate from the usage charge. Often there is a clear commercial reason for the standing charge, such as for the financing of a fixed cost such the provision of a meter or a telephone line, which is independent of the volume of usage. Apart from utilities, such tariffs may also be found in amusement parks, where there is an entry fee plus a charge for each activity (such as a ride on the roller-coaster). A discount club, where a subscriber must pay for a membership card to benefit from the club's lower prices, is another example of a 2-part tariff.

d. Block pricing

This has been illustrated above in the context of electricity tariffs. It often applies to other utilities, such as gas and water supply.

Some tariffs fall into more than one of the above categories. An electricity tariff may have:

- a time of-day element (e.g., lower prices are applied during the night);

- element (e.g., lower prices during night-time usage);
- a type-of-customer element (e.g., cheaper for senior citizens);
- block pricing (e.g., the first units consumed are charged a higher unit price than subsequent units); and
- a two-part tariff element.

7.4.4.3 Price measurement methods

There are essentially four types of measurement available for the pricing of tariffs:

a. Representative unit transactions in matched pairs of elements. In this method, changes in the component tariff prices are compared in different periods and combined using weights applicable to the individual components of the tariff.

b. Representative unit transactions defined by specified consumer profiles. In this method, a set of representative consumption or usage patterns of customers is defined. The price followed is the minimum price for the specified consumption/usage profile from a specified provider. This contrasts with the pricing of a set of component prices as used in the other approaches. The same profiles can be used for pricing the tariffs of different suppliers.

c. Sample of bills/actual usage. This method uses actual transaction data obtained from the suppliers of the good or service to customers, classified by consumption profiles.

d. Unit values. Where none of methods (a) to (c) is possible, and the components of the tariff are homogeneous, the average price change resulting from a tariff change may be calculated using overall revenue and quantity data, as supplied by the provider of the good or service. An example would be the mean cost of supplying one unit of electricity to all customers. This method should be used only if it is impossible to measure the price changes using one of the other methods.

Details of each method are given below.

a. Representative unit transactions in matched pairs of elements

In this method, changes in tariff prices are compared using weights applicable to the individual components of the tariff.

This method is consistent with the normal method of calculating price changes in the HICP. The price of each element of a tariff is monitored just as with a normal type of product offer. Ideally, weights should then be applied to each element to calculate an average tariff price change. Otherwise, the average can be calculated in the same way as for an elementary aggregate index, e.g., using the geometric mean (Jevons) formula. The tariff price itself may fall within an elementary aggregate if its total weight is low or unknown ([157]).

An example relating to a bus fare tariff is given in Table 7.4.19.

([157]) In fact, any index compilation method could be applied that is in line with Article 12 of Regulation 2020/1148 of the implementing regulation. This could also include methods that would use monthly weights if such monthly weights were available. An alternative would be to use weights from some past period. Otherwise, unweighted indices (e.g., Jevons) must be used to combine the prices of the representative unit transactions.

Table 7.4.19

Tariff calculation with matched pairs: bus fares

Tariff elements	Quantities	Prices: Fares (EUR)		Revenues (EUR)		
	No. of passengers	Period 1	Period 2	Period 1	Period 2	Change in revenues
Non-pensioners — peak time	2 000	0.40	0.50	800	1 000	1.250
Non-pensioners — off-peak time	3 000	0.30	0.25	900	750	0.833
Pensioners — peak time	100	0.20	0.50	20	50	2.500
Pensioners — off-peak time	1 000	0.15	0.13	150	130	0.867
Total	6 100			1 870	1 930	1.032

It is straightforward to calculate that the total expenditure (or revenue, from the point of view of the bus company) was EUR 1 870 before the tariff change and EUR 1 930 afterwards. The increase is thus 3.2 %.

It is worth noting that if no passenger numbers (i.e., weights) were available for each of the components, and it was decided to assume that they were equally weighted (i.e., 1 525 passengers in each component), the result using the Jevons (geometric mean) formula would have been 23 %, and with the Dutot formula 31 %. The fact that the true increase is only 3.2 % is attributable largely to the low weight (under 2 %) given to the component for pensioners travelling at peak time – while their increase was by far the largest of the four components. This example thus shows the importance of having weights for each tariff component. Normally these can be obtained only from the provider of the product, and because such information is often sensitive and confidential, a Member State may need to somehow persuade the provider to release the data — and to update it when the weights change significantly. It may, in fact, be necessary to invoke Article 5(3) of Regulation 2016/792.

It may not always be necessary to monitor the price of every single component of a tariff. Some are likely to be more important than others in terms of weight or the price developments could be similar Instead, representative components may be chosen, and the average tariff price change is calculated based on these components alone.

Note also that the above calculation assumes no change in the volume of passengers travelling in each fare component, although one would expect some change in response to the various fare changes.

This method may be appropriate to tariffs of types (a) and (b) in Section 7.4.4.2. In general, it should not be used in situations where there are major changes in tariff structures, or where the structures are often changed (i.e., during the year), for example mobile telephones (see Section 12.6).

b. Representative unit transactions defined by consumer profiles

In this method, a set of consumption patterns (or profiles) for consumers are defined as being representative of typical consumers of the tariff concerned. Consumer profiles should be derived from real data, which must be anonymised, or expert advice from the supplier or organisation which represents or regulates the industry.

The price to be collected is the price of the tariff which meets the minimum usage requirement of the specified consumer profile from a specified provider. Through time, the tariffs offered may change in terms of their components. However, as this method follows a fixed pattern of use rather than a fixed bundle of tariff components, it is not necessary to make any quality or quantity adjustments when new tariffs replace old ones. However, it is recommended that the selected consumer profiles are reviewed and updated annually to ensure that they remain representative of consumer behaviour.

It is generally necessary to develop several consumer profiles to cover consumers' typical usage patterns, which for some services such as telecommunications can vary substantially. These may be usage profiles, such as low-usage, medium-usage and high-usage consumers. Each of the consumer profiles priced should be weighted using expenditure weights also provided by the supplier or the regulator. Indices are calculated for each provider company, which are then weighted together using expenditure weights relevant to each supplier.

This method is appropriate to tariffs of all types (a) to (d) in Section 7.4.4.2, and it is particularly useful for types (c) and (d). An important advantage is that the method can reflect price trends correctly when tariff structures change, and elements are not comparable over time. However, it should not be used in cases where it is not possible to define typical consumers.

This method is greatly improved if migration rates are applied. Section 12.6 (telecommunications services) discusses both this approach and migration rates in more detail, providing numerical examples.

c. Sample of bills/actual usage

This method uses transaction data obtained from the suppliers of the good or service to customers classified by characteristics. In this method, the supplier agrees to provide the Member State with anonymised copies of actual bills reflecting the selected customer types. The method reflects actual customer behaviour by reference to real bills.

This method may be appropriate to tariffs of type (b) in Section 7.4.4.2. However, it should not be used in cases where, for any reason, it is not feasible to make sufficiently precise definitions of typical customers.

In practice, many Member States find it difficult to persuade suppliers to provide samples of bills, so this method should not normally be relied upon for dealing with tariffs.

d. Unit values

Where none of methods (a) to (c) is feasible, and the elements of the tariff can be finely stratified, thus resulting in a homogeneous product (see the definition of a homogeneous product), the average price change resulting from a tariff change may be calculated using overall revenue and quantity data supplied by the provider of the good or service.

The method has the advantage that there is no sampling within the tariff and no need to specify representative items or different customer types. However, it suffers from the usual disadvantages of using unit values in a CPI: they should not be calculated for sets of heterogeneous products. It also depends on the suppliers providing commercially sensitive data regularly and in good time. This method should therefore be used only in situations where none of the other methods is feasible and should in any case not be used where the elements of the tariff are heterogeneous.

A straightforward example of the calculation of unit value indices is shown in Table 7.4.20.

Table 7.4.20

Calculation of unit value indices

Quantities purchased			
Item	M1	M2	M3
A	150	150	140
B	46	48	56
C	75	75	87
Total	271	273	283
Revenues			
Item	M1	M2	M3
A	3 000	3 300	2 940
B	1 702	1 536	1 904
C	4 950	4 950	5 481
Total	9 652	9 786	10 325
Unit values			
	M1	M2	M3
Total	35.62	35.85	36.48
Unit value indices			
	M1	M2	M3
Total	n/a	1.006	1.0244

The top two sections of Table 7.4.20 (quantities purchased and revenues) contain the inputs (data relating to items (components) within a tariff). In the third section, the unit values are calculated as the revenues divided by the quantities, e.g., 35.62 = 9 652/271. The bottom section contains the Unit Value Indices. Thus, 1.006 = 35.85/35.62.

7.4.4.4 Classification issues

Most tariffs fall within an existing elementary aggregate — and hence a single ECOICOP 5-digit sub-class or 4-digit class — so there should usually be no problem with classification. For example, the electricity example given in Table 7.4.18 would fall entirely within ECOICOP 04.5.1. However, a single tariff can sometimes include components which fall into more than one elementary aggregate, or even more than one COICOP class or sub-class. In such cases, the tariff, together with all its components which are being priced, should be assigned to the ECOICOP class or sub-class which covers the greater part of the tariff expenditure, and within a single elementary aggregate of that class or sub-class. This corresponds to the recommended way of dealing with bundles (see Section 7.6).

An example is mobile phone tariffs, where a single tariff may include not only the various services associated with mobile phones, but also the handset itself. The handset, if separately purchased, would fall under ECOICOP 08.2.0.2, but if the handset is included in a tariff without an identifiable charge, the entire tariff would fall under ECOICOP 08.3.0.2.

In other cases, a decision must be taken on the class to which the tariff is to be assigned. In line with the HICP Recommendations on the treatment of bundles (see Section 7.6), both prices and expenditures should be allocated to the ECOICOP class that accounts for most expenditure.

7.4.4.5 Data sources for weights

In calculating a tariff's overall price change, one needs to consider not only the components' price changes, but also the appropriate weights (see Section 7.4.4.3 for an example). This is more complex than it may seem at first sight. Frequently, at the levels of disaggregation found within a tariff, no weights would be available at the component level. Such a tariff would be likely to fall within an elementary aggregate, where weights are normally unavailable. In most cases of tariff pricing, the only source of weights is the product supplier, such as an electricity provider. For some utilities, national regulators may also be able to supply weights data.

For some products, consumption expenditure on tariff components may possibly be derived from standard sources such as household budget surveys. However, the measurement of tariff component expenditures may be too demanding to include in the Household Budget Survey (HBS) questionnaires and diaries, which may already impose quite a heavy respondent burden. Rather, as noted above, it is often necessary to use data directly from the tariff suppliers; Regulation 2016/792 Article 5(3) imposes several obligations on suppliers.

For example, telephone operators typically have a detailed knowledge of the use of the services they provide, as they need this information when billing for their services. If data protection and confidentiality issues can be resolved, companies may be able to provide weighting data without imposing a significant response burden on their own internal accounting systems.

For public-sector services, the value and structure of tariff-based expenditures can often be derived from the relevant organisations' accounting systems. Authorities with regulatory functions, particularly for utilities, may be a useful source of information, as they also collect a large amount of information on price and volume to carry out their own functions. An example is a government agency responsible for issuing motor vehicle licences, the price of which may depend on factors including the age of the vehicle, its engine size and so on.

7.4.4.6 Quality adjustment

A tariff-based service may be supplied by a mobile phone network, and the geographic coverage of the network may be a relevant quality factor. The quality of the network, in terms of physical coverage, would ideally be consistent over the index period. In practice, changes in the coverage of networks do occur. Given the complex nature of such networks, it is usually not possible to quality adjust for such changes, and it should be accepted that this may result in some inaccuracy in the HICP. In some tariff-priced markets new tariff components are frequently introduced (e.g., multimedia messages or email on mobile phones). They should be introduced into pricing schemes or consumer profiles by resampling and chaining as they gain significant market share. At the very least, as part of the regular annual update of the HICP, the tariff structures or consumer profiles priced should be reviewed and resampled as required to make sure they remain representative. Such new components may pose special problems when they are available only as part of a more general package.

For general guidance on quality adjustment methods, see Chapter 6. As regards quality adjustment in tariff prices, when there are simultaneous changes in several parts of the tariff, as often happens — the matched pairs approach does not account for the joint effect of such changes. In practice, in the matched pairs approach with detailed definitions, the quality change situation always occurs in the form of a disappearing product offer, i.e., some pre-specified component of the tariff is no longer available for pricing. In principle, the treatment is the same as for other goods and services in the HICP. A replacement should be selected for the disappearing component: if the replacement is not comparable, it should be made essentially equivalent via quality adjustment. Quality adjustment of tariffs in the telecommunications sector is discussed in detail in Section 12.6.

7.4.4.7 New service providers and new products

In most product areas of the HICP, the outlet dimension is thought of as an element of the quality of the products, so it is kept fixed over the index period. In practice, emerging new outlets are chained into the index (normally with the updating of weights in December each year), thus assuring that they are differentiated from the existing outlets; only in rare cases is direct comparison or an explicit quality adjustment made. The underlying assumption may be that, in addition to the possible differences in the assortment, the location itself is a key quality factor.

When it comes to tariff-priced services the situation is somewhat different. Tariff-based services are often delivered on the spot (like mobile telephone services) or at the consumer's home (e.g., electricity, fixed-line telephone services). From the consumer’s point of view, many tariff-priced services are relatively uniform. Electricity delivered to the consumer is homogeneous almost by definition; if not, it would be unusable.

The same may hold true for other services, like telephone services or internet services, despite providers' attempts to differentiate their products and make their pricing structures more and more opaque. Suppliers of tariff-priced services should therefore be considered as providing the same type of service and treated as substitutes for each other where replacement suppliers are required. Changes in the market mix of a clearly homogeneous product with different tariff structures and suppliers should be incorporated in the index as part of the annual basket review process.

Index construction therefore requires the following:

- Information must be provided/obtained at frequent intervals about the market share of different providers and the various tariff/service plans.
- Significant new service providers should be included in the index during annual resampling.

7.4.4.8 Examples of changes in the specification of tariffs

a. Example of direct comparison: Changes in tariff components

Public transportation within a city where a tariff component changes from the city centre to suburb A, at 2 a.m. on a Saturday (night tariff, last connection).

Changed component: bus fare from city centre to suburb A, at 1.30 a.m. on a Saturday (night tariff, last connection).

The basis for direct comparison is the index compiler's judgement that from the consumer's point of view the change in timing is not a significant change. It could also be argued that the quality of the service has deteriorated, as the last connection is now earlier in the morning, and the index should reflect that. The decision to make a direct comparison is always a matter of judgement to some extent and should therefore be based on explicit reasoning.

b. The introduction of a new tariff component

Table 7.4.21 illustrates this case. A cinema tariff has two components: *adults* and *children*. A new category for *teenagers* is subsequently introduced. In this example, the old tariff structure had two categories (children and adults), while the new one has three (teenagers, which is found between children and adults). The previous categories must be transformed into the new ones. Using the best available information, the following results with regards to consumption shares are now defined. (See Table 7.4.21 below.) It is then possible to calculate the weighted average price of the ticket for both periods and compare the results to obtain the price relative for cinema tickets. The weights shown represent the percentage share to total expenditures for cinema tickets by type of customer.

Table 7.4.21

Cinema tickets, the introduction of a new tariff component

Old tariff	Weight (%)	Price (EUR)	New tariff	Weight (%)	Price (EUR)
Children 5–16	40.0	5	Children 5–12	20.0	5
			Teenagers 1–18	40.0	8
Adults 17+	60.0	10	Adults 19+	40.0	10

The result in this case translates into an overall price increase of 2.5 % for cinema tickets:

$$[(0.2 \times 5) + (0.4 \times 8) + (0.4 \times 10)] / [(0.4 \times 5) + (0.6 \times 10)] = 8.20 / 8.00$$

This is an example of the application of Article 5(3) of Regulation 2020/1148 (see Section 7.4.2, i.e., changes in the observed prices or conditions of a tariff shall be shown as price changes in the HICP). Here is a case for which the tariff discriminates according to the characteristics of purchasers. Changes in the specifications caused by the introduction of a new pricing structure when a new age group with corresponding price is introduced leads to a price change that should be recorded in the HICP.

7.5 Zero prices

7.5.1 Introduction

Sometimes, products that have previously been available for free can become chargeable. Conversely, products that once had a price may become subsequently free. The change from zero to non-zero prices and vice versa can occur at the level of the elementary aggregate, at an ECOICOP category level, or at a sub-elementary aggregate level depending on various factors such as for instance the sample size, the classification structure, and the nature of the product.

Examples of zero prices becoming positive prices in the case of services include introduction of toll facilities of electric cars in Norway. Other examples are:

- introducing fees for certain health services,
- university tuition fees,
- parking charges.

Examples involving goods are:

- school textbooks,
- medicines,
- medical equipment,
- hospital meals,
- domestic water supply.

Examples of prices falling to zero include the abolition of television licences and the abolition of university tuition fees in Germany. Inevitably, most examples of such changes involve products provided by the public sector.

The precise algebraic treatment depends on whether the price moves from zero to positive or from positive to zero, and on whether the product is:

a. at the level of the elementary aggregate,

b. at an ECOICOP category level, or

c. at a sub-elementary aggregate level.

These three cases are dealt with in turn.

a. b. Products at the level of the elementary aggregate or at an ECOICOP category level

The problem for the HICP compiler when prices move from zero to a positive price is twofold ([158]):

1. The weight, price-updated to the price reference period, is zero.
2. There is no price reference period price with which to compare the new price to create a price relative.

For a Laspeyres-type index such as the HICP, this raises a conceptual problem; if both the weight and the price of a certain product were zero, it could be argued that it should not be included in the price reference period. And, indeed, if it remained zero through the year up until the next chain-linking period, it would rightly be ignored. But if, during that period, the zero price becomes a positive price, then such an increase should be considered in a measure of inflation and be reflected in the index.

From another angle, it could be argued that the product is in principle included in the index since positive quantities were being consumed but that its price is zero.

It is noteworthy that there is a difference between the appearance on the market of a price for a product previously provided free and the appearance on the market of a newly significant product. In former, the product itself has always been available and consumed. In the latter, the product itself is new (or has become newly significant).

The change from a positive to a zero price does not generally involve the same difficulties as the reverse process.

c. Products at a sub-elementary aggregate level

One of the difficulties in dealing with a newly chargeable product and a product whose price has fallen to zero is that the Jevons formula cannot handle a zero price. This is because the Jevons index involves the geometrically weighting of the sample of prices at this level: if one of those price observations is zero, the geometric mean is zero ([159]). This problem is avoided with the use of the Dutot price index formula.

([158]) Practical Guide to Producing Consumer Price Indices; paragraph 8.35.

([159]) A discussion of zero prices and the Jevons index and also the impact on this index of extreme movements in prices can be found in para. 8.26 of the CPI Manual, ‘Concepts and Methods’ (2020).

7.5.2 Legal framework

Implementing Regulation 2020/1148 on concerning harmonised indices of consumer prices, Article 5 (7) states:

> *'If an individual product has been made available to consumers free of charge and a price is charged subsequently, this shall be shown as a price increase in the HICP. Conversely, if a price has been charged for an individual product that is subsequently made available to consumers free of charge, this shall be shown as a price decrease in the HICP.'*

This basic rule covers the essential reasons for dealing with the situation when a previously free product becomes chargeable, or vice versa. Article 8 of Regulation 2020/1148 on the Observation of prices states:

> *'1. An observed price for a good shall be included in the HICP for the month in which transactions can take place at that price.'*
>
> *'2. An observed price for a service shall be included in the HICP for the month in which consumption of the service can commence.'*

Therefore, for this regulation to be respected, any observed (positive price) must be included in the HICP — implying that changes from zero price to a positive one (and vice versa) must also be covered.

Furthermore, the CPI Manual (2020) recommends introducing new products because any delays may bias the index (paragraph 7.29). Note that a product that goes from a zero price to a positive price manifests a similar behaviour to a new product.

7.5.3 Typology of cases

Table 7.5.22 below gives the typology of cases discussed in this section.

Table 7.5.22

Typology of cases

Case	Price moves from zero to positive	Price moves from positive to zero
Level of the elementary aggregate	The exact solution comes from the fixed basket interpretation of the Laspeyres index. For the implementation, an estimate of the quantity is needed.	Since the zero sub-index multiplied by the positive weight gives a well-defined zero contribution, the price change is considered in the HICP.
ECOICOP category level	The exact solution comes from the fixed basket interpretation of the Laspeyres index. For the implementation, an estimate of the quantity is needed. Plus, an additional convention: only the weight of the higher-level ECOICOP category is	Since the zero sub-index multiplied by the positive weight gives a well-defined zero contribution, the price change is considered in the HICP.

Case	Price moves from zero to positive	Price moves from positive to zero
	redistributed, while the rest of the weights matrix remains unchanged. The implied sub-indices are then derived backwards. However, publication and dissemination remain open issues. Member States should therefore contact Eurostat in this case.	
Sub-elementary aggregate level ([160])	If the Jevons index is used, the solution is to find or estimate the quantity, i.e. the problem is treated in the same manner as at the level of the elementary aggregate.	If the Jevons index is used, the solution is to find or estimate the weight, i.e. the problem is treated in the same manner as at the level of the elementary aggregate.

7.5.4 Methods for treating products previously provided free

The analytic solution is to use the standard Laspeyres index formula, but to replace expenditure weights by quantities and, and use price *levels* rather than price *relatives*.

The precise formulation may need to be adapted slightly, depending on the classification level of the new product concerned (see (a) to (c) in Section 7.5.1). These three cases are dealt with in turn below ([161]).

a. Products at the level of the elementary aggregate

The product subject to the new charge can be treated as if it were already included with a zero price but with non-zero quantity corresponding to its estimated consumption in the price reference period.

The *Practical Guide to Producing Consumer Price Indices* ([162]) (paragraph 8.36) gives the solution as follows, where the Nth price was zero in the price reference period:

$(p_N^{0t} = w_N^{0t,t-1} = 0)$: ([163])

$$P_L^{0t,mt} = \frac{\sum_{i=1}^{N} p_i^{mt} \cdot q_i^{t-1}}{\sum_{i=1}^{N} p_i^{0t} \cdot q_i^{t-1}} = \sum_{i=1}^{N-1} \frac{p_i^{mt}}{p_i^{0t}} \cdot w_i^{0t,t-1} + \frac{p_N^{mt} \cdot q_N^{t-1}}{\sum_{i=1}^{N-1} p_i^{0t} \cdot q_i^{t-1}}. \quad (7.5.1)$$

([160]) Special care should be taken to check whether the results are meaningful. The introduction of quantities and weights, respectively, can yield indices that do not properly reflect the observed price change. A simple test would be to check whether the numbers derived are higher if prices move from zero to positive (or lower if prices move from positive to zero) than would be the case if, counterfactually, no price change had been assumed. Neither the retrospective introduction of quantities/weights, i.e., revision of the series, nor chain-linking are recommended.

([161]) Chapter 7 of the CPI Manual (2020) deals with the issue of maintaining the sample and covers the mechanics of introducing new products into the index between basket updates. In some cases, such an exercise can be compared to a situation where the price of a product goes from zero to positive.

([162]) Practical Guide to Producing Consumer Price Indices.pdf – 2009 (unece.org).

([163]) This formulation is adapted from the exposition in the Practical Guide.

Given that q_N^{t-1} is generally not known, the expression $p_N^{mt} \cdot q_N^{t-1}$ can be replaced, if there are no marked changes in quantities due to the new charge, by the estimated total expenditure on the product now subject to the new charge in period mt:

$$p_N^{mt} \cdot q_N^{t-1} = \frac{p_N^{mt} \cdot q_N^{mt}}{q_N^{mt}/q_N^{t-1}} \approx p_N^{mt} \cdot q_N^{mt} \Leftrightarrow q_N^{t-1} \approx q_N^{mt}. \tag{7.5.2}$$

The method is simple in principle, though there may be some difficulties in estimating the appropriate data and validating the assumption of unchanged quantities.

Example of a product moving from zero to a positive price: entering Antwerp with a car (elementary aggregate index level)

Since February 1, 2017, the entire city centre of Antwerp and part of Linkeroever in Belgium now have a low emission zone. Only those cars that fulfil the conditions for admission may continue to enter the city freely. Some vehicles are prohibited while others may enter only after purchasing a permit. The price for a permit depends on the vehicle's size. The regular tariff for a passenger car is EUR 350 per year.

According to the figures, about 8 000 owners of a passenger car would have to pay for this permit. The experience in Rotterdam, a nearby city in the Netherlands, where a similar measure had been introduced in 2016, showed that 2 % of the cars were too old and polluting and that this number dropped to 0.1 % after the introduction of the tariff. Considering that people change their behaviour in a similar way, and applying the same magnitude for the reduction, this means there still 400 cars left ([164]). Assuming that the owners pay the annual fee of EUR 350 this gives a total expenditure of EUR 140 000.

That amount has been added to ECOICOP 07.2.4.2, toll facilities. The December expenditure of this sub-class has been EUR 113 400 000. Since the new rule was not enforced in February, it was only introduced in the HICP in March. The effect at the ECOICOP category level is:

$$\frac{140\ 000}{113\ 400\ 000} \cdot 100 = 0.12.$$

According to the EUROSTAT database table, the published index level was 103.00 in December 2016 and has been 103.12 in March 2017.

b. Products at the ECOICOP category level

Treatment at this level is essentially the same as that at the elementary aggregate level. This rationale is applied to the higher-level ECOICOP index so that at this level there are now only positive sub-indices and weights, which should thus remain unchanged. In a first step, based on this solution, only the weight of the higher-level ECOICOP category is redistributed, reflecting the price-updated observed expenditures and estimated hybrid expenditures; the rest of the weights matrix remains unchanged. Then, the implied sub-indices are derived backwards. However,

([164]) If 2 % of all cars translates into 8 000 cars, then 0.1 % of cars translates into 400 cars. It should be noted that Belgium not only used evidence from the Netherlands in their assessment of the effect but particularly that only those cars (400) are included that are expected to be paid for after the introduction, although analytically the quantity from before the introduction (8 000) should be incorporated. That practice, however, would have led to a considerable overestimation of the actual effect (20-fold) of moving to a positive price.

publication and dissemination of these ECOICOP indices remain open issues, and Member States should first consult Eurostat (see Chapter 10 — methodological changes and revisions).

c. *Products at a sub-elementary aggregate level*

Explicit weighting at this level (typically this is at the product offer level) is generally not available. In cases where the Dutot index is used, when the price of a single product goes from zero to positive, the computation of the index is tractable ([165]).

$$P_{0,1}^{Du} = \frac{\Sigma_{i=1}^{N} P_{i1}}{\Sigma_{i=1}^{N} P_{i0}}$$

Where the usual interpretations of the notations apply.

The Jevons index formula is:

$$P_{0,1}^{Je} = \sqrt[n]{\frac{\Pi_{i=1}^{N} P_{i1}}{\Pi_{i=1}^{N} P_{i0}}}$$

When one of the prices becomes positive in period 1 after being offered for free in period 0 then the EA index needs to suddenly include in its computation this new price change between both periods.

One possibility for remedying this problem is to exceptionally use a weight of w for the corresponding product offer within the elementary aggregate (EA).

$$\text{Index}_{EA} = ((1-w) \times \text{Je}(N-1)) + (w \times 0) = (1-w) \times \text{Je}(N-1)$$

Where the JE(N – 1) is the Jevons index for the price observations that are non-zero for both comparisons periods.

If no weighting data is available, then an equally weighted sample of price observations could be used within the EA: w = 1/N.

To impute a price at period 0 to be included in the calculation of the EA, an estimated price can be obtained from the following formula:

$$\hat{P}_{N0} = \frac{1}{(1-w)^N \times \text{JE}(N-1)} \times P_{N1}$$

7.5.5 Prices falling to zero

The expression zero prices may not always refer to prices being charged for a product which was previously free of charge. The process can also work in the opposite direction; a product which used to have a positive price can subsequently be provided to households free of charge. Section 7.5.1 provides some examples. However, a change from a positive to a zero price does not involve the same difficulties as the reverse process. Using the same categorisation as before, the calculations would be as follows.

([165]) This inspiration for this sub-section is drawn from a room document from the 15th annual Ottawa Group Meetings: Zero prices in the CPI by Jan Walschots (2017).

a. Products at the level of the elementary aggregate

An elementary aggregate would have a positive weight but a zero price relative, and the price change would thus be reflected in the overall index.

b. Products at the ECOICOP category level

In this situation, the ECOICOP category would again have a positive weight and the price change would thus be reflected in the overall index.

c. Products at a sub-elementary aggregate level

Since weights at this level are generally unknown, the treatment of this case — assuming a Jevons index is used — is very much the same as that of the case when a price goes from zero to positive. In other words, the solution is to estimate a weight, thus the problem is treated in the same manner as at the level of the elementary aggregate.

More precisely, when one of the prices goes to zero in period 1 after being positive in period 0, then the Jevons index becomes zero. Note that replacing the zero price with a very low price, either to simulate a zero price or for legitimate reasons, will generate an odd result.

Turning to formula for the elementary aggregate index presented above and using a weight of w for the corresponding product offer within the elementary aggregate (EA) we get:

$$\text{Index}_{EA} = ((1-w) \times \text{Je}(N-1)) + (w \times 0) = (1-w) \times \text{Je}(N-1)$$

As above, if no weighting data was previously available, then an equally weighted sample of price observations could be used within the EA: $w = 1/N$.

Then to obtain an estimated price (or index) for an individual product offer at period 1 we inverse the formula used for computing the estimated price for period 0.

$$\hat{P}_{N1} = (1-w)^N \times \text{JE}(N-1) \times P_{N0}$$

7.6 Bundles

7.6.1 Introduction

A form of marketing which shares some similarities with tariffs (see Section 7.4) is known as *bundling*. The formal definition is given below (Section 7.6.3). In brief, a bundle is a product offer comprising different components (goods and/or services). The components are not sold separately in this product offer, although they may sometimes be available separately as a set of individual product offers.

The essential problem with bundles is how to define the *product*. There are several components in a typical bundle which could also be sold separately, and each component could have its own price index. Such components may already exist within an HICP. But the consumer (and the Member State itself) may have no means of identifying the prices and quantities within a bundle. Moreover, the consumer may not be interested in the individual components on their own; the attraction of a bundle may lie in the bundle itself and the complementary nature of the components, not in the individual components themselves.

A typical example is a package holiday, which comprises travel and accommodation, and may also include meals, guided tours, and entertainment, sold at an all-inclusive price, which can often be less than the total price if the components were purchased separately. A key difference between a tariff and a bundle is that a tariff is a set of sales conditions for a single product, such as a bus fare or entry to a museum, while a bundle is a set of related objects sold together. Separate prices for the components may or may not exist. For example, the components bundled together in a package holiday cannot normally be specified and priced separately.

Another example of a bundle is a mobile phone package, which may include the handset, calls, SMS and internet data usage allowances. Services may also be bundled with goods, such as with repair warranties for vehicles or heating systems.

The way bundles are dealt with in the HICP is essentially determined by practical considerations and is necessarily arbitrary to some extent. For certain types of economic analysis, it is useful to be able to treat the different components separately, and to assign them to their appropriate ECOICOP headings, even if they are only estimates. For the analysis of consumer behaviour, however, it is also necessary to treat expenditure on bundles as if they were indeed combined product-offers. A consumer does not necessarily need to be able to disentangle the price components of a package holiday to determine which holiday offers the best value.

7.6.2 Legal framework and HICP Recommendations

Although the problem of dealing with bundles has been discussed in various fora over the years and is, for instance, included in the CPI Manual (e.g., paragraph 11.273 and 6.137) there are currently no legal acts requiring Member States to treat bundles in any way. However, there are HICP Guidelines issued by Eurostat on the subject ‘Treatment of bundles/packages in COICOP/HICP — Guidelines note (June 2010) ([166]). This section of Chapter 7 is based on Section 3 (HICP Guidance) of these Guidelines, the relevant parts contain the following information:

- Bundles should be classified by the purpose for which the main component is intended to be used by the consumer.
- Where the package price is itemised and can readily be divided among the constituent components, the bundle may be split on the condition that component weights can be estimated.
- Where the price is not itemised, but the expenditure can be split within the bundle so that component weights can be calculated for each component, the change in the bundle price may then be applied to each component weight for the compilation of the HICP, irrespective of the group or division to which each component is assigned.

In practice, this means:

- Bundles should be classified by the purpose for which the main component is intended to be used by the consumer. In cases where it is not possible to estimate the component weights, the entire bundle should be assigned to the main component category. This would usually be identified as the probable main intended use of the product.

([166]) Compendium of HICP reference documents, 2013 (Eurostat) pp. 118-119.

- Where the price of the bundle can be divided into its individual components, the bundle may be split into separate ECOICOP categories, if component weights can be estimated. This is generally the most appropriate way to deal with bundles. However, it depends on the prices of the individual components being itemised, which is often not the case.
- Where the component prices are not itemised, but the expenditure can be split into component weights, the change in the bundle price may be applied to each component weight within the relevant ECOICOP sub-classes.

In Section 7.6.5, several common bundles are listed along with advice on how to treat them, based on the above information, and with the guidance given in ECOICOP regarding classification of expenditures.

7.6.3 Definitions

Bundling: a method of marketing that involves offering two or more goods and/or services that serve two or more different purposes as if they were a single product. Bundling usually enables consumers to spend less than they would have to if they purchased the component goods and/or services individually.

Pure bundling: offering a group of products which are available only as a bundle and are not sold separately, such as hospital in-patient services and mobile phone call plans.

Mixed bundle: a group of products which are sold both as bundles and as individual units, such as combined software packages and cable TV services.

Package: the same as *bundle*.

Tariff: see Section 7.4.3.

7.6.4 Examples of pure and mixed bundles

Bundling has become an important way of marketing both goods and services. The following list gives a range of examples, showing which of the three categories they are likely to fall into: pure, mixed or with their own ECOICOP category. As noted above, national charging practices do vary, so what might be classified as a pure bundle in one country may be a mixed bundle in another. The examples are thus only indicative.

Likely to be 'pure' (available only as a bundle)

Streaming of audiobooks and e-books – both services are accessible through the same single app.

Package holidays — include travel, board, lodging and maybe more.

Mobile phone subscriptions — packages with varying levels of usage of calls, SMS, data downloads, etc. (N.B. In some countries, the handset may also be included).

Domestic gas/oil boiler maintenance — includes parts, maintenance, and safety checks.

Set-price menus — special two or three-course restaurant meals at a set price.

TV channels — a typical TV subscription includes a choice of channel packages, e.g., including or excluding sports channels or films.

Bundled retail services – services such as Amazon Prime now include, in addition to free deliver, steaming services for movies and music, for example.

Likely to be 'mixed' (available both as a bundle or in separate units)

Rents — some rents cover not only the cost of housing, but also services such as water supply, sewerage and other utilities, which are not necessarily priced separately on the tenant's bills, though they are necessarily included as part of the rental package.

Insurance — combinations of such services as, car insurance and home insurance or health and travel insurance may be offered as a package at a cheaper price than separate purchases.

Ready meal deals — e.g., a meal for two persons for EUR15 provided by supermarkets in one or more boxes, sometimes including two or three courses and a bottle of wine, sold at a discount compared with separate purchases.

TV/broadband/phone — various options offered by telecoms companies. These *triple pay* services are often sold as a set of bundled options for a single monthly fee. In many cases, these bundles can be tailored to individual consumers' preferences (e.g., including sports or on-demand movie services). In many cases, the cost of each option within the bundle is advertised. Alternatively, if these services are sold as *a pure* bundle, then the expenditure and prices can be assigned to Bundled Telecommunications Services (ECOICOP 08.3.0.4).

Mobile phone handset combined with service subscription — if a separate charge is made for the handset, this is an example of a mixed bundle. If the handset is not separately itemised, this is an example of a pure bundle (see above.)

Dual fuel — energy providers offer a combined tariff for electricity and gas, accompanied by a dual fuel discount.

Software — it is possible to purchase various Microsoft applications such as Word and Excel separately, or to buy a combined set as Office, at a discount.

Special ECOICOP categories for bundles ([167])

Maintenance charges in multi-occupied dwellings — (ECOICOP 04.4.4.1), co-proprietor services charges for cleaning, lighting and heating and management of communal areas etc.

In-patient hospital stays — (ECOICOP 06.3.0.0 hospital services) which may include medical services, accommodation, catering etc.

Combined passenger transport — (ECOICOP 07.3.5.0); this may, for example, cover tickets for combined rail and bus or ferry journeys.

Bundled telecommunications services — (ECOICOP 08.3.0.4 telephone/internet/TV packages) should be classified here if they are sold as a pure bundle.

Package holidays — (ECOICOP 09.6).

([167]) This list is not necessarily comprehensive.

7.6.5 Methods for treating bundles in the HICP

The treatment of bundled products is an important matter of concern for the HICP. Although, as previously mentioned, there are no Acts to guide the treatment of bundles in the index by Member Countries, at least some comparability can be achieved by ensuing that these products can at least be properly classified. With the previous ECOICOP the classification of bundles could be problematic because of certain ambiguities on where best to classify certain bundled products. Countries were therefore often left to decide where best certain bundled products should be classified. Of course, this is not always optimal when constructing a harmonized price index such as the HICP.

Bundled products are generally required, if feasible in practice, to be separated and assigned to a particular ECOICOP subclasses or classes within the same or different ECOICOP groups or divisions. However, while ECOICOP shows awareness of the problem of bundling (see below), it does not normally provide clear guidance on the classification of bundled products. Exceptions, where there are ECOICOP categories that include bundled products, include for example: package holidays (ECOICOP 09.6), Mobile communication services, a category that encompasses, among other features, local calls, MMS messaging, voice mail, and data plans. (ECOICOP, 08.3.0.4), and Bundled telecommunication services which includes telephony/Internet/TV packages and any combination of telecommunication packages (ECOICOP, 08.3.0.4).

If Member States decided to classify similar bundles differently the comparability of the HICP would be compromised.

However, it should be recognised that marketing practices will often vary across Member States, and it is therefore impractical for all of them to follow the same pricing procedures in all cases.

The introduction to the original COICOP ([168]) (paragraphs 46–48) provides the following guidance regarding the treatment of bundled goods and services:

> *Single expenditure outlays (i.e., where there is no itemized price information for the individual goods or services) may sometimes comprise a bundle of goods and services that serve two or more different purposes. For example, the purchase of:*
>
> - *telecommunications bundles including a combination of home telephone, mobile phone, Internet and television services as well as mobile phone(s) (good);*
> - *all-inclusive package tours including payment for transport, accommodation and catering services;*
> - *education services that include payments for health care, transport, accommodation, board, educational materials, etc.;*
> - *in-patient hospital services that include payments for medical treatment, accommodation, and catering; and*
> - *transport services that include meals and accommodation in the ticket price (e.g. passenger air transport).*

([168]) Statistical Papers, Series M No 84, Department of Economic and Social Affairs, Statistics Division, United Nations, New York, 2000.

> *Single outlays covering two or more purposes and not separately invoiced are dealt with on a case-by-case basis with the objective of obtaining a purpose break-down that is as precise as possible and consistent with practical considerations of data availability. Hence, there is no attempt to isolate expenditure values related to separate purposes for telecommunication bundles, package tours, in-patient hospital services or transport services with accommodation and catering included in the single price. In all these cases, the outlay should be categorized with the predominant good or service.*
>
> *Health care, transport, accommodation, board and educational materials linked with education, on the other hand, should be allocated as far as possible to Health (06), Transport (07), Recreation, sport and culture (09), and Restaurants and accommodation services (11).*

An often-overlooked aspect of bundle pricing is the question of quality change. Generally, quality adjustment for services is an area which, given the conceptual and practical difficulties involved with bundles, is still not well developed. However, in principle, quality adjustment methods, such as hedonics and option pricing, may be applied to partition the bundle price or deal with changes in the characteristics or contents of a bundle (see Chapter 6).

7.6.6 Changes in bundle composition

From time to time the composition of a bundle can change. For example, within internet and TV subscriptions (an example of a mixed bundle), a specialty channel that was once charged separately, such as movies, may now be included as part of a package. Mobile telephone call plans, with a set number of minutes or text messages, are an example of a pure bundle.

As with any other product in the HICP, when comparing prices, the aim is always to compare over time like-with-like. Where a replacement product offer differs from the replaced product offer, an appropriate quality adjustment should be made. Take the example of the addition of a movie channel to an internet and TV subscription bundle. If the cost of the movie channel as a separate service is known, it can be straightforward to make an appropriate quality adjustment to the price of the bundle (Chapter 6 covers various methods for quality adjustment and product replacement). In a second example where there is a change in the call or text message allowances within a pure bundle, adjusting for quality can be more of a challenge, as the individual features are not often sold separately. Depending on the method used to price these types of bundles (tariff), a quality adjustment may or may not be required. Refer to Section 7.4 and Section 12.6 for a discussion on the quality adjustment of telecommunication services.

8

Index calculation

8 Index calculation

8.1 Introduction

While the HICP measurement rules prescribe that the HICPs be *chain-linked Laspeyres-type indices*, the implementing EU Regulation (EU) 2020/1148 does not prescribe specific price index methods to be used at the elementary aggregate level but requires that these formulae should guarantee certain properties. Therefore, the HICP calculation usually proceeds in two stages. First, price indices are computed for each elementary aggregate (i.e. the elementary price index) within the classification structure. At this stage, there are several options regarding the index formulae. In the second stage, these elementary price indices are aggregated into a number of higher level indices up to and including the all-items HICP using a Laspeyres-type index formula.

This chapter illustrates various index calculation methods ([169]) that are in accordance with the HICP legal framework. Generic mathematical formulae are given to express the principles and provide an unambiguous basis for their implementation in computer programming.

The chapter starts with the higher level indices, defining the HICP as a *Laspeyres-type index* (Section 8.2). Statistically, the structure of household expenditures resembles an inverse tree, descending from the total to increasingly detailed aggregates. As defined by the Commission Implementing Regulation (EU) 2020/1148 of 31 July 2020, Article 2 (13) ([170]): 'elementary aggregate' means the smallest aggregate used in a Laspeyres-type index.

NSIs may define elementary aggregates in different ways depending on the product type, the

([169]) For discussions of alternatives and the reasons for the choices made, see ILO, IMF, OECD, UNECE, Eurostat, and The World Bank (2020), *Consumer Price Index Manual: Theory and Practice*, International Labour Office; v.d. Lippe, P.M. (2001), *Chain Indices: A Study in Price Index Theory*, Metzler-Poeschel; v.d. Lippe, P.M. (2007), *Index Theory and Price Statistics*, Lang; Balk, B.M. (2008), *Price and Quantity Index Numbers: Models for Measuring Aggregate Change and Difference*, Cambridge University Press.

([170]) Implementing regulation - 2020/1148 - EN - EUR-Lex (europa.eu).

sampling approach used and the resources available (see Chapter 3 for a discussion of the classification structure of the HICP).

Since price collection within elementary aggregates is becoming increasingly multimodal with prices being webscraped from the internet, fieldcollected and obtained from transaction data, the NSI can use any index formulae that ensure 'time reversibility' and 'transitivity' properties as enforced by Article 12(1) of the Commission Implementing Regulation (EU) 2020/1148.

Section 8.3 focuses on the computation of elementary price indices starting from traditional unweighted bilateral index methods used when only price information is available for the products, as in the case of field collected data or web-scraped data, or when weights derived from transaction data are not considered in the production process. Indeed, traditional methods for gathering price data, involving collectors visiting individual outlets to collect prices for goods and services, continue to be used in several Member States, in many cases with the help of local statistical offices across the country. In addition, NSI may use transaction data only to replace field-collected prices without changing the method for computing elementary price indices.

Section 8.3.2 illustrates multilateral methods which have been implemented in HICP/CPI production in many European countries to deal with the rich set of information contained in transaction data. Multilateral methods have also increasingly been used to compute elementary price indices for internet data in order to capture the large amount of data and the high frequency of data collection characterizing this source.

Section 8.4 explains chaining, i.e. constructing longer time series from short-term indices. Chaining has the advantage of allowing the weights, the sample of products and sample of outlets to be updated at each link, i.e. every year, thus ensuring that the HICP is as representative of consumers' current expenditure and consumption patterns as possible.

Section 8.5 covers the calculation of monthly and annual rates of change.

Annex 8.1 contains some countries' examples illustrating the calculation of elementary price indices. Annex 8.2 provides a numerical example illustrating the index theory covered in this chapter.

8.2 Higher-level indices

8.2.1 Legal obligations

Article 3(2) of Regulation (EU) 2016/792 laying down a common framework for the production of the harmonised index of consumer prices (HICP) and the Implementing Regulation EU 2020/1148 provides that the harmonised indices shall be annually chain-linked Laspeyres-type indices.

The latter term is defined in Article 2(14) of Regulation (EU) 2016/792 as follows:

> *'Laspeyres-type index' means the price index that measures the average change in prices from the price reference period to a comparison period using expenditure shares from a period prior to the price reference period, and where the expenditure shares are adjusted to reflect the prices of the price reference period.*

A 'Laspeyres-type index' is defined as:

$$P^{0,t} = \sum \frac{p^t}{p^0} \cdot w^{0,b}.$$

The price of a product is denoted by p, the price reference period is denoted by 0, and the comparison period is denoted by t. The weights ww are expenditure shares of a period b prior to the price reference period, and are adjusted to reflect the prices of the price reference period 0.

The price reference period 0 means the period to which the price of the comparison period is compared; for monthly indices, the price reference period is December of the previous year according to Article 2(16) of Regulation (EU) 2016/792.

8.2.2 The HICP concept

The HICP is designed as a chained Laspeyres-type index ([171]), where weights are updated at the beginning of each calendar year and kept constant throughout.

Consider a set of N products with prices p_i^t and quantities q_i^t $(i = 1, \dots, N)$ for any time period t $(t = 1, \dots, T)$. The *short-term* Laspeyres index *with annual weights* ([172]) for month $m = 1, \dots, 12$ of current year t, mt being the comparison period, relative to December of the preceding year $t-1$, which is the price reference period, denoted as month 0 of year *t*, is given by ([173])

$$P_L^{0t,mt} = \frac{\sum_{i=1}^N p_i^{mt} \cdot q_i^{t-1}}{\sum_{i=1}^N p_i^{0t} \cdot q_i^{t-1}} = \sum_{i=1}^N \frac{p_i^{mt}}{p_i^{0t}} \cdot \frac{p_i^{0t} \cdot q_i^{t-1}}{\sum_{j=1}^N p_j^{0t} \cdot q_j^{t-1}}, \tag{8.1}$$

where year $t-1$ is the weight reference period ([174]).

It is important to note that in the construction of the HICP, the month of December plays a dual role: it is sometimes used as a comparison period, but is always the price reference period. To distinguish clearly between these two roles and to avoid complications, we use the notation in equation (8.1). Thus, December in year t (occurring in the numerator of equation (8.1)) is labelled as $m = 12$, whereas December of year $t-1$ (occurring in the denominator of equation (8.1)) is labelled as month $m = 0$ in year t. In other words, each year t is considered as consisting of 13 months, running from December of year $t-1$ $(0t)$ to December of year t $(12t)$.

Since the HICP is a chained Laspeyres-type index, the weights used in the index compilation are updated every year to have the most representative expenditures patterns and obtain the most accurate aggregate indices.

([171]) In literature, the HICP is often referred to as a Lowe index since weight and price reference periods are not the same (Lowe, 1823).

([172]) *Short-term* here denotes the index relative to the price reference period rather than a month-on-month index. The exposition in equation (8.1) deviates from the standard textbook definition of the Laspeyres (price) index because of the use of annual weights for a monthly index.

([173]) For reasons of presentation, the index numbers are usually multiplied by 100.

([174]) In Regulation (EU) 2016/792, the price reference period $0t$ is labelled '0', the comparison period mt is labelled '*t*' and the weight reference period $t-1$ is labelled '*b*'.

This is further elaborated in Regulation (EU) 2016/792, specifying the frequency and the deadline for submitting HICP weights:

Article 6(4):

Each year, Member States shall provide the Commission (Eurostat) with updated sub-index weights for the harmonised indices.

Article 7(2):

Member States shall provide the Commission (Eurostat) with the updated weights by no later than 13 February each year for the monthly indices; …

The procedure and key requirements concerning the practical compilation of the weights have changed from 1 January 2023, according to the Implementing Regulation (EU) 2020/1148*:*

Article 3

1. Member States shall derive the sub-index and elementary aggregate weights used in the index for year t as follows:

(a) Until 31 December 2022, national accounts data for year t–2 and any available and relevant information from household budget surveys and other data sources shall be used to obtain subclass expenditure shares and divide them among the elementary aggregates of the subclass. From 1 January 2023, national accounts data for year t–2, which can be complemented with data from a recent household budget survey and other sources, shall be used to obtain subclass expenditure shares and divide them among the elementary aggregates of the subclass;

(b) The expenditure shares for year t–2 shall be reviewed and updated to make them representative of year t–1;

(c) The expenditure shares for the elementary aggregates shall be adjusted with an appropriate price change between year t–1 and December of year t–1.

This implies that NSIs should estimate new sub-index weights using the latest available data from the national accounts (normally estimates relating to the calendar year *t*–2) and should price update the weights. If detailed expenditure information from national accounts is not available, then other data sources, such as the household budget survey and administrative data, can be used to subdivide the higher-level ECOICOP expenditures derived from the national accounts to estimate 4-digit class and 5-digit sub-class weights.

The price-updated weights, denoted by $w_i^{0t,t-1}$, are used to calculate the Laspeyres-type index as a weighted arithmetic mean of price relatives of products:

$$P^{0t,mt} = \sum_{i=1}^{N} \frac{p_i^{mt}}{p_i^{0t}} \cdot w_i^{0t,t-1}, \qquad (8.2)$$

8.2.3 Deriving the weights

The weights $w_i^{0t,t-1}$ may or may not correspond to observable expenditure shares, as they can have been obtained from household expenditure data in annual national accounts of the year $t-\ 2$.

They can be derived from the observed ([175]) annual expenditures values of year $t-2$ as follows:

$$v_i^{t-2} = \frac{(p_i^{t-2} \cdot q_i^{t-2})}{\sum_{j=1}^{N} (p_j^{t-2} \cdot q_j^{t-2})} \tag{8.3}$$

When using data of annual national accounts from year $t-2$, the weights of year $t-1$ can be derived in two ways.

Option 1 simply uses v_i^{t-2} as the best approximation for the true, but unknown weight w_i^{t-1}:

$$w_i^{t-1} := v_i^{t-2} = \frac{(p_i^{t-2} \cdot q_i^{t-2})}{\sum_{j=1}^{N} (p_j^{t-2} \cdot q_j^{t-2})} \tag{8.3a}$$

In option 2, the expenditure shares are price-updated ([176]) by the price change between year $t-2$ and year $t-1$:

$$w_i^{t-1} := \frac{v_i^{t-2} \cdot \frac{p_i^{t-1}}{p_i^{t-2}}}{\sum_{j=1}^{N} v_j^{t-2} \cdot \frac{p_j^{t-1}}{p_j^{t-2}}} = \frac{(p_i^{t-1} \cdot q_i^{t-2})}{\sum_{j=1}^{N} (p_j^{t-1} \cdot q_j^{t-2})}. \tag{8.3b}$$

If goods and services are substitutes at such a rate that expenditure on one product relative to another is independent of the relative prices (Cobb-Douglas preferences), Option 1 is the preferred approach. If goods and services are perfect complements, i.e. there is no substitutability between them and they are consumed in fixed proportions (Leontief preferences), the best approximation is the price-updated weight of option 2. Of course, the degree of substitutability may vary across products and the choice of either of the two options is not necessarily straightforward ([177]).

With the outbreak of the COVID-19 pandemic, consumption patterns changed markedly. To ensure representativity in these extraordinary times, HICP weights were estimated for the first time from preliminary (quarterly) national accounts expenditures of the year $t-1$ (Eurostat, 2020 ([178])), $\hat{v}_i^{t-1}$.As these expenditures are expressed in the prices of $t-1$, no further adjustment is needed to receive the weights w_i^{t-1}, i.e.

$$w_i^{t-1} := \hat{v}_i^{t-1} = \frac{(p_i^{t-1} \cdot \hat{q}_i^{t-1})}{\sum_{j=1}^{N} (p_j^{t-1} \cdot \hat{q}_j^{t-1})}. \tag{8.3c}$$

([175]) The brackets indicate that only the product of (price × quantity) can be observed, but neither prices nor quantities separately.

([176]) This option should not be confused with the price update to the price reference period.

([177]) NSIs can evaluate retrospectively which of the two options performs better in practice by comparing the outcomes with that from using actual $t-1$ expenditures shares (available later).

([178]) Eurostat (2020) Guidance on the compilation of HICP weights in case of large changes in consumer expenditures.pdf (Europa.eu).

Finally, the weights w_i^{t-1} need to be price-updated to December $t-1$ (the price reference period), which should be carried out as follows ([179]):

$$w_i^{0t,t-1} = \frac{w_i^{t-1} \cdot \frac{p_i^{0t}}{p_i^{t-1}}}{\sum_{j=1}^{N} w_j^{t-1} \cdot \frac{p_j^{0t}}{p_j^{t-1}}} \tag{8.4}$$

where the (theoretical) expression using prices and quantities depends on whether equation (8.3a), (8.3b) or (8.3c) is used to estimate w_i^{t-1}.

Annex 8.2 provides a practical example illustrating the process of derivation and price updating of the weights to be used for HICP computation.

If the expression based on equation (8.3a) is substituted in equation (8.2), the resulting formula is known as the Young index ([180]). Equation (8.3b), on the other hand, yields the Lowe index.

When the correlation between expenditures and relative prices is negative, as is usually the case, the Lowe index will tend to exceed the Laspeyres index. However, it is more difficult to generalise about the relationship between the Young index and the Laspeyres index. The Young may be greater or less than the Laspeyres, depending on how sensitive expenditures are to changes in relative prices.

8.2.4 Higher-level compilation

In practice, the higher-level index compilation is based on estimates of the expenditure shares for the weight reference period, sub-indices for price-updating those shares and sub-indices for the comparison month relative to the price reference period. The indices allowed for elementary aggregation are covered in Section 8.3. This section shows two options to obtain the higher-level indices and how both should provide the same result.

Aggregation is a *hierarchical process*, i.e. elementary aggregates are first aggregated to elementary product groups, which are then aggregated to ECOICOP five-digit sub-class indices, which are in turn aggregated to ECOICOP four-digit class indices, etc. For maximum precision, aggregation should be performed on unrounded indices.

A feature of the Laspeyres-type index is its *consistency in aggregation*. Suppose that the set of all products N is divided into mutually disjoint subsets N_h $(h = 1, \dots, H)$. Then the following is true:

$$P^{0t,mt} = \sum_{h=1}^{H} \left(\sum_{i_h=1}^{N_h} \frac{p_{i_h}^{mt}}{p_{i_h}^{0t}} \cdot \frac{w_{i_h}^{0t,t-1}}{\sum_{j_h=1}^{N_h} w_{j_h}^{0t,t-1}} \right) \cdot \left(\sum_{i_h=1}^{N_h} w_{i_h}^{0t,t-1} \right) = \sum_{h=1}^{H} P_h^{0t,mt} \cdot w_h^{0t,t-1} \tag{8.5}$$

([179]) In practice, price-updating may be executed at a higher aggregation level, involving indices rather than individual prices.

([180]) Under *homogeneous* Cobb-Douglas preferences, the Young index coincides with the Laspeyres index as expenditure shares remain constant. However, it should be borne in mind that the HICP is designed to assess price stability and is not intended to be a cost of living index (see recital (12) of Regulation (EU) 2016/792).

Thus, the overall Laspeyres-type index is a weighted arithmetic mean of the Laspeyres-type indices for the subsets of products, defined as:

$$P_h^{0t,mt} = \sum_{i_h=1}^{N_h} \frac{p_{i_h}^{mt}}{p_{i_h}^{0t}} \cdot \frac{w_{i_h}^{0t,t-1}}{\sum_{j_h=1}^{N_h} w_{j_h}^{0t,t-1}}. \qquad (8.6)$$

The weights

$$w_h^{0t,t-1} = \sum_{i_h=1}^{N_h} w_{i_h}^{0t,t-1} \qquad (8.7)$$

are the expenditure shares of the *subsets*.

The geographical aggregation to the euro area and European Union works in the same way, with h then denoting Member States rather than subsets of products (see Chapter 11).

Theoretically, the overall Laspeyres-type index could be calculated in one stage, from the product price relatives (as in equation (8.2)), or in two stages (as in equation (8.5)), from product price relatives to subset Laspeyres-type indices and then from these subset indices to the overall index.

8.3 Indices for elementary aggregates

8.3.1 Introduction

Over the last decades, European NSIs have made substantial progress in developing new price collection techniques, implementing alternative sampling procedures and index calculation methods.

The availability of large administrative data sets and transactional data has greatly improved HICP compilation methods. Traditionally, elementary price indices have been constructed using unweighted bilateral index methods, using only price information locally collected by price collectors or centrally collected by NSIs (see Chapter 5).

The availability of itemised information on quantities and prices at individual product level has opened new perspectives to the use of weighted bilateral indices at the level of elementary aggregates as well as the use of multilateral indices previously applied for comparing prices at territorial level. The economic and statistical theory underlying the HICPs compilation process, especially concerning the relative strengths and weaknesses of the various formulae and methods used to process different sources of data, is continually being refined by research in this field.

The evolution of EU regulations on HICP reflects the increasing use of transaction data for price statistics and developments in several Member States. The issues related to lack of information on expenditure weights at the most disaggregated level of index compilation were embedded in the Regulation 1749/96 (on initial implementing measures for Council Regulation (EC) No 2494/95) that substantially established that the price indices for elementary aggregates had to be compiled by using either Jevons or Dutot formula. The implementing EU Regulation 2020/1148, laying down the methodological and technical specifications in accordance with Regulation (EU) 2016/792 and repealing Regulation 1749/96, states that it is necessary to define elementary aggregates and to specify the properties that an index formula must respect to form elementary price indices (Article 12).

Then Regulation 2020/1148 established that:

Article 12

1. *The prices of individual products shall be aggregated to obtain elementary price indices using either of the following options:*
   a. *an index formula that ensures transitivity. The price index of prior periods shall not be revised when using transitive index formulae;*
   b. *or (b) an index formula that ensures time reversibility and compares the prices of individual products in the current period with the prices of those products in the base period. The base period shall not be changed frequently if such change leads to significant violation of the transitivity principle.*
2. *An index formula that is consistent with those described in paragraph 1 shall be used to obtain a price index for an elementary aggregate from two or more elementary price indices.*

The transitivity property requires that an index that compares periods r and t indirectly through period s is identical to one that compares periods *r* and *t* directly. The chained index between two periods should equal the direct index between the same two periods. Time reversibility is a property that requires an index between periods *r* and *t* to be equal to the inverse of the same index between periods *t* and *r*. In other words, if all the data for the two periods are interchanged, the resulting price index should equal the reciprocal of the original price index.

In line with the HICP Regulation 2020/1148, the Jevons and Dutot index formulae can still be used for the compilation of price indices at the lowest level of aggregation (elementary aggregate) as well as any multilateral index formulae that ensure transitivity and time reversibility. In addition, the index methods used at the elementary aggregate level may vary, even within a single sub-index, due to the mix of data sources, e.g. transaction data, web-scraped and traditionally collected data (see Chapter 4 and Chapter 5). In the following sub-sections, an overview of various approaches to constructing elementary price indexes will be given by considering some practical and methodological issues and referring to the methods used in different Member Countries. References to the ILO Manual (2020) and to the Guide on Multilateral Methods in the Harmonised Index of Consumer Prices (Eurostat, 2022 ([181])) will be made for detailed discussion.

8.3.2 Bilateral indices

Bilateral indices are used for obtaining the elementary price indices when weights for each product -offer are not available as in the case of traditionally collected prices in the field. When transaction data are available, bilateral indices may be used for compiling unweighted elementary price indices or fixed base weighted indices. Bilateral indices are also used for comparing prices obtained from the internet (manually or web-scraped) as this source of data includes only price quotes and not the associated quantities in which products were sold in each period ([182]).

([181]) Eurostat (2022) Guide on multilateral methods in the Harmonised Index of Consumer Prices (HICP) — 2022 edition - Products Manuals and Guidelines – Eurostat.

([182]) Different methods have been suggested for estimating weights for web-scraped data, for example via statistical distribution based on their page rankings or by the total number of webscraped prices for a product in a month. Research is ongoing in this field.

This sub-section discusses the properties, advantages and disadvantages of the mainly used bilateral indices aiming at providing guidance on the choice.

As already mentioned, the price indices for elementary aggregates are usually calculated using unweighted formulae. Nevertheless, even in this case, it is worth noting that when the varieties are selected with probabilities proportional to the size of some relevant variables, weights are implicitly introduced by the sampling procedure (ILO Manual, 2020).

It is worth noting here that following a two-stage aggregation process involves losing consistency in aggregation between stages 1 and 2, as a Laspeyres-type index cannot be calculated at the lower level.

Although (due to new and disappearing products) the set of products available for sampling generally varies from month to month, for ease of exposition the presentation here is restricted to matched model indices, i.e. it is assumed that there are no missing observations and no changes in the quality of the products sampled so that the sets of prices are perfectly matched. An elementary price index is therefore typically calculated from two sets of matched price observations.

Several formulae have been proposed in the literature for measuring the price change of an elementary aggregate. The three most widely known elementary.index formulae are the Carli, the Dutot, and the Jevons. While the Jevons index is the most used elementary index (when only price information is available), the Dutot formula is used by a few Member Countries.

Dutot index
(ratio of arithmetic mean prices)

$$P_D^{0t,mt} = \frac{\frac{1}{N}\sum_{i=1}^{N} p_i^{mt}}{\frac{1}{N}\sum_{i=1}^{N} p_i^{0t}} \tag{8.8}$$

Jevons index
(ratio of geometric mean prices, or geometric mean of price relatives)

$$P_J^{0t,mt} = \frac{\left(\prod_{i=1}^{N} p_i^{mt}\right)^{\frac{1}{N}}}{\left(\prod_{i=1}^{N} p_i^{0t}\right)^{\frac{1}{N}}} = \left(\prod_{i=1}^{N} \frac{p_i^{mt}}{p_i^{0t}}\right)^{\frac{1}{N}} \tag{8.9}$$

Carli index
(arithmetic mean of price relatives)

$$P_C^{0t,mt} = \frac{1}{N}\sum_{i=1}^{N} \frac{p_i^{mt}}{p_i^{0t}} \tag{8.10}$$

where p_i is the price observed for product offers/individual products $i = 1, \ldots, N$ in each elementary aggregate. When transaction data are used, unit values (average prices) are calculated by dividing the individual product turnover by the quantity sold (see also Section 5.5 for product specification). With web-scraped data, prices are obtained as unweighted arithmetic or geometric averages of the time-aggregated product offers which fall under the definition of the homogeneous product in a given month.

The issue of which formula is ‘best’ could be addressed considering which properties for elementary indices are required. The *time reversibility property* and the transitivity are, as mentioned before, binding by Article 12 of Implementing Regulation 2020/1148.

The *time reversibility property* can be verified for the Dutot and Jevons but the Carli index fails it (Diewert, 2021 ([183])). The same stands true for the *transitivity property*. Other index properties can also be considered when selecting the elementary price index formulae (e.g. Diewert, 2021; Dalen, 1992 ([184])). The Jevons elementary index exhibits most of these properties, thus emerging as best formula from the viewpoint of the axiomatic approach to elementary indices when individual product weights are not available.

The Jevons index can also be based on a smaller sample of individual products S obtained from transaction data:

$$P_J^{0t,mt} = \left(\prod_{i \in S} \frac{p_i^{mt}}{p_i^{0t}}\right)^{\frac{1}{|S|}} \tag{8.11}$$

NSIs can use different strategies to select the initial sample which must be priced over time, taking into account how often a product was sold in past periods (e.g. the previous year), such as cut-off sampling and proportional sampling to size([185]). A Jevons index has been implemented, for example, in Switzerland ([186]) (see Annex 8.1).

The above elementary price indices may be calculated as direct price indices by comparing the prices of the current period with those of a fixed price reference period, or as chained short-term indices obtained by multiplying the monthly (or quarterly) price indices into a long-term price index. A price index calculated by multiplying the period-to-period or short-term price indices is referred to as a linked price index. For elementary indices calculated as linked short-term price indices, it is crucial that the index satisfies the transitivity test.

If the samples remain unchanged throughout the year, as is assumed here, the linked Jevons and Dutot indices reduce to the respective direct indices. For example, using the ratio of arithmetic means ([187]):

$$\begin{aligned} Ch_D^{0t,mt} &= P_D^{0t,1t} \cdot P_D^{1t,2t} \cdot \ldots \cdot P_D^{(m-1)t,mt} \\ &= \frac{\frac{1}{N}\sum_{i=1}^{N} p_i^{1t}}{\frac{1}{N}\sum_{i=1}^{N} p_i^{0t}} \cdot \frac{\frac{1}{N}\sum_{i=1}^{N} p_i^{2t}}{\frac{1}{N}\sum_{i=1}^{N} p_i^{1t}} \cdot \ldots \cdot \frac{\frac{1}{N}\sum_{i=1}^{N} p_i^{mt}}{\frac{1}{N}\sum_{i=1}^{N} p_i^{(m-1)t}} = \frac{\frac{1}{N}\sum_{i=1}^{N} p_i^{mt}}{\frac{1}{N}\sum_{i=1}^{N} p_i^{0t}} = P_D^{0t,mt}. \end{aligned} \tag{8.12}$$

$Ch_D^{0t,mt}$ becomes the simple ratio of arithmetic means $P_D^{0t,mt}$ (or similarly with the geometric formula described above)

Hence, the index for an elementary aggregate may be calculated as a linked month-on-month index using one of the two preferred formulae (8.8 and 8.9).

([183]) Diewert (2021) Elementary Indices, Draft Chapter 6 Consumer Price Index Theory.

([184]) Dalen, J., (1992). Computing elementary aggregates in the Swedish consumer price index. Journal of Official Statistics 8 (2), 129–147.

([185]) It is worth nothing that with probability sampling proportional to size, if the expenditure of an individual product in a base period is used as a size variable, then the sample Jevons price index is an approximately unbiased estimator for the population geometric Laspeyres price index (ILO Manual, 2020).

([186]) Harmonised index of consumer prices (HICP) (prc_hicp) – National metadata: Switzerland – point 18.5.1, Annex ‘ Calculation method’ (europa.eu).

([187]) Where misunderstanding is possible, here and elsewhere in the text, months and years, such as $m-1$ or $t-1$, are put in brackets.

The linked Carli index would provide the following elementary aggregate index:

$$
\begin{aligned}
Ch_C^{0t,mt} &= P_C^{0t,1t} \cdot P_C^{1t,2t} \cdot \ldots \cdot P_C^{(m-1)t,mt} \\
&= \left(\frac{1}{N}\sum_{i=1}^{N}\frac{p_i^{1t}}{p_i^{0t}}\right)\cdot\left(\frac{1}{N}\sum_{i=1}^{N}\frac{p_i^{2t}}{p_i^{1t}}\right)\cdot\ldots\cdot\left(\frac{1}{N}\sum_{i=1}^{N}\frac{p_i^{mt}}{p_i^{(m-1)t}}\right) \neq \frac{1}{N}\sum_{i=1}^{N}\frac{p_i^{mt}}{p_i^{0t}} = P_C^{0t,mt}.
\end{aligned} \tag{8.13}
$$

$Ch_C^{0t,mt}$ does not reduce to a direct Carli index $P_C^{0t,mt}$ if the samples do not change.

The chained Carli should be avoided because it can produce potentially substantial upward bias. The underlying phenomenon is that the Carli index does not satisfy the transitivity test.

Two important final tests should be added to the above transitivity test. The first is the *commensurability test*, i.e. if the units of measurement for each product are changed, then the elementary aggregate index remains unchanged. The Dutot index $P_D^{0t,mt}$ fails this test since the price levels are affected by the measurement unit. If there are heterogeneous products in the elementary aggregate, this is a rather serious failing and price statisticians should be careful when using this index under these conditions. The other is the *test of determinateness as to prices*, i.e. if any single price tends to zero, then the index should not tend to zero or plus infinity. It can be verified that the Jevons index does not satisfy this test. Thus, when using the Jevons index $P_J^{0t,mt}$, care must be taken to bound the prices away from zero in order to avoid a meaningless index number value (see Section 7.5).

The differences between the elementary aggregate indices, in terms of changes in the variances of the prices, has generally been considered for calculated sample indices by means of Taylor approximations (see Balk, 2005 ([188]), Diewert, 2021).

By expanding $P_J^{0t,mt}$ by a second-order Taylor series approximation around the arithmetic mean prices $p_i^{0t} = \bar{p}^{0t}$ and $p_i^{mt} = \bar{p}^{mt}$ for all $i = 1, \ldots, N$ (N being sufficiently large), we can verify that the difference between the Dutot and the Jevons indices depends on the change over time of the squared coefficient of variation of individual prices:

$$
P_J^{0t,mt} \approx P_D^{0t,mt}\left(1 + \frac{1}{2}\frac{\mathrm{Var}[p_i^{0t}]}{\left(\mathrm{E}[p_i^{0t}]\right)^2} - \frac{1}{2}\frac{\mathrm{Var}[p_i^{mt}]}{\left(\mathrm{E}[p_i^{mt}]\right)^2}\right). \tag{8.14}
$$

Likewise, by expanding $P_D^{0t,mt}$ around the geometric mean prices $\ln p_i^{0t} = \ln \bar{p}^{0t}$ and $\ln p_i^{mt} = \ln \bar{p}^{mt}$, we obtain the following second-order approximate relationship:

$$
P_D^{0t,mt} \approx P_J^{0t,mt}\left(1 - \frac{1}{2}\mathrm{Var}[\ln p_i^{0t}] + \frac{1}{2}\mathrm{Var}[\ln p_i^{mt}]\right). \tag{8.15}
$$

However, whether the difference between the Jevons and Dutot indices is positive or negative, large or small, is an empirical matter. Still, Silver and Heravi (2007 (189)) show that this difference depends on the change over time in price dispersion. Some of the price dispersion will be due to product heterogeneity.

([188]) Balk, B.M., (2005). Price indices for elementary aggregates: the sampling approach, Journal of Official Statistics, 21(4), 675.

([189]) Silver, M., and Heravi, S. (2007). Why elementary price index number formulas differ: Evidence on price dispersion. Journal of Econometrics, 140(2), 874-883.

The Dutot index has the drawback of tending primarily to reflect the price development of products at relatively high prices. This can be seen if we consider again equation (8.8):

$$P_D^{0t,mt} = \frac{\frac{1}{N}\sum_{i=1}^{N} p_i^{mt}}{\frac{1}{N}\sum_{i=1}^{N} p_i^{0t}} = \sum_{i=1}^{N} \frac{p_i^{mt}}{p_i^{0t}} \cdot \frac{p_i^{0t}}{\sum_{l=1}^{N} p_l^{0t}}. \quad (8.8a)$$

It appears that the Dutot index can be written as a weighted arithmetic mean of individual price relatives, its weights being relative prices in the price reference period. In the Dutot index, products with higher relative prices get a higher weight and products with lower relative prices get a lower weight. Thus, it is advisable to use the Dutot index only for elementary aggregates in which the relative prices exhibit small variance, i.e. the price levels are similar.

A quick glance at the formula of the Jevons index (equation (8.9)) tells us that it is not a linear index. Nevertheless, the unique *linear* approximation to the Jevons index first described by Mehrhoff (2007), and independently devised by Balk (2008) (190) as the unweighted Walsh index, yields what is referred to as the Balk-Mehrhoff-Walsh (BMW) index ([191]). It is *weighted* by the square root of the inverse price relatives:

$$P_J^{0t,mt} = \left(\prod_{i=1}^{N} \frac{p_i^{mt}}{p_i^{0t}}\right)^{\frac{1}{N}} \approx \sum_{i=1}^{N} \frac{p_i^{mt}}{p_i^{0t}} \cdot \frac{\sqrt{p_i^{0t}/p_i^{mt}}}{\sum_{l=1}^{N} \sqrt{p_l^{0t}/p_l^{mt}}} = P_{BMW}^{0t,mt}. \quad (8.9a)$$

Thus, this index is more robust with respect to the variance of relative prices within an elementary aggregate.

When explicit weights are used, we assume that transactions at the most detailed product level, that is at item code level (GTINs or SKU), are aggregated considering product, time and outlet dimensions to obtain unit values (Eurostat, 2022) and sale information is used for obtaining weights at individual product level.

In line with the fixed basket principle, one approach consists in pricing the same set of individual products (a 'basket') over time. In **the geometric Laspeyres formula** ([192]), prices in the current period p_i^t are compared with the prices in the base period for a fixed basket of products denoted by N_b, using weights equal to expenditure shares referring to some past period and are kept fixed (e.g. for a year).

Direct geometric Laspeyres-type (GL)

$$P_{GL}^{0t} = \left(\prod_{i \in N_b} \frac{p_i^t}{p_i^0}\right)^{\frac{p_i^b q_i^b}{\sum_{j \in N_b} p_j^b q_j^b}} \quad ;b<0 \quad (8.16)$$

where q_i^b denote the total number of units sold of the individual product *i* in period b.

([190]) Balk, B.M. (2008), Price and Quantity Index Numbers: Models for Measuring Aggregate Change and Difference, Cambridge University Press

([191]) See Mehrhoff, J.: 'A linear approximation to the Jevons index,' in: v.d. Lippe, P.M. (2007), op. cit.; Balk, B.M. (2008), op. cit. Because it is a linear index, it can be directly compared with other linear indices such as Dutot or Laspeyres(-type) indices using a theorem of v. Bortkiewicz. It should be noted that the approximation is exact when the number of products is not greater than two.

([192]) The geometric Laspeyres can be considered as a special case of the Geometric Young index in which b = 0; that is, the expenditure shares are those of the price reference period 0 (ILO Manual, 2020)

Geometric Laspeyres can also expressed in log terms (Vartia and Suoperä, 2018 ([193])):

$$P_{GL}^{0t} = exp\left(w_i^0 \sum_{i \in N_b} log \frac{p_i^t}{p_i^0}\right) \qquad w_i = \frac{p_i^b q_i^b}{\sum_{j \in N_b} p_j^b q_j^b} \tag{8.16a}$$

If a product becomes permanently missing,then in order to ensure that the initially selected basket is kept fixed and remains representative, a replacement product needs to be selected and a quality adjustment should be performed (see Chapter 6). An approach based on a geometric Laspeyres-type index has been implemented in France (see Annex 8.1).

Another approach based only on products that are available in both the current and base period is **the Fixed-base Törnqvist index** where prices in the current period are directly compared with the prices of the same products in the base period using weights based on expenditure related to each individual product in each period.

Fixed-base Törnqvist index (Tq)

$$P_{Tq}^{0t} = \left(\prod_{i \in N_0 \cap N_t} \frac{p_i^t}{p_i^0}\right)^{0.5 \times \left(\frac{p_i^0 q_i^o}{\sum_{j \in N_0 \cap N_t} p_j^0 q_j^o} + \frac{p_i^t q_i^t}{\sum_{j \in N_0 \cap N_t} p_j^t q_j^t}\right)} \tag{8.17}$$

A limitation of this method is that, as we move away from the base period, it is likely that the overlap between the two comparison periods decreases. With the aim of overcoming this issue, an entire year can be used as a base period, thus allowing seasonal products to be incorporated (Eurostat, 2022). A fixed-base Törnqvist index has been implemented in Finland together with other formulae chosen considering data characteristics (see Annex 8.1).

Since transaction data usually show a big churn in terms of new and disappearing items, a fixed item basket will rapidly lose its representativity. To deal with this issue, a dynamic basket method ([194]) can be used that selects a representative sample of item codes for each consecutive set of two months (Eurostat, 2017 ([195])). Usually, cut-off sampling is applied which selects the most sold products in two consecutive periods. In this way a crude type of implicit weighting is introduced since high-sales products are included in the sample with certainty whereas unimportant items are excluded. However, period-on-period chaining of weighted indices, including superlative indices, will suffer from chain drift ([196]) which occurs once a chained price index, unlike its direct counterpart, is not equal to 100 once all prices of all products revert to their original base month values. This effect is usually caused by activities of sales and

([193]) Vartia, Y., and Suoperä, A. (2018). Contingently biased, permanently biased and excellent index numbers for complete micro data, unpublished paper.

([194]) The dynamic basket method was initially proposed in Van der Grient and de Haan (2010) who suggested the use of a monthly chained matched-item index at the elementary (product group) level. van der Grient, H. A., & de Haan, J. (2010, May). The use of supermarket scanner data in the Dutch CPI. In Joint ECE/ILO Workshop on scanner data.

([195]) (Eurostat, 2017) The Eurostat guide on processing transaction data.

([196]) Ivanic et al (2011) noted that this term dates back to Frisch (1936; 8): ‘The divergency which exists between a chain index and the corresponding direct index (when the latter does not satisfy the circular test) will often take the form of a systematic drifting.’ Frisch, R., 1936. Annual survey of general economic theory: the problem of index numbers. Econometrica 4, 1-39.

discounts resulting in stock keeping behaviour of consumers (Diewert and Fox 2022 ([197]); Melser and Webster 2021 ([198])).

Therefore, a pragmatic compromise in a dynamic basket approach is to choose the unweighted Jevons formula at the elementary level expressed in equation (8.9) even if a chained Jevons index can still show some downward bias when products exit the sample at reduced prices. It is worth noting that if relaunches and replacements occur frequently, specific quality adjustments methods should be used ([199]).

The dynamic basket method has been implemented, for example, in Slovenia, (Republic of Slovenia Statistical Office, 2018 ([200])), Italy (ISTAT, 2022 ([201])) and Spain (INE, 2021).

8.3.3 Multilateral indices

As already mentioned, the advantage of using transaction data for computing elementary price indices is that prices and quantities on items are often available, namely on scanner data so weights can be used below the elementary aggregate. However, matched-model superlative indices can be biased if product churn is significant and quality change is relevant or when relaunches of individual products occur frequently and are accompanied by 'hidden' price changes, which will not be captured by methods based on exact matching (De Haan et al, 2016) ([202]).

To deal with the chain drift problem Ivancic, Diewert and Fox (2009; 2011) proposed the use of multilateral indices in the scanner data context even if the basic idea of adapting a multilateral method to the time series context is due to Balk (1981) ([203]). Indeed, multilateral price index methods were originally developed and applied for geographic price comparisons (see for example Laureti and Polidoro, 2022 ([204])).

These methods, transferred to the time domain, proved to be a solution to the problems encountered with bilateral methods, as they allow to consider all the products that are available in the different periods, while explicitly weighting each product according to its importance in each period. Thanks to these advantages multilateral methods have been recommended as suitable price index compilation methods for transaction data, despite their additional complexity compared with bilateral methods.

(197) Diewert, W. E., and Fox, K. J. (2022). Substitution bias in multilateral methods for CPI construction. Journal of Business & Economic Statistics, 40(1), 355-369.

(198) Melser, D., and Webster, M. (2021). Multilateral methods, substitution bias, and chain drift: Some empirical comparisons. Review of Income and Wealth, 67(3), 759-785.

(199) See Chapter 6 for appropriate replacements and quality adjustments procedures to keep the sample representative in a changing market environment.

(200) Republic of Slovenia Statistical Office (2018), Changes in Computing Inflation in 2018.

(201) Consumer prices - December 2022 (istat.it).

(202) De Haan, J., Willenborg, L., Chessa, A. G., and Verburg, J. (2016). An overview of price index methods for scanner data. In Meeting of the Group of Experts on Consumer Price Indices UNECE-ILO, Geneva 2 – 4 May 2016.

(203) Balk, B.M. (1981), A Simple Method for Constructing Price Indices for Seasonal Commodities, Statistische Hefte 22 (1), 1-8.

(204) Laureti, T., & Polidoro, F. (2022). Using Scanner Data for Computing Consumer Spatial Price Indexes at Regional Level: An Empirical Application for Grocery Products in Italy. Journal of Official Statistics (JOS), 38(1).

Consequently, over the last years, a range of multilateral approaches have been pursued by different statistical agencies for subcomponents of the HICP calculated from transaction data but also for subcomponents based on web-scraped data characterised by a high number of products entering and leaving the market (see Chessa and Griffioen, 2019 ([205]) and Van Loon and Roles, 2018 ([206])).

These new developments clearly show that the number of methodological choices has considerably extended in different directions, thus making the problem of compiling accurate index numbers more complex. The Guide on Multilateral Methods in the Harmonised Index of Consumer Prices (Eurostat, 2022) underlines that when applying a multilateral method, various technical choices have to be made including i) the definition of the individual product that serves as input to the multilateral method; ii) the specification of the time window over which the index formula is compiled and the splicing technique to be used to combine the respective indices and iii) the selection of an index formula. By referring to the Guide on Multilateral Methods in the HICP (Eurostat, 2022) and to the CPI Manual (2020), this section illustrates the methods most frequently used by Member States.

GEKS-Törnqvist multilateral price index method

The GEKS (Eltetö and Köves 1964; Gini 1931; Szulc 1964) index is based on a bilateral index that is used to compare any two periods belonging to the time window. The GEKS method between period 0 and period t is calculated as the geometric average of the ratios of matched-model bilateral price indices $I^{0,l}$ and $I^{0,t}$ constructed using the same index number formula, where each period *l* is taken as the base (CPI Manual, 2020).

In its standard form, the GEKS method uses bilateral Fisher indices, but any bilateral index which satisfies the time reversibility property can be used, such as the Törnqvist index ([207]).

The GEKS based on Törnqvist (GEKS-Tq) for a given time window W can be calculated as follows:

$$P^{0,t}_{W(GEKS-Tq)} = \prod_{l\in W}\left[\frac{I^{0,l}_{Tq}}{I^{t,l}_{Tq}}\right]^{1/|W|} = \prod_{l\in W}\left[I^{0,l}_{Tq}\cdot I^{l,t}_{Tq}\right]^{1/|W|} \quad (8.18)$$

The transitivity property implies that the GEKS-Tq index can be written as a period-to-period chained index as follows:

$$P^{0,t}_{W(GEKS-Tq)} = \prod_{s=1}^{t}\left[P^{s-1,s}_{W(GEKS-Tq)}\right]^{1/|W|} \quad (8.18a)$$

which should be free of chain drift (Ivancic, Diewert and Fox, 2011).

The GEKS method requires that there is at least one product match for any two periods of the time window so that a bilateral Törnqvist index can be compiled (see Eurostat, 2022 and CPI Manual, 2020 for details).

([205]) Chessa, A. G., and Griffioen, R. (2019). Comparing Price Indices of Clothing and Footwear for Scanner Data and Web Scraped Data. Economie et Statistique, 509(1), 49-68.

([206]) Van Loon K. and Roles D, (2018). Web scraping and online data collection and processing for the consumer price index | Statbel (fgov.be).

([207]) The GEKS- Törnqvist index is also known as CCDI (Caves, Christensen and Diewert, 1982).

Time-Product Dummy (TPD) and Weighted Time-Product Dummy (WTPD)

The TPD approach consists of running a regression that includes dummy variables for the products and time periods that belong to the time window. Therefore, the TPD model is estimated by pooling together data for a specified window length W and modelling the log of price lnp_i^t against time and product binary indicators as follows:

$$lnp_i^t = \alpha + \sum_{\substack{r\epsilon W \\ r\neq 0}} \delta^t D_i^r + \sum_{\substack{j\epsilon N \\ j\neq 1}} \gamma_j K_j \ + \epsilon_i^t \qquad \forall t \in T, \qquad \forall i \in N_t \tag{8.19}$$

Where K_j is a dummy variable with the value 1 if the observation relates to the individual product j and 0 otherwise, and D_i is a dummy variable with the value 1 if the observation relates to period *r* and 0 otherwise. The parameters γ_j are known as 'item fixed effects' and the δ^t are 'time dummy parameters'. Dummies for item *n* and period *0* are excluded to identify the model (ILO Manual, 2020).

Diewert (2003 ([208])) proposed to estimate model (8.19) by Weighted Least Squares regression with the items' expenditure shares in each period serving as weights to reflect the economic importance of the items given by:

$$s_i^t = \frac{p_i^t q_i^t}{\sum_{j\in N_t} p_j^t q_j^t} \quad \forall t \in W, \qquad \forall i \in N_t \tag{8.20}$$

The final index (WTPD) is obtained by taking the exponential of the estimated coefficient for the time dummy variables:

$$P_{W(WTPD)}^{0,t} = \exp\left(\widehat{\delta^t}\right) \tag{8.21}$$

If a set of product characteristics is identified, model (8.19) can be extended and the hedonic TPD model can be estimated (De Haan and Krsinich, 2014 ([209])) . In this way, quality adjusted price index numbers can be obtained by exponentiating the time dummy coefficients (see Chapter 6 for details on hedonic regression).

Geary-Khamis

The GK index ([210]) is a quality-adjusted value index since it is entirely constructed upon the unit value concept. The family of quality-adjusted unit value methods (QU methods) encompasses the GK method illustrated here as different choices for the v_i lead to different price index formulas (see Chessa, 2016 ([211]) for details and for an application in the Dutch CPI). The GK index is obtained by solving the following system of equations:

([208]) Diewert, W. E. (2003). Hedonic regressions: A review of some unresolved issues. In 7th meeting of the Ottawa Group, Paris, May (Vol. 29).

([209]) De Haan, J., & Krsinich, F. (2014). Scanner data and the treatment of quality change in nonrevisable price indices. Journal of Business & Economic Statistics, 32(3), 341-358.

([210]) The Geary-Khamis (GK) multilateral method was introduced by Geary (1958) in the context of making international comparisons of prices. Khamis (1970) showed that the equations that define the method have a positive solution under certain conditions.

([211]) Chessa, A. G. (2016), 'A new methodology for processing scanner data in the Dutch CPI', EURONA Eurostat Review on National Accounts and Macroeconomic Indicators, No 1/2016, pp. 49-70.

$$P_{W(GK)}^{0,t} = \frac{\sum_{i \in N_t} p_i^t q_i^t / \sum_{\in N_0} p_i^0 q_i^0}{\sum_{i \in N_t} v_i \ q_i^t / \sum_{i \in N_0} v_i \ q_i^0} \quad (8.22)$$

$$v_i = \sum_{l \in W} \frac{q_i^l}{\sum_{s \in W} q_i^s} \frac{p_i^l}{P_{W(GK)}^{0,t}} \quad (8.23)$$

In equations (8.22 and 8.23) v_i can be considered as a weighted average of deflated prices of products and $\varphi_i^l = \frac{q_i^l}{\sum_{s \in W} q_i^s}$ is the quantity share of product *i* in time period *l* where $q_i^l$is the quantity of product in period *l* and $\sum_{s \in W} q_i^s$ is the total quantity of product *i* over all time periods W. In other words, the GK price level for period t can be interpreted as a quality adjusted unit value index where the v_i acts as the quality adjustment factor. The v_i and $P_{W(GK)}^{0,t}$ are only determined up to a scalar multiple, so an additional normalisation is required to determine a unique solution. In practice, the system of equations can be solved by iteration choosing initial values for adjustment factors (see the Eurostat Guide on Multilateral Methods for examples).

8.4 Integration of different data sources

An important aspect to consider is at which level the data from different sources (scanner data, web-scraped data, field price collection) could be combined. Depending on local circumstances, the multilateral methods could be applied at different levels. The ECOICOP subclass level (or any other level below the subclass) could be stratified by region and outlet -type according to the data source (see also Chapter 5). Each data source corresponds to a stratum of the subclass or the sub-division to which a weight must be assigned and for which an elementary price index is compiled.

To combine elementary price indices obtained from different data sources, it is necessary to use fixed weights because only fixed weights are available for the stratum that represents the traditionally collected prices. To obtain these weights, different data sources could be used, including scanner data, for the aggregates covered by this data source, turnover data from structural business survey, tax data, the business register and household budget survey, for the regional dimension, and possibly for the outlet -type dimension.

The aggregation methods will vary according to the definition of an elementary aggregate. If the different sub-divisions are elementary aggregates, the standard Laspeyres-type aggregation applies, which does not preclude the possibility that other weights or finer sub-divisions are used within the elementary aggregate (e.g. by type of outlet). If the different sub-divisions are strata of an elementary aggregate, there are two main options to combine the stratum indices: weighted arithmetic average which would be consistent with the higher -level Laspeyres-type aggregation and a geometric weighted average which would be consistent with a Jevons index. Transitivity and time reversibility are satisfied for both the arithmetic, assuming fixed stratum quantities during the year, and the geometric average.

8.5 Chaining

8.5.1 Chaining with bilateral methods

The Laspeyres-type index defined by equation (8.2) compares prices in month m of year t to those in December of the preceding year, $t-1$. When t moves through time, there is for each year a series of 13 index numbers running from December of year $t-1$ (its index number being equal to 100) to December of year t.([212])

Now these separate 13-month series can be chained together into a single long-term series, which compares month m of year t to some earlier period. The chained Laspeyres-type index:

$$\begin{aligned} ChI^{b,mt} &= \left(P^{b,12(0)} \cdot P^{0(1),12(1)} \cdot \ldots \cdot P^{0(t-2),12(t-2)} \cdot P^{0(t-1),12(t-1)}\right) \cdot P^{0t,mt} \\ &= Ch^{b,12(t-1)} \cdot P^{0t,mt} \end{aligned} \tag{8.24}$$

compares month m of year t with a certain year b ([213]). As noted above, month 0 of any year t is the same as month 12 of year $t-1$. In principle, each short-term index of this chained series uses a different set of weights and an updated sample of products and outlets. In this case year b, used in the initial link of the long term series, is the *index reference period* ([214]).

8.5.2 Extension methods for multilateral indices

When using multilateral methods, a sequence of transitive index series is generated on subsequent time windows. However, since incorporation of a new month into the multilateral window may result in a revision of previously published price indices, and this fact is not acceptable to NSIs, several alternative methods have been suggested for linking the multilateral indices for compiling the next index to be published (Ivancic, Diewertand Fox, 2011 ([215]); De Haan ([216]), 2015, Krsinich, 2016).

An interesting classification is provided by Chessa (2021 ([217])), who underlined that once the length of the time window is chosen, three choices are made that characterise index extension methods: i) The adjustment of the time window from month to month; ii) The linking month; iii) The index to be used in the linking month (the new series or the published series).

([212]) Changes in the production methods can be incorporated each December. However, care should be taken to ensure that such changes do not significantly affect the structural characteristics of the entire series of index numbers (see Chapter 10).

([213]) For the HICP, this is currently 2015. Previous reference periods were 2005 and 1996.

([214]) 'Index reference period' means the period for which the index is set to 100 index points (Article 2(15) of Regulation (EU) 2016/792). For the procedure of re-referencing the HICP to its current index reference period 2015 see Section 8.4.4.

([215]) Ivancic, L., W.E. Diewert and K.J. Fox (2011), 'Scanner Data, Time Aggregation and the Construction of Price Indices', Journal of Econometrics 161, 24-35.

([216]) de Haan, J. and Hendriks, R. 2013. Online Data, Fixed Effects and the Construction of High-Frequency Price Indices. Paper presented at the Economic Measurement. Group Workshop, 28-29 November 2013, Sydney, Australia.

([217]) Chessa, A. G. (2021). Extension of multilateral index series over time: Analysis and comparison of methods. Technical report, Department of Consumer Prices Statistics Netherlands.

As regards the first issue, to adjust the time window to include the data from the latest month two main strategies can be adopted: a) Rolling time windows, where each month the time window is shifted forward by 1 month while the length of the time window is kept constant; b) Expanding time windows, where each month the time window is extended by 1 month thus increasing the length of the time window (see Eurostat, 2022 for details).

Focussing on the choice of the linking month, it is worth underlying that any month between the first month and the penultimate month of the adjusted window can be chosen as the 'linking month' on which each new index series is linked. The possible choices can be subdivided into two main types: a) A moving linking month; b) A fixed linking month.

Finally, an additional element is that some extension methods link onto the published index, while other methods take a recalculated index for linking a new series. Therefore, both the recalculated and published indices are candidates for the index on which a new index series can be linked.

The following formulae refer to the published indices, but similar expressions can be provided for calculated index series (see Eurostat, 2022). Let $P_{pub}^{0,t}$ denote a price index to be published in month t, where 0 denotes the starting month of the index series. In addition, T is used as the 'default length' of the time window W, which is fixed in the case of rolling windows and is equal to the maximum window length for expanding windows.

Window splice

The method was suggested by Krsinich (2014 ([218])) and uses a fixed length rolling window $t - T + 1$. The first month of the rolling window is used as the linking month. Because of this property, the method is sometimes also called full window splice. The most recently calculated index in the linking month is used to link the new index series:

$$P_{pub}^{0,t} = P_{pub}^{0,t-1} \times P_{pub}^{t-1,t-T+1} \times P_{[t-T+1,t]}^{t-T+1,t} \quad (8.25)$$

Movement splice

De Haan and van der Grient (2011) and Ivancic, Diewert and Fox (2011) suggested this method, called '*movement splice*', as part of the Rolling Year GEKS. The penultimate month of the adjusted window is taken as linking month (*t*–1), and the month-on-month index of the adjusted window is chained to the published index of the previous month.

The new index series with movement splice is:

$$P_{pub}^{0,t} = P_{pub}^{0,t-1} \times P_{[t-T+1,t]}^{t-1,t} \quad (8.26)$$

Half splice

De Haan (2015) suggested that the link period t should be chosen to be in the middle of the first window time span; i.e., choose t = T/2 if T is an even integer or t = (T+1)/2 if T is an odd integer. Considering the published series:

$$P_{pub}^{0,t} = P_{pub}^{0,t-1} \times P_{pub}^{t-1,t-\frac{T+1}{2}+1} \times P_{[t-T+1,t]}^{t-\frac{T+1}{2}+1,t} \quad (8.27)$$

([218]) Krsinich, F. (2014). The FEWS Index: Fixed Effects with a Window Splice: Non-revisable quality-adjusted Price Indices with no Characteristic Information. Paper presented at the Meeting of the Group of Experts on Consumer Price Indices, 26-28 May 2014, Geneva, Switzerland.

The Australian Bureau of Statistics (2016) called this the '*half splice method'* for linking the results of the two windows.

Mean splice

Diewert and Fox (2022) suggested the '*mean splice method*', defined as an equally weighted geometric mean of the indices obtained by linking on indices in each of the past T months for time windows of length T + 1. Considering the published series:

$$P_{pub}^{0,t} = P_{pub}^{0,t-1} \times \prod_{k=t-T+1}^{t-1} \left(P_{pub}^{t-1,k} \times P_{[t-T+1,t]}^{k,t}\right)^{\frac{1}{T-1}} \quad (8.28)$$

Fixed base

This method uses a rolling window but takes a base month as linking month. Considering December of the previous year and linking to the published series:

$$P_{pub}^{0,t} = P_{pub}^{0,t-1} \times P_{pub}^{t-1,Dec_{(t)}} \times P_{[t-T+1,t]}^{Dec_{(t)},t} = P_{pub}^{0,Dec_{(t)}} \times P_{[t-T+1,t]}^{Dec_{(t)},t} \quad (8.29)$$

The calculation of the above splicing methods is numerically illustrated in Eurostat (2022). The various splicing methods all have their advantages and drawbacks, and some amount of chain drift cannot be excluded. The performance of a splicing method can be tested empirically by comparing the resulting index with the index compiled over a full-time window which covers several years. Note, however, that the 'benchmark' index may also be slightly affected by a very long time window, as the result in a given month can be influenced by very distant data points.

8.5.3 Loss of consistency in the aggregation of chained indices

The technique of chaining indices involves losing consistency in aggregation. To see this, return to equation (8.5) and recall that the set of elementary aggregates $H \;\; = 1, \ldots$,now without loss of generality assumed to be constant over time, is divided into mutually disjoint subsets L_h $(h = 1, \ldots, H)$. Then, as explained above, the consistency in aggregation of the short-term Laspeyres-type index (now at higher levels) implies that:

$$P^{0t,mt} = \sum_{h=1}^{H} P_h^{0t,mt} \cdot w_h^{0t,t-1}. \quad (8.30)$$

This holds for any month $m = 1, \ldots, 12$, any year t and any subset of elementary aggregates.

Once chained, however, such a relation does not exist, i.e. there is *no* set of weights (adding up to unity) such that:

$$ChI^{b,mt} = \sum_{h=1}^{H} ChI_h^{b,mt} \cdot w_h \;, \quad (8.31)$$

where $ChI_h^{b,mt}$ is the chained index for subset $h = 1, \ldots, H$. Even if the weights were constant over the entire time span, this would not imply consistency in aggregation of the chained index, because it would still not reduce to a direct Laspeyres-type index ([219]).

Only *unchained indices* should be aggregated. This applies to all levels of index aggregation. Once chained, index series are no longer consistent in aggregation.

It may be necessary to produce bespoke aggregates, which are often requested by users. To achieve this index, indices must be use unchained. To obtain unchained indices, the chained indices are divided by the chained December indices of the previous year (and multiply by 100). The unchained index for month m of year t is calculated by solving equation (8.32) for the short-term series:

$$P^{0t,mt} = \frac{ChI^{b,mt}}{ChI^{b,12(t-1)}}. \tag{8.32}$$

The unchained indices are then aggregated using their relevant weights to produce unchained index series for the new bespoke aggregate. These indices are then chained.

8.5.4 Re-referencing

Every 10 years, there is a requirement to re-reference or rescale the HICP to a more recent index reference period ([220]). This can be done by dividing the series by the arithmetic mean for the months of the index reference year (equation (8.24)). Thus, the chained index for month m of year t relative to the current index reference period 2015 ([221]) is defined by:

$$ChI_{2015}^{b,mt} = \frac{ChI^{b,mt}}{\frac{1}{12}\sum_{m=1}^{12} ChI^{b,m(2015)}}. \tag{8.33}$$

It is instructive to see what happens in the months of the index reference year. It turns out that:

$$\begin{aligned} ChI_{2015}^{b,m(2015)} &= \frac{P^{0(2015),m(2015)}}{\frac{1}{12}\sum_{m=1}^{12} P^{0(2015),m(2015)}} = \frac{P^{0(2015),m(2015)}}{P^{0(2015),2015}} \\ &= \sum_{h=1}^{H} \left(\frac{P_h^{0(2015),m(2015)}}{P_h^{0(2015),2015}}\right) \cdot \left(w_h^{0(2015),2014} \cdot \frac{P_h^{0(2015),2015}}{P^{0(2015),2015}}\right) \\ &= \sum_{h=1}^{H} P_h^{2015,m(2015)} \cdot w_h^{2015,2014} = P^{2015,m(2015)}, \end{aligned} \tag{8.34}$$

where $P^{0(2015),2015}$ is the arithmetic mean of the short-term index in this period. Thus, in this

([219]) This is due to the failure of the 'transitivity in prices for fixed value weights test', a (weak) variant of the transitivity test, where the weights are held constant while making all price comparisons. The argument found in the literature that the Lowe index is (strongly) transitive would hold true only if the weights, starting from some out-of-date base period, were derived by continual price -updating rather than being genuinely newly observed every year. The only index satisfying the transitivity test is a weighted geometric mean of all the individual price ratios, the weights being constant through time. After all, The whole point of chaining has been to enable the weights to be continually updated to take account of the changing consumption patterns.

([220]) See Article 5(6) of Regulation (EU) 2016/792, which also requires rescaling in the case of a major methodological change.

([221]) See Article 5(5) of Regulation (EU) 2016/792.

situation, the chained index is again a Laspeyres-type index, where the price reference period and index reference period coincide, i.e. the price-updated weights are:

$$w_h^{2015,2014} = w_h^{0(2015),2014} \cdot \frac{P_h^{0(2015),2015}}{P^{0(2015),2015}} \tag{8.4a}$$

Apart from rounding errors, re-referencing a series of index numbers has no impact on monthly or annual rates of change.

8.6 Rates of change

8.6.1 Monthly rate

The rate of price change between month $m-1$ and month m ($m = 1, \ldots, 12$), both of year t, is calculated as the relative change of the chained Laspeyres-type indices and is usually presented as a percentage, i.e. times 100:

$$\frac{ChI^{b,mt}}{ChI^{b,(m-1)t}} - 1 = \frac{P^{0t,mt}}{P^{0t,(m-1)t}} - 1. \tag{8.35}$$

Recall that month 0 of year t is the same as month 12 of year $t-1$ (see above). Also, the computations are dependent on the short-term indices, rather than the chain-linked index.

Using equation (8.2) and (8.5), equation (8.35) can be rewritten as:

$$\begin{aligned}\frac{P^{0t,mt}}{P^{0t,(m-1)t}} - 1 &= \frac{P^{0t,mt} - P^{0t,(m-1)t}}{P^{0t,(m-1)t}} = \frac{\sum_{h=1}^{H}\left(P_h^{0t,mt} - P_h^{0t,(m-1)t}\right) \cdot w_h^{0t,t-1}}{P^{0t,(m-1)t}} \\ &= \sum_{h=1}^{H}\left(\frac{P_h^{0t,mt}}{P_h^{0t,(m-1)t}} - 1\right) \cdot \left(w_h^{0t,t-1} \cdot \frac{P_h^{0t,(m-1)t}}{P^{0t,(m-1)t}}\right) \\ &= \sum_{h=1}^{H}\left(P_h^{(m-1)t,mt} - 1\right) \cdot w_h^{(m-1)t,t-1} = P^{(m-1)t,mt} - 1,\end{aligned} \tag{8.36}$$

where $P^{(m-1)t,mt}$ is again a Laspeyres-type index, but now with month $m-1$ as the price reference period, i.e. the weights are price-updated to month $m-1$ of year t:

$$w_h^{(m-1)t,t-1} = w_h^{0t,t-1} \cdot \frac{P_h^{0t,(m-1)t}}{P^{0t,(m-1)t}} \tag{8.4b}$$

The *contribution* of sub-index H, $with\ h = 1, \ldots, H$ for example, to the overall monthly price change is:

$$\begin{aligned}\Delta_H^{(m-1)t,mt} &= \left(P_H^{(m-1)t,mt} - 1\right) \cdot w_H^{(m-1)t,t-1} \\ &= \left(\frac{P_L^{0t,mt}}{P_H^{0t,(m-1)t}} - 1\right) \cdot \left(w_H^{0t,t-1} \cdot \frac{P_H^{0t,(m-1)t}}{P^{0t,(m-1)t}}\right),\end{aligned} \tag{8.37}$$

i.e. rate of change times price-updated weight (222). The contribution of a higher aggregate is the sum of the contributions of constituent sub-indices.

8.6.2 Annual rate

Very much like the monthly rate, the annual rate of price change between month m of year t and the same month of year $t-1$ is calculated as the relative change of the chained Laspeyres-type indices. The result when the chained index for month m of year t is divided by the chained index for month m of year $t-1$ is a chained index consisting of two parts:

- a ratio of two Laspeyres-type indices for December of year $t-1$ and month m of year $t-1$, respectively, both relative to December of year $t-2$; multiplied by
- a Laspeyres-type index for month m of year t relative to December of year $t-1$.

Thus:

$$\frac{ChI^{b,mt}}{ChI^{b,m(t-1)}} = \frac{P^{0(t-1),12(t-1)}}{P^{0(t-1),m(t-1)}} \cdot P^{0t,mt} = P^{m(t-1),12(t-1)} \cdot P^{0t,mt}. \tag{8.38}$$

The right-hand side of equation (8.38) shows that the ratio of two Laspeyres-type indices can be written as a Laspeyres-type index for December of year $t-1$ relative to month m of the same year with price-updated weights:

$$w_h^{m(t-1),t-2} = w_h^{0(t-1),t-2} \cdot \frac{P_h^{0(t-1),m(t-1)}}{P^{0(t-1),m(t-1)}} \tag{8.4c}$$

Since equation (8.38) is a chained index, the rate of change between corresponding months m of adjacent years $t-1$ and t cannot be written as a weighted mean of sub-indices. It is therefore not possible to express the *contribution* of a sub-index to the overall annual price change as a *simple* formula. This is because chained time series for the HICP may contain statistically related breaks from one year to another (223).

To show this, we resort to the basket interpretation of the Laspeyres index in equation (8.1) and rewrite equation (8.38) as follows (224):

$$\begin{aligned} P_L^{m(t-1),12(t-1)} \cdot P_L^{0t,mt} &= \frac{\sum_{i=1}^N p_i^{12(t-1)} \cdot q_i^{t-2}}{\sum_{i=1}^N p_i^{m(t-1)} \cdot q_i^{t-2}} \cdot \frac{\sum_{i=1}^N p_i^{mt} \cdot q_i^{t-1}}{\sum_{i=1}^N p_i^{0t} \cdot q_i^{t-1}} \cdot \frac{P_L^{m(t-1),mt}}{P_L^{m(t-1),mt}} \\ &= \frac{\sum_{i=1}^N p_i^{mt} \cdot q_i^{t-1}}{\sum_{i=1}^N p_i^{m(t-1)} \cdot q_i^{t-1}} \cdot \left(\frac{\sum_{i=1}^N p_i^{m(t-1)} \cdot q_i^{t-1}}{\sum_{i=1}^N p_i^{0t} \cdot q_i^{t-1}} \middle/ \frac{\sum_{i=1}^N p_i^{m(t-1)} \cdot q_i^{t-2}}{\sum_{i=1}^N p_i^{0t} \cdot q_i^{t-2}} \right). \end{aligned} \tag{8.39}$$

The first factor of the second part of equation (8.39) measures pure price change. The second factor in brackets is a technical distortion that will generally differ from unity. More specifically, the less the price structure in month m of the previous year deviates from that of December of the

(222) It should be noted that the contribution in January becomes just $\left(P_H^{0t,1t} - 1\right) \cdot w_H^{0t,t-1}$, which means that the short-term index is not rescaled, nor the weight price-updated.

(223) Section 8.5.3 explains why this holds true even if the weights are constant over the entire time span (reference to the failure of the transitivity in prices for fixed value weights test).

(224) It is straightforward to extend this decomposition to the Young and Lowe indices using the expressions involving quantities.

same year, and the smaller the relative quantity change from year to year, the smaller such breaks arise from the change of the weight basis.

Using the theorem of von Bortkiewicz, we can derive the following equation for the annual rate of a fixed basket in an annually chained Laspeyres index (225):

$$P_L^{m(t-1),12(t-1)} \cdot P_L^{0t,mt} = P_L^{m(t-1),mt} \cdot \left(1 + \frac{\mathrm{Cov}\left[\frac{p_i^{m(t-1)}}{p_i^{0t}}, \frac{q_i^{t-1}}{q_i^{t-2}}\right]}{\mathrm{E}\left[\frac{p_i^{m(t-1)}}{p_i^{0t}}\right] \cdot \mathrm{E}\left[\frac{q_i^{t-1}}{q_i^{t-2}}\right]}\right). \tag{8.39a}$$

Thus, the technical distortion vanishes if, and only if, there is no (weighted) correlation between the price change from December of the previous year to month m of year $t-1$ and quantity changes from year $t-2$ to year $t-1$ (226). It is very unlikely that this criterion holds in reality. Worst of all, not even the sign is determined *a priori*.

The measure of inflation that is given prominence in the HICP is the annual rate. When the change in this rate between two consecutive months, i.e.

$$\pi^{mt} - \pi^{(m-1)t} = \left(\frac{ChI^{b,mt}}{ChI^{b,m(t-1)}} - 1\right) - \left(\frac{ChI^{b,(m-1)t}}{ChI^{b,(m-1)(t-1)}} - 1\right), \tag{8.40}$$

is described, *base effects (*227*)* are often mentioned. In a purely technical sense, the contribution of the monthly rate between month $m-1$ and month m, both of year $t-1$, to the change in the annual rate could be referred to as a base, or denominator effect.

To show this, we approximate equation (8.40) by:

$$\pi^{mt} - \pi^{(m-1)t} \approx \left(\frac{ChI^{b,mt}}{ChI^{b,(m-1)t}} - 1\right) - \left(\frac{ChI^{b,m(t-1)}}{ChI^{b,(m-1)(t-1)}} - 1\right), \tag{8.40a}$$

where the approximation $\pi^{mt} \approx \ln ChI^{b,mt} - \ln ChI^{b,m(t-1)}$ (and similarly for $\pi^{(m-1)t}$) is used (228).

Thus, the difference between the annual rates in two subsequent months is approximately the same as the difference between the monthly rate in the current month and the monthly rate one year earlier. This illustrates that the change in the annual rate from one month to the next reflects both recent price changes and price movements 12 months earlier. For example, if the index declines in the period from November to December of year $t-1$, this will amplify the change in the annual rate between November and December of year t (229).

(225) In principle, this distortion of the annual rate could be avoided by chaining over the same month of the previous year (which would then also be the price reference period) rather than December throughout. However, the results from this over-the-year technique would allow only for the meaningful interpretation of annual rates, while the infra-annual pattern of the chained series could be spurious and distorted. Due to the disturbing time series properties, this technique should be avoided.

(226) Should all prices or quantities change at the same rate, the variance and the covariance would be zero.

(227) See *ECB Monthly Bulletin*, Issue 8, 2022.

(228) Since the total HICP base effect is the monthly rate one year earlier, the contribution of a sub-index to the total HICP base effect is its contribution to the previous year's monthly rate.

(229) However, the monthly rate, and hence the base effect, are affected by seasonally fluctuating prices, which is not desirable from an economic perspective.

8.6.3 Contributions to the annual rate

In general, the concept of contributions *per se* is no longer well defined in chained indices and different approaches produce different results with different properties. Here, two competing approaches are presented: one that assures additivity (Ribe contributions) and one that has a direct interpretation (Kirchner contributions) ([230]).

As one of many possible conventions circumventing the problems associated with the abovementioned statistical break, Ribe (1999 ([231])) showed how the rate of change of a chained index can be decomposed into the sum of the contributions of the sub-indices covered by the higher aggregate (see also Balk 2017 ([232]) and Walschots 2016 ([233])).

The annual rate can be decomposed additively into a *this-year term* (TYT) and a *last-year term* (LYT), according to ([234]):

$$\begin{aligned} P^{m(t-1),12(t-1)} \cdot P^{0t,mt} - 1 &= \left[P^{m(t-1),12(t-1)} \cdot \left(P^{0t,mt} - 1\right)\right] \\ &\quad + \left[\left(P^{m(t-1),12(t-1)} - 1\right)\right] \\ &= TYT^{m(t-1),mt} + LYT^{m(t-1),mt}, \end{aligned} \tag{8.41}$$

where the first bracketed term is the this-year term from December of year $t-1$ to month m of year t, adjusted 'to take account of the differences in the overall price levels involved in the comparisons', and the second is the last-year term from month m of year $t-1$ to December of the same year.

Again, the interesting point is to decompose the overall annual price change into components by sub-indices. The this-year term and the last-year term can now each be decomposed, analogously to the monthly contribution for sub-index HH, according to:

$$\begin{aligned} TYT_H^{m(t-1),mt} &= P^{m(t-1),12(t-1)} \cdot \left(P_H^{0t,mt} - 1\right) \cdot w_H^{0t,t-1}; TYT_H^{m(t-1),mt} &= P^{m(t-1),12(t-1)} \cdot \left(P_H^{0t,mt} - 1\right) \cdot w_H^{0t,t-1}; \\ LYT_H^{m(t-1),mt} &= \left(P_H^{m(t-1),12(t-1)} - 1\right) \cdot w_H^{m(t-1),t-2}. \quad LYT_H^{m(t-1),mt} &= \left(P_H^{m(t-1),12(t-1)} - 1\right) \cdot w_H^{m(t-1),t-2}. \end{aligned} \tag{8.42}$$

It should be noted that the factor $P^{m(t-1),12(t-1)}$ in TYT pertains to the overall index. This choice is arbitrary since the factor is also part of the price change to be decomposed (see LYT). Had $P^{0t,mt}$ been held constant in LYT instead, which is equally justified, the resulting contributions would be different, though still additive ([235]).

([230]) Contrary to the 'Kirchner' contributions initially proposed by the Deutsche Bundesbank to compute contributions to GDP growth, 'Ribe' contributions are additive by construction, up to rounding errors, which is their main advantage.

([231]) Ribe, M. (1999, October). Effects of subcomponents on chained price indices like the HICPs and the MUICP. In Eurostat meeting of the working party of consumer price indices, Luxembourg, September.

([232]) Balk, B. M. (2017). Mixed-form indices: a study of their properties. In 15th meeting of the Ottawa Group on price indices, May 2017.

([233]) Walschots J. (2016) Contributions to and Impacts on Inflation. Statistics Netherlands.

([234]) Note that the short-term indices are rescaled (see third part of equation (8.38)) and the weights are price-updated (see equation (8.4c)).

([235]) This gives rise to the idea of a *modified* Ribe contribution, which takes the arithmetic average of the two alternatives. While this is still additive, it is somewhat less arbitrarily defined.

The special case of December ($m = 12$) gives:

$$TYT_H^{m(t-1),mt} = \left(P_H^{0t,12t} - 1\right) \cdot w_H^{0t,t-1}; LYT_H^{m(t-1),mt} = 0. \quad (8.42a)$$

As another measure to ascertain the importance of a sub-index for price dynamics, the Kirchner contribution shows the difference between the actual annual rate and that which one would obtain if, under otherwise equal conditions, this sub-index had remained constant vis-à-vis the comparison period ([236]). Unlike the Ribe contributions, these contributions thus have a direct interpretation. For example, the Kirchner contribution of sub-index HH is:

$$\begin{aligned}
\Delta_H^{m(t-1),mt} &= P^{m(t-1),12(t-1)} \cdot P^{0t,mt} \\
&\quad - \left(P^{m(t-1),12(t-1)} - \left(P_H^{m(t-1),12(t-1)} - 1\right) \cdot w_H^{m(t-1),t-2}\right) \\
&\quad\quad \cdot \left(P^{0t,mt} - \left(P_H^{0t,mt} - 1\right) \cdot w_H^{0t,t-1}\right) \\
&= P^{m(t-1),12(t-1)} \cdot \left(P_H^{0t,mt} - 1\right) \cdot w_H^{0t,t-1} \\
&\quad + P^{0t,mt} \cdot \left(P_H^{m(t-1),12(t-1)} - 1\right) \cdot w_H^{m(t-1),t-2} \\
&\quad - \left(P_H^{0t,mt} - 1\right) \cdot \left(P_H^{m(t-1),12(t-1)} - 1\right) \cdot w_H^{0t,t-1} \cdot w_H^{m(t-1),t-2}.
\end{aligned} \quad (8.43)$$

The expression on the right-hand side of the equation has three terms. The first two terms relate to the price change of the sub-index before and after the chaining in December, the third term refers to the whole 12-month period. The latter term will normally be dominated by the former two terms because the weight part is approximately square. Owing to the statistical break from one year to another, the sum of the Kirchner contributions of the sub-indices for this period is not necessarily equal to the annual rate ([237]).

The special case of December ($m = 12$) gives:

$$\Delta_H^{m(t-1),mt} = \left(P_H^{0t,12t} - 1\right) \cdot w_H^{0t,t-1}, \quad (8.43a)$$

which is again additive.

The difference between the Kirchner contributions presented here and the Ribe contributions is:

$$\left(P_H^{m(t-1),12(t-1)} - 1\right) \cdot w_H^{m(t-1),t-2} \cdot \left(\left(P^{0t,mt} - 1\right) - \left(P_H^{0t,mt} - 1\right) \cdot w_H^{0t,t-1}\right), \quad (8.43b)$$

which is expected to be close to zero; it is exactly zero in December. As such, it can be said that the Kirchner contributions have an exact direct interpretation and are approximately additive (and vice versa for the Ribe contributions).

([236]) See Eurostat (2013), *Handbook on Quarterly National Accounts*, Publications Office of the European Union, para. 6.109. The Deutsche Bundesbank proposed this way to compute contributions to GDP growth, which is adapted here to fit with the HICP concept.

([237]) To reiterate, the additivity of the Ribe contributions is imposed and the contributions are derived accordingly.

8.6.4 Annual average rate

Aggregation of the Laspeyres-type index from months to the year is performed by means of *arithmetically* averaging the 12 months of year t, as the weights remain constant within a *calendar year* (238):

$$ChI^{b,t} = \frac{1}{12}\sum_{m=1}^{12} ChI^{b,mt} = ChI^{b,12(t-1)} \cdot \left(\frac{1}{12}\sum_{m=1}^{12} P^{0t,mt}\right) = ChI^{b,12(t-1)} \cdot P^{0t,t}. \tag{8.44}$$

The annual average rate is obtained by dividing the arithmetic mean of the chained indices for year t by a mean of the same indices for year $t-1$, i.e.:

$$\frac{ChI^{b,t}}{ChI^{b,t-1}} = \frac{P^{0(t-1),12(t-1)}}{P^{0(t-1),t-1}} \cdot P^{0t,t} = P^{t-1,12(t-1)} \cdot P^{0t,t}. \tag{8.44a}$$

Much like the annual rate, the result is a chained index consisting of two parts:

- a ratio of two Laspeyres-type indices for December of year $t-1$ and the entire previous year, respectively, both relative to December of year $t-2$; multiplied by
- a Laspeyres-type index for the entire year t relative to December of year $t-1$.

The first part can be written as a Laspeyres-type index for December of year $t-1$ relative to the entire previous year. The corresponding price-updated weights are obtained as follows:

$$w_h^{t-1,t-2} = w_h^{0(t-1),t-2} \cdot \frac{P_h^{0(t-1),t-1}}{P^{0(t-1),t-1}}. \tag{8.4d}$$

It is straightforward to see that the relative importance of a price change for the annual average rate also depends on the month in which it occurs. A permanent upward shock to the price level in January, say, has an impact 12 times greater than the same shock in December. A first order Taylor series approximation of equation (8.44a) around $P^{\tau-1,\tau} = 1$ ($\tau = 2(t-1), \dots, 12t$) yields:

$$\begin{aligned} &P^{0(t-1),12(t-1)} \cdot \frac{\frac{1}{12}\sum_{m=1}^{12} P^{0t,mt}}{\frac{1}{12}\sum_{m=1}^{12} P^{0(t-1),m(t-1)}} - 1 \\ &\approx \frac{1}{12}P^{1(t-1),2(t-1)} + \frac{2}{12}P^{2(t-1),3(t-1)} + \cdots + \frac{11}{12}P^{11(t-1),12(t-1)} \\ &\quad + \frac{12}{12}P^{0t,1t} + \frac{11}{12}P^{1t,2t} + \cdots + \frac{2}{12}P^{10t,11t} + \frac{1}{12}P^{11t,12t}. \end{aligned} \tag{8.44b}$$

(238) Should the 12-month average not correspond to a calendar year, nothing can be said about its properties.

Annex 8.1: Country examples – Index calculation with different data sources

France

Insee uses three types of data collection methods: i) traditional collection. ii) webscraped. iii) scanner data of retail chains, whose transmission to Insee was made compulsory for public statistics purposes by an implemented order of April 13, 2017. Scanner data are used for the manufactured food products and cleaning and personal care products sold in supermarkets and hypermarkets.

Insee adopts different formulae for computing CPI/HICP according to the type of data collection because scanner data provide information on the quantity sold of each specific product in each outlet; the number of prices observed and the frequency of observation is significantly higher. Prices are collected every day for all sold products.

As a result, price aggregation has been modified at the most detailed level. The choice of aggregation formulae and their impact on CPI results are discussed in Leclair et al (2019 ([239])). Table 8.6.23 shows the formulae used at each level and for each type of data.

Table 8.6.23

Modification of the Aggregation Formulae used to calculate a General Consumer Price Index

Level of aggregation	Field collection	Scanner data
Price of a product on a given day in an outlet		Calculated as a unit price: turnover for the day divided by the quantities sold
Given product in an outlet	There is only one price for a product in an outlet for a given consumption segment	Calculated as a unit price: turnover for the month divided by the quantities sold
Consumption segment in an outlet		Geometric Laspeyres
Consumption segment in an urban unit	Jevons or Dutot index	Arithmetic Laspeyres
Consumption segment at the national level	Horvitz-Thompson estimator using the sampling weights of urban units	Arithmetic Laspeyres
Consumption segment in an itern	Arithmetic Laspeyres	Arithmetic Laspeyres

Source: Leclair M (2019) Using Scanner Data to Calculate the Consumer Price Index Courrier des statistiques N3

([239]) GOPA-LU-fwc-statmet-lot1

Finland

A fixed-base Törnqvist index has been implemented in Finland together with other formulae chosen on the basis of data characteristics. Starting from year 2017, Statistics Finland has introduced new data sources for the production of CPI and HICP. These new data sources are based on either scanner (consumer purchases of daily products and pharmaceutical products recorded at point of sales) or on operative data covering service sales, such as charges for mobile phone subscriptions and internet broadband.

Statistics Finland uses different index formulae and weight reference periods according to the scanner datasets:

- pharmaceutical products – formula: Geometric Laspeyres with weight reference period in previous year
- alcoholic beverages – formula: Geometric Laspeyres, weight reference period: previous year
- wireless telephone services and internet subscription fees – Fisher formula. It is worth noting that 2 companies out of 3 are calculated using Fisher. Price reference period: previous month (chain strategy). Weight reference period: average of previous month and current month. All three companies are aggregated together using retailerspecific weights.
- food, non-alcoholic beverages, daily products – Törnqvist index, normalised average month of previous year.

Italy

Italy uses different sources of price data for compiling CPI/HICP. Since 2018, Istat has been using scanner data of grocery products (excluding fresh food) while starting from January 2021 also the ECOICOP group 06.1.2 (other medical products) is covered by scanner data. scanner data have replaced the traditional survey for 13.7% of the HICP basket. However, for some products groups prices are also collected by the municipal statistical offices (in dedicated shops such as pharmacies, perfumeries, and pet shops). From 2022, web-scraping is used to collect prices of transport services by train, electricity in the liberalised market, town gas and food delivery. Finally, administrative data, centrally collected by Istat, are used for fuels, rents and tobacco. From 2022, the estimation of the private housing rents index is also based on administrative data (i.e. rents contracts database provided by the Real Estate Market Observatory of the Revenue Agency).

Since 2020 the dynamic approach has been implemented for the selection of the elementary items. Indices for scanner data are calculated at outlet level as the unweighted Jevons index (geometric mean) of GTINs elementary indices. scanner dataindices are stratified by market using a classification shared by industrial and distribution companies linked to the aggregates of product of ECOICOP classification.

eights for the integration of product aggregates indices of modern and traditional distribution, at the provincial level, are estimated from specialised sources. Territorial stratification is carried out for index calculation.

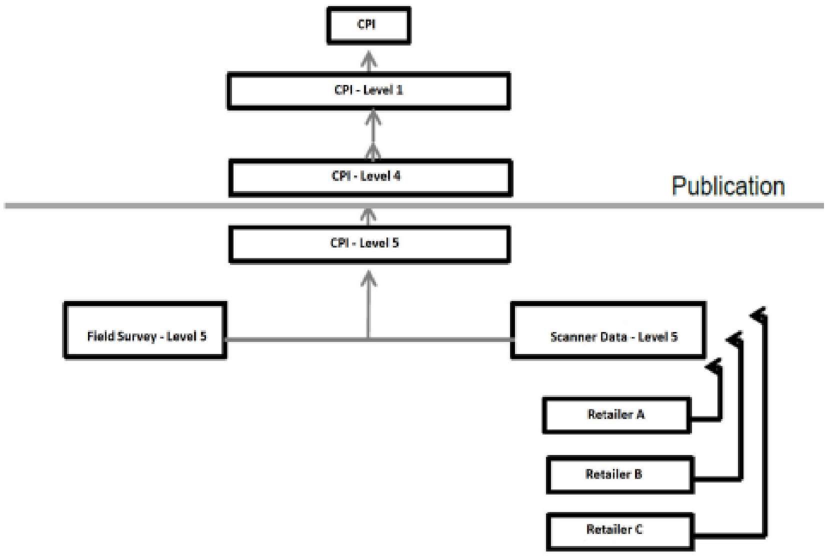
Luxembourg

Statistics Luxembourg (STATEC) has been using transaction data from participating retailers in Luxembourg for CPI/HICP calculations since January 2018 (for more details on product classification and matching, see Guerreiro et al., 2018 ([240])). The method used from 2018 to 2020 was the so-called'dynamic basket' method, which involved the creation of a dynamic basket of products and the use of a monthly chained Jevons index as recommended by Eurostat (2017).

Considering the limitations of the bilateral method used, STATEC (2021 ([241])) started a research project to compare selected multilateral price index methods with the old method. In conclusion, the GEKS half-splice on published indices on a 25-month window has been implemented since 2021. The GEKS method has been selected for Luxembourg's CPI production for two main reasons. First it provided more favourable results in terms of splicing method use compared to the GK and WTPD methods. Second, the GEKS method is generally consistent with the economic approach of index number theory which suggests that consumers' utility functions are generally non-linear.

The aggregation structure combining the different data sources is presented in the following figure.

Figure 1: Overall CPI Aggregation Structure



Source: Radjabov B. and Ferring M. Économie et statistiques N° 123 The Implementation of a Multilateral Price Index Method for Scanner Data in the Luxembourg CPI

([240]) Guerreiro, V., Walzer, M. and Lamboray, C. (2018) The use of supermarket scanner data in the Luxembourg consumer price index. Economie et Statistiques, 97.

([241]) Radjabov B. and Ferring M. Économie et statistiques N° 123 The Implementation of a Multilateral Price Index Method for Scanner Data in the Luxembourg CPI.

Austria

After several years of preparation and a two-year test period, scanner data were introduced into the Austrian CPI and HICP in January 2022. Statistik Austria tested various multilateral methods and found minor differences between them for most items. For practical reasons, Statistik Austria opted for the GEKS-Törnqvist index as it is also the easiest method to communicate and to comprehend.

The elementary aggregate used to calculate the index is the unit value of products by retail chain and by region. At this level of aggregation, nine regional indices are compiled at the federal state level and then aggregated into a national index. this way, the procedure is harmonised with the index calculation methodology of the other survey types, the calculations of which are still based on a traditional, likewise hierarchical methodology: cities, regions (federal state) and country. Given the current international legal framework, monthly overlap is the standard method for linking the conventional and the new index.

Norway

In 2021 Statistics Norway implemented a GEKS-Törnqvist based on a 25-HASP, for the index of food and non-alcoholic beverages. The use of multilateral method was further extended in 2022 by applying it also to indices for non-food products from grocery stores and goods and services from petrol stations and kiosks. The main improvements of these implementations were increased product coverage and product weighting.

However, for non-food products, increasing the scanner data coverage created some challenges related to the integration of different data sources, traditional data collection and scanner data. Since turnover information is often lacking at product group level for parts of the market not covered by scanner, retail trade statistics became an important additional data source for weighting.

Switzerland

The Swiss Federal Statistical Office (FSO) uses data from different sources such as traditional collection and scanner data (since 2008). The price collection with scanner data is centrally managed by the FSO.

The FSO did not change calculation methods with the introduction of scanner data – there is however an improvement in the underlying information. In traditional collection, the price of an individual product is compared with the price of the same individual product in the previous month. With scanner data, the average transaction price (sales/quantity) per individual product throughout Switzerland in the first 14 days of the month is compared with the price in the preceding period.

Annex 8.2: Numerical example

The Excel file contains four groups of tabs. In the blue tabs (*Index* and *Item weights*) the data referring to the changing composition of the euro area are those published by Eurostat on 22 February 2017. The indices and item weights are both rounded to two decimals, which will affect the calculation results. They are, nonetheless, exact except for rounding differences. The grey tabs (*Aggregation*, *Non-consistency*, *Re-referencing (1) and (2)*, and *Disaggregation (1) and (2)*) contain the examples relating to Section 8.5, while the yellow tabs (*Monthly rate*, *Annual rate*, *Base effect* and *Annual average rate*) contain those relating to Section 8.6. The green tab *Deriving weights* contains an example on the derivation and price update of HICP weights (see Sub-section 8.2.3).

Aggregation

The five special aggregates (processed food, unprocessed food, non-energy industrial goods, energy and services) are aggregated to the total HICP. The procedure involves three steps:

- Unchain the chained indices to obtain the short-term series using equation (8.32);
- Aggregate the unchained sub-indices to the total short-term index using the item weights provided and equation (8.30); and
- Chain-link the short-term series together into a single long-term series using December as the linking month and equation (8.24) when chaining with bilateral methods.

Non-consistency

Here it is shown that aggregating the chained indices directly using equation (8.31), rather than their unchained counterparts, does not ensure consistency in aggregation. The zero check is different from zero, not only because of rounding, but particularly because the Laspeyres-type index fails the circularity test.

Re-referencing

Re-referencing the index with reference period 2005=100 to an index with reference period 2015=100 is simply a matter of applying the *rule of three* using equation (8.33), as shown on the first tab. The second tab derives the chained index in the new index reference period from rescaled short-term indices and price-updated weights using equations (8.34) and (8.4a).

Disaggregation

An exclusion measure without food and energy is derived from the total HICP. The procedure is the same as for aggregation, except that we deduct sub-indices from the total on the first tab rather than adding them to form the total. The second tab shows the same calculation, but with aggregation of the constituent sub-indices.

Monthly rate

The monthly rate has been defined in equation (8.35). The calculation of contributions, here for the energy sub-index, involves the short-term indices, so the chained indices are first unchained, again using equation (8.32). As shown in equations (8.36) and (8.4b), the indices have to be rescaled and the item weights price-updated, respectively. On this basis, the contribution of energy to the monthly rate of the total HICP is derived using equation (8.37). In December 2016, for example, the contribution of energy to the monthly rate of the total HICP of 0.5 % was 0.2 percentage points (pp).

Annual rate

The calculation for the annual rate is repeated analogously to the monthly rate, using equation (8.38). Again, the contributions involve the short-term indices and, after unchaining the chained indices using equation (8.32), the indices derived in this way are rescaled using equation (8.41) and the item weights price-updated using equation (8.4c). The Ribe contribution of energy to the annual rate of the total HICP follows from equation (8.42) as the sum of the *this-year term* and the *last-year term*. The Kirchner contribution, on the other hand, involves three terms, as given in equation (8.43). In December 2016, for example, the contribution of energy to the 1.1 % annual rate of the total HICP was 0.2 pp. As is to be expected, the two contributions are virtually identical.

Base effect

The base or denominator effect on the change in the annual inflation rate in the HICP (equation (8.40)) is the monthly rate observed one year earlier, the subtrahend of equation (8.40a). In December 2016, for example, the month-on-month change in the annual rate of energy was 3.6 pp; approximately half of this was due to the monthly rate of –1.8% in December 2015. Since the base effects use information from 12 months ago, the monthly rates of the year 2016 will be the base effects for the year 2017, i.e. the base effect for energy in January 2017 will be 2.7 pp upwards (which will also translate into the total HICP base effect, with 0.3 pp upward contribution in January 2017) ([242]).

Annual average rate

The annual average index is calculated using equation (8.44) and the annual average rate using equation (8.44a). The average annual rate can be approximated from the monthly rates using equation (8.44b).

Price updating of weights: a case study from Italy

A case study is provided by the Italian National Institute of Statistics (Istat) to illustrate calculation of weights based on expenditure estimates for the (first 10 and last 10) product aggregates (8-digits level of the classification used for the Italian HICP) to be used for HICP computation for the year 2023 using equation (8.3c).

([242]) See *ECB Economic Bulletin*, Issue 1/2017 (energy prices are assumed to show no seasonal influences).

9

HICP-constant tax rates and HICP-administered prices

9 HICP-constant tax rates and HICP-administered prices

9.1 Introduction

This chapter discusses the HICP at constant tax rates (HICP-CT) (Section 9.2) and HICP-administered prices (HICP-AP) (Section 9.3). These are analytical indices which complement the HICP in assessing the extent to which movements in free market prices and changes in fiscal policy are responsible for explaining inflation behaviour.

The HICP-CT and HICP-AP are mentioned in Regulation (EU) 2016/792 (the Framework Regulation). They complement each other since they capture different but related aspects of price changes influenced by the policy decisions of public administrations. Transparent rules govern their compilation, as described in this chapter. The chapter also presents limitations in the use and interpretation of these indices.

The HICP-CT is an index series that, for most countries, begins in 2002. It employs the same computational approach as the HICP, with the exception that it is based on prices reflecting the tax rates that prevailed in December of the previous year.

The HICP-CT is an important tool for estimating the contribution of tax changes to inflation. It does not provide an exact measure of the actual contribution but rather an approximate upper bound. The difference between HICP and HICP-CT rates of change corresponds to the theoretical contribution of tax changes to overall inflation, assuming that the effect of tax-rate changes is instantaneously and completely passed on to the final prices paid by consumers.

The HICP and the HICP-CT are essentially identical except for the treatment of taxes. The methodology for the latter is outlined in the *HICP-CT manual* ([243]). The treatment of subsidies is not covered by the legal framework. Therefore, any changes to subsidies on consumer goods and services will not affect the HICP-CT. This asymmetric treatment between taxes and subsidies (i.e., a negative tax) is due to the fact that prices reflected in the HICP are net of subsidies.

The HICP-AP is a series of inflation indices that were first released by Eurostat in February 2010. These indices track the development of administered and non-administered prices. Administered prices are those prices that are decreed by the government or a central authority. The purpose of the HICP-AP, similar to that of the HICP-CT, is to assess the impact of changes in prices for which the public authorities have significant influence on inflation.

The main objective of the HICP-AP is to identify how market prices faced by consumers are influenced either entirely or to a high degree by the government or some centralized authority. It provides valuable insights and transparency regarding how governments and centralized authorities affect inflation.

It should be noted that the HICP-AP is a complementary and partial tool for economic analysis; it is not intended to be a substitute for a more comprehensive analysis of overall price changes in the HICP and their underlying causes. There will probably be other market factors influencing changes in the prices of administered goods and services. This is particularly applicable to certain types of administered prices. World energy and commodity prices, as well as technological progress, for example, affect the price behaviour of many goods and services. However, in most cases, it is not possible to determine the specific contribution of each of these factors to the HICP-AP. Similarly, changes in the HICP-AP can only provide an approximation of price change following a change in regulation and as a result should be interpreted accordingly.

The full impact of government interventions is not measured in a single index series, as the HICP-CT solely includes tax-rate changes, and the HICP-AP only includes interventions related to price setting.

9.2 HICP at constant tax rates

9.2.1 Legal obligations, definitions, and concepts

Article 2 of Regulation (EU) 2016/792 contains the following definitions:

> *'(7) 'harmonised index of consumer prices at constant tax rates' or 'HICP-CT' means the index that measures changes in consumer prices without the impact of changes in tax rates on products over the same period of time;*
>
> *(8) 'tax rate' means a tax parameter and may be a certain percentage of the price or an absolute tax amount levied on a physical unit;*

([243]) *HICP-CT manual 2009 (Europa.eu)*, Working Group Harmonisation of Consumer Price Indices, 2009, Document HCPI 09/547-rev.3, Luxembourg: Eurostat.

[…]

(17) *'basic information' means data covering:*

(a) with reference to the HICP and the HICP-CT:

(i) purchase prices of products which need to be taken into account in order to compute sub-indices in accordance with this regulation;

(ii) characteristics that determine the product price;

(iii) information on taxes and excise duties levied;

(iv) information as to whether a price is fully or partially administered; and

(v) weights reflecting the level and structure of the consumption of the products concerned.'

The reference in paragraph 17 to 'taxes and excise duties levied' is particularly relevant to the HICP-CT.

Further relevant definitions are provided in Article 2 of the Implementation Regulation (EU) 2020/1148. These are:

'(31) 'general government sector' means central government, state government, local government and social security funds, as defined in paragraphs 2.113-2.117 of Annex A to ESA 2010;

'(32) 'taxes on products' means taxes that are payable per unit of a given good or service produced or transacted, as defined in paragraphs 4.16-4.20 of Annex A to ESA 2010;

'(33) 'individual taxes in scope for the HICP-CT' means individual taxes on products that relate to household consumption and are included in the following categories, defined in Table 9.2.24 ('Detailed tax and social contribution receipts by type of tax or social contribution and receiving sub-sector including the list of taxes and social contributions according to national classification') in Annex B to ESA 2010:

a. D.211 Value added type taxes (VAT);
b. D.2122e Taxes on specific services;
c. D.214a Excise duties and consumption taxes (other than those included in taxes and duties on imports);
d. D.214d Car registration taxes;
e. D.214e Taxes on entertainment;
f. D.214g Taxes on insurance premiums;
g. D.214h Other taxes on specific services; and
h. D.214l Other taxes on products not elsewhere classified.

The Implementing Regulation (Implementing Regulation (EU) 2020/1148) for the HICP-CT can be found under Article 21(1), (2), (3) and (4a, b):

1. An individual tax inscope for the HICP-CTshall be taken into account if its annual revenue represents 2 % or more of the sum of all individual taxes in scope collected by the general government sector.

2. The annual revenue from taxes taken into account in the HICP-CT shall cover at least 90 % of the sum of all individual taxes in scope collected by the general government sector.
3. The HICP-CT shall be compiled in the same way as the HICP, except that observed prices are adjusted so that the tax rates on products are kept constant in the observation period, as compared with the price reference period.
4. Changes in tax rates shall be reflected in the HICP-CT as follows:
   a. in the month for which the new rate is applied to the individual product and included in the observed price; or
   b. in the first entire month for which the new rate is applicable. Rate changes that enter into force on the first day of the month shall be reflected in the HICP-CT for that month. Rate changes that enter into force later that month shall be reflected in the HICP-CT for the following month ([244]).

9.2.2 Idea, use and interpretation

Meaning of constant tax rates

The HICP-CT is an index that measures price changes similarly to the HICP, with the difference being that the tax rates on products remain constant during the comparison period at the level they had in the price reference period. Hence, in the event of a tax-rate change, the difference in the current monthly or annual rate of change between the two indices corresponds to the contribution of the tax change to price change, indicating the overall rate of inflation. This assumes that tax changes are passed on instantaneously and in full.

As defined in Article 2(8) of Regulation (EU) 2016/792, the term *tax rate* basically refers to a parameter that is the object of a political decision. A tax rate can be expressed in different forms but is usually one of the following:

- as a *monetary amount per physical unit* of the product in question, e.g., € x per cigarette; this is sometimes (ambiguously) defined as a *specific* tax;
- as a *percentage of the price* of the product (*ad valorem* tax (or rate)); or
- in the form of a *value added tax* (VAT), a percentage of the total price of the product and any other taxes levied on the purchase of the product.

The main aim of the HICP-CT is to provide a comparison of the rates of change in the HICP and the HICP-CT. Thus, it is of analytical value when a tax rate changes between the price reference period and the comparison period.

([244]) Note that in practice, a tax change can lead to different monthly rates between the HICP and the HICP-CT, not only in the month when the tax change takes place but also in the following months, albeit on a much smaller scale. This phenomenon, known as the 'spill over effect', persists until the end of the calendar year. However, these differences will disappear with the updated chain linking in December of the following year.

The following example illustrates the basics of such a comparison:

Table 9.2.24

Example of how the HICP and HICP-CT can be compared

Period	HICP	HICP-CT	HICP	HICP-CT
	Chained		Dec y-1 =100	
***t*–1 December**	120.50	117.60	100.00	100.00
***t* January**	120.70	117.49	100.17	99.91
***t* August**	121.30	118.11	100.66	100.43

The difference between 100.66 and 100.43 reflects the impact of changes in tax rates that happened in August, while the difference between 121.30 and 118.11 show the effect of changes in tax rates since December the previous year(y-1) on the HICP for August.

From the definition of the HICP-CT, it can be inferred that the changes in HICP-CT correspond to those in HICP over a period in which no tax rates have been altered.

Limitations in use of the HICP-CT

The HICP-CT presumes that changes in tax rates are instantaneously and fully transferred to the consumer. However, this is often not the case in reality, and as a result, the HICP-CT can be viewed as an upper limit of the impact on inflation of a tax increase (and vice versa). In reality, tax changes are not always fully passed on to consumers at the exact moment they are introduced by the authorities. Retailers are, of course, at liberty to absorb part or all of the tax increase and choose to adjust the prices of their products later at their discretion. Alternatively, they can anticipate the rate change and adjust their prices upward prior to the tax change. Thus, the HICP-CT might overestimate a price increase in instances where the tax change is not fully reflected in the final price. Conversely, if retailers increase their prices prior to the tax taking effect, the HICP-CT will underestimate the impact of the tax on inflation.

Moreover, as it maintains only the rates of product tax that are applied at the retail stage (the point of purchase), the HICP-CT does not eliminate indirect effects of tax changes, such as price reductions in response to market reactions to taxes, or tax changes at earlier stages of production or trade, as is the case with certain taxes on production.

Quality requirements and comparability

The HICP-CT is part of the HICP system of indices and should thus meet the same quality standards as the HICP. As explained above, it is crucial to the primary use of the HICP-CT that it be fully comparable in its approach with the HICP and across countries.

In practice, it is necessary to strike a balance between completeness, feasibility, and cost when producing the HICP-CT. Compromises are acceptable regarding the inclusion/exclusion of taxes with a relatively small impact on the overall HICP (see

Section 9.2.4 below). This may apply to local taxes and taxes levied on product groups with a low weight in the basket.

Tax rate ad valorem versus per unit

Differences in national tax structures can lead to different effects of tax changes on the HICP-CT. The following example illustrates this.

Let us assume an ad valorem tax on wine of 20 % for country A in December y-1 (see Table 9.2.25A). In period 1, the tax rate increased to 23 %. While the new market price is now 14,40, which will be captured in the HICP, the price at constant tax to be included in the HICP-CT will be 14.05 (14.40 / (1+ 23 %) * (1+ 20 %)), thus while HICP increases 20 %, the HICP-CT increase is only 17 %.

Table 9.2.25A

The effect of an *Ad valorem* tax

Period	Price	Ad Valorem tax (%)	Pre-tax price	Tax value	Price at constant taxes	Price change for HICP (%)	Price change for HICP-CT (%)
December y-1	12.0	20	10.00	2.00	12.00		
1	14.4	23	11.71	2.69	14.05	20	17

Country B (see Table 9.2.25B) differs from Country A in that it applies a specific unit tax on wine instead of an ad valorem tax. In this case, the specific (or unit) tax in December of the previous year is 2.00. This specific tax is now applied to the pre-tax price of 10.00 to arrive at the market price of 12.00. In period 1, the specific tax value increased to 2.6 and the market price also rose to 14.4. The price at constant tax to be used for the HICP-CT compilation for period 1 is 13.80 (14.4 - 2.6 + 2.00). Due to the tax change, the HICP increased 20 % while the HICP-CT increased only 15 %, i.e., 5 % of the increase of the HICP was due to a change in the tax policy.

Table 9.2.25B

The effect of a per-unit (specific) tax on the HICP-CT

Period	Price per unit	Value of tax per unit	Pre-tax price	Price at constant taxes	Price change for HICP (%)	Price change for HICP-CT (%)
December	12.0	2.0	10.0	12.0		
1	14.4	2.6	11.8	13.8	20	15

The HICP-CT is designed to measure the impact of taxation policy, as opposed to measuring the development of the actual amount of taxes paid by the consumer.

9.2.3 Taxes in scope

Rules on taxes in scope

Taxes in scope are taxes on products relating to household final monetary consumption expenditure and taxes directly linked to the level of final consumption. Table 9.2.26 lists the forms of tax that are currently relevant for the EU. As previously mentioned, subsidies on products are not factored into the calculation of the HICP-CT.

For the calculation of the HICP-CT, the following rules apply:

a. An individual tax in scope for the HICP-CT shall be considered if its annual revenue represents 2 % or more of the sum of all individual taxes in scope collected by the general government sector; and

b. The annual revenue from taxes considered in the HICP-CT shall cover at least 90 % of the sum of all individual taxes in scope collected by the general government sector.

According to the implementing regulation 2020/1148, the coverage of the regulation includes the whole general government sector. In other words, if a state or local government controls a tax source which satisfies criteria a. and b. above, then this tax is within the scope of the HICP-CT.

Table 9.2.26

ESA classification of *taxes on products* in scope of the HICP-CT

ESA classification	ESA paragraph reference	Description	HICP code
D.211	4.2	Value-added type taxes (VAT)	D.211
D.2122	4.18.b.5	Taxes on specific services	D.2122e
D.214	4.20.a	Excise duties and consumption taxes (other than those included in taxes and duties on imports)	D.214a
D.214	4.20.d	Car registration taxes	D.214d
D.214	4.20.e	Taxes on entertainment	D.214e
D.214	4.20.g	Taxes on insurance premiums	D.214g
D.214	4.20.h	Other taxes on specific services	D.214h
-	-	Other taxes on products n.e.c.	D.214l

The distinction between taxes and administrative fees

The distinction in ESA 2010 (paragraph 4.79(d)) between *taxes* and *administrative fees* is relevant for the scope of the HICP in general (see Chapter 2). It is also important for the HICP-CT, because the latter qualify as administered prices and not as a tax, and therefore should not be kept constant when calculating the HICP-CT.

Tax reference period

The *tax reference period* is the period which is used to determine the tax rate to be held constant for the compilation of the HICP-CT. Each year, the tax reference period shall be the month of December of the preceding year. This means that the price reference period (for HICP and HICP-CT) and the tax reference period (for HICP-CT) are identical.

If a new tax is introduced for a specific product in the current year, its reference period tax rate is set to zero. For the next year, the tax rate of December of the present year is used as the reference rate.

The HICP-CT is chained at the end of every year in the same way as the HICP (see Chapter 8). This consistency of method ensures its comparability with the HICP (see Section 9.2.3).

For the same reason, the set of weights used for the HICP-CT is identical to that used for the HICP. The weights reflect the actual expenditure shares at the weight reference period, price-updated to December of the previous year.

Time of entering tax-rate changes

According to Article 21(4), the timing of a tax change can be reflected in the HICP-CT in one of two ways. It can be applied to the calculation of the HICP-CT in the month the tax is introduced by the authorities, regardless of the day of the month the tax is introduced (e.g., first day or last day). Alternatively, the tax change can be included in the HICP-CT in the month following the month the tax is applied. Either option is acceptable according to the Implementing Regulation.

In principle, even after a tax change has occurred, it is the actual tax paid that remains relevant for the purposes of calculating the HICP-CT. For instance, in some cases, such as for cigarettes, unsold inventories with their old stamped-on price or tax stamps can remain in the marketplace for some time even after the change in tax policy. In such cases, the change in the tax will not necessarily be immediately reflected on the retail price. In other cases (e.g., fuel duties, excise taxes, and other similar taxes), changes to the tax are applied universally either from the time they are announced or at some future date. Under such conditions, the tax change should follow the practice as decreed in Article 21(4) of the Implementing Regulation and stated above, i.e., the tax is to be captured in the month in which it is applied (regardless of the day) or in the following month.

Lastly, it may not always be obvious to price statisticians if the collected prices include the old or updated tax rates. It is important that such market intelligence be obtained at the time of the price collection; the retailer should have access to such information. Where it is available, the tax actually paid should be reflected in the HICP-CT.

9.2.4 Calculation and index formulas

Description of index calculations in algebraic form

The treatment below provides operational formulas for calculating the HICP-CT.

A Laspeyres-type constant tax rate price index $CTP^{0t,mt}$ may be written as follows:

$$CTP^{0t,mt} = \sum_{i=1}^{N} \frac{p_i^{mt}(\tau_i^{0t})}{p_i^{0t}(\tau_i^{0t})} \cdot w_i^{0t,t-1} \qquad (9.2.1)$$

where $w_i^{0t,t-1}$ are the HICP-CT weights, which are the same as for the HICP, i.e., they are not adjusted (see Chapters 3 and 8).

Further, $p_i^{mt}(\tau_i^{0t})$ denotes the constant tax rate price of product i (i=1,2, …, N) in month m (m=1,…,12) of year t. The vector τ_i^{0t}, pertaining to month 0t, i.e., December (*t*–1), comprises product-related taxes that are within the scope of a constant tax-rate price index. For each product i, the vector τ_i^{0t} usually comprises up to three tax rates: $\tau_i^{0t} = (\alpha_i^{0t}, \beta_i^{0t}, \gamma_i^{0t})$.

Three forms of taxes on products are distinguished here (cf. section 9.2.3.1):

- α_i^{0t} – tax levied at a given rate per physical unit of product i in month 0t, $\alpha_i^{0t} \geq 0$;
- β_i^{0t} – tax levied at a given rate per monetary unit of the price of product i in month 0t (ad valorem tax), $\beta_i^{0t} \geq 0$; and
- γ_i^{0t} – value-added tax (VAT) levied at a given rate on the price for product i in month 0t, $\gamma_i^{0t} \geq 0$.

Similarly, $p_i^{mt}(\tau_i^{mt})$ denotes the observed price in month mt, with $\tau_i^{mt} = (\alpha_i^{mt}, \beta_i^{mt}, \gamma_i^{mt})$.

The sequence of taxes (i.e., what price an ad valorem tax is levied on) may differ by type of product:

- The per-unit tax α_i^{0t} may be levied before or after the ad valorem tax β_i^{0t}; while
- The *ad valorem* tax β_i^{0t} is levied either directly on the pre-tax price or on the pre-tax price plus the per-unit tax α_i^{0t}, or it is linked to the final purchaser price.

The VAT γi is levied on the pre-tax price plus all other taxes (the last tax to be applied).

The exact sequence of the taxes will have to be considered in each case. The order in which the taxes are applied in the tax system can vary between countries and product categories, e.g., a per-unit tax may be levied before or after an *ad valorem* tax which is also in force. However, the VAT is generally applied last, after all other taxes. For tobacco, the *ad valorem* tax is always applied on gross prices, including any per-unit tax.

In the HICP-CT calculation, taxes should be considered as being applied in the same order as in the tax system of the country in question.

To show the formulas reflecting differing taxation practices, three possible cases are presented below. However, other taxation rules may exist, and the calculations must be made accordingly ([245]).

CASE 1

Sequence of taxes:

- the *ad valorem* tax β_i^{mt} is levied on the pre-tax price plus the per-unit tax α_i^{mt} ;
- the VAT γ_i^{mt} is levied on the pre-tax price plus all other taxes (it is the last tax to be applied).

The purchaser price p_i^{mt} to be paid for a product *i* in period mt may be expressed as follows:

$$p_i^{mt} = \tilde{p}_i^{mt} + \alpha_i^{mt} + \beta_i^{mt}\,(\tilde{p}_i^{mt} + \alpha_i^{mt}) + $$
$$+ \gamma_i^{mt}[\tilde{p}_i^{mt} + \alpha_i^{mt} + \beta_i^{mt}\,(\tilde{p}_i^{mt} + \alpha_i^{mt})] \qquad (9.2.2)$$

where $\tilde{p}_i^{mt}$ denotes the pre-tax price of product *i* in period *mt*, which is the price excluding product-related taxes. Equation (9.2.2) can be rewritten as:

$$p_i^{mt} = (1+\gamma_i^{mt})\,(1+\beta_i^{mt})\,(\tilde{p}_i^{mt} + \alpha_i^{mt}). \qquad (9.2.3)$$

Solving this for $\tilde{p}_i^{mt}$, the pre-tax price of a product is given by:

$$\tilde{p}_i^{mt} = \frac{p_i^{mt}}{(1+\gamma_i^{mt})\,(1+\beta_i^{mt})} - \alpha_i^{mt} \qquad (9.2.4)$$

The ‘constant tax rate’ price, i.e. the (unobservable) price of product *i* in the

([245]) The calculation of the HICP-CT in the following examples is conducted using comparisons with reference period prices, In practice, comparing an average price of a product with its December (reference period) price can yield different results than if the comparison period price was calculated by multiplying the reference period price by the index. This can occur when quality adjustments to a product are made during the period. Even if the product is homogeneous, there can be differences influenced by factors such as the closure of a store.

comparison period mt which would have appeared if the reference period (0t) tax rates had been in force, can be calculated as:

$$p_i^{mt}(\tau_i^{0t}) = (1+\gamma_i^{0t})\,(1+\beta_i^{0t})\,(\tilde{p}_i^{mt} + \alpha_i^{0t}) \qquad (9.2.5)$$

Given this, and referring to equation (9.2.3), the price relation that reflects the relative price movement of product *i* from 0*t* to mt is:

$$\frac{p_i^{mt}(\tau_i^{0t})}{p_i^{0t}(\tau_i^{0t})} = \frac{(1+\gamma_i^{0t})\,(1+\beta_i^{0t})\,(\tilde{p}_i^{mt} + \alpha_i^{0t})}{(1+\gamma_i^{0t})\,(1+\beta_i^{0t})\,(\tilde{p}_i^{0t} + \alpha_i^{0t})} = \frac{\tilde{p}_i^{mt} + \alpha_i^{0t}}{\tilde{p}_i^{0t} + \alpha_i^{0t}} \qquad (9.2.6)$$

CASE 2

Sequence of taxes:

- the *ad valorem* tax β_i^{mt} is levied on the pre-tax price;
- the VAT γ_i^{mt} is levied on the pre-tax price plus all other taxes (it is the last tax to be applied).

The purchaser price p_i^{mt} to be paid for a product *i* in period *mt* can now be written as follows:

$$p_i^{mt} = \tilde{p}_i^{mt} + \alpha_i^{mt} + \beta_i^{mt}\,\tilde{p}_i^{mt} + \gamma_i^{mt}(\tilde{p}_i^{mt} + \alpha_i^{mt} + \beta_i^{mt}\,\tilde{p}_i^{mt}) \qquad (9.2.7)$$

or alternatively,

$$p_i^{mt} = (1+\gamma_i^{mt})(\tilde{p}_i^{mt} + \alpha_i^{mt} + \beta_i^{mt}\,\tilde{p}_i^{mt})$$

$$= (1+\gamma_i^{mt})(1+\beta_i^{mt})\,\tilde{p}_i^{mt} + (1+\gamma_i^{mt})\,\alpha_i^{mt}. \qquad (9.2.8)$$

The pre-tax price of product *i* is now given by:

$$\tilde{p}_i^{mt} = \frac{p_i^{mt}}{(1+\gamma_i^{mt})(1+\beta_i^{mt})} - \frac{\alpha_i^{mt}}{1+\beta_i^{mt}} \qquad (9.2.9)$$

The 'constant tax rate' price, i.e., the (unobservable) price of product *i* in the comparison period mt which would have appeared if the reference period (0*t*) tax rates had been in force, can be calculated as:

$$p_i^{mt}(\tau_i^{0t}) = (1+\gamma_i^{0t})(\tilde{p}_i^{0t} + \alpha_i^{0t} + \beta_i^{0t}\,\tilde{p}_i^{0t}) \qquad (9.2.10)$$

Given this and using equation (9.2.8), the price relation that reflects the relative price movement of product *i* from 0*t* to *mt* is:

$$\frac{p_i^{mt}(\tau_i^{0t})}{p_i^{0t}(\tau_i^{0t})} = \frac{(1+\gamma_i^{0t})(\tilde{p}_i^{mt} + \alpha_i^{0t} + \beta_i^{0t}\, \tilde{p}_i^{mt})}{(1+\gamma_i^{0t})(\tilde{p}_i^{0t} + \alpha_i^{0t} + \beta_i^{0t}\, \tilde{p}_i^{0t})}$$

$$= \frac{\tilde{p}_i^{mt} + \alpha_i^{0t} + \beta_i^{0t}\, \tilde{p}_i^{mt}}{\tilde{p}_i^{0t} + \alpha_i^{0t} + \beta_i^{0t}\, \tilde{p}_i^{0t}} \qquad (9.2.11)$$

This case could also be described with the same formula as case 1, assuming that the per-unit tax rate α’ could be defined as α/(1+β). The price relation (9.2.11) then becomes:

$$\frac{p_i^{mt}(\tau_i^{0t})}{p_i^{0t}(\tau_i^{0t})} = \frac{(1+\gamma_i^{0t})\,(1+\beta_i^{0t})\,(\tilde{p}_i^{mt} + \alpha_i^{0t})}{(1+\gamma_i^{0t})\,(1+\beta_i^{0t})\,(\tilde{p}_i^{0t} + \alpha_i^{0t})} = \frac{\tilde{p}_i^{mt} + \alpha_i^{0t}}{\tilde{p}_i^{0t} + \alpha_i^{0t}} \qquad (9.2.11a)$$

CASE 3

Sequence of taxes:

- the *ad valorem* tax β_i^{mt} is linked to the final purchaser price;
- the VAT γ_i^{mt} is levied on the pre-tax price plus all other taxes (it is the last tax to be applied, even though it has some impact on the ad valorem tax).

The purchaser price p_i^{mt} to be paid for a product *i* in period *mt* can now be written as follows:

$$p_i^{mt} = \tilde{p}_i^{mt} + \alpha_i^{mt} + \beta_i^{mt}\, p_i^{mt} + \gamma_i^{mt}(\tilde{p}_i^{mt} + \alpha_i^{mt} + \beta_i^{mt}\, \tilde{p}_i^{mt}) \qquad (9.2.12)$$

Or

$$p_i^{mt} = (\tilde{p}_i^{mt} + \alpha_i^{mt})(1+\gamma_i^{mt}) + \beta_i^{mt}\, p_i^{mt}\,(1+\gamma_i^{mt})$$

$$= \frac{(\tilde{p}_i^{mt}+\alpha_i^{mt})(1+\gamma_i^{mt})}{1-\beta_i^{mt}(1+\gamma_i^{mt})} \qquad (9.2.13)$$

Hence, the pre-tax price is:

$$\tilde{p}_i^{mt} = \frac{p_i^{mt}[1-\beta_i^{mt}(1+\gamma_i^{mt})]}{1+\gamma_i^{mt}} - \alpha_i^{mt} \qquad (9.2.14)$$

and the ‘constant tax rate’ price i.e., the (unobservable) price of product *i* in the comparison period *mt* which would have appeared if the tax reference period (0*t*) tax rates had been in force, can be calculated as:

$$p_i^{mt}(\tau_i^{0t}) = \frac{(\tilde{p}_i^{mt}+\alpha_i^{0t})(1+\gamma_i^{0t})}{1-\beta_i^{0t}(1+\gamma_i^{0t})} \qquad (9.2.15)$$

Given this and using equation (9.2.14), the price relation that reflects the relative price movement of product *i* from 0*t* to mt is:

$$\frac{p_i^{mt}(\tau_i^{0t})}{p_i^{0t}(\tau_i^{0t})} = \frac{(\tilde{p}_i^{mt}+\alpha_i^{0t})(1+\gamma_i^{0t})}{1-\beta_i^{0t}(1+\gamma_i^{0t})} \Big/ \frac{(\tilde{p}_i^{0t}+\alpha_i^{0t})(1+\gamma_i^{0t})}{1-\beta_i^{0t}(1+\gamma_i^{0t})}$$

$$= \frac{\tilde{p}_i^{mt}+\alpha_i^{0t}}{\tilde{p}_i^{0t}+\alpha_i^{0t}} \qquad (9.2.16)$$

These three cases demonstrate that the relative price movement, keeping the price reference period's tax rates constant, depends not only on changes in the pre-tax prices, but also on the values of per-unit tax rates in the reference period or even on the *ad valorem* tax rate β if it is levied on a price prior to a per-unit tax. However, the VAT rate γ does not by itself influence the relative price movement with tax rates kept as in the reference period, although it can do so together with other tax rates. The choice of the constant tax reference period is therefore neutral as regards the treatment of VAT, but it matters for the treatment of per-unit taxes and sometimes for the treatment of *ad valorem* taxes other than a VAT.

The treatment of replacements and quality changes

When product-offers are replaced, possibly with an adjustment for quality changes (see Chapter 6), the replacement prices should be used in the same way for the index calculation of the HICP-CT as for the HICP.

Forms comprising several years

The HICP-CT is especially relevant for comparing short-term (i.e., infra-annual) movements against those of the HICP; it was not designed for making long-term comparisons for which any conclusions drawn from such analysis should be interpreted with some care. For strict interpretation of the comparison of annual rates of change, it should be noted that in the chained index, the reference tax rates are updated for each year in December of the preceding year. By comparing the annual change in the HICP with the HICP-CT, we see the effects of tax changes on inflation for the current year. Over periods of more than one year, there is a cumulative impact of each year's tax changes, giving lasting contributions to a difference in level between both index series. Regardless of the caveats associated with long term comparisons using the HICP-CT, some users may still find some value pursuing such an exercise. Therefore, the following briefly describes how HICP-CT comparisons can be made over several years.

To provide notation for an annually chained HICP-CT covering time spans of several years, the set of periods for year *t* should comprise 13 months, i.e., 0*t*, 1*t*, …, 12*t*, yielding the annually chained index:

$$CTP^{0(t-h),mt} = \sum_{i=1}^{N_{t-h}} \frac{p_i^{12(t-h)}\left(\tau_i^{0(t-h)}\right)}{p_i^{0(t-h)}\left(\tau_i^{0(t-h)}\right)} \cdot w_i^{0(t-h),t-h-1} \cdot$$

$$\sum_{i=1}^{N_{t-h+1}} \frac{p_i^{12(t-h+1)}\left(\tau_i^{0(t-h)}\right)}{p_i^{0(t-h+1)}\left(\tau_i^{0(t-h+1)}\right)} \cdot w_i^{0(t-h+1),t-h} \cdot \ldots \cdot \sum_{i=1}^{N_t} \frac{p_i^{mt}(\tau_i^{0t})}{p_i^{0t}(\tau_i^{0t})} \cdot w_i^{0t,t-1} \qquad (9.2.17)$$

From the dependence of prices on tax rates, it follows that *chaining effects* in the HICP-CT are due not only to annually updated weights, but also to tax rates that have changed. In case 2, per-unit and *ad valorem* tax rates have some impact. In cases 1 and 3, only the former has an impact on the HICP-CT.

9.2.5 Examples of different types of tax

The approach described in this chapter involves performing the calculations at the most detailed product level feasible, such as the level of the national average price for a product. The information required for each product *i* is monthly data on:

- product classification (the most detailed product level);
- product description;
- price and tax reference period purchaser price (p_i^{0t});
- comparison period purchaser price (p_i^{mt});
- tax rates in reference period and comparison period:
    - per-unit taxes ($\alpha_i^{0t}, \alpha_i^{mt}$);
    - ad valorem taxes ($\beta_i^{0t}, \beta_i^{mt}$); and
    - VAT ($\gamma_i^{0t}, \gamma_i^{mt}$); and
- product characteristics relevant for product-related taxation (i.e., per-unit taxes).

The examples below illustrate how this is done in practice when a VAT rate changes (up and down), when excise duties (per-unit and *ad valorem* taxes) change, and when a new tax is introduced.

EXAMPLE 1A: VAT RATE DECREASES FROM 19.6 % TO 5.5 %

Product:	Hotel services
Classification code:	11.2.0.1.x.x
Reference period	
…purchaser price p_i^{0t}:	€45.58 (incl. 19.6 % VAT)
Comparison period	
…purchaser price p_i^{mt}: …price index:	€50.71 (incl. 5.5 % VAT) 111.25
…purchaser price excl. VAT= 50.71×100/105.5	€48.07
…purchaser price incl. original VAT= 48.07×1.196	€57.49
…CT price index = 57.49/45.58 × 100:	**126.12**

As the VAT rate has fallen, the higher CT price index (126.12) compared to the lower price index (111.25) indicates how much higher inflation would have been had the original (high) VAT rate been kept in the sub-index.

EXAMPLE 1B: VAT RATE INCREASES FROM 7 % TO 16 %

Product: services	Admission to cultural /theatres
Classification code:	09.4.2.1.x.x
Reference period (0*t*)	
…purchaser price p_i^{0t}:	€30.50 (incl. 7 % VAT)
Comparison period (*mt*)	
…purchaser price p_i^{mt}:	€33.39 (incl. 16 % VAT)
…price index:	109.48
…purchaser price excl. VAT= 33.39100/116:	€28.78
…purchaser price incl. original VAT = 28.78×1.07:	€30.80
…CT price index = 30.80 / 30.50×100:	**100.98**

As the VAT rate has increased, the lower CT price index (100.98) compared to the higher HICP price index (109.48) indicates how much lower inflation would have been had the original (low) VAT rate been kept in the sub-index.

EXAMPLE 2: PER-UNIT AND *AD VALOREM* TAX INCREASE

All three types of tax are levied on cigarettes in this example, i.e. a per-unit tax, an *ad valorem* tax and VAT (the VAT rate is not changed from the reference to the current period).

Product:	Cigarettes, brand X
Quantity:	40 cigarettes
Classification code:	02.2.0.1.x.x
Reference period (0*t*)	
… purchase price p_i^{0t}:	€7.88 (incl. taxes)
Comparison period (*mt*)	
… purchase price p_i^{mt}:	€10.00 (incl. taxes)
… price index in mt:	126.90

Taxes

VAT rate in reference and current period: γ_i^{0t} = γ_i^{mt} = 19 %

Tax per 200 cigarettes in 0t : α_i^{0t}=	€7.5678
… … for 40 cigarettes =	€1.51356
… Tax per 200 cigarettes in mt; α_i^{mt} =	€8.4578

… ... for 40 cigarettes =	€1.69156
… ad valorem tax in 0t: β_i^{0t}	
=	21.5 %
… ad valorem tax in mt; β_i^{mt} =	21.6 %

Pre-tax prices calculated by equation (9.2.4):

Comp. period pre-tax price $\tilde{p}_i^{mt}$= 10.00/(1.19×1.216) -1.69156 = €5.22

Ref. period pre-tax price $\tilde{p}_i^{0t}$ = 7.88/(1.19×1.215) - 1.51356 = €3.94

CT price index (in comparison period mt):

$$\frac{p_i^{mt}(\tau_i^{0t})}{p_i^{0t}(\tau_i^{0t})} \cdot 100 = \frac{(\tilde{p}_i^{mt} + \alpha_i^{0t})\,(1+\gamma_i^{0t})\,(1+\beta_i^{0t})}{(\tilde{p}_i^{0t} + \alpha_i^{0t})\,(1+\gamma_i^{0t})\,(1+\beta_i^{0t})} \cdot 100$$

$$= \frac{\tilde{p}_i^{mt} + \alpha_i^{0t}}{\tilde{p}_i^{0t} + \alpha_i^{0t}} \cdot 100$$

= (5.22+1.51356) / (3.94 +1.51356) ×100 = **123.53**

Hence, the lower per-unit and *ad valorem* taxes in the reference period mean that inflation in the comparison period would have been lower (CT price index = 123.53) than is actually the case (HICP price index 126.90).

EXAMPLE 3: TAXES ON ENERGY (UNLEADED PETROL)

Product:	Unleaded petrol 98 octane chain X
Quantity:	10 litres
Classification code:	07.2.2.2.x.x
Reference period (0t)	
… purchase price p_i^{0t}:	€ 15.58 (incl. taxes)
Comparison period (mt)	
… purchase price p_i^{mt}:	€ 21.32
… price index in mt:	136.84
Taxes:	

… VAT rate in reference and comparison period: γ_i^{0t} = γ_i^{mt} = 16 %

… Excise duty per 100 litres in 0t; $\alpha_{1,i}^{0t}$ =	€ 45.98
… ... for 10 litre: 45.98 / 100×10 =	€ 4.598
… Excise duty per 100 litres in mt; $\alpha_{1,i}^{mt}$ =	€ 84.54
… ... for 10 litre: 84.54 / 100 × 10 =	€ 8.454
… Environmental taxes per 100 litres in 0t; $\alpha_{2,i}^{0t}$ =	€ 5.12

… … For 10 litres: 5.12 / 100×10 = € 0.512

… Environmental taxes per 100 litres in mt; $\alpha_{2,i}^{mt}$ = € 4.62

… ... For 10 litre: 4.62 / 100×10 = € 0.462

Pre-tax prices calculated by equation (9.2.4):

Comp. period pre-tax price = 21.32/1.16 - 8.454 - 0.462 = € 9.46

Ref. period pre-tax price $\tilde{p}_i^{mt}$= 15.58 / 1.16 – 4.598 – 0.512 = € 8.32

CT price index (in comparison period *mt*):

$$\frac{p_i^{mt}(\tau_i^{0t})}{p_i^{0t}(\tau_i^{0t})} \cdot 100 = \frac{(\tilde{p}_i^{mt} + \alpha_{1,i}^{0t} + \alpha_{2,i}^{0t})\,(1+\gamma_i^{0t})\,(1+\beta_i^{0t})}{(\tilde{p}_i^{0t} + \alpha_{1,i}^{0t} + \alpha_{2,i}^{0t})\,(1+\gamma_i^{0t})\,(1+\beta_i^{0t})} \cdot 100$$

$$= \frac{\tilde{p}_i^{mt} + \alpha_{1,i}^{0t} + \alpha_{2,i}^{0t}}{\tilde{p}_i^{0t} + \alpha_{1,i}^{0t} + \alpha_{2,i}^{0t}} \cdot 100$$

= (9.46 + 4.598 + 0.512) / (8.32 + 4.598 + 0.512) ×100 = **108.50**

In this example, two per-unit taxes and VAT make up the product taxes. The total direct effect of the tax-rate changes is 28.34 index points, i.e., if the reference period's overall lower tax rates had been in force in the comparison period, the index would have been 108.50 instead of 136.84. The example illustrates that the decrease in environmental tax from the reference to the comparison period has only a small impact on the index level as compared with the increase in excise duty (removing this tax would make the CT price index equal 108.13).

EXAMPLE 4: INTRODUCTION OF A NEW TAX ON ENERGY

A new per-unit tax is introduced after the reference month.

Product: Electricity

Quantity: 10 kWh

Classification code: 04.5.1.x.x

Reference period (*0t*)

… purchase price p_i^{0t}: € 2.10 (incl. taxes)

Comparison period (*mt*)

… purchase price p_i^{mt}: € 2.30 (incl. taxes)

… price index in mt: 109.52

Taxes

… VAT rate in reference and current period: $\gamma_i^{0t} = \gamma_i^{mt}$ = 20 %

… Tax per kWh in 0t: α_i^{0t} = € 0

… … for 10 kWh: 0×10 / 1 = € 0

… Tax per kWh in mt; α_i^{mt} = € 0.015

… … for 10 kWh: 0.015×10/1 =	€ 0.15
Pre-tax prices calculated by equation (9.2.4):	
Comp. period pre-tax price $\tilde{p}_i^{mt}$= 2.30/(1.20) - 0.15 =	€ 1.7667
Ref. period pre-tax price $\tilde{p}_i^{0t}$= 2.10/(1.20) - 0 =	€ 1.75
CT price index (in current period) *mt*:	
$\frac{p_i^{mt}(\tau_i^{0t})}{p_i^{0t}(\tau_i^{0t})} \cdot 100 = \frac{(\tilde{p}_i^{mt}+\alpha_i^{0t})(1+\gamma_i^{0t})}{(\tilde{p}_i^{0t}+\alpha_i^{0t})(1+\gamma_i^{0t})} \cdot 100$	
$= \frac{\tilde{p}_i^{mt}+\alpha_i^{0t}}{\tilde{p}_i^{0t}+\alpha_i^{0t}} \cdot 100$	
= (1.7667 + 0) / (1.75 + 0) ×100 =	**100.95**

Hence, if the tax had not been introduced, inflation in the comparison period would have been lower (CT price index=100.95) than is actually the case (HICP price index 109.52).

9.2.6 Geographical coverage, special aggregates

The geographical coverage of the HICP-CT aligns with that of the HICP.

HICP-CT sub-indices are produced monthly for ECOICOP categories and selected aggregates of ECOICOP classes, including:

GD — goods (overall index excluding services)

FOOD — food including alcohol and tobacco

FOOD_P — processed food including alcohol and tobacco

FOOD_NP — unprocessed food

IGD — industrial goods

IGD_NNRG_D — non-energy industrial goods, durables only

IGD_NNRG_SD – non-energy industrial goods, semi-durables only

IGD_NNRG_ND — non-energy industrial goods, non-durables only

NRG — energy

SERV — services (overall index excluding goods)

9.2.7 The HICP-CT and multilateral methods

The HICP and HICP-CT are compiled in a very similar way using the same index number formula at both the higher levels of the aggregation structure as well as at the lowest level, i.e., elementary aggregate including individual product weights within the elementary aggregate. The only difference is that in the case of the HICP-CT, constant-tax prices are used in the calculation.

Therefore, the HICP-CT is compiled in the same way as the HICP, and this is true if the weights at all levels of the aggregation structure are indeed fixed. However, in the case where individual product weights, below the elementary aggregate level, happen to be variable, the compilation of the HICP-CT becomes more complicated and will depend on the index formula which is used to aggregate the individual constant tax rate prices at the level of the individual product. This issue and the calculation methods are fully covered in section 9.1 of the Guide on the Multilateral Methods in the Harmonised Index of Consumer Prices ([246]) (2022):

For the compilation of the HICP-CT using multilateral methods (which also applies by the way to bilateral indexes), the compiler should ensure that the two following conditions are satisfied:

1. The calculated index should be consistent with the framework of the HICP-CT. This means that the price change between the December month and a current month should be based on the tax rates of the December month.
2. The calculated index should be consistent with the multilateral method used in the HICP. If there are no tax rate changes, then the HICP (calculated with a multilateral method) and the HICP-CT should be the same.

The reader can refer to Section 9.2 from the Guide on the Multilateral Methods in the Harmonised Index of Consumer Prices for an illustrative 3-step guide that explains the technique for compiling the HICP-CT using multilateral method. An additional numerical example worked out in MS Excel for *ad valorem* and unit tax rates can be found here ([247]):

Note finally that with a multilateral method, the HICP and HICP_CT are only different during that month when the tax rate changes if the tax is qualified as an *ad valorem* tax (i.e., the HICP and the HICP-CT are therefore consistent). By contrast, when a unit tax changes, the HICP and HICP-CT can differ beyond the months for which the change in tax occurred. A brief discussion on the issue of consistency between the HICP and HICP-CT can be found in Section 9.3 of the Guide on the Multilateral Methods in the Harmonised Index of Consumer Prices.

9.3 HICP-administered prices

9.3.1 Legal obligations, definitions, and concepts

Article 2 of Regulation (EU) 2016/792 contains the following definition:

> *‘(5) ‘administered prices’ means prices that are either directly set or influenced to a significant extent by the government;’*

‘Laspeyres-type index’ and ‘basic information’, along with the rules on index compilation and data requirements in the above Regulation (see Section 9.2.2) are also relevant for the

([246]) Guide on multilateral methods in the Harmonised Index on Consumer Prices (HICP) — 2022 edition - Products Manuals and Guidelines - Eurostat (europa.eu).

([247]) CIRCABC - Guide on multilateral methods – Example 4 – HICP at constant tax rates, 2022, Eurostat.

HICP-AP. The aforementioned definition of administered prices is particularly pertinent to the HICP-AP, as it determines its scope.

9.3.2 Definitions — fully and mainly administered prices

To produce the HICP-AP, the following forms and degrees of administered prices are recognised:

Fully administered prices are prices of goods and services directly set by the government. For example, a government may choose to increase local public transit charges at regular intervals. Other examples may include education fees, theatre tickets, waste collection, childcare, and fees for administrative documents, etc.

Mainly administered prices cover prices of goods and services over which the government, including any national regulator, has a significant influence. The influence of the national regulator's decisions could be direct (on retail prices) or indirect (via wholesale prices); in any case, the regulator must have a 'significant influence' on the consumer price. Note that sometimes there maybe sub-classes below the ECOICOP 5-digit level that may be defined as 'fully-administered' which may lead to the 5-digit level category being qualified as 'mainly-administered' or even 'not administered' if the weight of the 'fully-administered' subclasses is too low. Applying expert judgement is needed in such situations.

In the context of the HICP-AP, 'significant influence' means that government or a regulatory body influence causes price levels to be noticeably different from what they would have been if the prices had been set freely ([248]). If prices, by and large, are close to market prices, the influence is not defined as significant.

It should be noted that consumer prices subject to indirect taxation and excise duties (e.g., tobacco, petrol) are not classified as 'administered'. The effects of indirect taxes and excise duties are captured in the HICP-CT; see Section 9.2.

Examples of some form of price administration are:

- direct price setting by government; prices are always classified as fully administered.
- approval by government or a regulator; prices are considered as mainly administered if the government has actual and significant influence.
- subsidies on products; unless insignificant.
- indexation; indexed prices are to be classified as administered if the indexation is required by law
- price caps; prices are regarded as mainly administered if the maximum or minimum price set by government has a significant influence on the price level.

Explanatory notes on the definitions

In the definition of *mainly administered prices*, the expression '*significant influence*' involves an element of judgement.

([248]) Examples of the significance of government influence can be found in the Annex of the document *HICP Recommendation on Administered Prices*, 2018.

'Significant influence' at product level means that prices and/or price developments clearly differ, because of the administrative decision, from what they would otherwise have been. For example, the fact that prices need to be approved by government would not necessarily result in significant influence — in this case a judgement must be made as to whether prices are clearly influenced.

The classification of product categories according to whether their prices are considered fully-, mainly-, or not-administered should in principle be undertaken at the five-digit level of the ECOICOP. However, when weights are applied to items that fall below the 5-digit category, it is possible to classify the products below that level.

At the ECOICOP five-digit level, a rule of 50 % should be applied. If 50 % or more of households' final monetary consumption expenditure on a sub-class of the ECOICOP relates to products that are classified as mainly administered, the whole sub-class should be qualified as mainly administered. The same logic applies when classifying ECOICOP sub-classes as fully administered.

When however, 50 % or more of households' final monetary consumption expenditure on a sub-class of the ECOICOP relates to a mixture of products whose prices are either mainly or fully administered, then a second-stage rule is applied to determine whether the sub-class is considered as mainly or fully administered. If 50 % or more of the expenditure on products whose prices are administered is spent on products whose prices are fully administered, the whole sub-class is classified as fully administered. Otherwise, the whole sub-class is classified as mainly administered.

A few examples of administered prices are mentioned in the above definitions. An example of mainly administered prices in some countries is social rents, which are often subject to public regulation in some form, usually to ensure affordable shelter for some categories of tenant (see Section 12.4). For such rents, increases can be limited to a certain percentage or maximum monetary amount or made subject to procedures prescribed by law. Rail fares in some countries are controlled in similar ways.

Borderline cases — what to do

In practice, borderline cases occur in the form of product categories where it is not clear whether prices qualify as 'administered'. In such cases, judgements must be made, preferably supported by international practices and experiences. These have led to the development of agreed-upon conventions, which are set out in Section 9.3.3.

9.3.3 Supplementary explanations and conventions ([249])

Conventions

According to the European Commission's document HICP Recommendation on Administered Prices (see annex), the Harmonised Index of Administered Consumer Prices (HICP-AP) refers to products whose prices are set or significantly influenced by central government, local government, national regulators, or supervising authorities ('government'). For the HICP-AP, the sub-indices that are considered as mainly or fully

([249]) Experimental HICP-based estimates of administered prices in the euro area (europa.eu).

administered are defined at the five-digit level of the European classification of individual consumption according to purpose (ECOICOP).

The definition of administered prices *covers*:

- price changes approved by government and other national supervisory authorities. This may be the case, in particular, for network industries (e.g., telecommunication services by fixed-line providers or postal services) and some insurance prices depending on the country; the supervisory authority's decisions must be taken with the explicit objective of influencing consumer prices, even if only indirectly, through changes in producer prices;
- the effects of intentional restrictions on the consumer price level (price caps/price floors); and
- the effects of *permanent* (e.g., long-term) restrictions on consumer price changes.
- subsidies on products which should be classified as mainly administered unless the level of the subsidy is insignificant.

The definition *does not cover*:

- consumer prices subject to indirect taxation and excise duties (i.e., prices of goods and services with a high indirect tax component, e.g., tobacco, petrol). These are excluded as the effect of change in taxation is reflected in the HICP-CT;
- the effects of product regulation such as safety or environmental standards (e.g., safety standards for cars). These are excluded, as their effect on consumer prices is difficult to determine with any accuracy and almost all goods and services are subject to some form of regulation;
- prices subject to regulations under the EU's common agricultural policy. These mainly have an influence on food products at an intermediate stage, so their impact is very difficult to quantify;
- index-linked prices unless the reference indicator for linking is an administered price or the index-linking is mandatory and enforced by regulation and law. For example, the linking of rent changes and changes in insurance gross premiums to the overall HICP, CPI or other price indices, or the linking of gas-price changes to changes in oil prices, should normally not be considered as involving administered prices, as they are based on contractual agreements aimed at simplifying price adjustments, rather than government control of price changes;
- subsidies on production, the minimum wage and other regulated input prices affecting production costs; and
- the effects of *transitory* restrictions on consumer price changes, i.e., restrictions which are not *permanent* (e.g., restrictions in place in some countries around the time of the euro changeover).
- Temporary measures that are initiated by government policy to stimulate the economy or mitigate external shocks.

For *telecommunications*, the following conventions have been adopted:

- fixed line and internet services — if binding price regulation exists at the retail level (for at least 50 % of the consumption expenditures), fixed-line services should be considered as mainly administered. If price regulation exists only at wholesale level, fixed-line and internet services should be classified as non-administered unless there is (quantitative or qualitative) evidence of a dominant impact on prices over several years; and
- mobile services are considered as non-administered unless there is (quantitative or qualitative) evidence of a dominant impact on prices over several years or regulated termination rates account for over 50 % of operators' total revenues.

For *electricity and gas*, the HICP sub-indices cover a service component (transmission and distribution of electricity/gas) and a commodity component (the electricity and gas itself); the following conventions have been adopted:

- In cases where only the service component falls under the definition of an administered price, the whole sub-index is considered as non-administered; and
- In cases where both components fall under the definition of an administered price, the whole sub-index is qualified as administered.
- In some cases, such as in Germany, the prices for energy in general imply an administered price component and a 'free market price' component. If the administered share is higher than 50 % then this product group is qualified as administered. In practice however, the administered share fluctuates around 50% over time. Therefore, classifying a component as not-administered or mainly-administered if its share lies above the 50 % threshold for two consecutive years.
- In cases where a product group contains a mix of items below the 5-digit level for which the prices are fully- , mainly-, and not-administered, then the weight of the item may not be the best criteria for qualifying the nature of the product for purposes of the HICP-AT. In such exceptional cases, the classification of the category should be based on judgement.

Integrating changes in price administration practices over time into the HICP-AP

As previously stated, the HICP-AP ought to incorporate solely product groups for which prices are deemed as administered across the entire the calendar year. Over time, fully- and mainly-administered prices may become not-administered. Conversely, free-market (or non-administered) prices may become administered. Therefore, it can be expected that the composition of the HICP-AT will evolve over time. A review of the HICP-AP must be conducted in the month of January, and its content subsequently updated, following the year in which the change in status of a product has occurred.

Further comments

The following comments may be added:

- The list of administered prices in force in each Member State is updated annually following a Eurostat survey that Member States are obliged to respond to;
- When a product category is newly re-classified as administered or is no longer

administered, any price change for that category in connection with the re-classification should similarly be considered as administered or non-administered;

- Ambiguous cases between *permanent* and *transitory* restrictions on prices should be clarified via judgement or established convention, where available; and
- Situations may arise in which market prices are subject to government restrictions, such as price ceilings, price floors or price freezes. Such prices should be regarded as administered if the restrictions exert a significant influence on the price level.

9.3.4 Geographical coverage, special aggregates

The geographical coverage of the HICP-AP aligns with that of the HICP.

For the HICP-AP, the following special aggregates are produced monthly and made accessible on Eurostat's public database:

AP – administered prices
APF – fully administered prices
APM – mainly administered prices
TOT X AP – overall index excluding administered prices
TOT X APF – overall index excluding fully administered prices
TOT X APM – overall index excluding mainly administered prices

9.3.5 Index calculation

The HICP-AP weights coincide with the corresponding HICP weights and the price indices utilised are those used in the HICP. However, the HICP-AP contains only those weights and price indices where prices are administered as per the aforementioned definition. The HICP-AP index is thus calculated as the weighted aggregate of all ECOICOP indices that are classified as either fully or mainly administered.

The HICP-AP indices are calculated using the same methods as those used for the HICP (refer to Chapter 8). The monthly aggregation of the HICP-AP to the specified aggregates listed in Section 9.3.4 is performed by Eurostat.

10

Revisions

10 Revisions

10.1 Introduction

Revisions are broadly defined as any change in the value of a statistic made by an official national statistical agency ([250]) and released to the public. Revisions contribute to the improvement of statistics, enhancing their quality, reliability, and accuracy. To serve the interests of users, it is important to minimise the frequency and magnitude of revisions.

Within the context of the HICP and its latest Implementing regulations (EU) 2020/1148 (see below), three events can trigger a revision:

- Finalisation of provisional data
- Revisions due to mistakes
- Other revisions

It is worth noting that unlike national accounts, where revisions are an integral part of the production process, national consumer price indices, including the HICP, are generally not subject to revision. They are considered final when they are released, except in cases where a Member State provides a provisional estimate of their HICP data, which is likely to be revised when finalised. Any other type of revision must be agreed upon with Eurostat.

The European statistics code of practice (2017 edition) addresses the issue of revisions through three principles, as cited below ([251]):

1. Principle 6.6: *Advance notice is given regarding major revisions or changes in methodologies.*

([250]) Carol S. Carson, Khawaja, S., Morrison, T.K (1987), 'Revisions Policy for Official Statistics: A Matter of Governance', *IMF Working Paper,* WP/04/87.

([251]) European Statistics Code of Practice - Quality - Eurostat (europa.eu).

2. Principle 8.5: *Revisions follow standard, well-established, and transparent procedures.*
3. Principle 12.3: *Revisions are regularly analysed to improve source data, statistical processes, and outputs.*

It is the responsibility of the national statistical institute to inform users of revisions, including those resulting from errors. This code of practice aims to promote confidence in the HICP among users and contributes to more accurate and credible estimates. Data producers should recognise a clear and well-thought-out revision policy as an important aspect of good governance.

Article 7(5) of Regulation (EU) 2016/792, which establishes a common framework for the production of a harmonised index of consumer prices, states that:

> *'Harmonised indices and their sub-indices that have already been published may be revised.'*

This chapter will therefore outline the circumstances under which revisions may occur for the HICP and how they should be communicated to the public, including significant changes in the production method.

10.2 Legal provisions

The Commission Implementing Regulation (EU) 2020/1148, issued on 31 July 2020, outlines the methodological and technical specifications for harmonised indices of consumer prices (HICP) and the house price index in accordance with Regulation (EU) 2016/792 of the European Parliament and the Council. This regulation establishes the rules governing revisions in the HICP. Additionally, Article 9(3) of Regulation (EU) 2016/792 governs the introduction of significant changes in production methods by a Member State, as defined in Article 2 (21). The relevant provisions are described in the sections below.

The following provisions are derived from Implementing regulation (EU) 2020/1148 and are pertinent to this chapter on revisions.

Article 16: *Finalisation of provisional data*

Where a Member State transmits sub-indices or their weights as provisional, it shall finalise them with the following month's transmission.

Article 17 (1) and (2): *Revisions due to mistakes*

1. Member States shall correct mistakes and transmit the revised sub-indices or sub-index weights to the Commission (Eurostat) without unjustified delay.
2. Member States shall provide the Commission (Eurostat) with information on the cause of the mistake at the latest with the transmission of the revised data.

Article 18 (1) and (2): *Other revisions*

1. The timing, length and integration into the HICP of revisions other than those pursuant to Articles 16 and 17 shall be coordinated with the Commission (Eurostat).
2. Member States shall provide the Commission (Eurostat) with estimates of the revised HICP

sub-indices no later than 3 months prior to the planned implementation of the proposed revision.

Article 19: *Release of revisions*

Except for revisions pursuant to Article 16, any revision of the all-items HICP shall be made public, together with an explanation, on the website of the national body responsible for compiling the HICP.

Article 20: *Revision of sub-index weights*

Without prejudice to Articles 16 and 17, Sub-index weights shall not be revised.

10.3 Definitions

Most of the definitions pertaining to HICP revisions are stipulated in Article 2:

‘(*29*) *‘revision’ means a change in the indices or weights published by the Commission (Eurostat). A change between the flash estimate and the HICP for the same reference month shall not be considered a revision’*

‘(*30*) ‘*Provisional data’* means indices or weights that a Member State is expected to finalise in a later month

The Implementing Regulation (EU) 2020/1148 and Regulation (EU) 2016/792 do not explicitly define *other revisions.* However, one could argue that these revisions may arise from changes in production methods and new basic information, as defined in Article 2 (21) of Regulation (EU) 2016/792. A production method encompasses all steps involved in index compilation, including statistical production methods, compilation methods, data sources, concepts, definitions, or classifications. Changes in production methods are typically implemented in a coordinated manner according to Eurostat guidelines.

Not all changes occurring in the HICP each year are considered new production methods; for instance, the introduction of new weights and sample updates during the annual basket update exercise are not considered a new production method but are part of the regular compilation process.

The definition of HICP ‘flash estimates’ can be found in Article 2(13) of Regulation (EU) 2016/792:

‘Flash estimate of the HICP’ refers to an early estimate of the HICP provided by euro currency Member States, which may be based on provisional information and, if necessary, appropriate modelling.

10.4 Treatment of revisions

10.4.1 Reasons for revisions

As mentioned earlier, there are three reasons for revising the HICP:

1. Finalisation of provisional data (Article 16 of the Implementing Regulation)
2. Correction of mistakes (Article 17 of the Implementing Regulation)

3. Other revisions (Article 18 of the Implementing Regulation), often explained by changes in production methods and new basic information (see Regulation (EU) 2016/792 Art. 2 (17)).

Reasons 1) and 3) are typically planned revisions, while reason 2) normally leads to an un-planned revision.

10.4.2 Index and weights changes for which Eurostat's coordination is not required

For the euro area, Eurostat publishes a *flash* estimate of selected HICP aggregates based on early estimates of the indices received from euro area Member States (see Chapter 8). The euro area flash estimates are later replaced by finalised indices. The replacement of a flash estimate with finalised data is not considered a revision in the HICP, as per the above definition (Article 2(29)): '… *A change between the flash estimate and the HICP for the same reference month shall not be considered a revision*'.

Published HICP aggregates may also be compiled with country data transmitted as provisional estimates, which can be revised in the subsequent month (see Article 16 of the Implementing Regulation). Coordination with Eurostat is not required for such revisions, provided that the provisional indices are clearly indicated as such.

Finalisation of provisional data (Article 16)

According to Article 16:

> *'... Where a Member State transmits sub-indices or their weights as provisional, it shall finalise them with the following month's transmission'*

In the HICP, price collection is generally considered final at the end of each reporting month, although in practice, some late reporting can be taken into account in the subsequent release. Note that new input data very rarely become available after the HICP estimate is deemed final, but it is possible. In the event that such a situation arises, the finalisation of the HICP may be delayed by a month but cannot exceed that timeframe. Both provisional and revised figures should be clearly indicated in all publications.

10.4.3 Revisions for which Eurostat's coordination is required

As mentioned previously, there are three types of revisions: finalisation of provisional data, correction of mistakes, and other revisions. The latter two necessitate coordination with Eurostat.

Revisions due to mistakes (Article 17(1) and (2) of Implementing Regulation (EU) 2020/1148)

Mistakes are usually caused by errors in the calculation of indices or in data collection and entry. A mistake is always a possibility and puts pressure on the compilers of official statistics (e.g., errors in spreadsheet calculations or keying errors). When identified, it should be rectified, and the affected series should be revised. This practice is consistent with the recommendation outlined in the CPI Manual (2020), which states in Appendix 4 (para. 73): '*When it is found that published index estimates have been seriously distorted because of errors or mistakes made in* *their compilation, corrections should be made and published. Such corrections should be made as soon as possible after detection according to publicly available policy for correction*.'

Regardless of the possibility of revisions, efforts should be made to minimise their frequency due to mistakes by employing appropriate quality management techniques and validation procedures. However, it is impossible to completely eliminate errors.

According to Article 17:

> *'... 1.Member States shall correct mistakes and transmit the revised sub-indices or sub-index weights to the Commission (Eurostat) without unjustified delay.*
>
> *2. Member States shall provide the Commission (Eurostat) with information on the cause of the mistake at the latest with the transmission of the revised data.'*

Other revisions (Article 18)

Unlike the correction of mistakes (Article 17) and the finalisation of HICPs first published as provisional (Article 16), 'other revisions' typically entail a significant improvement in the accuracy of the HICP. The most common reasons for 'other revisions' are the adoption of new production methods or the availability of new basic information. The timing of these revisions is often foreseeable or even planned. Eurostat should be notified of the planned revision at least three months in advance, along with an estimate of its impact.

For instance, new or improved basic information for the compilation of HICPs may become available inter *alia* because of new and better sources of data, such as recent updates and changes in the revenue or tiered pricing structures of a public utility (e.g., electricity or water) company. The availability of such new information does not normally occur without prior notice.

The HICP serves as a key macroeconomic indicator used for the implementation of monetary policy. Therefore, revisions should only be considered in exceptional cases. Sometimes, the introduction of a new production method or of new basic information coincides with a revision of previously published indices. When a decision has been made to revise, the compiler may need to determine the period for which the revision of the HICP should apply. It could be limited to revising only the latest month's data when new information becomes available, or a new production method is introduced. Revisions covering a longer time span, such as a year or more, would not prevent a break in the series; they would simply be shifted backward in time. The advantage of longer retrospective revisions (i.e., a historically consistent HICP), permitted under the legal framework, is that recent inflation rates can be more accurately estimated. This accuracy is significant for the implementation of monetary policy and assessing its performance.

National revision policies, practices, and specific user needs may also influence the decision to revise. In cases where the HICP is used to index pensions, social benefits, and other monetary contracts, users should be made aware that the index is subject to such revisions. Nevertheless, price statisticians should be mindful that even if revisions are permitted, they should be kept to a minimum. When a NSI consider revising past data, the implementation should align with Article 18 of the Implementing Regulation.

According to Article 18:

> *'... 1.The timing, length and integration into the HICP of revisions other than those pursuant to Articles 16 and 17 shall be coordinated with the Commission (Eurostat).*

2. Member States shall provide the Commission (Eurostat) with estimates of the revised HICP sub-indices no later than 3 months prior to the planned implementation of the proposed revision.'

10.4.4 Weights revisions

The legal framework sets forth the fundamental criteria for determining the weights in the HICP. The matter of weights is addressed in the subsequent articles of both the HICP Framework Regulation and the Implementing Regulation.

The Framework Regulation

The Framework Regulation in question is Regulation (EU) 2016/792, enacted by the European Parliament and the Council on 11th May 2016. This regulation pertains to the harmonised indices of consumer prices and the house price index, while also repealing Council Regulation (EC) No 2494/95.

'Article 3 — Compilation of the harmonised indices

(10) Each year, Member States shall update sub-index weights for the harmonised indices. The Commission shall adopt implementing acts specifying uniform conditions for the quality of weights of the harmonised indices. Those implementing acts shall be adopted in accordance with the examination procedure referred to in Article 11(2).'

The Implementing Regulation

Commission Implementing regulation (EU) 2020/1148

'Article 3 – Weights

1. Member States shall derive the sub-index and elementary aggregate weights used in the index for year t as follows:

(a) Until 31 December 2022, national accounts data for year t–2 and any available and relevant information from household budget surveys and other data sources shall be used to obtain subclass expenditure shares and divide them among the elementary aggregates of the subclass. From 1 January 2023, national accounts data for year t–2, which can be complemented with data from a recent household budget survey and other sources, shall be used to obtain subclass expenditure shares and divide them among the elementary aggregates of the subclass;

(b) The expenditure shares for year t–2 shall be reviewed and updated to make them representative of year t–1;

(c) The expenditure shares for the elementary aggregates shall be adjusted with an appropriate price change between year t–1 and December of year t–1.

Article 17 (Release of revisions) of Implementing Regulation (EU) 2020/1148 offers comprehensive guidance on handling revisions in relation to weights. This article stipulates the following:

1. Member States shall correct mistakes and transmit the revised sub-indices or sub-index weights to the Commission (Eurostat) without unjustified delay.

2. Member States shall provide the Commission (Eurostat) with information on the cause of the mistake at the latest with the transmission of the revised data.

Consequently, revisions to HICP weights from previous years should only be carried out if a ‘mistake’ in their calculation has been identified. HICP weights *should not be revised* when new national accounts or HBS data become available, even if such data could potentially improve the weighting system. This precautionary measure prevents repeated revisions of HICPs until the underlying national accounts data are finalized.

It should be noted that the HICP differs in this respect from national accounts, where revisions are a common feature reflecting the availability of more comprehensive and detailed information for a given quarterly or annual estimate. HICP weights should be based on the most reliable data accessible during their compilation, even if these data are anticipated to undergo planned revisions from national accounts or other sources in the future.

In situations where a Member State has transmitted provisional sub-index weights, these weights should be finalised with the following month’s transmission. This procedure aligns with the provisions set forth in Article 16 of Commission Implementing Regulation (EU) 2020/1148.

Lastly, according to Article 20 of Commission Implementing Regulation (EU) 2020/1148, it should be noted that sub-index weights shall not be revised (with the exception of Articles 16 and 17).

Weights for elementary aggregates below the five-digit ECOICOP level are not governed by the HICP regulation. Therefore, countries possess the freedom to revise those weights. Typically, such revisions are infrequent within a year, owing to the utilisation of bilateral fixed quantities formulae. Conversely, when employing multilateral methods, the lower level weight (below ECOICOP) may undergo monthly changes.

10.5 Practical issues

10.5.1 How to make revisions

It is of utmost significance that all Member States have well-established and transparent revision policies. The OECD/Eurostat have developed comprehensive guidance and best practices on revision policy and analysis for sub-annual economic statistics([252]). Member States should consider this guidance as the fundamental starting point when contemplating revisions.

The process of implementing a revision involves several distinct steps, the nature of which will vary based on the reasons behind the revision. However, there are several core steps that should be adhered to when carrying out a revision. These steps are elucidated below.

- Initially, in all revision cases, Member States should conduct a thorough assessment to determine the necessity and feasibility of the revision. This involves analysing the impact of the changes on the index and carefully examining the applicable rules specific to the given situation.

([252]) Guidelines for Establishing a Real-Time Database for Performing Revisions Analysis - OECD Web Archive.

- Subsequently, Member States concerned, depending on the reason for the revision (see Section 10.4), should inform Eurostat in advance of their decision to revise their data, if required.
- The next step involves the primary revision work. Member States concerned should recalculate the all-items HICP index and the sub-indices for all ECOICOP categories in question, where relevant. This recalculation should encompass the 12 months preceding the reference month in which the revision takes effect (see Section 10.5.2).
- Finally, the revised data should be published. Revisions ought to be clearly elucidated on the national body's website responsible for compiling the HICP (Article 19). These revised estimates must be communicated to users promptly and added to the corresponding metadata. It is essential to coordinate revisions with Eurostat at least three months prior to the release of the revised estimates.

10.5.2 Timing of revisions (Articles 16, 17, and 18)

The timing of an HICP revision depends on the cause of the revision.

For revisions arising from the correction of mistakes (Article 17(1) and (2)), revisions to the sub-indices or sub-index weights should be made without undue delay. Furthermore, '*Member States shall provide the Commission (Eurostat) with information on the cause of the mistake at the latest with the transmission of the revised data'.*

Regarding revisions resulting from the utilisation of new or improved basic information, and new methodologies (referred to as 'Other revisions' in Article 18(1) and (2)), the '*timing, length and integration into the HICP of revisions shall be coordinated with the Commission (Eurostat).* Additionally*, 'Member States shall provide the Commission (Eurostat) with estimates of the revised HICP sub-indices no later than 3 months prior to the planned implementation of the proposed revision'.*

As outlined in Article 16, revisions arising from the finalisation of an HICP a Member State initially '*transmits sub-indices or their weights as provisional it shall finalise them with the following month's transmission*'

10.5.3 Procedure for publishing a revision

Article 19 (Release of revisions) within Implementing Regulation (EU) 2020/1148 stipulates the following:

> *'Except for revisions pursuant to Article 16, any revision of the all-items HICP shall be made public, together with an explanation, on the website of the national body responsible for compiling the HICP.'*

For the sake of transparency, revised data should be accompanied, preferably at the time of publication, by documentation and complete metadata allowing users to be informed of the reasons for the revisions. At a minimum, the documentation should include:

- The reasons for the revision (e.g., new methodology, additional basic information, or correction of a mistake), as well as the method used to correct the data or the details relating to the new methodology.

- For a new methodology, an estimate of its impact on the sub-indices affected by the change and on the overall HICP.
- An assessment of the impact on the annual inflation rates and the method employed for calculating this impact.

Prior to the publication of indices resulting from a planned methodological change, users should be duly informed about the nature of the change, the underlying reasons, and its likely implications for future indices and rates of change. If the changes are significant, they should be announced in advance. In particular, key users (central banks, finance ministries, etc.) should be given prior notification of any substantial methodological revisions to facilitate their preparedness and enhance their comprehension of the reasons for and nature of the modifications.

The Member State may incorporate the pre-announcement in its monthly publication or issue a dedicated press release through websites or social media channels.

11

Data requirements and processes at Eurostat

11 Data requirements and processes at Eurostat

11.1 Introduction

During each month Eurostat releases separate sets of HICP data at two different times. One set of data, the preceding month's HICP for each Member State and various European-level aggregates, is disseminated around the middle of the month, included here is the complete dataset of the latest HICP (i.e., its sub-components and the all-items for all Member States, which also includes various special aggregates). The other dataset is released to the public at the end of each reference month and comprises flash estimates for the monthly and annual inflation rates for various Euro-level HICP sub-components, the all-items and special aggregates; also included in this release are monthly and annual flash estimates of the inflation rate for those euro area countries. These two datasets are made available through Eurostat's dissemination database and tables which can be found in its *Statistics Explained* articles while also being widely reported by the usual media outlets. Moreover, the newly released data are sent directly to the Directorate-General for Economic and Financial Affairs (DG ECFIN) and the European Central Bank (ECB); these organisations use the information for policy purposes. Other users can retrieve these data directly from Eurostat's dissemination database [253].

Before their release, HICP input data are processed at Eurostat; they undergo successive steps for validation, computation and preparation before being published. Eurostat also collects, produces and makes available a range of metadata on the HICP [254].

The entire HICP dataset includes the full indices and weights for each Member State and European aggregates (i.e., country-group indices for the EU, the euro area and the European Economic Area (EEA)). These data are provided for aggregates for the hierarchical categories of the ECOICOP (see Chapter 2 and Annex I) and several special aggregates. The special

[253] Database - Harmonised Indices of Consumer Prices (HICP) - Eurostat (europa.eu).

[254] HICP metadata – Eurostat (Europa.eu).

aggregates are derived from the ECOICOP indices by combining them thematically (see Annex 11.1). Eurostat produces the European and special aggregate ECOICOP indices and weights provided by the Member States.

This chapter describes how Eurostat produces the HICP estimates and the corresponding metadata. More precisely, it describes the various steps and processes involved with producing the estimates and finally releasing them to the users.

11.2 Legal provisions

The legal framework provides the minimum standards in terms of the data requirements that the Member States must adhere to when providing their data to Eurostat for the purpose of generating the HICP. The issue of data requirements is covered in the following articles of the HICP Framework Regulation and the Implementing Regulation.

The Framework Regulation

Regulation (EU) 2016/792 sets out the requirements for the provision of data relevant to the HICP. Article 3(1) states that:

‘Member States shall provide the Commission (Eurostat) with the harmonised indices as defined in point (12) of Article 2.’

Article 2(12) defines the harmonised indices:

‘’harmonised indices’ means the HICP, the HICP-CT, the OOH price index and the HPI;’

Member States are thus required to transmit the HICP and HICP-CT indices to Eurostat. Regulation (EU) 2016/792 also contains the following provisions:

- The index reference period is defined in Article 5(5):

‘The common index reference period for the harmonised indices shall be 2015. That index reference period shall be used for the full time series of all harmonised indices and their sub-indices.’

- For cases where the transmission of sub-indices is voluntary, Article 5(7a) applies:

‘Member States shall not be required to produce and transmit:

(a) sub-indices of the HICP and of the HICP-CT accounting for less than one part in a thousand of the total expenditure;’

- For sub-indices which are part of the ECOICOP classification but are not included in the coverage of the HICP, Article 5(8) applies (see Chapter 2):

‘Member States shall not be required to produce the following sub-indices of ECOICOP, either because they are not included in the household final monetary consumption expenditure or because the degree of methodological harmonisation is not yet sufficient:

02.3 Narcotics;

09.4.3 Games of chance; ([255])

12.2 Prostitution;

12.5.1 Life insurance;

12.6.1 FISIM.'

- The frequency of HICP indices is stated in Article 6(1):

  'Member States shall provide the Commission (Eurostat) with the HICP, the HICP-CT and their respective sub-indices at monthly intervals, including those sub-indices produced at longer intervals.'

- The provision of annual updated weights is specified in Article 6(4):

  'Each year, Member States shall provide the Commission (Eurostat) with updated sub-index weights for the harmonised indices.'

- The data transmission deadlines for the indices are stated in Article 7(1a):

  'Member States shall provide the Commission (Eurostat) with the harmonised indices and all sub-indices by no later than:

  (a) 15 calendar days, for the February to December indices, and 20 calendar days, for the January indices, after the end of the month for which the indices are calculated; …'

- For weights, Article 7(2a) states that:

  'Member States shall provide the Commission (Eurostat) with the updated weights by no later than:

  (a) 13 February each year for the monthly indices;'

- For flash estimates, Article 7(3) states that:

  'Member States whose currency is the euro shall provide the Commission (Eurostat) with the flash estimate of the HICP no later than the penultimate calendar day of the month to which the flash estimate refers.'

- The standards to be used for data and metadata transmissions are referred to in Article 7(4):

  'Member States shall provide the Commission (Eurostat) with the data and metadata required by this Regulation in accordance with data and metadata exchange standards.'

- Article 7(5) makes it clear that HICP indices can be revised (see Chapter 10):

  'Harmonised indices and their sub-indices that have already been published may be revised'.

The Implementing Regulation

Commission Implementing regulation (EU) 2020/1148

Chapter 2: Harmonised Index of Consumer Prices and Harmonised Index of Consumer Prices at Constant Tax Rates

([255]) Games of chance were only temporarily excluded from the coverage of the HICP for methodological reasons and are expected to be included in 2026.

'*Article 15 - Breakdown of the flash estimate*

Member States whose currency is the euro shall transmit to the Commission (Eurostat) flash estimates for all sub-indices in their HICP.

Chapter 4: Data and Metadata Exchange Standards and Deadlines

'*Article 26 – Data and metadata exchange standards*

1. Member States whose currency is the euro shall transmit to the Commission (Eurostat) flash estimates for all sub-indices in their HICP.
2. Confidential data as defined in Regulation (EC) No 223/2009 of the European Parliament and of the Council shall be flagged appropriately when transmitted to the Commission (Eurostat).

'Article 27 – Metadata exchange deadlines

1. *Member States shall annually review and update their HICP and HICP-CT metadata for the current year and transmit them to the Commission (Eurostat) by 31 March.*
2. *Member States shall annually review and update their OOH price index and HPI metadata for the current year and transmit them to the Commission (Eurostat) by 30 June.*

11.3 Input data for the HICP

Most of the input data required to produce and publish the HICP come directly from the same Member State statistical departments that are responsible for producing their consumer price indices. Some additional input data, such as purchasing power parities (PPPs), are also needed for the country weights that are used for generating the European-level HICPs.

Member States send the following data to Eurostat according to a pre-determined timetable:

- *HICP and HICP-CT*: these are produced and transmitted monthly for all relevant ECOICOP categories. They refer to the common reference year 2015. The exception is new sub-indices for which the series do not cover the year 2015. When integrated into the HICP, they are linked into the HICP in December of a preceding year at the level of 100 index points and published from the following January onwards;
- *HICP flash estimates (HICP-FE)*: euro area Member States send the full set of ECOICOP indices. Only euro area countries are required to send HICP-FE data;
- *National ECOICOP category weights*: Member States send these annually for all ECOICOP categories for which they produce an HICP;
- *Complementary data for deriving country weights*: Member States also provide Eurostat with annual estimates of *income in kind* and *administrative charges of private pension funds and the like*, which are part of 'individual consumption expenditure by households' but do not fall within the scope of the HICP. These expenditure categories are not identified separately in the ECOICOP expenditure data and thus need to be deducted from the expenditures (see Section 11.4.6); and
- *Administered prices definitions*: each year, Member States send a list of the full set of ECOICOP items where they are classified as fully, mainly or not administered (see Chapter 9).

Member States transmit their data files using Eurostat's single data entry point system, EDAMIS (electronic data files administration and management information system). The use of EDAMIS is compulsory for the transmission of all regular ESS datasets to Eurostat. Data are transmitted using a secure channel, traffic records are kept and the EDAMIS system sends notifications automatically to senders and recipients when files arrive. EDAMIS also sends automatic reminders to the senders before the expected data transmission. EDAMIS is installed in all Member States that provide Eurostat with HICP data. Eurostat also uses it to send data to the Member States if needed and to the ECB and DG ECFIN.

Detailed technical requirements for the data files and their transmission can be found in the HICP data transmission guide. Eurostat continuously updates the guide, which is sent to all data suppliers . The guide shows which data flows are currently active for the HICP domain. It gives the conventions used for naming the files, along with the required data format. It also lists the additional information that must be included with each file and for each transmitted record, how to code the records, etc. The files can be sent under embargo to Eurostat by including a date and time stipulating the earliest that the data can be released (i.e., when the embargo expires).

In practice, each transmitted index and weight file contains information for a single period (month or year). The files consist of several lines, each of which contains information about a single observation (index, inflation rate, weight, etc.) or the embargo for a given period for each expected item. Member States transmit all HICP datasets using the SDMX format ([256]). Each data item can be recorded with a flag indicating its status. In the HICP publications, the most frequently used flags are listed in table 11.3.27.

Table 11.3.27

Flags used in the publication of HICP data ([257])

Flag	Title	Use
'p'	Provisional	Used when it is known that the data are likely to be revised with the subsequent transmission.
'd'	Definition differs	Used when the index or weight is not compiled fully following the set standards; or, in the case of the accession and candidate countries, if Eurostat has not made a thorough assessment of the conformity of the country's HICP with the HICP standards.
'e'	Estimated	Used when data were not compiled according to the normal process, but using statistical modelling; typically used for HICP-FE.
'c'	Confidential	Used when a Member State does not give permission to publish the data.

([256]) SDMX (Statistical Data and Metadata eXchange) is an international initiative that aims at standardising and modernising the mechanisms and processes for the exchange of statistical data and metadata among international organisations and their member countries.

([257]) This list of flags may be subject to change.The full list of flags currently used by Eurostat can be found in the Eurostat's database (europa.eu).

Flag	Title	Use
‘r’	Revised	Used when previously transmitted data are changed.
‘u’	Low reliability	Used, for example, during the COVID-19 crisis for data based on over 50% of imputed prices and therefore considered having lower than usual quality.
‘b’	Break	Used when a time series statistical break is introduced (i.e. a different methodology is going to be applied in comparison to the preceding periods).
‘:’	Not available	Data was not available at the time of publication.

To complement the HICP data, Eurostat collects and publishes a complete set of metadata about the HICP. Member States update the structured SDMX-compliant metadata annually using a web-based tool provided by Eurostat.

11.3.1 Transmission of indices

Around the middle of each month, Member States transmit to Eurostat a full set of national HICP and HICP-CT indices for all hierarchical levels of the ECOICOP. The files transmitted each month will therefore include an index value for all ECOICOP categories from the lowest level (five-digit sub-class) up to the all-items index that a given Member State produces. For the HICP-FE, the euro area countries also send a data file at the end of each month, consisting of the full set of detailed ECOICOP indices.

The transmitted index sets must be consistent in aggregation, i.e., aggregated correctly from the lowest level to the highest all-items level when combined with the ECOICOP category weights that Member States provide at the beginning of each year.

The indices are provided with the same number of decimal places as Member States use in their own production process, so that Eurostat can re-compute the aggregation from the lowest ECOICOP level indices up to the highest. By convention, Eurostat publishes the national hierarchical HICP and HICP-CT as aggregated and published by Member States. However, Eurostat is responsible for calculating the special aggregates.

All indices are sent monthly with the index reference year 2015=100, except for the index series that start later than December 2014, which are to be transmitted based on values from the previous December. In principle, starting with a January index, Member States may adjust the set of indices they send to Eurostat by adding new sub-indices that have become relevant in the country, or removing sub-indices that have become obsolete and are therefore no longer produced.

Eurostat uses the indices transmitted by Member States, but (where country data are missing) also price data for petroleum products taken from DG ENERGY’s *Weekly oil bulletin*. Also, if a Member State has not delivered the index data file on time for the scheduled publication, Eurostat produces an estimated index set using a statistical model for the country in question. The estimated indices are used to compute the aggregates but are not published.

11.3.2 Transmission of ECOICOP category weights

The ECOICOP category weights as supplied by each Member State are used directly, without adjustment, to calculate the HICP, HICP-CT, HICP-FE and HICP-AP, and the special aggregates. Thus, only one set of weights is used throughout the HICP domain.

Every February, Member States transmit a new set of HICP weights for all ECOICOP categories or positions for which they will be producing an index in the current year. The weights are applied to the indices for January to December of the current year. As the official deadline for transmitting the new weights is after the release date for the January HICP-FE, the euro area Member States are asked to transmit in advance the preliminary weights to be used for the January HICP-FE.

The weights are transmitted with the same precision (i.e., same number of decimal places) as Member States use in their national HICP aggregation. They are provided as parts per thousand and the sum of weights from lower levels must aggregate correctly to those at the higher levels. The all-items (ECOICOP 00) weight has to equal exactly 1000.

Member States do not always have to produce all the lowest-level ECOICOP indices. There is an exemption where the weights are below a threshold of one part per thousand. In such cases, the preferred approach is that positive, but below-threshold weights are distributed within an ECOICOP class proportionally among products with above-threshold weights (see Chapter 3).

11.3.3 Country weights

In addition to ECOICOP category weights, Eurostat needs country weights to establish the European-level aggregates (see Table 11.2). These aggregates are calculated by Eurostat and are not transmitted by the Member States. For all these aggregates, each country's weight corresponds to its share of consumption expenditure in the total of the group.

11.3.4 Administered prices (HICP-AP)

The HICP-APs are specific indices that are produced by Eurostat based on the classification of the ECOICOP indices which defines the extent of price administration. This information is provided by the Member States (see Chapter 9).

For the calculation of HICP-AP aggregates, Member States provide Eurostat annually with information on which categories of ECOICOP are administered, and whether they are qualified as fully or mainly administered. Changes to the HICP-AP classification that are relevant to the HICP are included in the compilation of the HICP-AP indices with the index for January; the classification should not change within the year. The HICP-AP classification by Member States ([258]) is published on Eurostat's website.

([258]) The classification can be found through the HICP administered prices dataset.

11.3.5 Transmission deadlines and publication calendar

The legal deadlines for the transmission to Eurostat of the HICP, HICP-CT and HICP-FE indices and the ECOICOP category weights are set out in Regulation (EU) 2016/792 (see Section 11.2). For other datasets, such as the HICP-AP classification and preliminary HICP-FE weights data, Eurostat establishes deadlines in cooperation with the Member States. It expects to receive the data by 11.00 CET on the day of the agreed deadline.

Regulation (EU) 2016/792 requires Member States to provide Eurostat with the February to December HICP and HICP-CT indices no later than 15 calendar days after the end of the reference month; for the January indices, the period is 20 calendar days after the reference month. For the HICP-FE, the euro area Member States must send the indices no later than the penultimate calendar day of the month.

For the ECOICOP category weights, the annual deadline is 13 February. Eurostat asks the euro area countries to provide preliminary weights for the January HICP-FE calculation a few days before the index delivery deadline, so that they can be processed prior to the index calculation.

For the HICP-AP, the annual update for the classification of ECOICOP product categories at five-digit class level as fully, mainly, or not administered is normally requested with the same deadline as the one for the ECOICOP category weights.

For the February to December indices of each year, Eurostat's target is to publish the complete set of HICP and HICP-CT indices two working days after the transmission deadline, which is about 17 calendar days after the end of the reference month. The publication of the January index is normally scheduled five working days after the data delivery deadline, i.e., on or around February 25th.

The HICP-FE publication target is the day following the data delivery deadline. Eurostat aims to release the HICP-FE on the last working day of the month, except for December, for which the publication date is the beginning of January the following year.

The HICP publication calendar [259] which takes into account the deadlines given in Regulation (EU) 2016/792, weekends and public holidays, is finalised in the autumn and published on Eurostat's website.

11.3.6 Data validation

Member States validate their data files using their own data quality checks before transmitting them to Eurostat. Regardless of any checks by the Member States, Eurostat subjects all incoming data files to a set of structure and content validation steps.

As regards the index files, in addition to the structural validation, Eurostat checks:

- that index values are provided for all ECOICOP categories/positions which have a non-null (zero) weight;
- that each index value is the result of the aggregation of its constituent lower-level ECOICOP index values;

(259) HICP release calendar (inflation) – Eurostat (Europa.eu).

- that index values are within a reasonable prediction range. The one-step-ahead prediction is done using a statistical model integrated into the FAME production system. Values with extreme changes are further inspected and if necessary the Member State could be asked to verify and confirm the change;
- whether there are any gaps in the full time series;
- whether an index value is the same as in the previous month; and
- that the HICP and HICP-CT data are consistent, i.e., that the rates of change in the two indices can differ only if there has been a tax change. The comparison further informs the judgement as to whether extreme HICP values are plausible.

With regards to the weights files, in addition to the structural validation, Eurostat checks:

- that the weights sum to 1000;
- whether there are missing or null (zero) values;
- the additivity of the weights, e.g., the weight of ECOICOP 07 should be the sum of all its corresponding sub-categories ECOICOP 071, 072 and 073, etc.; and
- for significant differences from the previous year.

The results of Eurostat's validation are sent to the Member States for final verification. If it appears that there have been errors in the structure or the content of a file, the Member State is asked to return a corrected file to Eurostat. Once the file passes all validation checks, the data are uploaded to Eurostat's production database and they are then ready to be disseminated and used in the computation of the special and European aggregates.

11.4 Index calculation at Eurostat

Eurostat's index calculation system uses the indices and ECOICOP weights reported by Member States, complemented by country weights calculated by Eurostat. All data are aggregated according to the ECOICOP classification (see Chapters 2 and 3).

Based on these three sets of data (indices, ECOICOP category weights and country weights), Eurostat computes the following monthly indices:

- The European aggregates – these cover all countries in each group for which all standard sub-indices and special aggregates are calculated. Eurostat produces two types of European aggregate:
  - those that have changing country composition over time, i.e., euro area and EU aggregates that refer to country compositions at a specific point in time; and
  - those that have fixed country composition over the whole series (see Annex 11.2);
- The special aggregates at country and European levels – these are combinations of specific ECOICOP classes; and
- The HICP-AP aggregates – these differ from the other special aggregates in that their composition varies depending on the country and over time.

All index calculations are performed with unrounded data and the resulting indices are rounded to one or two decimal places depending on national practice. All European aggregates are published with two decimal places. As Eurostat uses unrounded data in the aggregation, users cannot exactly replicate the results using the published rounded data.

In addition to the monthly index aggregation, Eurostat calculates a set of average indices and rates of change (see Table 11.5.31).

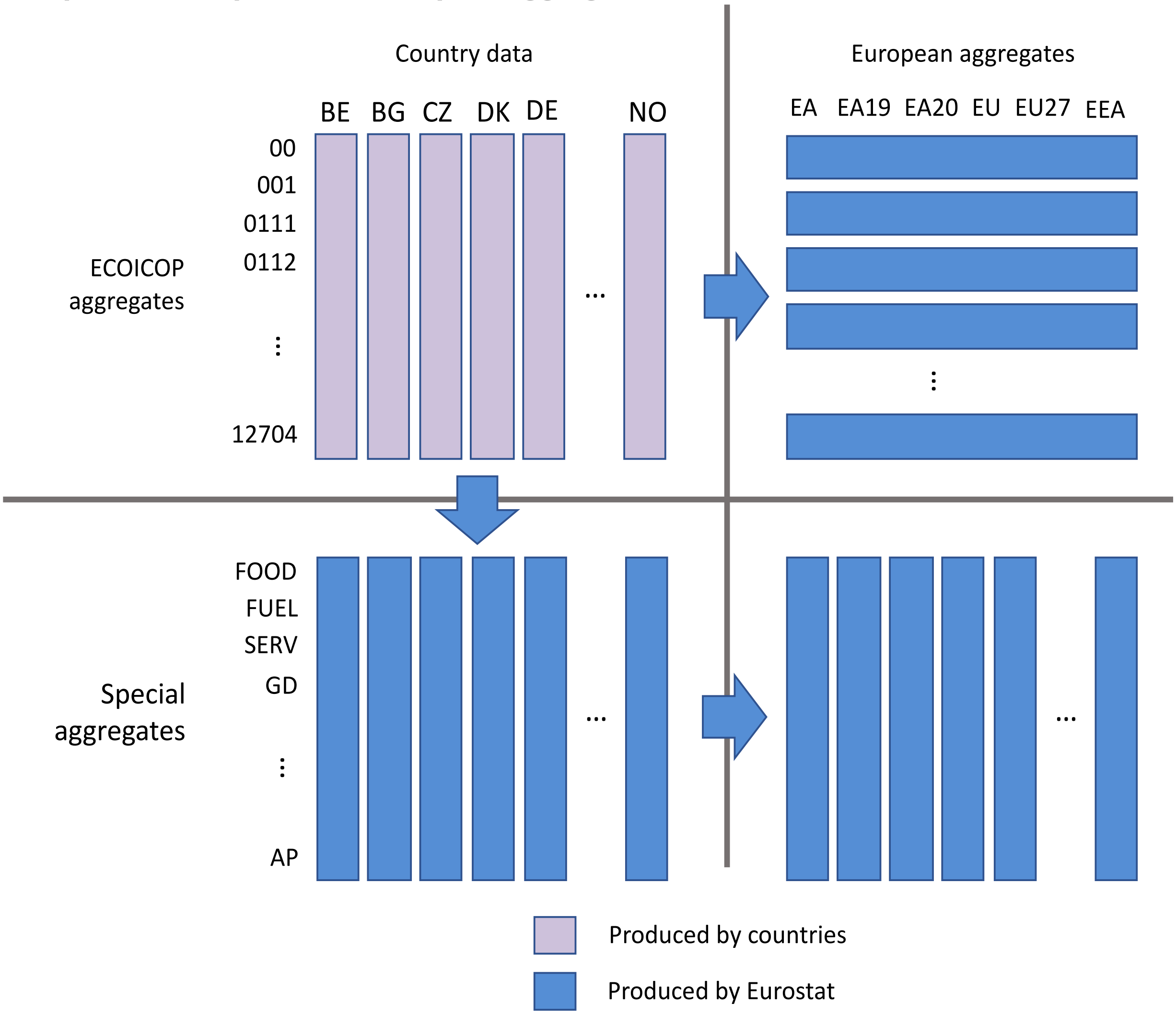
In Eurostat's production process, the special and European aggregates are compiled as outlined (a weighted average of unchained indices at each level of ECOICOP), using the formulas presented in Chapter 8. The country indices (index reference year 2015) are first unchained, and the aggregates are computed from these unchained time series using appropriate country and ECOICOP category weights. As the resulting aggregates series are also unchained, they need to be chained back so that a longer time series can be created and referenced back to the index reference year.

The computation of the unchained index values for a given year from a chained index requires the index value for December of the previous year.

For HICP-AP aggregates, the ECOCIOP category compositions can change over the years, but the computation as such is the same as for fixed-composition special aggregates.

Figure 11.4.7

Computation of special and European aggregates at Eurostat



11.4.1 European aggregates

European aggregates (the euro area, EU and EEA indices) with changing compositions are computed based on the relevant country compositions at a specific point in time. New countries are integrated into the aggregates using a chain index formula. Annex 11.2 shows how the compositions have changed over time. The fixed-composition aggregates have the same country composition throughout the index series.

The aggregates are calculated as a weighted average of the unchained indices of the countries belonging to the European aggregate. The weights used in the aggregation are computed every year to reflect each country's share of expenditure in the EU, euro area or EEA total. The calculation for the EU and the EEA aggregates includes the euro area as a single entity.

Based on the indices provided by the countries (or the special aggregates it has computed for each country), Eurostat computes the European aggregates grouping for the Member States.

Table 11.4.28

European aggregates

Aggregate	Acronym	Composition	Use	Notes
Euro area	EA	Changing composition	Official euro area aggregate	provides the index of the countries that were euro area members at any specific point in time
Euro area 20	EA20	Fixed composition	Published for analytical purposes	All current euro area Member States
Euro area 19	EA19	Fixed composition	Published for analytical purposes	EA20 without Croatia
European Union	EU	Changing composition	Official EU aggregate	All Member States at any given point in time
European Union 27	EU27	Fixed composition	Published for analytical purposes	All current Member States
European Union 28	EU28	Fixed composition	Published for analytical purposes	EU27 with UK for the pre-Brexit period
European Economic Area	EEA	Changing composition	Official EEA aggregate ([260])	The EU + Norway and Iceland

New Member States are integrated into the aggregates using a chain index formula. When the composition changes at the short-term index reference month December, the standard computation presented in Chapter 8 applies. However, if the composition of the European aggregates changes at any other time of the year (e.g., when Croatia joined the EU in July 2013), then the year is divided into two periods (before and after the change) that are then chained together. The aggregate for the first part of the year (from January to the month preceding the month of the change) is computed in the usual way. For the months after month m of the composition change, the aggregate is computed on indices referenced to (m-1). The second part of the year is considered as a new year. This operation requires a technical price-updating of the ECOICOP category weights from the Dec t-1 weight/price reference to the new link month, thus establishing new country weights. As a result, there will be two sets of weights within the year in such cases.

([260]) Liechtenstein does not provide an HICP.

11.4.2 Special aggregates

Special aggregates are computed by Eurostat, but also by some Member States.

Based on indices provided by Member States, Eurostat computes special aggregates by aggregating/grouping several sub-indices (e.g., the ‘seasonal food’ special aggregate regroups the sub-indices 01131, 01133, 01161 and 01171).

Except for HICP-AP, the compositions of the special aggregates are fixed over time and over countries, provided that a country is producing all the sub-indices for the special aggregate in question.

There are two possible ways of computing European special aggregate indices:

1. Option 1: computation from countries’ special aggregates; or
2. Option 2: computation from the ECOICOP indices of European aggregates.

In theory, both options lead to the same results, except where some figures are not available. Eurostat uses Option 1 to compute the European special aggregates.

11.4.3 HICP flash estimate

The HICP-FE for the euro area is based on early national HICP data provided by all euro area Member States. The HICP-FE gives an early indication of what the euro area HICP is likely to be when the full dataset is available.

HICP-FE is produced only for the total euro area (changing composition) and for the following aggregates:

- all-items HICP (CP00);
- food, alcohol & tobacco (FOOD)
    - processed food including alcohol and tobacco (FOOD_P);
    - unprocessed food (FOOD_NP);
- energy (NRG);
- non-energy industrial goods (IGD_NNRG);
- services (SERV);
- overall index excluding energy (TOT_X_NRG);
- overall index excluding energy and unprocessed food (TOT_X_NRG_FOOD_NP); and
- overall index excluding energy, food, alcohol and tobacco (TOT_X_NRG_FOOD).

11.4.4 ECOICOP category weights

Once a year, Member States produce ECOICOP weights at all levels of the classification. A Member State is not obliged to produce indices and weights for every ECOICOP category (although it may choose to do so) if the expenditure on the category represents less than one part per thousand of its total household final monetary consumption expenditure compiled according to the HICP concept (see Chapter 2 and Section 11.2).

11.4.5 Calculation of country weights

The country weights are calculated at Eurostat in cooperation with the Member States. They are produced annually, for use starting in January of each year.

In the calculation of the country weights, Eurostat uses, as inputs, national accounts expenditure data, purchasing power parities (PPPs), HICP data, and the irrevocable euro conversion rates ([261]) (if necessary). These data are taken from sources available at Eurostat. As the national accounts expenditure data are not sufficiently detailed to enable all necessary adjustments to achieve complete adherence to the HICP concepts, Eurostat asks the Member States for additional information for those expenditures that fall outside the scope and coverage of the HICP (see Chapter 2). This information is then used to adjust the provided expenditure data by deducting expenditure on items that do not have a specific ECOICOP category.

The national accounts aggregate that is used as the starting point for estimating the country weights is ‘individual consumption expenditure by households’, in national currency units, adjusted for HICP coverage and scope, and (for non-euro area countries) PPP exchange rates. Eurostat uses year *t-1* expenditures for the country weights in year *t*. For example, the country weights for year 2022 are derived from the corresponding national accounts figures from year 2021.

In the first step of the country weights calculation, the following six expenditure categories, which fall outside the coverage of the HICP, are deducted from ‘individual consumption expenditure by households’:

1. narcotics (02.3.0.0);
2. imputed rentals for housing (04.2.0.0);
3. games of chance (09.4.3.0);
4. prostitution (12.2.0.0);
5. life insurance (12.5.1.0); and
6. FISIM (financial intermediation services, indirectly measured) (12.6.1.0).

In addition, *net purchases abroad* (13.0.0.0), (i.e., purchases by resident households outside the economic territory of the country less purchases by non-resident households living on the economic territory of the country), are deducted from the total so that the estimated weights correctly reflect the domestic concept on which the conceptual framework of the HICP is based (see Chapter 2).

To complete the transformation of the data from ‘individual consumption expenditure by households’ to ‘household final monetary consumption expenditure’, two positions that are not individual ECOICOP classes must be deducted. Member States are asked to provide an estimate

([261]) Where the expenditure data are not yet expressed in euro, but in the previous national currency; the irrevocable euro conversion rates are normally needed, but only for the first year after a country has joined the euro area.

for them. At the same time, the Member States are asked to verify the expenditure data to be used in the country data calculation. The two positions for which Eurostat requests data are:

1. income in kind, such as free food for employees in agriculture and final consumption items that does not involve a monetary transaction (e.g. consumption of own-account production of goods); and
2. administrative charges of private pension funds and the like (part of ECOICOP 12.6.2). Although monetary transactions, these items fall outside the coverage of the HICP (see Chapter 2).

Table 11.4.29

Adjustments to 'individual consumption expenditure by households' data

Individual consumption expenditure by households:
minus:
narcotics;
imputed rentals for housing;
games of chance;
prostitution;
life insurance;
FISIM;
income in kind;
administrative charges of private pension funds and the like; and net purchases abroad;
= household final monetary consumption expenditure, domestic concept (in national currency)

To derive the country weights from total household final monetary consumption expenditure, the figures are price-updated to December *t*–1 using the all-items HICP. Also to be albel to sum up the country data, values must be expressed in the same currency. For the euro area aggregate, the country weights are calculated based on the Member States' expenditures expressed in euros. For the non-euro countries in the EU and the EEA aggregates, the common currency unit is the purchasing power standard (PPS). The country final monetary consumption expenditure figures are converted to euros using the EU-27 PPS based on the PPPs for household final consumption expenditure (e011) from *t*–2. In the EU and EEA aggregates, the euro area is included as one *country* using price-updated total euro area final monetary consumption expenditure as its weight. This means that in all European aggregates the euro area indices are always aggregated using the same relative country weights derived from the expenditure data expressed in euro.

The country weights for the fixed-composition European aggregates are established in a similar way.

Table 11.4.30

Country weights datasets in the dissemination database

Code	Label
COWEU	Country weights for European Union (EC12-1994, EU15-2004, EU25-2006, EU27-2013, EU28-2013, EU27-2020)
COWEU27_2020	Country weights for EU-27 (European Union from 2020)
COWEU28	Country weights for EU-28 (European Union 2013-2020)
COWEA	Country weights for the euro area (EA11-2000, EA12-2006, EA13-2007, EA15-2008, EA16-2010, EA17-2013, EA18-2014, EA19-2015, EA20 from 2023))
COWEA20	Country weights for EA-20 (Euro area from 2023)
COWEA19	Country weights for EA-19 (Euro area 2015-2022)
COWEEA	Country weights for EEA (European Economic Area)

11.4.6 Derived statistics

Eurostat also produces several derived statistics that are calculated from published monthly indices.

All rates of change (inflation rates) are computed from the published, rounded indices and are rounded to one decimal place for publication (see Section 8.5).

The following rates of change are calculated:

- monthly rate of change (rate of change between the current and previous month’s index);
- annual rate of change (rate of change between the current month’s index and the index for the corresponding month of the previous year);
- moving 12-month average rate of change; and
- annual average rate of change (rate of change between the calendar year annual average index and the previous calendar year’s annual average index). The annual average rate of change is not calculated from rounded published annual average indices, but from *unrounded unpublished* monthly indices (see Section 8.5.4).

Eurostat also computes the contributions to the euro area annual inflation. Contributions quantify the importance of a component (sub-index or an aggregate) to the all-items inflation rate and can approximately be interpreted as the difference between the actual all-items inflation rate and that which one would obtain if this component remained unchanged. The contributions are calculated (see Section 8.5.3) in a way that ensures their additivity, meaning that the all-items inflation rate can be decomposed into the sum of the contributions of the components. Eurostat presents the contributions to inflation data with two decimal places. Due to the use of unrounded figures in all steps of the calculations, including unrounded input data, the sum of the contributions may not exactly match the all-items inflation rate, which is presented with one decimal place.

11.5 Publication of HICP data and metadata

Eurostat provides HICP data to users free of charge via the Eurostat website to facilitate access by a wider range of users and further processing of the information. Generally, Eurostat data and other content may be re-used freely, including for commercial purposes, subject to the conditions set out on the website.

In line with the European Statistics Code of Practice, Eurostat disseminates the HICP on its website while respecting professional independence and in an objective, and transparent manner with all users treated equitably. Detailed arrangements for pre-release access to the HICP are given in the Eurostat protocol on impartial access to Eurostat data for users.

11.5.1 Dissemination database

Twice a month, the HICP data are released according to a pre-announced schedule. The complete set of the previous month's HICP data is released around the middle of the month, while the HICP FE for the euro area is released on the last working day of the month or shortly thereafter. The HICP's release schedule for the upcoming calendar year HICP is made available in the autumn of the previous year.

All data are released at 11.00 CET, which in the case of the mid-month HICP release is two working days after the transmission deadline, and in the case of the HICP FE one day after the transmission deadline. The HICP media releases are published simultaneously with the release of the data.

The HICP data and reference metadata are published in a dissemination database that is accessible via Eurostat's website. The HICP can be found in three parts of Eurostat's website: 1) database by themes: 2) EU key indicators (inflation) and 3) Euroindicators*.* The data are identical in all three sections.

The *database by themes* contains the full range of HICPs disseminated by Eurostat and is presented as multi-dimensional tables with full detailed breakdowns and a complete set of time series. The data browser offers direct access to the data and the metadata, with a choice of several export formats. The HICP data can be found in the 'economy and finance' section under 'prices'.

The dataset comprises 37 countries and six European aggregates giving price indices, annual average price indices, monthly and annual rates of change and moving 12-month rates of change. None of the estimates are seasonally adjusted.

In addition to the all-items HICPs, 422 sub-indices for different goods and services are made available for the HICP and HICP-CT. These data are complemented with 40 special aggregates.

Also the HICP series includes five HICP-AP special aggregates.

The HICP-FE data are included in the tables with HICP indices, annual rates of change and monthly rates of change. The data consist of the all-items figure and nine special aggregates. The HICP-FE data are overwritten with the actual HICP data at the time of release.

Also, the weights for the full range of indices, including the special aggregates, are made available for the individual countries and for all country groups.

The EU key indicators (inflation) shows the Annual rate of change in a simple way, derived from the above-mentioned multi-dimensional tables. The data browser allows for the display of the data using graphs and maps. In the *Euroindicators section*, the HICP is included under Database/ Selected datasets and Detailed datasets, and referred to as '*Consumer prices*'.

Table 11.5.31

HICP data in the *database by themes*

Database code	Description	Periodicity
prc_hicp_midx	HICP indices	Monthly
prc_hicp_manr	HICP annual rates of change	Monthly
prc_hicp_mmor	HICP monthly rates of change	Monthly
prc_hicp_mv12r	HICP 12-month average rates of change	Monthly
prc_hicp_aind	HICP annual averages and rates of change	Annual
prc_hicp_cow	Country weights	Annual
prc_hicp_inw	ECOICOP category weights (aka item weights)	Annual
prc_hicp_fp	HICP indices as first published	Monthly
prc_hicp_cind	CT indices	Monthly
prc_hicp_cann	CT annual rates of change	Monthly
prc_hicp_cmon	CT monthly rates of change	Monthly
prc_hicp_apc	Administered prices (composition)	Annual
prc_hicp_ctrb	Contributions to euro area annual inflation (in percentage points)	Monthly

The indices are currently disseminated with 2015 as the index reference year, with the exception of index series that end before 2015. Those data are referenced to 2005 where possible, or if the 2005 data are also missing, to 1996. If the series do not cover any of those years, the data are shown with the reference period with which they were originally transmitted to Eurostat.

In addition, Eurostat publishes the HICP index series with the reference years 2005=100 and 1996=100 for users who need data based on those previously used index reference years. The HICP series of these two previous reference years are derived (rescaled/re-referenced) from the 2015-based indices using all decimal places. All inflation rates are calculated from the reference year 2015=100 data. The data are included in the HICP table ‘prc_hicp_midx’, in which the reference year 2015, 2005 or 1996 can be selected in the *Unit* tab. The index reference year 2015 is set as the default.

The HICP is a revisable index, so data that have already been published may be changed in the database. In particular, the HICP data release may include some provisional data for the latest month. These are usually confirmed as final figures, or revised, the following month. Other major revisions are normally released with explanatory notes included with the press release. Also substantial changes in methodology are also described in the first release of data affected by them (see Chapter 10).

In the monthly HICP update, new data are added and the existing data are overwritten with any revised data. Changes compared with the previous update are flagged with code ‘r’ only for a short period of time, generally until the next update. The unrevised HICP data as first published on the day of the most recent HICP release, are available in the HICP table ‘prc_hicp_fp’. The table contains data for all geographical entities, the complete set of indices with reference years 2015=100, 2005=100 and 1996=100 and the HICP annual rates.

All datasets can be downloaded using the standard data extraction tools on the Eurostat website.

The published indices for individual countries are rounded to either one or two decimal places, in line with national practices. The released indices of European aggregates are rounded to two decimals. The monthly and annual inflation rates are calculated from these index levels and subsequently rounded to one decimal place for publication. This ensures that the published inflation rates match the corresponding released indices. The disseminated ECOICOP category and country weights are rounded to two decimals.

Table 11.5.32

Rounding of the published indices

Published rounded to two decimal places	Published rounded to one decimal place
AL, AT, BE, BG, CY, ES, EE, FI, FR, EL, HR, HU, IS, LT, LU, LV, ME, MK, MT, NL, PT, RO, SE, SI, SK, TR, US, XK	CH, CZ, DE, DK, UK [262], IE, IT, NO, PL, RS
EA, EA20, EA19, EU, EU27_2020, EU28, EEA	

[262] As UK left the European Union, its data is not available after 2020.

11.5.2 HICP news releases

The news releases are the most visible example of HICP data dissemination. They rank highest in terms of policy relevance and regularly attract comprehensive media coverage.

HICP news releases are published twice per month in English, French and German on Eurostat's website and are sent directly by email to accredited journalists who have subscribed to that service. The releases are issued at 11:00 CET/CEST on the pre-determined dates. They are provisionally announced in the Eurostat release calendar for euro indicators, which lists the release schedule up to 12 months ahead.

11.5.3 HICP metadata and other documents

The HICP data are complemented by a comprehensive set of metadata reference material, explanatory notes, other reference documents and statistical articles. All information and data are accessible via the dedicated HICP section ([263]) of Eurostat's website.

The HICP reference metadata ([264]) is compiled by the Eurostat and Member States following the Euro-SDMX metadata structure and comprises information *inter alia* on concepts and definitions, data coverage, periodicity, compilation practices and procedures, revisions, data quality and release policy. Other metadata (e.g., keywords, footnotes or flags linked to a code list) are directly attached to a value in the Eurostat dissemination database. In addition, the EU vocabularies tool is used for the dissemination of various additional categories of metadata (e.g. classifications, concepts and definitions, standard code lists, legal acts, methodological manuals and glossaries). It is possible to browse the classifications using the ShowVoc application which includes the COICOP/HICP classification with the currently used special aggregates and ECOICOP classification in all official EU languages with detailed descriptions.

([263]) Overview - Harmonised Indices of Consumer Prices (HICP) - Eurostat (europa.eu).

([264]) Harmonised index of consumer prices (HICP) metadata (prc_hicp) (europa.eu)

Annex 11.1: Special aggregates definitions

Special aggregate code	Label	Composition
EDUC_HLTH_SPR	Education, health and social protection	06, 10, 124
ELC_GAS	Electricity, gas, solid fuels and heat energy	0451, 0452, 0454, 0455
FOOD	Food including alcohol and tobacco	FOOD_P, FOOD_NP
FOOD_NP	Unprocessed food	01121, 01122, 01123, 01124, 01125, 01126, 01131, 01133, 01147, 01161, 01171
FOOD_P_X_ALC_TBC	Processed food excluding alcohol and tobacco	FOOD_P without 02
FOOD_P_X_TBC	Processed food excluding tobacco	FOOD_P without 022
FOOD_P	Processed food including alcohol and tobacco	0111, 01127, 01128, 01132, 01134, 01135, 01136, 01141, 01142, 01143, 01144, 01145, 01146, 0115, 01162, 01163, 01164, 01172, 01173, 01174, 01175, 01176, 0118, 0119, 012, 02
FOOD_S	Seasonal food	01131, 01133, 01161, 01171
FROOPP	Frequent out-of-pocket purchases	01, 02, 0314, 0322, 0561, 05621, 05622, 0611, 07221, 07222, 07223, 07241, 07242, 0731, 0732, 0735, 081, 0914, 09411, 09421, 09422, 09424, 09425, 095, 111, 1211, 1213
FUEL	Liquid fuels and fuels and lubricants for personal transport equipment	0453, 07221, 07222, 07223
GD	Goods (overall index excluding services)	FOOD, IGD
IGD	Industrial goods	IGD_NNRG, NRG
IGD_NNRG	Non-energy industrial goods	IGD_NNRG_ND, IGD_NNRG_SD, IGD_NNRG_D
IGD_NNRG_D	Non-energy industrial goods, durables only	0511, 05121, 05122, 0531_2, 05511, 071, 08201, 08202, 08203, 0911, 0912, 0913, 0921_2, 09322, 12121, 12311, 12312
IGD_NNRG_ND	Non-energy industrial goods, non-durables only	0431, 0441, 0561, 0611, 0612, 07224, 0933, 0934, 0952, 0953_4, 12132

Special aggregate code	Label	Composition
IGD_NNRG_SD	Non-energy industrial goods, semi-durables only	0311, 0312, 0313, 0321, 05201, 05202, 05203, 05209, 05401, 05402, 05403, 05521, 05522, 06131, 06132, 06139, 0721, 0914, 0931, 09321, 09511, 09512, 09513, 12131, 12321, 12322, 12329
NRG	Energy	ELC_GAS, FUEL
NRG_FOOD_NP	Energy and unprocessed food	NRG, FOOD_NP
NRG_FOOD_S	Energy and seasonal food	NRG, FOOD_S
SERV	Services	SERV_REC, SERV_TRA, SERV_HOUS, SERV_COM, SERV_MSC
SERV_COM	Services related to communication	081, 08204, 0830
SERV_HOUS	Services related to housing	041, 0432, 0442, 0443, 0444, 05123, 0513, 05204, 0533, 05404, 0562, 1252
SERV_MSC	Services – miscellaneous	05512, 05523, 06133, 062, 063, 0935, 10, 12122, 12313, 12323, 124, 1253, 1255, 126, 127
SERV_REC	Services related to recreation, including repairs and personal care	SERV_REC_HOA, SERV_REC_X_HOA
SERV_REC_HOA	Services related to package holidays and accommodation	096, 112
SERV_REC_X_HOA	Services related to recreation and personal care, excluding package holidays and accommodation	0314, 0322, 0915, 0923, 09323, 094, 09514, 111, 1211
SERV_TRA	Services related to transport	0723, 0724, 073, 1254
TOT_X_ALC_TBC	Overall index excluding alcohol and tobacco	00 without 02
TOT_X_EDUC_HLTH_SPR	Overall index excluding Education, health and social protection	00 without EDUC_HLTH_SPR
TOT_X_FOOD_S	Overall index excluding seasonal food	00 without FOOD_S
TOT_X_FROOPP	Overall index excluding frequent out-of-pocket purchases	00 without FROOPP
TOT_X_FUEL	Overall index excluding liquid fuels and lubricants for personal transport equipment	00 without FUEL

Special aggregate code	Label	Composition
TOT_X_HOUS	Overall index excluding housing, water, electricity, gas and other fuels	00 without 04
TOT_X_NRG	Overall index excluding energy	00 without NRG
TOT_X_NRG_FOOD	Overall index excluding energy, food, alcohol and tobacco	00 without NRG and FOOD
TOT_X_NRG_FOOD_NP	Overall index excluding energy and unprocessed food	00 without NRG_FOOD_NP
TOT_X_NRG_FOOD_S	Overall index excluding energy and seasonal food	00 without NRG_FOOD_S
TOT_X_TBC	Overall index excluding tobacco	00 without 022
AP	Administered prices	Composition changing across time
APF	Fully administered prices	Composition changing across time
APM	Mainly administered prices	Composition changing across time
AP_NRG	Administered prices, energy	Composition changing across time
AP_NNRG	Administered prices, non-energy	Composition changing across time
TOT_X_AP	Overall index excluding administered prices	00 without AP — Composition changing across time
TOT_X_APF	Overall index excluding fully administered prices	00 without APF — Composition changing across time
TOT_X_APM	Overall index excluding mainly administered prices	00 without APM — Composition changing across time

Annex 11.2: Compositions of European aggregates

The following table describes the European aggregates and their composition across time.

European aggregate	Description	From	To	Composition
EA	Euro area		Dec-2000	BE, DE, FR, IT, LU, NL, IE, ES, AT, PT, FI
		Jan-2001	Dec-2006	BE, DE, FR, IT, LU, NL, IE, ES, AT, PT, FI, EL
		Jan-2007	Dec-2007	BE, DE, FR, IT, LU, NL, IE, ES, AT, PT, FI, EL, SI
		Jan-2008	Dec-2008	BE, DE, FR, IT, LU, NL, IE, ES, AT, PT, FI, EL, SI, CY, MT
		Jan-2009	Dec-2010	BE, DE, FR, IT, LU, NL, IE, ES, AT, PT, FI, EL, SI, CY, MT, SK
		Jan-2011	Dec-2013	BE, DE, FR, IT, LU, NL, IE, ES, AT, PT, FI, EL, SI, CY, MT, SK, EE
		Jan-2014	Dec-2014	BE, DE, FR, IT, LU, NL, IE, ES, AT, PT, FI, EL, SI, CY, MT, SK, EE, LV
		Jan-2015	Dec-2022	BE, DE, FR, IT, LU, NL, IE, ES, AT, PT, FI, EL, SI, CY, MT, SK, EE, LV, LT
		Jan-2023		BE, DE, FR, IT, LU, NL, IE, ES, AT, PT, FI, EL, SI, CY, MT, SK, EE, LV, LT, HR
EA20	Euro area (20 countries)	BE, DE, FR, IT, LU, NL, IE, EL, ES, AT, PT, FI, SI, CY, MT, SK, EE, LV, LT, HR		
EA19	Euro area (19 countries)	BE, DE, FR, IT, LU, NL, IE, EL, ES, AT, PT, FI, SI, CY, MT, SK, EE, LV, LT		
EU	European Union		Dec-1994	BE, DE, FR, IT, LU, NL, DK, IE, UK, EL, ES, PT
		Jan-1995	Apr-2004	BE, DE, FR, IT, LU, NL, DK, IE, UK, EL, ES, PT, AT, FI, SE
		May-2004	Dec-2006	BE, DE, FR, IT, LU, NL, DK, IE, UK, EL, ES, PT, AT, FI, SE, CY, CZ, EE, HU, LT, LV, MT, PL, SK, SI
		Jan-2007	Jun-2013	BE, DE, FR, IT, LU, NL, DK, IE, UK, EL, ES, PT, AT, FI, SE, CY, CZ, EE, HU, LT, LV, MT, PL, SK, SI, BG, RO
		Jul-2013	Jan-2020	BE, DE, FR, IT, LU, NL, DK, IE, UK, EL, ES, PT, AT, FI, SE, CY, CZ, EE, HU, LT, LV, MT, PL, SK, SI, BG, RO, HR
		Feb-2020		BE, DE, FR, IT, LU, NL, DK, IE, EL, ES, PT, AT, FI, SE, CY, CZ, EE, HU, LT, LV, MT, PL, SK, SI, BG, RO, HR

European aggregate	Description	From	To	Composition
EU27_2020	European Union (27 countries) from 2020			BE, DE, FR, IT, LU, NL, DK, IE, EL, ES, PT, AT, FI, SE, CY, CZ, EE, HU, LT, LV, MT, PL, SK, SI, BG, RO, HR
EU28	European Union (28 countries)			BE, DE, FR, IT, LU, NL, DK, IE, UK, EL, ES, PT, AT, FI, SE, CY, CZ, EE, HU, LT, LV, MT, PL, SK, SI, BG, RO, HR
EEA	European Economic Area		Apr-2004	BE, DE, FR, IT, LU, NL, DK, IE, UK, EL, ES, PT, AT, FI, SE, IS, NO
		May-2004	Dec-2006	BE, DE, FR, IT, LU, NL, DK, IE, UK, EL, ES, PT, AT, FI, SE, IS, NO, CY, CZ, EE, HU, LT, LV, MT, PL, SK, SI
		Jan-2007	Jun-2013	BE, DE, FR, IT, LU, NL, DK, IE, UK, EL, ES, PT, AT, FI, SE, IS, NO, CY, CZ, EE, HU, LT, LV, MT, PL, SK, SI, BG, RO
		Jul-2013	Jan-2020	BE, DE, FR, IT, LU, NL, DK, IE, UK, EL, ES, PT, AT, FI, SE, IS, NO, CY, CZ, EE, HU, LT, LV, MT, PL, SK, SI, BG, RO, HR
		Feb-2022		BE, DE, FR, IT, LU, NL, DK, IE, EL, ES, PT, AT, FI, SE, IS, NO, CY, CZ, EE, HU, LT, LV, MT, PL, SK, SI, BG, RO, HR

Annex 11.3: Country codes

Code	Country	Code	Country
BE	Belgium	PL	Poland
BG	Bulgaria	PT	Portugal
CZ	Czech Republic	RO	Romania
DK	Denmark	SI	Slovenia
DE	Germany	SK	Slovakia
EE	Estonia	FI	Finland
IE	Ireland	SE	Sweden
EL	Greece		
ES	Spain	IS	Iceland
FR	France	NO	Norway
HR	Croatia	CH	Switzerland
IT	Italy		
CY	Cyprus	ME	Montenegro
LV	Latvia	MK	North Macedonia
LT	Lithuania	AL	Albania
LU	Luxembourg	RS	Serbia
HU	Hungary	TR	Türkiye
MT	Malta	XK	Kosovo (under United Nations Security Council Resolution 1244/99)
NL	Netherlands	UK	United Kingdom
AT	Austria	US	United States of America

12

The treatment of selected product groups

12 The treatment of selected product groups

This chapter provides methodological guidance for selected product groups that present challenges to index compilers. Guidance on using scanner data and web-scraped data to compile HICPs is available on the Eurostat website ([265]),([266]),([267]).

The product groups included are:

- 12.1 Health, education and social protection services
- 12.2 Insurance services
- 12.3 Purchase of motor vehicles
- 12.4 Actual rentals
- 12.5 Air fares and package holidays
- 12.6 Telecommunication services
- 12.7 Clothing and footwear
- 12.8 Financial services
- 12.9 Electronic goods

([265]) CIRCABC/Price Statistics/Library/Public/Manuals and Guidelines, Eurostat, 2017.

([266]) Guide on Multilateral Methods in the Harmonised Index of Consumer Prices, Eurostat, 2022.

([267]) Practical guidelines on web scraping in the HICP, Eurostat, 2020.

12.1 Health, education and social protection services

12.1.1 Introduction

In many Member States, expenditures on the health, education and social protection sectors of the economy account for a large share of total economic activity. One distinctive feature of these services is that their provision is often state-funded or funded by non-profit institutions serving households (NPISHs). They may be offered without explicitly charging the household, be partially subsidised or not subsidised at all, which means that the household must pay the partial or full cost of the service.

Goods and services in the health, education and social protection sectors are included in the HICP if household expenditures on these products are above the one part per thousand share, otherwise they are out of scope.

Estimating the weight and price development for products from the health, education and social protection fields can be challenging.

For instance, cases can arise in the health, education and social protection sectors that require *special* treatment. Education services are an example where tuition fees will sometimes include products that would normally be classified under other expenditure categories of the HICP (e.g., textbooks, and room and board), but for practical reasons they sometimes are not.

One purpose of Commission Implementing Regulation (EU) 2020/1148 is to ensure that Member States apply a common methodology when faced with complicated situations that might otherwise lead to different treatments.

However, even with such a regulation, the complexities can be so overwhelming and the cases so unique that there is no guarantee that it will always be interpreted and applied consistently across Member States. For example, Annex 12.1.1 of this manual describes a case in the Netherlands following major reforms to the healthcare system in 2006. The changes were so far-reaching that questions were raised as to how, under the current regulatory framework, the effects of the reforms could be accounted for when compiling the HICP. The recommendations stemming from these events in the Netherlands are discussed in that section.

For an introductory overview of the methodological and conceptual issues involved in compiling price indices in the health, education and social protection services fields, see paragraphs 11.293-11.338 of the CPI Manual: Concepts and Methods. *The Practical Guide to Producing Consumer Price Indices* (2009), section 9.3, also covers the topic of health, education, and social protection services in relation to consumer price indices (CPIs) in general.

12.1.2 Legal requirements

The treatment of health, education and social protection products in the HICP is governed by Commission Implementing Regulation (EC) 2020/1148 of 31 July 2020, laying down the methodological and technical specifications in accordance with Regulation (EU) 2016/792 of the

European Parliament and of the Council as regards harmonised indices of consumer prices and the house price index ([268]).

The coverage of health, education and social protection products in the HICP is laid down in Article 5 of the Implementing Regulation under the following subsections:

1. *Observed prices for health, education and social protection products shall be net of reimbursements.*
2. *Changes in the observed prices or conditions of a tariff shall be shown as price changes in the HICP.*
3. *If observed prices are index-linked, changes resulting from changes in the index shall be shown as price changes in the HICP.*
4. *If household income is a condition determining the price, changes in the observed prices resulting from changes in household income shall be shown as price changes in the HICP.*
5. *If an individual product has been made available to consumers free of charge and a price is charged subsequently, this shall be shown as a price increase in the HICP. Conversely, if a price has been charged for an individual product that is subsequently made available to consumers free of charge, this shall be shown as a price decrease in the HICP.*

12.1.3 Definitions and concepts

Article 2 of Implementing Regulation (EU) 2020/1148 contains the following definitions on the treatment of products in these sectors:

> *17. 'reimbursement' means a partial or complete payment by government or non-profit institutions serving households of approved purchases by households of specified products, as defined in paragraphs 4.108-4.110 of Annex A to Regulation (EU) No 549/2013 of the European Parliament and of the Council (18) (ESA 2010).*
>
> *18. 'inducement' means a change, often temporary, in the characteristics of an individual product by increasing the quantity of the product, attaching another individual product free of charge or offering other benefits to the consumer.*
>
> *28. 'tariff' means a list of prices and conditions for a product that is differentiated according to the quantities purchased, the timing of consumption or the characteristics of purchasers.*

The complementary terms and definitions below, relating to health, education and social protection, will also be used in this section. Although these definitions are not explicitly included in Implementing Regulation (EU) 2020/1148, they are relevant for this section and useful for the reader.

> *Social expenditures* [social protection] *are a measure of the extent to which countries assume responsibility for supporting the standard of living of disadvantaged or vulnerable groups. Social spending comprises cash benefits, direct in-kind provision of goods and services, and tax breaks with social purposes. Benefits may be targeted at low-income households, the elderly, disabled, sick, unemployed, or young persons. To be considered 'social', programmes*

([268]) OJ L 252/12, 4.8.2020, p. 1.

must involve either redistribution of resources across households or compulsory participation ([269]).

Income-dependent prices are prices for which their level is a function of household income. In other words, high-income families typically pay more for the product compared to low-income families and there is usually a maximum and a minimum fee.

Index-linked prices (also known as indexation) involves a recalculation of the purchase price to reflect any increases (or decreases) in a relevant price Findex.

12.1.4 Classification and coverage

12.1.4.1 Classification

In ECOICOP, expenditures on health are classified in division 06, education in division 10 and social protection in group 12.4. Lower-level classes and subclasses of these expenditures can be found in ECOICOP ([270]).

12.1.4.2 Coverage

On coverage, in Implementing Regulation (EU) 2020/1148 Article 5(3) is clear – transactions that involve expenditure by a household in the health, education and social protection services sectors are in scope and should be covered in the HICP. This approach is consistent with the concept of household final monetary consumption expenditure; see Chapter 2 – HICP Concepts.

In many countries, services produced by the health, education and social protection sectors are provided by government or non-profit institutions serving households, and no explicit fee is charged to households. In other words, although a household may consume these services, their provision is financed by the tax or social security system.

In such cases, the consumption (and cost of producing) these goods and services should not be included in the HICP, an approach which is consistent with the household final monetary consumption expenditure concept. However, should the household have to subsequently pay for the product, it is then in scope of the HICP, including for the period that it was offered free of charge. This is because, under the Implementing Regulation, price changes that go from zero to a positive value should be reflected in the HICP (see Article 5 (7) of the Regulation (set out in Section 12.1.5 above) and Section 7.5).

With regard to childcare systems where the government partially subsidises the cost of the service, it is the *net* price paid by the household that is covered by the HICP, regardless whether the childcare service is privately or publicly managed.

The same Regulation excludes, however, services produced by the household. These are categorised as ‘own consumption’ and so do not involve a monetary transaction. For example, in the case of home schooling, although a service is consumed by some members of the

([269]) See Social Spending by the OECD.

([270]) Link to detailed ECOICOP – HICP.

household, it is also being produced by the same household so it is out of scope of the HICP. This approach is consistent with the conceptual basis of the national accounts, where, according to paragraph 1.37(a) of the European System of National and Regional Accounts (ESA 2010), domestic and personal services produced and consumed within the same household fall outside the production boundary and are not to be recorded in the ESA.

There should be consistency between the conceptual basis on which the weights are compiled and the range of products for which prices are to be collected for the HICP. For partially subsidised goods and services in the health, education and social protection sectors, expenditures incurred by the household should be the basis for calculating the weights. For example, if the public healthcare system finances 75% of a medical device, such as a hearing aid, then only the remaining 25% of the cost, which the household would be required to pay out of pocket is within scope of the HICP and included in the index's weighting scheme.

In the case of expenditures on education, ECOICOP 10 (Education) should exclude those ancillary expenditures to education but that are not defined as an education service per se. Examples of such goods and services are healthcare services (06), transport services (07.3), books (09.5.1), stationery (09.5.4), catering services (11.1.2), and accommodation services (11.2.0). Expenditures on these non-education products should, in principle, be allocated to their respective areas of the ECOICOP.

For example, some higher education institutions, such as universities, may offer, in addition to their tuition fees, rooms and board. Products under ECOICOP 10 should be limited to tuition and enrolment fees. If an all-inclusive price is charged that covers more than just the education service, such as room and board costs, then it becomes a bundled service. The acceptable procedure for treating such services in the HICP (see Section 7.6) is, where possible, to separate each of the bundle's constituent components and allocate them to their appropriate ECOICOP area.

Practitioners may sometimes encounter what can be qualified as borderline cases where there may be confusion as to how to best classify primary education services and the social protection service of child-minding and nurseries. Both types of service cater to children of the same age group (typically three to six years of age but can vary depending on the country) but their functions differ.

Many institutions that cater for children in this age group offer a service that can be qualified as educational in nature. Here the child is in an early childhood education setting and is being prepared for the start of compulsory education at primary school. In such cases, the activity should be classified under class ECOICOP Division 10.

By contrast, if little in terms of a pre-school educational environment is offered, then the service being provided is more appropriately described as 'childcare services', which should be allocated to social protection (ECOICOP class 12.4.0). Methodological issues may also arise if the institution offers during say a week, both types of services to the child. Here, the price statistician will need to determine, usually after consulting with the institution, if its primary function is more educational in nature or more day care.

It should be remembered, however, that as with any borderline case, it is often worth exploring how the situation is treated in the national accounts to ensure consistency between prices and weights.

A case in point is the treatment in the HICP of what are recognised as *voluntary contributions* by households, often to private schools, that appear to be gaining in popularity in some Member States. These types of contributions are excluded from the HICP, because, according to the national accounts, they are considered transfers.

With healthcare and more specifically in the case of hospitals which, in addition to basic services as defined in ECOICOP 06.3, provide other goods or services for in-patients on a separate charge basis. These additional services should not be allocated to class 06.3.0, but to the relevant ECOICOP category.

For example, a patient who has spent several days in a hospital after a medical procedure may not have to pay for their treatment since the cost is covered by the public healthcare system. If, however, during their stay, the patient rented a TV, these extra charges should be allocated to their proper area (e.g., the rental fee for a TV would be allocated to ECOICOP (09.4.2.4)).

12.1.5 Prices

The concept of prices to be used when compiling the indices for health, education and social protection services is regulated according to section 2 of Article 5 of Implementing Regulation (EU) 2020/1148, see 12.1.2.

12.1.5.1 Observed prices

Article 5(2) of Implementing Regulation (EU) 2020/1148 stipulates that observed prices for health, education and social protection, shall be net of reimbursements (i.e., the amount paid by the consumer minus reimbursements they may receive). Only reimbursements by government units, social security administrations or non-profit institutions serving households, which are made as a direct consequence of purchases of individually specified goods and services in the education, health and social security sectors, will be considered as reimbursements. Payments from an insurance company for a claim made by a household are not taken into consideration, as they are not considered as reimbursements according to the definition found in Article 2(17) of Implementing Regulation EU 2020/1148. In such cases, the full market price is included in the index calculation (see also Section 12.2.).

Other types of payments or rebates by government units, social security administrations or non-profit institutions serving households that provide a form of assistance to (low-income) households are considered social benefits or transfers in kind and do not qualify as reimbursements and are therefore not used to calculate the observed price. Examples include housing allowances to low-income tenants and scholarships to students.

To estimate the expenditure weight for a product for which a reimbursement as described above is likely the national accounts data on household consumption expenditures can be a relevant source of information, since its scope follows the same purchaser price principle set out in the Regulation. On the other hand, if the household budget survey is used as the source of detailed weights in this sector, it is important that the questions in the survey are properly formulated so that the respondent provides information to qualify the expenditures (i.e., the expenditure after the qualified reimbursement is deducted), otherwise the data will need to be adjusted. A potential source of information on the amount of reimbursements to execute this task would be the authority whose responsibility is to manage the reimbursements.

12.1.5.2 Changes in rules, income-dependent prices and index-linked prices

Under Implementing Regulation (EU) 2020/1148, Article 5, paragraphs 3, 4, and 5, a change in a price for a product in the health, education and social protection sectors should be recorded in the HICP if it results from a change in government policy, the up-rating of the index used for the specified product (i.e., an index-linked price) or from the consumers' income level.

At times, the price paid for goods and services in the health, education and social security sectors are linked to a price index, for example a country's HICP (or CPI). Article 5(4) covers the effect of changes to the index used for determining changes to the observed price of an index-linked product in the health, education and social protection sectors: If observed prices are index-linked, then changes resulting from changes in the index shall be shown as price changes in the HICP. Index-linking is usually applied at a pre-set date once a year.

For prescribed medicines, if there are no legislative changes to a reimbursement policy, an accurate price index for this product can be estimated simply by sampling the listed prices.

However, if public authorities decide to change the policy governing reimbursements, this is likely to affect the price. Price level changes resulting from a change in the reimbursement policy should be reflected in the HICP as per Article 5(2) of the Implementing Regulation.

Estimating the relevant price is not straightforward when it is not directly observable. If the list price differs from the price paid, the latter will need to be determined to reflect how the change in the amount of the reimbursement has affected the true or actual amount paid by the household. To achieve this, some information is needed, usually from a third-party source, on the rules and conditions for reimbursement and the allowable amounts of any claims. This source is usually the health authority or the entity responsible for administering the reimbursements. In some cases, publicly available *official* price lists may be accessible for these products which may show the net price after reimbursement.

Example: How to account in the HICP for a change in reimbursement rules

*The reimbursement for a given drug has fallen to **EUR 10** in period* t *from the previous level of **EUR 20** in period* **t–1**.

*If information on the market price from a pharmacist during the regular field collection exercise is available. The net price paid for the drug by the household, once the reimbursement is factored in, now stands at **EUR 90** in period* **t**; *this compares to the out-of-pocket price of **EUR 80** previously paid at* **t–1**.

The reimbursement amount fell in period **t**, *leading to a **higher net price** of **EUR 90**, on average.*

*The estimated price index for the drug is estimated at **112.5** (=EUR 90/EUR 80 - 1 x 100), owing to the change in policy.*

Changes in the public policies may be complex to capture. As an example of a change in a rule and its treatment in the HICP, assume that the public authorities partially subsidise tuition for students whose household income is below a certain threshold. In a subsequent period, the authorities decide to raise this threshold. Consequently, household income must now be higher to qualify for the subsidy. Because of this policy change, certain segments of the population that previously had access to the subsidised tuition fee will now have to pay more for this service.

If the elementary aggregates under the education division (or health and social protection categories) are stratified according to income levels and the price paid for the service, then it is relatively straightforward to apply the new lower price for that segment of the classification structure of the HICP. If, on the other hand, this is not an option, perhaps because of a lack of information, then another approach can be applied, which is similar in practice to changes to a tariff structure and its effect on the price index. See Section 7.4 on tariffs for more details on how to treat a change in tariff structures.

Beyond the situations described above, many other types of arrangements and schemes exist in the healthcare, education and social protection fields that can often blur the observed price that should be used for the HICP.

For example, prices that vary according to household income (i.e., income-dependent prices) occur in many jurisdictions and often challenge the price statistician. These schemes, although similar in spirit, can be applied often quite differently by the different jurisdictions, which makes it difficult to offer a single standard methodology for measuring how these prices should be used in the HICP.

The following five examples provide some guidance on what to do in the kind of circumstances described above.

Example 1: Reimbursements (tax credits) vs direct subsidy

For this example, assume two Member States offer childcare services, but each uses a different strategy to reduce the cost of childcare services for the household.

Country A pays a price subsidy to the service provider, country B uses the tax system and provides a tax credit to the household. How should each of these cases be treated in the HICP?

In this example, Article 5(2,3) of Implementing Regulation (EU) 2020/1148 applies: *Observed prices for health, education and social protection products shall be net of reimbursements* and *Changes in the observed prices or conditions of a tariff shall be shown as price changes in the HICP.*

In country A, the entity offering childcare services charges a price of EUR 20 per hour at period *t*-1; then at period *t*, the price of the services increased to EUR 21 per hour.

Children typically spend 50 hours per month in the kindergarten so the generated revenue for the entity for the service goes from EUR 1 000 per child to EUR 1 050 between both periods.

To recognise the greater burden on the household caused by the higher price, the hourly price subsidy offered by the public authorities to the service provider is also increased from EUR 8 at period *t*–1 to EUR 9 at period *t*.

These subsidies translate into an unchanged *net* price paid by the household of EUR 12 in both periods which leaves the HICP unchanged.

In country B, the situation is the same, except that the authorities offer an income tax transfer (tax credit) instead of a price subsidy to fully compensate for the increased cost of the service. As a result of the new higher price, the household now receives an increase in its allowance from the previous amount of EUR 400 at period *t*–1 to EUR 450 at period *t*.

Regardless of the approach used for reducing the burden from the higher price of the service, the net cost to the household for consuming the childcare service is the same under both scenarios. This is also what needs to be reflected in the HICP as what matters for the index is the net price. Both strategies to reduce the costs of childcare services for the household lead to the same result in the HICP. This treatment also agrees with the treatment in national accounts.

Example 2: A rule change

This example illustrates the case where the price has changed because of a change in policy and shows its effect on the HICP. Implementing Regulation (EU) 2020/1148, Article 5(3) applies here: *Changes in the observed prices or conditions of a tariff shall be shown as price changes in the HICP.*

A market price is initially charged by an institution and is set at EUR 20.00 at period *t*–1 (see table 12.1.33); moreover, of that amount EUR 1 is paid directly by the household (i.e., the observed price) while the public authority pays the balance of EUR 19.00. At period *t*, the public authority dramatically reduces the price subsidy to EUR 12.00. Conversely, the burden of the cost paid by households now increases from EUR 1.00 to EUR 8.00. The price index for this service at period *t* (period *t*–1 = 100) is now 800 (= EUR 8.00/EUR 1.00 x 100). The fact that this change in government policy affects this component of the HICP respects the spirit of the Regulation, as consumers now pay more at period *t* for the service compared with period *t*–1 because of the change in policy.

Table 12.1.33

The effect on the HICP of a lowering of the price subsidy on a product

	t–1	*t*
Price charged by institution for the service (in EUR)	20.00	20.00
— Share of price paid by public authority (in EUR)	19.00	12.00
— Share of price paid by household (in EUR)	1.00	8.00
HICP (*t*–1 = 100)	100.0	800.0

Example 3: Income-dependent prices — scenario 1

Income-dependent prices present another example of how a change of policy by the public authority can affect the index. An income-dependent price can for example be any tariff where the price paid by a consumer is a function of his or her income level in each period. The ways that an income-dependent price may manifest itself will be made clear with the upcoming examples. It is important to identify all products in the HICP sample whose price is related somehow to household income for them to be treated appropriately in the HICP. It should be noted that income-dependent prices only change when the level of income changes because of a wage increase or a policy change, or both.

The challenge is how to estimate a price index that will best mirror these price changes. In accordance with a fixed sample approach, the structure of consumption is held constant and is not adjusted for the period between planned weight updates, i.e., December of year *t*–1 and December of year *t*. This fixity principle extends beyond the sample to include the sociodemographic characteristics and income structure of the target population. Of course, the reality is that these factors can vary at any point between the weight updating periods. However, for practical reasons such as data limitations (e.g., issues of data availability and prohibitive cost of collecting the data on an ongoing basis), they are assumed not to vary during this period.

Changes in household income leading to a change to the price paid for a good or service in the health, education, and social security sectors are covered in Article 5(5) of Implementing Regulation (EU) 2020/1148: *If household income is a condition determining the price, changes in the observed prices resulting from changes in household income shall be shown as price changes in the HICP.*

The following examples depict various possible scenarios where this Regulation applies.

Example 3 (see Table 12.1.34) illustrates a case with childcare services in which this category has been segmented into three elementary aggregates, one for each of the three pre-defined income segments: (1) less than and including EUR 20 000/year; (2) over EUR 20 000/year. and including EUR 20 500/year; and (3) above EUR 20 500/year. At period *t*–1, the eligibility threshold is at income level EUR 20 000/year.

Table 12.1.34

An example of the effect on the index when the income threshold is changed to match the change in income.

	Annual income threshold of EUR 20 000			Annual income threshold of EUR 20 500			
	Weekly rates (in EUR)	Share of households within bracket	Average weighted price per week (in EUR)	Weekly rates (in EUR)	Share of households within bracket	Average weighted price per week (in EUR)	Price index (*t*/*t*–1)
Household income (in EUR)	Period (*t*–1)			Period *t*			
Less than and including 20 000	100	0.30		100	0.20		
Over 20 000 and including 20 500	300	0.10		100	0.10		
Above 20 500	300	0.60		300	0.70		
			240			240	100

Assuming the household budget survey shows that 30 % of households in the population qualified for the subsidised childcare rate while the remainder of households did not. Consequently, the latter group paid the full rate in period *t*–1. The average rate paid for the subsidised service was EUR 100/week for that period compared with the average unsubsidised rate of EUR 300/week. The average price for childcare services in period *t*–1 is, for the population, a weighted average of EUR 240/week (= (EUR 100 x 0.30) + (EUR 300 x 0.10) +(EUR 300 x 0.60)).

The equation to calculate the index is:

$$\text{Index} = \frac{\sum(S_j^t \times P_j^t)}{\sum(S_j^{t-1} \times P_j^{t-1})}$$

where:

- S_j^t and S_j^{t-1} is the share of households in income category j in period t and $t-1$, respectively.
- P_j^t and P_j^{t-1} is the price or rate that applies to income category j in period t and $t-1$, respectively.

Note that the formula is not a Laspeyres-type index. It is simply the ratio of the weighted average of prices (or rates) from period *t* to the weighted average of prices (or rates) in period *t*–1. Moreover, the weight is expressed as the share of households in that specific income range for a given period. This ‘share-weight’ can change over the two periods unlike a Laspeyres-type index where this share would remain invariant (at least within the same sample period).

Subsequently, in period *t*, the authorities decide to adjust the eligibility threshold by increasing it to EUR 20 500/year. so that it matches the measured increase in average incomes between both periods. This way, after the change, the share of households in the population benefiting from the reduced rate remains the same as before (30 %). Furthermore, the average price paid for the service (i.e., EUR 240/week = (EUR 100 x 0.20) + (EUR 100 x 0.10) +(EUR 300 x 0.70)) is also unchanged and thus the price index over the two periods equals 100. This is the expected outcome when the threshold is adjusted at a rate equal to that of incomes (in this example income rose by 2.5 % annually and so did the threshold).

Example 4: Income-dependent prices — scenario 2

This example is based on the same information as example 3 but this time the authorities have not adjusted the income threshold over the two periods, so it remains at EUR 20 000/year. However, household incomes have risen at the same 2.5 % annual rate as in the previous example. A circumstance such as this will unavoidably lead to some households losing the benefit of the lower rate.

Therefore, each elementary aggregate will now consist of a new distribution of households according to the income brackets (see Table 12.1.35) and a new distribution of eligible households. Note that in this case, with the new distributions of eligible households, that the index over periods *t*–1 and *t*, is 108.3 because of the increase in average price paid over the period from EUR 240/week to EUR 260/week (= (EUR 100 x 0.20) + (EUR 300 x 0.10) +(EUR 300 x 0.70)).

Table 12.1.35

An example of the effect on the index when the income threshold is not changed to match the change in income.

	Annual income threshold of EUR 20 000			Annual income threshold of EUR 20 000			
	Weekly rates (in EUR)	Share of households within bracket	Average weighted price per week (in EUR)	Weekly rates (in EUR)	Share of households within bracket	Average weighted price per week (in EUR)	Price index (*t*/*t*–1)
Household income (in EUR)	Period (*t*–1)			Period *t*			
Less than and including 20 000	100	0.30		100	0.20		
Over 20 000 and including 20 500	300	0.10		300	0.10		
Above 20 500	300	0.60		300	0.70		
			240			260	108.3

12.1.5.3 Quality change

Under Article 11(1) of Implementing Regulation (EU) 2020/1148, when there is a quality change between the old and new product, Member States shall make a quality adjustment. This principle also applies to goods or services in the health, education and social protection fields where prices should be treated according to the rules applied for specification changes, and, in particular, those regarding quality adjustment.

The reality in the health, education and social protection sectors is that many products do not undergo any perceivable quality change. When they do, assessing the monetary value associated with the change is often difficult and near impossible (except in the obvious case of a change, for example, in package size for medicines). For example, an improvement in the student-to-teacher ratio or the hiring of more experienced and better trained teachers in a private school, new and improved paid-for medical testing procedures, or even renovations to the physical facilities of a nursing home are all examples of quality change in these fields for which a monetary value cannot be practically or reliably assigned. In most cases, the only realistic solution for the price statistician is to assume that no change has occurred and therefore estimate the index accordingly. Such a decision is not likely to have a meaningful adverse effect on the overall HICP, since the relevant sample weight in the index is, in most cases, quite small.

An exception is prescription medicines, as the EU has taken legislative initiatives to shorten the time span of patent coverage of branded drugs. Each Member State may have their own distinct programmes to promote the use of generic substitutes to reduce the cost of providing this public healthcare service.

When a drug patent expires then it is commonplace to have both a generic substitute and the branded drug available on market at the same time. Typically, the generic drug will sell for a lower price than the branded drug. If there is no clear or proven difference in quality between the original and generic drug, it may be appropriate to treat them as close (or even perfect) substitutes ([271]).

If, on the other hand, the generic drug is indeed different from its branded counterpart, it cannot be considered a perfect or even close substitute. Under such circumstances, the ideal option is to track the prices of both the branded and generic varieties and possibly weight them by their relevant market shares. This way, when a branded drug comes off patent and a new generic drug is then available to the public, the price decrease of this branded drug resulting from the market dynamics that follow the introduction of the generic drug on the market will be properly captured in the index.

12.1.5.4 Zero to positive prices and tariffs

Implementing Regulation (EU) 2020/1148 Article 5(7) states:

> *'If an individual product has been made available to consumers free of charge and a price is charged subsequently, this shall be shown as a price increase in the HICP. Conversely, if a price has been charged for an individual product that is subsequently made available to consumers free of charge, this shall be shown as a price decrease in the HICP'.*

Clearly from this regulation, where goods or services in the health, education and social protection sectors have been made available to consumers free of charge and subsequently an actual price is charged, the change from zero to an actual price, and *vice versa*, shall be reflected in the HICP.

Goods and services in the health, education and social protection sectors that are offered for *free* to households (i.e., are fully subsidised by the Member State) during the price reference period as well as during the current month are out of scope of the HICP, because the household's expenditure weight is zero.

Section 7.5 of this manual provides insights on how to account for a product that was initially available for free but is subsequently provided on the market for a positive price (and *vice versa*).

Tariff pricing is common in health, education and social protection. Article 5(3) of Implementing Regulation (EU) 2020/1148 states that 'changes in the observed prices or conditions of a tariff shall be shown as price changes in the HICP'. For the treatment of tariff pricing and how to properly estimate the weights of tariffed products in the HICP, the approach for goods and services in this sector is the same as that presented in Section 7.4, which explains the methodology of tariff pricing in greater detail.

An exceptional borderline case is presented in Annex 12.1.1, which shows how the Netherlands treated in their HICP a reform that led to a broadening of the population coverage of *free* government-sponsored healthcare. Due to this case, at the time Recommendation 2005/881/EC was introduced (no longer in force).

([271]) For simplicity it is assumed here that quality means that the outcome of each type of drug (branded or generic) is identical.

Annex 12.1.1: The case of healthcare reforms in the Netherlands

Context

Healthcare insurance in the Netherlands was reformed in January 2006. Prior to that period, both private and public healthcare co-existed in the country. With the new compulsory basic social insurance scheme that was introduced in 2006 it was expected that a much larger share of healthcare would cover the total population. Consequently, 37.5 % of the total population were expected to shift from the private to the new social insurance scheme.

The reform introduced a fundamental change in the organisation and institutional structure of the healthcare system which raised concerns about its appropriate treatment in the HICP given the existing legal framework. Under the new scheme, the entire population would have access to the free basic healthcare services; this service would be covered by the public healthcare system and be provided for free. Health services that were provided above the basic level would be covered by a compulsory private healthcare insurance system.

From an HICP perspective, the reform meant that after 2006, a larger share of the population compared to the pre-2006 reform would now have access to *free* insurance and the corresponding free health services.

The price statisticians in the Netherlands (Central Bureau of Statistics) interpreted the previously existing Regulation (EC) No 2166/1999 (and now replaced by Implementing Regulation (EU) 2020/1148) in the following manner:

- Healthcare that is covered by social insurance is not part of the coverage of HICP. The medical goods and services are available free of charge, except for a possible nominal own contribution fee that consumers pay for some medical goods or services.
- Healthcare that is covered by private insurance or not covered by any health insurance at all is part of the coverage of HICP. The price of private health insurance and the full price of these medical goods and services are included in the HICP.
- Article 4(4) of Regulation No 2166/1999 explains that where goods or services in the health, education and social protection sectors have been available to consumers free of charge and subsequently a fee is charged, then the change from a zero price to a real price, (or *vice versa*), must be considered in the HICP.
- Therefore, the shift from private insurance to social insurance must be taken as a price falling to zero and the shift from social insurance to private insurance must be taken as a price going from zero to the market price.

Assuming that the Regulation would be implemented as prescribed, it was expected that the impact of the healthcare reform would lower the headline estimate of the HICP by anywhere between 3 to 4 percentage points compared with the level it would have been had the Regulation not been accounted for in the index. This led to some questions about the interpretation of the Regulation. The section below discusses the new Recommendations that flowed from this event.

Recommendations

Recommendation 2005/881/EC was developed to establish a clear distinction between developments considered to be price changes and those that are changes in population or consumption and thus do not affect the HICP.

This Recommendation makes a distinction between:

1. changes in the eligibility and access rules for social health insurance; and
2. changes in the prices in a single scheme and price changes resulting from changes in the rules determining prices in a single scheme.

The first type of change is *not* considered for the purpose of the HICP to be a price change. By contrast, changes of the second type are price changes and should be reflected in the HICP.

This Recommendation implied that the change in the health insurance scheme fell under the first type of change and therefore no price change should be recorded.

Meaning of the Recommendations

1. In cases where both private and public health insurance co-exist in a country, then a price index for healthcare insurance should be stratified in two parts: a stratum for private health insurance and a stratum for public health insurance. Price changes would then be applied to their respective stratum.
2. This flows from the first Recommendation where each of the strata would have its proper weight according to the health insurance regime and healthcare service which applies. The corresponding price behaviour would be estimated according to the stratum to which it belongs.
3. The new weights to be introduced in January of each year should reflect the new insurance regime in that country. Until the weights are updated, the price index for health insurance should be based on prices drawn from the existing regime only and not reflect any changes in prices because of the new regime.

12.2 Non-life insurance services

12.2.1 Introduction

The basic economic activity of (non-life) insurers is in collecting premiums and the payment of claims to policy holders ([272]). Two elements characterise the activity of these insurance companies ([273])

First, they pool the risks of the insured policyholders by using premiums received to reimburse claimants for loss or damage. Second, they maintain and manage their financial reserves so that they can meet future obligations. Most of the revenues generated by insurance companies are

([272]) The treatment of insurance in a CPI is also covered in the CPI Manual: Concepts and methods (2020) in paragraphs 2.134 to 2.137, 3.88 to 3.89, and for medical insurance 11.312 to 11.323.

([273]) To simplify the text the use of the term insurance will be understood to mean non-life insurance.

from premiums, returns from investments, and other income generated from reserves. In brief, insurance activity organises a redistribution of money among insured households to replace or reimburse loss or damaged property covered by insurance policies.

Expenditures of households, as policyholders, for insurances services are covered in the HICP. However, this only applies to non-life insurance, e.g., health, vehicle, and home contents insurances, while life insurance and real-estate (buildings) insurance are excluded from the coverage of HICP (see Chapter 2).

The *basic principle* underlying the treatment of insurance services in the HICP is that weights, but not prices, are recorded net of claims.

The weight for insurance in the index should reflect the consumer expenditure for the fee included in the insurance premiums for providing insurance services to households. This fee is known as the *service charge* and largely corresponds to the premiums paid by households' net of claims paid to them by insurers. Accounting for the expenditure for premiums net of claims in this way is known as the *net approach*.

This net approach recognises the service charge as the expenditure for consuming the insurance service. The other part of the premium, corresponding to reimbursement of claims, is an element of the redistribution among households and thus is not expenditure for a service from an insurer. By excluding the redistribution part from the insurance service expenditure, the net approach is consistent with the notion of the HICP as an indicator of consumer inflation and the concept of household final monetary consumption expenditure. The net approach also avoids double-counting expenditures made by households after insurance claim reimbursements for the ensuing repairs or replacement of property lost or damaged.

Although the weight for insurance is calculated based on the net weight approach, the same cannot be applied to the prices (i.e., premiums) used to compile insurance in the HICP, for practical reasons. Therefore, full or *gross prices* are used. Accordingly, the net weight, gross premium approach would be the chosen approach for the treatment of insurance services in the HICP. The next section describes how this should be implemented.

12.2.2 Legal requirements and definitions

Article 5(6) of Implementing Regulation (EU) 2020/1148 provides the following terms and definitions with regards to insurance:

Definitions

19. 'actual premiums' means the amounts paid for a specific insurance policy to obtain insurance cover over a stated time period.

20.'implicit service charge' means the output of insurance companies, as defined in paragraph 16.51 of Annex A to ESA 2010.

21. 'non-life insurance claims' means claims as defined in paragraph 4.114 of Annex A to ESA2010.

Articles 3 and 5 of the same Regulation provides the rules for insurance weights and prices:

Article 3

Treatment of insurance weights

6. The sub-index weights that relate to non-life insurance shall be derived from aggregate expenditure by households on implicit service charges.

7. Consumption expenditure financed from non-life insurance claims, including payments made directly by the insurance companies, shall be included in the sub-index weights of the relevant ECOICOP categories.

Furthermore, the Annex to Implementing Regulation (EU) 2020/1148 states the following about the quality of the weights for non-life insurance:

'2. In further specifying the quality of weights, the final monetary consumption expenditure shall include the following examples of household final consumption expenditure as defined in the following points in paragraph 3.95 of Annex A to ESA 2010:

'… the part of point (f) that relates to non-life insurance services by the amount of the implicit service charge'.'

Article 5

Treatment of insurance prices

6. Observed prices for insurance shall be actual premiums.

Household final consumption expenditure

The Annex to Implementing Regulation (EU) 2020/1148 is relevant for defining the coverage of the HICP. More specifically, paragraph 2 relates to non-life-insurance services and reads: In further specifying the quality of weights, the final monetary consumption expenditure shall include the following examples of household final consumption expenditure as defined in the following points in paragraph 3.95 of Annex A to ESA 2010:

- *the part of point (f) that relates to non-life insurance services by the amount of the implicit service charge.*

For references purposes, point (f) in ESA 2010 states that Household final consumption expenditure includes insurance services by the amount of the implicit service charge.

12.2.3 Classification of insurance services

Under Article 2(11) and Article 3(6) of Regulation (EU) No 2016/792, HICP sub-indices should be compiled for the categories of ECOICOP, which classifies insurance services in the following way:

Insurance

Service charges for insurance are classified by type of insurance, namely:

[Life insurance and] non-life insurance (that is, insurance in connection with the dwelling, health, transport, etc.)

Service charges for multi-risk insurance covering several risks should be classified based on the cost of the principal risk if it is not possible to allocate the service charges to the various risks covered.

In ECOICOP, insurance expenditures included in the HICP are:

- **12.5.2.0** Insurance connected with the dwelling
- **12.5.3.2** Private insurance connected with health
- **12.5.4** Insurance connected with transport
- **12.5.5** Other insurance

Regarding the ECOICOP definitions above, the following may be noted:

- Life insurance (ECOICOP 12.5.1) – although the *service charges* for life insurance are included in both household final consumption expenditure, and household final monetary consumption expenditure - is nevertheless excluded from the HICP under Article 5(8) Regulation (EU) 2016/792. This is for practical reasons, as the service charges for life insurance are often bundled with an element of saving or investment which, because the degree of methodological harmonisation is not yet sufficient, cannot easily be identified and isolated (see Chapter 2).
- Social (compulsory) health insurance (ECOICOP sub-class 12.5.3.1), is excluded from the HICP because it is not considered part of household final consumption expenditure.

12.2.4 Insurance weights

Derivation

In accordance with the net approach and Article 3(6) of Implementing Regulation (EU) 2020/1148, the weights used in the index should reflect household expenditure on service charges for insurances covered by the HICP:

> *'The sub-index weights that relate to non-life insurance shall be derived from aggregate expenditure by households on implicit service charges.'*

Since this expenditure is not directly observable (i.e., it's an implicit charge), being included in the premiums charged together with redistribution among households within the gross premium, it must be derived. Accordingly, the weight of the service charge is derived as follows:

(+)	Gross insurance premiums
(+)	Premium supplements
(-)	Claims
(-)	Changes to actuarial provisions
=	Service charge

The above definition can potentially lead to negative weights, which are an artificial result of the estimation procedure and do not reflect the actual expenditure for the service to households. This could happen due to irregular and unexpected large fluctuations in claims due to natural disasters or large-scale incidents (e.g., major floods, hurricanes, oil spills). Under the ESA 2010 (paragraph 16.38), negative weights due to volatility in claims are in principle no longer possible. Namely, output of non-life insurance uses adjusted claims incurred, which is an estimate corrected for volatility in claims.

However, it is important to note that negative weights can also still occur because of the marketing strategies applied by some insurance companies. This may happen if an elementary product group pertains to a certain insurance type, such as mandatory motor vehicle liability insurance. Insurance companies may choose to sell this insurance product at a loss for promotional reasons to attract customers when purchasing other insurance products (e.g., comprehensive motor vehicle insurance). In such cases, elementary product groups should be redefined and broadened to include further types of insurance products to avoid the issue of negative weights.

Article 3(7) of Implementing Regulation (EU) 2020/1148 referred to above states that:

> *'consumption expenditures financed from non-life insurance claims, including payments made directly by the insurance companies, shall be included in the sub-index weights of the relevant ECOICOP categories'*

in which these expenditures occur.

For example, after a car accident, either a new replacement vehicle is partially (or fully) financed, or the damaged vehicle is repaired out of the funds issued by the insurance company to the car owner from the claim. In the first case, the expenditure for the purchase of the new car funded from the insurance reimbursement is included in the weight for ECOICOP 07.1.1 Motor cars; for the latter case, the expenditure is included in the weight for ECOICOP 07.2.3 Maintenance and repairs. However, if the weights for insurance are derived from the national accounts, these requirements will automatically be fulfilled since they are compatible with that data source.

Taxes on insurance premiums are regarded as a part of the insurance service charge faced by consumers and form part of the net insurance expenditure weights.

Data sources

The main data sources to derive household final monetary consumption expenditure insurance service weights at ECOICOP level is the national accounts, below two approaches are possible:

- *demand side* data sources – national accounts, household budget surveys.
- *supply side* data sources – insurance supervision authorities, business surveys, insurance companies.

National accounts should normally be the primary source for weights. The national accounts follow the net approach for insurance services and can thus directly provide data on the service charges, as required for the HICP. The data from this source is based on data collected from the insurance industry, duly edited, and can thus be viewed as the most accurate that is practically accessible.

Data from other sources can be useful for breaking down weights to elementary aggregates or lower levels, including within ECOICOP categories. Depending on each country's data availability, these sources should be compared for best accuracy. Each of these different data sources may provide information that could complement other sources of information. Insurance supervision authorities, for example, could provide data on technically detailed accounts for the insurance industry.

Data from *business surveys,* although less detailed, could be used to complement the data supplied by insurance supervision authorities.

Household budget surveys, combined with the data provided by insurance supervision authorities on average share of service charge in gross premiums, can offer an alternative way of estimating insurance weights at low levels, although with somewhat coarse assumptions and approximations.

Specific data from *insurance companies* could be used similarly in rough approximate calculations of low-level weights. The details of the procedure would have to be worked out about the structure of the available data. However, the availability of this data source could be restricted due to business confidentiality.

12.2.5 Insurance prices

12.2.5.1 Gross premiums

The prices to be used in the compilation of the insurance indices in the HICP are gross insurance premiums. This is clearly stated in Article 5(6) of Implementing Regulation (EU) 2020/1148 which states:

> *'Observed prices for insurance shall be actual premiums.'*

This rule serves to ensure international comparability and continuity over time.

The choice of the gross approach rather than the net approach as the price target for the HICP was made for practical reasons. Insurance companies set their premiums based on long-term considerations, while in the HICP it is the estimation of short-term price changes that is the target. When setting premiums, insurance companies distribute exposure to risks across many policyholders and estimate expected future claims. Therefore, it is impossible to derive individual net prices on a monthly and timely basis, and thus only gross premiums can, for practical purposes, be tracked for the HICP.

Nevertheless, the ideal target would be to follow the development of the service charges under constant price-determining conditions (i.e., constant quality). To that end, for a sample of insurance policies, gross premiums are followed as a proxy for individual service charges.

The prescribed approach implicitly assumes that the ratio of the service charge to the gross premium is constant in the short term. It seems likely that this assumption does not considerably affect the estimated index, particularly when net weights are used.

Tax change

Tax levies on insurance premiums should be treated as a part of the insurance service charge. Changes in the gross insurance premiums should thus include any tax change when applicable to the insurance premium.

Following identical individual products

Once insurance policies, i.e., individual products, have been sampled, it is important to respect the general principle of constant quality underlying the compilation of the index, i.e., the insurance policies to be followed are those in which the characteristics of the insurance policy are held constant.

12.2.5.2 Sampling of insurance policies

The exact definition and the number of the sampled insurance policies required to construct indices depend, to a great extent, on the institutional and legal framework in a country. General guidelines to be applied when selecting a sample of insurance policies are the following:

- *Representativity:* Enough representative policies should be selected to ensure that most insurance products available on the market are covered.
- *Clarity:* For each policy selected for the target sample, the price-determining characteristics should be clearly identified, such as the demographics of the policyholder and the specific areas of risk which are insured.

In relation to the first point, care must be taken to ensure that a good sampling frame is used and that the selected sample is representative of the insurance market it is meant to cover. Where possible, different sources of information, such as associations of insurers and insurance companies, should be contacted and consulted to help Member States develop reliable sampling frames.

The sample should be reviewed and updated as required every December, as consumers can switch providers at the time their contract is due for renewal to obtain the best deal. Binding contracts purchased earlier but still in force should be represented as well as newly purchased contracts, in proportion to their market share. Preferably sampled insurance companies could be asked to help prepare frames for sampling insurance policies.

A clear identification of each policy's price-determining characteristics is important for the completion of the sampling, for price collection, for replacements and for quality adjustments. Where applicable, the description of the insurance policy should include details such as the characteristics of the insured person, excess fees, kinds of property or objects insured, the amounts or values insured, the amount of the excess, and price-determining features of the policyholder. Some examples of insurance policies that could be included in the ECOICOP 12.5 sub-index are:

- 12.5.2: Insurance providing cover for fire, theft, and damage of the contents of a home (permanent address) for a person with no criminal record. Doors are reinforced and equipped with security locks. Total value insured is EUR 50 000.
- 12.5.3.2: Insurance providing coverage for expenditures relating to a series of specified private medical treatments up to an annual total amount of EUR 25 000 for a 25- to 35-year-

old male. One third of the expenditure of medical treatments is not refundable until an amount of EUR 200 is reached.

- 12.5.4: Insurance covering expenditures due to accidental damage of a particular make of car (petrol engine), provided that the car does not exceed 20 000 km a year, is owned by a 45-year-old driver who has had a driving licence for 15 years with no record of accidents within the past two years.
- 12.5.5: Civil liability insurance for third-party damage for a 30- to 40-year-old person, with an indemnity limit of EUR 10 000.

12.2.5.3 Quality adjustment of insurance products

As stated in the preamble (6) of Implementing Regulation (EU) 2020/1148:

> *'The HICP should provide a measure of pure change in prices that is unaffected by quality change. Therefore, it is necessary to establish rules for replacements and quality adjustments.'*

This principle extends to non-life insurance services.

When characteristics of an insurance policy specified in the price reference period change, this could imply that the utility to policyholders has also changed. Changes in the price-determining characteristics should be reflected in the HICP. Hence, the gross insurance premium should be quality-adjusted according to the same rules and principles that apply to other goods and services (see Chapter 6).

When the amount insured increases to reflect the inflation of the consumer goods and services covered by a specified policy, the utility from the consumer perspective does not change, thus this should not translate into a quality adjustment.

Example: a change in the excess

From an index compilation point of view, the excess is one of the price-determining characteristics and needs to be monitored by the price statistician over time for any changes. Thus, a change in the excess stated is considered a quality change, if the change in the excess amount is greater than the general inflation rate.

Suppose for example an insurance policy protecting against theft contains the condition that claims are to be paid only if the stolen good is worth an amount at least equal to the excess amount of EUR 300, which is then deducted from the value of the stolen goods in the reimbursement. Now suppose that the excess amount is raised to EUR 500. This change diminishes the degree of insurance protection and thus reduces the insurance coverage to the policyholder. If inflation was 3%, the previous EUR 300 are adjusted to EUR 309. The impact on the price is 1.62 % (500/309). Assuming an initial premium of EUR 1 200 the premium adjusted is now EUR 1941.75 (1200*1.62).

Example: a change in the amount insured (cover value)

In principle changes to the amount insured by (i.e., the cover value of) an insurance policy, between sample updates in December of each year, should be subject to quality adjustment. This is done by a measurement or an estimation of what difference in gross premium corresponds to the change in the amount insured. If this difference in gross premium is very small, then direct comparison of prices, without quality adjustment, can be used.

If the amount insured is index-linked, such an adjustment would be irrelevant and should not be made. If, however, the nominal amount insured by a policy is not index-linked, it should be updated by an appropriate price index; for example, that country's HICP or one of its components. The updating can be carried out by the Member State in the price collection, to correspond to the situation if the policy had been index-linked, and the amount insured thus automatically updated by the insurer. In principle, updates of the amount insured should be carried out at least once a year, in conjunction with annual resampling.

For example, consider an accident insurance with compensation amounts stated in monetary terms in the contract. The amount is EUR 100 000 in the event of permanent total disability caused by an accident, while less severe injuries are compensated with stated percentages of the insured amount. If the policy is not index-linked, the amount insured can be updated with a suitably chosen price index, such as the all-items HICP or a sub-index within healthcare (i.e., within ECOICOP 06). If the price index increased by 2.0 % between times *t* and *t* +1, the updating works as in Table 12.2.36.

Table 12.2.36

An example: a change in the amount insured

	t		t+1		
	Amount insured (EUR)	**Gross premium (EUR)**	**Amount insured (EUR)**	**Gross premium (EUR)**	**Price change (%)**
Adjusted (index-linked or correspondingly updated)	100 000	20.00	102 000	20.30	+1.5
Not adjusted	100 000	20.00	100 000	20.00	0.0

The column on the far right-hand side gives the impact on the price index for the accident insurance policy.

The impact on the gross premium of updating the amount insured must be based on an enquiry to the insurance company.

Quality adjustment for changes in the amount insured can be relevant for insurance of this nature, where the compensation for damage is immediately related to the amount insured, as a stated proportion of the latter. This approach is not particularly relevant for insurance policies for home contents, where the amount insured is an upper ceiling for compensation, which is based primarily on appraisals of the actual damage or loss, which are generally lower than the value of the insured property.

Changes in risk are not treated as a quality change

Gross premiums should not be adjusted for changes in the risk of paying out a claim. Risk is not related to the quality of the insurance service from a consumer perspective but is one of many factors affecting the economics of the insurance business, together with interest rates on funds, other returns on investments, etc. In addition, it would not be practical to adjust for risk.

It could be argued that a change in risk would entail a change in the functionality of the insurance to the policyholder. But a change in risk, e.g., due to an increase in a neighbourhood's crime rate, is an environmental (external) factor, so the resultant changes in the cost of insurance premiums should be reflected in the price index, and no further adjustments are required.

However, the range of risks covered by an insurance policy can be perceived as a dimension of quality. For example, a travel insurance policy that covers extreme sports such as skiing, and rock climbing in the event of an accident could be considered as being a policy of a higher quality compared to one that does not cover such activities. Such characteristics should not be adjusted for unless a replacement product includes such additional coverage.

Table 12.2.37 below summarises the arguments put forward in relation to the quality adjustment of insurance prices (i.e., premiums) in the HICP.

Table 12.2.37

Changes in insurance policy price-determining characteristics (examples)

Changing variable	Quality-adjust gross insurance premiums?	Justification
Automatic change of the amount (value) insured (Index-linked)	No	The amount insured should reflect the depreciation of money and represent the value of the insured goods and services at base month prices (December of each year).
Extraordinary change of the amount insured	Yes	The amount insured changes by a discretionary rule (minimum threshold) established by law and not related to the risk of paying out a claim.
Price-determining demographic characteristics	Yes	Insurance indices should follow a particular insurance policy with its price-determining characteristics fixed over time.
Excess amount or other terms or conditions in policy contents	Yes	It is a price-determining characteristic.
Risk of paying out a claim	No	Not a price or quality feature of the insurance service, adjustment not practical. HICP convention.
Insurance premium tax	No	Insurance premium taxes are a part of the insurance service charge.

12.2.5.4 Bundled insurance products

Many insurance policies cover several types of risk. Bundling is often used by insurance companies in the form of multi-risk insurance products. For example, an insurance policy for home contents may insure for fire, theft, etc. but also for other risks, such as the loss of luggage when travelling or civil liability, all for a single price. This is a pure bundle. In such cases it is straightforward to classify the insurance based on the main risk, following the guidance given in ECOICOP (see section 12.2.3 above). Corresponding principles apply in cases where the price is itemised by components and therefore constitutes a mixed bundle. See Section 7.6 on the treatment of bundles.

12.3 Purchase of motor cars

12.3.1 Introduction

Motor cars are expensive, so that although not frequently purchased by most consumers, they command a relatively high expenditure share (weight) in most country's sample thus entailing an adequate treatment in the HICP. Furthermore, second-hand cars purchased from car dealers are within the scope of the HICP (see Chapter 2). Additionally, cars consist of various components, ranging from luxury seats to high-technological electronic devices such as sensors, all contributing to their functionality.

Motor cars referred to here are of those types notably purchased by households. This primarily means passenger cars, but depending on the nature of a country's market, other types may also be included, such as vans and SUVs.

This section on the purchase of motor cars partly draws on work undertaken in the CENEX project mentioned in Section 6.1 ([274])

12.3.2 Legal requirements

Minimum standards on coverage of motor vehicles

In accordance with Implementing Regulation (EU) 2020/1148 of 31 July 2020, which lays down the methodological and technical specifications under Regulation (EU) 2016/792 for harmonised indices of consumer prices and the house price index, the following ECOICOP categories of motor cars are covered:

- **07.1.1** Motor cars
  - **07.1.1.1** New motor cars
  - **07.1.1.2** Second-hand motor cars

([274]) CENEX: Handbook on the Application of Quality Adjustment Methods in the Harmonised Index of Consumer Prices. Statistisches Bundesamt, Germany. 2009.

According to Paragraph 3 of the Annex to Implementing Regulation (EU) 2020/1148:

Final monetary consumption expenditure shall exclude the following example that is not part of household final consumption expenditure:

> *Current transfers between households, defined in paragraph 4.129 of Annex A to ESA2010.*

In other words, the weight of second-hand motor cars which are transacted directly between households (when one household sells its car to another household) cancels out resulting in a zero weight.

As for purchases of motor vehicles (new or second-hand), they are net of sales by households of second-hand vehicles to other institutional sectors. In this case, Member States may take either:

i. *a net weight for new cars (gross weight minus trade-in value of second-hand cars); This net weight principle also applies to purchases of second-hand cars from say a second-hand car dealership, or*

ii. *a gross weight for new cars (not considering the trade-in* [value] *of second-hand cars), and a weight for second-hand cars including any business sector trade-margin.*

Purchases also cover purchases through financial leasing arrangements.

Note: The trade-in value refers to the price offered by the seller to the household for the used car when purchasing a car, be it new or second-hand.

The above Regulation text offers two options on how to distribute the weight of new and second-hand cars within the total. Section 3.4.2 provides examples of how these two options can be estimated.

12.3.3 Definitions and concepts

The definitions of concepts and methods for quality adjustment are described in Chapter 6.

The following definitions also apply:

Primary model: means a car model specification that allows for similar versions of the same brand, e.g., Volkswagen ID.4.

Sub-model: means a particular version of a primary model, specified with respect to engine version and distinguishing features or equipment details, e.g., Volkswagen ID.4 Pro.

Minor change: means a quality change that involves changes in equipment details or detailed features of the car.

Fundamental change: means a quality change that involves complex technological changes or modifications between models that normally result in differences of several (i.e., more than one) characteristics of the car, or changes in the basic functionality of the car, e.g., a considerable change in the internal space.

12.3.4 Recommendations

For clarity, the treatment of new and second-hand cars are presented separately. Although the Recommendations have not been formally adopted, they describe good practices that can be used to comply with the legal requirements.

Recommendation 1: Stratification

The universe of car purchases, new and second-hand, should first be stratified according to the consumption purpose. Size is a popular proxy variable for the purpose of the car. The different car size groups can be taken as elementary aggregates if required (see Chapter 4). The elementary aggregate can then be stratified further according to the type of engine (electric, hybrid, petrol, diesel, etc.).

For second-hand cars it is recommended to also stratify according to age class.

Recommendation 2: Target sample

Primary models should be selected, preferably within strata, by probability sampling or a combination of probability and cut-off sampling. Unless justified, it is not recommended to apply only cut-off sampling.

Sub-models should be selected by purposive sampling according to well-defined criteria like representativity (large sales), unless probability sampling is also used for sub-models.

Recommendation 3: Price collection

Transaction prices are the preferred prices to collect and use. As an approximation of transaction prices, list prices for the chosen sub-models may be used. All unavoidable costs linked to the purchase of a car such as taxes, duties, and delivery charges (if applicable) are to be included.

Recommendation 4: Product replacement

When a sub-model is replaced, the replacement model should be selected within the same primary model. If a primary model is replaced, the replacement model should be selected within the same elementary aggregate. Generally, the main criterion for the selection of replacement models should be to maintain representativity.

Recommendation 5: Quality adjustment methods

Changes in the equipment of a basically unchanged model constitute minor changes. For minor changes, option pricing or supported judgements by product experts are the preferred methods for when adjusting for quality differences.

For complex technological changes or changes in basic functionality of the car, or the introduction of a completely new replacement model, explicit quality adjustments such as option pricing or hedonic methods are often recommended.

For second-hand cars, supported expert judgement based on age and mileage can be used. Alternatively, CENEX proposes an interesting methodology (see section 3.4). Hedonic methods are also an option.

Recommendation 6: Annual resampling

Resampling is to be conducted in the December of each year and will take effect in January of the following year. Both the selection of primary models and of sub-models should be reviewed.

Recommendation 7: Leasing

The financial leasing of cars by households should be included in the HICP and is classified under ECOICOP 07.1.1. The leasing of cars is akin to short term car rentals and is classified under ECOICOP 07.2.4 ([275]).

12.3.4.1 New cars

Stratification (Recommendation 1)

If sub-groups of car models differ in purchase expenditure, precision can be improved by stratified sampling. Further, stratification with appropriate stratum weights helps ensure representativity where non-probability sampling is used, as is usually the case with new car sub-models (see also Chapter 4).

In general, stratification by consumption purpose seems most appropriate (see below). Whether stratification by type of outlet or by region is justified must be assessed at a national level. Engine displacement or size of car may determine the applicable tax rate for a car and hence may be used as the relevant stratification variables in some countries.

Identification of elementary aggregates

Elementary aggregates are described in Chapter 4. To identify elementary aggregates proxy variables can be useful. For new cars the size of the car is a suitable proxy variable of the consumption purpose. Small cars are predominantly used for travelling short distance in urban areas (e.g., for local shopping trips), while larger cars are more suitable for travelling long distances such as vacation trips.

A suggestion is to use the following stratification based on the classification scheme of the European New Car Assessment Programme (Euro NCAP):

- Supermini
- Small family car
- Large family car
- Roadster sport
- Executive
- Large multi-purpose vehicle
- Small multi-purpose vehicle
- Family van
- Small off-road
- Large off-road
- Pick-up

([275]) The major difference between financial leasing and operating leasing is that in the former, the lessee takes ownership of the car whilst with the latter, the ownership remains in the hands of the lessor. Furthermore, financial leases typically run for many years while in contrast, operating leases are of a duration of less than a year.

Either fewer or more strata, e.g., by type of engine (electric/petrol/diesel/ hybrid) could also be considered.

Assigning the universe of car models to an elementary aggregate can be achieved based on both primary models and sub-models. Primary models, e.g., VW ID.4, often have several sub-models, which include specific engine displacement and equipment versions of the primary model, e.g., VW ID.4 Pro.

Strata below elementary aggregates may or may not have explicit weights. Elementary aggregates are a useful tool for replacement situations (see Chapter 6).

Weighting of strata

It is suggested to explicitly weight strata according to expenditure shares. The expenditure can be obtained by multiplying the total number of sales from the preceding year by an average price for each stratum.

Use of the national car register

A data set with cars transactions can be derived from the information in the central car register. This contains the number of initial registrations (from the preceding year) per primary model which can serve as a proxy for the sales frequencies of the primary models.

The national car register is usually an excellent source of data for this purpose, but some care must be taken. The degree of detail in the register often varies across makes. For some makes in some countries, the primary models may either be only partially subdivided into sub-models or not subdivided at all, while other makes may have many sub-models without any significant differences among them and still have a high level of detail in the register.

The exclusion of business cars

Cars used for business purposes are not covered in the HICP as they are not part of household consumption.

The practical feasibility of this rule depends on whether business cars can be identified, for example through the national car registry. Normally this is possible with the VAT number of the buyer.

The term ‘business cars’ refers to two cases:

1. Company cars provided by employers and used by employees while performing their duties.
2. Cars provided by self-employed persons to themselves and used while conducting their business.

Employees often finance in part the price of the company car, to allow for their private use, and cars of self-employed persons are often used for non-business purposes too.

If the distinction between business and household car purchases can be made (e.g., by consulting the national car registry), business cars should be excluded. If no such distinction can be made, alternatives should be investigated, such as data on leasing, or some type of expert judgement (e.g., conversations with car dealers), to adjust data from the registry. An approximate consideration is usually acceptable, as the issue primarily concerns the weighting of strata rather than that of the prices (price developments should be similar regardless of the use of the vehicle).

Target sample (Recommendation 2)

In accordance with the Recommendation, the sample should be constructed in a two-step process:

1. Select primary models by probability sampling or a combination of probability and cut-off sampling.
2. Select sub-models by purposive sampling.

Selection of primary models by probability or cut-off sampling

Two possible sampling methods are commonly used: probability sampling with probability proportional to size (PPS), and cut-off sampling (see Chapter 4).

PPS sampling is generally feasible given that national car registers with information on the number of registrations are generally accessible. Another possibility is cut-off sampling within the strata. The selection criterion for both sampling methods is the number of initial registrations in the preceding year for each primary model. Normally probability sampling is preferred to cut-off sampling because all available primary models have a non-zero probability of being included in the sample.

Selection of sub-models

After the sampling of primary models, sub-models of the selected primary models must be chosen. For this stage, purposive sampling is the suggested approach.

The sub-models can be selected according to the following criteria:

- The sub-model should be representative (well sold).
- The sub-model should be expected to be on the market for reasonable time.

If the national car registry contains information on sub-models, probability sampling can in principle also be used for selecting sub-models. This must be done with some care, as the degree of detail in the register can differ between brands, so that sub-models may possibly not be easily identifiable for all brands. In some cases, it may be necessary to carry out the final selection of sub-model with each car dealer.

Sampling of outlets

The sampling process also involves sampling outlets for price collection. This can be undertaken in the general sampling of outlets for most product categories, but for car outlets it can be efficient to start from the target sample of primary models. Using information from the manufacturers and importers it can be feasible to construct a sampling frame for outlets for the brands in question.

When the outlets have been sampled, they can, if needed, help select representative sub-models. So, it can be appropriate to select outlets before selecting sub-models. The assistance of staff in sampled outlets to select sub-models can be particularly helpful for brands where the central car registry contains little data on sub-models.

Price collection (Recommendation 3)

To successfully collect car prices for the HICP, the product specifications should include price all characteristics to ensure that the prices of the exact same car are being collected in each collection period (i.e., monthly, quarterly, or other). As an example of these features, we find:

- Engine displacement (e.g., 2 litres)
- Horsepower
- Fuel type (e.g., diesel, gas, hybrid, electric)
- Leather seats
- Heated seats
- Make (e.g., Polo)
- Brand (e.g., Volkswagen)
- Number of doors (e.g., 3, 4, 5)
- Infotainment system (yes or no)
- Type of transmission (Manual or automatic)
- Advanced Driver-Assistance Systems (e.g., Adaptive Cruise Control, Blind-Spot Alert, Lane-Departure Warning, and Reverse Brake Assist)
- Automatic Emergency Braking
- Wireless Smartphone Connectivity and Charging
- 360-Degree Camera
- LED headlights

Specifically for hybrid or electric cars, the following features could be considered as price determining factors:

- Driving range
- Driving power: petrol/electronic, petrol/hybrid, petrol/light hybrid, full electronic
- Maximum torque
- Power (kW/horsepower)
- Gross weight
- Battery capacity
- Carbon dioxide emission (WLTP) (for hybrid cars only)
- Consumption kWh per 100km (available for certain cars only)

These product descriptions are also very useful in two other areas: 1) They are critical for assessing if a quality adjustment must be performed and for helping estimate its monetary value; and 2) They play an important role for determining the appropriate replacement car model when required.

Actual transaction prices can deviate from price lists since in a typical car purchase there is a negotiation process that will bring the advertise price down. Also, the buyer’s old car can be traded in as a part of the negotiations, where some portion of the discount on the new car can be hidden by a overly high trade-in value. For practical reasons, list prices are collected as a proxy, on the assumption that transaction prices are likely to move in parallel to it.

List prices can occur in different forms, such as:

- a retail price recommended by the manufacturer or importer.
- an offer price (asking price) of a car dealer.

In the first case, central price collection from manufacturers' websites is feasible, while regional and outlet dimensions are disregarded. If car dealers are known to set offer prices that do not follow the recommended retail prices of the manufacturers, the prices should be collected from the individual car dealers.

Product replacement (Recommendation 4)

If a sub-model becomes rare on the market or disappears, it should be replaced. Assuming the primary model is still representative, replacements should preferably be undertaken by selecting a new sub-model of the primary model.

If the primary model itself needs to be replaced, the replacement model should normally be of the same make and should anyway belong to the same elementary aggregate as the replaced model. For a newly chosen primary model, a new sub-model also must be selected.

Quality adjustment (Recommendation 5)

For new cars, quality changes are often due to innovations, such as technological improvements and newly introduced measures for environmental protection, etc.

Quality changes in replacement situations are classified as either minor or fundamental changes, as defined in Section 12.3.3 above.

In practice, borderline cases occur between what is considered a quality change and not a quality change, and between minor and fundamental change. In such cases, some judgement must be applied as consistently as possible. Generally, changes in superficial features, such as the colour of the car or wheel design, should not be interpreted as a quality change and thus should not lead to a quality adjustment. A direct comparison should be made. Chapter 6 discusses in detail the main quality adjustment methods used in the HICP.

Quality adjustment in the case of minor changes — option pricing

Option pricing is a preferred method for quality adjustment in respect of minor changes. An alternative is supported judgement by product experts, but this method is to some extent subjective and is therefore considered less preferable.

Minor quality changes are, for example, changes in the contents of the standard equipment package, such as the inclusion of a GPS system or safety sensors.

Option pricing is applicable if the newly added standard equipment was available as an option prior to the inclusion into the standard equipment package. Generally, the cost of options should preferably be provided by the manufacturer or a retailer of the model or equipment in question. If such information is not available, prices pertaining to a similar model could be used instead.

The price of the new model is adjusted for 50 % of the price that the added equipment would have when purchased as an option for a model without it. The motivation for this 50 % reduction is explained in Chapter 6 (6.6.3).

Example 1: New features and option pricing

In period 1 (the price reference period), a model had a list price of EUR 21 000. The model is replaced in period 2 by a similar model that differs in two respects: 1) navigation system and 2) parking assistant. These where optional in period 1 but are included as standard equipment in period 2. The price of the car in period 2 is EUR 22 400. In period 1, the prices for the two optional features were EUR 350 and EUR 500.

The quality-adjusted base price for period 1 is calculated as:

$$\text{EUR } 21\,000 + 0.5 \times (\text{EUR } 350 + \text{EUR } 500) = \text{EUR } 21\,425.$$

Thus, after the quality adjustment, the resultant price relative is:

$$\text{EUR } 22\,400 / \text{EUR } 21\,425 = 1.0455075$$

In this example, the quality adjustment is applied to the price reference prices. Accordingly, the option prices used are also taken from the price reference period.

Example 2: Changes in fuel consumption as a quality change

Based on the two following assumptions:

1. A travel distance of 15 000 kilometres (km) per year.
2. An expected lifetime for the car of five years.
3. The estimated average of the price of fuel for the next 5 years of EUR 1.80 per litre.

In period 1 (the price reference period) a model had a list price of EUR 32 000. The model is replaced in period 2 by a model that differs in one respect that matters to drivers, namely that on the stated fuel consumption that has changed from 7.0 to 6.4 litres per 100 km. The price of the vehicle in period 2 is EUR 34 200.

The monetary value of the change in fuel consumption is calculated by multiplying the difference in fuel consumption over 75 000 kilometres by the estimated average of the price of fuel for the next 5 years.

Thus, the value of the fuel economy over 5 years is: $(7.0 - 6.4) / 100 \times 75\,000 \times 1.80$ = EUR 810.

Applying 100 % of the value of the fuel economy to the price of the car in the first period results in a quality-adjusted reference price of EUR 32 000 + EUR 810 = EUR 32 810 ([276]).

Then the resultant price relative is EUR 34 200 / EUR 32 810 = 1.042365.

The use of 100% of the value warrants an explanation since fuel economy is a special quality adjustment case. It is a given that drivers try to minimise their driving costs. Drivers will assume the full monetary benefits from the expected savings in their fuel expenditures from a more fuel-efficient car. It is therefore justifiable that the adjustment coefficient be 100 %.

Example 3: Changes in engine displacement and option pricing

Suppose that two sub-models in period 1 (the price reference period) have engine power of 81 kW and 92 kW, and list prices of EUR 22 000 and EUR 23 500, respectively. In period 2, the

([276]) The choice of 100% as the adjustment coefficient is somewhat arbitrary and may result in an overstatement of the consumers' valuation of improved fuel efficiency as a quality improvement.

cheaper model is replaced by a similar model that differs in one respect that matters to drivers, namely that the engine displacement is now 85 kW, and the price is now EUR 22 750.

A calculated base period option price per kW is then obtained as a ratio between the differences in price and in engine power of the two sub-models, in the base period, that is:

(EUR 23 500 – EUR 22 000) / (92 – 81) = 136.36363

The quality-adjusted base price of the cheaper model is thus:

EUR 22 000 + 136.36363 × (85 – 81) = 22 545.46,

and the resultant price ratio for this model is:

EUR 22 750 / EUR 22 545.46 = 1.0090726

As with in the example on fuel economy, the value to the user is reflected in the quality adjustment coefficient of 100 % and not 50 % of the option price. This is because the change in displacement is assumed to be of value to all purchasers. Here the choice may not be quite as obvious, but it can be argued that engine displacement (like fuel economy) is equally valuable to all users.

Fundamental changes

In the case of fundamental changes in the car model, quality adjustment by option pricing or other explicit methods will not be practical as the replaced model and the replacement model are too different. If this is the case, hedonic methods and bridged overlap may be the considered. Bridged overlap assumes that the price development of other models within the elementary aggregate would be similar to that of the replaced model. A more detailed discussion about the bridged overlap method can be found in Eurostat’s document HICP recommendation on bridged overlap (June 2021).

Annual resampling (Recommendation 6)

Periodic resampling should be conducted every year in December of each year to ensure that the target samples (cars and outlets) included as of next January is as current as possible.

The selection process should be repeated as described for the construction of the target sample (see Recommendation 2) depending on the sales figures (or the number of initial registrations).

Leasing (Recommendation 7)

Purchases of motor cars also cover purchases through financial leasing arrangements as this is part of household final consumption expenditure. Guidance on how to include these purchases is provided in ESA 2010 on the treatment of hire purchase (leasing):

> ***‘15.20*** *Hire purchase is a type of financial leasing*.
>
> *Definition: a hire purchase arrangement exists when a durable good is sold to a purchaser in return for agreed future payments. The buyer takes possession of the good immediately, though legally it remains the property of the lessor as collateral/guarantee until all agreed payments have been made by the lessee.*
>
> ***[...]***

15.22 In the case of hire purchase, the durable good is recorded as if acquired by the purchaser on the day they take possession of the asset at the market price that would have been realised in an equivalent transaction. …'

According to the ESA, financial leasing involves the purchase of a car on credit by way of loan agreement with the provider of the car. For the HICP, the mean of payment is irrelevant thus financial leasing, cash payments or other types of loans are within its scope. As in financial leasing, the car is registered in the name of the lessee, as in any other type of sale, its treatment offers no challenges.

The *operating leases,* which cover the right to use a car for a specified term at a specified monthly payment. It is not a transaction of a car but of a service – use of a car. The car will not be registered in the name of the household because it remains the property of the lessor. Operating leasing should therefore be classified under ECOICOP 07.2.4 and not under ECOICOP 07.1.1.

A possible approach for price collection for operating leases could be to select a representative set of car models and record the monthly payments (i.e., prices) for these models. Information about these payments can be found both on the websites of the car manufacturers or on the websites of independent leasing companies. A representative combination of annual mileage, contract duration and the amount of the initial payment should be chosen as the parameters of the product specifications. More than one representative combination per model is also possible. It is suggested to set the initial payment to EUR 0.00 in order not to confound this type of leasing with funding. Note that because with an operating lease the ownership of the car remains with the lessor, ancillary expenses such as insurance and maintenance are not the responsibility of the lessor; therefore, these expenditures are not part of the HICP.

12.3.4.2 Second-hand cars

Overview

The circumstances for second-hand cars and the application of the Recommendations are analogous to those for new cars. The differences are summarised below:

- There is an issue of excluding purchases of second-hand cars directly from other households since these are not within the scope of the HICP.
- Stratification of second-hand cars by age seems an appropriate approach for defining the elementary aggregate.
- The role of quality adjustment is somewhat different, as discussed below.

The transactions of second-hand cars among households on the economic territory will cancel out, meaning that the net weight is zero for these transactions. However, households also buy second-hand vehicles from car dealers and other sources for which the weights will not necessarily be negligible.

Although household final monetary consumption expenditure does include information on second-hand car sales it may be grouped with the sales data on new cars. Chapter 3 discusses the options for weights for new and second-hand cars.

Stratification (Recommendation 1)

It is generally suggested that stratification of second-hand cars is undertaken using two principal dimensions, age classes and primary models, using information from the national car register. A final step is to assign precise sub-models to each primary model.

Age classes are country specific. To define this classes information can be obtained from the national car register. To be pragmatic, the following age classes could be considered:

- 2-year-old cars
- 4-year-old cars
- 6-year-old cars.

If older cars are common, additional strata may be needed.

The elementary aggregates for second-hand cars are largely the same as that for new cars.

The universe of primary models within the second-hand car market might be larger than the new car population since the second-hand car universe goes back in time and therefore contains primary models sold over several years.

Price collection (Recommendation 3)

The selection of primary models and sub-models is like the approach for new cars.

For second-hand cars, list or advertised prices are accepted estimates for transaction prices if the latter are not available.

In most cases, central price collection is appropriate. Regional price collection should only be considered justifiable if supported by evidence that price movements differ by region.

In general, there are two alternative approaches for central price collection:

1. Observation of transaction prices or offer prices from market research or a trade body, the prices of which are based on actual recent sales.
2. Observation of offer prices from web sites.

Using data from market research or a trade body may often be preferable as the data may be of a higher quality. In many European countries data is available from sites like Eurotax, Schwacke, and Glasses Guide, for example. Either way, it is important to regularly monitor the quality of the data from a market research company.

Data can also be obtained by web scraping or manually from websites.

Data obtained from market research, trade bodies and web scraped can be large enough to use compilation methods such as hedonics or multilateral methods.

For manual price collection the following principles should apply:

1. It is necessary to refer to the same sub-model over time.
2. The age in months should be held constant as far as possible.
3. The mileage should be kept in the same order of magnitude, e.g., between 45 000 and 60.000 km.
4. If there is a large range of sub-models that fit all the mentioned criteria, any sub-model may be selected.

Product replacement (Recommendation 4)

A peculiarity of the second-hand car market is that is not possible to find exactly the same car in consecutive periods because the values for the characteristics *age* and *mileage* will vary every month. This is not a problem when hedonics or multilateral methods are used. However, for bilateral matched model methods this means that, in principle, in every period each observed second-hand car must be replaced. In practice, the differences between the priced model age and mileage should be kept minimal and ranges for age and mileage should be used. Unless you use the market publications mentioned above where the same product description can be found month after month.

Representativity check within the scope of the monthly price collection

The concrete sub-models that were in the sample in the preceding month serve as a starting point for the manual price collection of the current month.

If the sub-model of the preceding month is no longer available, it should be replaced. The replacement sub-model must correspond as closely as possible to the primary model. The new sub-model should be:

1. of the same primary model
2. of the same age class
3. of the same mileage dimension.

If the primary model significantly loses its market share within the elementary aggregate and age class, it must be replaced by a more representative primary model. This replacement primary model may — as with new cars — be of the same or an alternative brand. For the new primary model new sub-models in the corresponding age class must be chosen.

Quality adjustment (Recommendation 5)

Quality adjustments for second-hand cars can be addressed in several ways.

Explicit quality adjustment methods such as hedonic methods, expert judgements, option pricing, etc., should be used.

A distinction between minor and fundamental changes helps to decide whether an explicit or implicit quality adjustment is necessary. In general, fundamental changes in the quality of second-hand cars are too complex for an explicit quality adjustment, whereas minor changes can be adjusted explicitly (see Table 12.3.38).

Table 12.3.38

Main quality adjustment methods for second-hand cars

Second-hand cars	Where large data are available		Use hedonic methods
	Otherwise	Minor change	Use supported judgement or direct comparison
		Fundamental change	Use bridged overlap

Minor changes in quality of second-hand cars can only occur when observing the same sub-model over time, as:

1. the age of the car differs.
2. the mileage of the car differs.
3. changes in the equipment occur.

Fundamental changes in the quality of second-hand cars should be treated the same way as for new cars.

The case of minor changes

Minor quality changes in the equipment of a precise sub-model cannot be adjusted for explicitly since the value of a singular component of the second-hand car is unknown, and such minor features are less relevant to the user functionality of second-hand cars than new cars. In practice it is better to keep the observed second-hand car as similar as possible and either apply supported judgement or direct comparison.

The case of changes in mileage or age – supported expert judgement

Changes in the age or in the mileage of the car should be adjusted by supported expert judgement. A supported expert judgement is calculated for each primary model and age class for the depreciation rate for age and for mileage. These depreciation rates are calculated on a yearly basis.

This means, for each primary model in each relevant age class two additional samples must be collected: One sample to calculate a depreciation rate for age and one sample for mileage. The price observations of these two samples should refer to one specific sub-model and exclude cars that have been involved in an accident or are special in some other way.

To calculate a depreciation rate for the age of a particular primary model and in a particular age class, 10 used car prices should be observed. These 10 price observations consist of five pairings, each should be of the same sub-model, very similar mileage and of different ages within the range of the corresponding age class. It is important that the mileage of the observation pairs is very similar (nearly constant) whereas the age in months can vary within the interval of the considered age class.

Based on the first sample, a depreciation rate for the age in months can be calculated. Therefore, five depreciation rates for the five observed pairings must be computed. These depreciation rates are averaged using the arithmetic mean formula:

$$\delta\ Model\ A, Age\ class\ Age = \frac{1}{5}\left(\frac{(P_1-P_2)}{(Age_2-Age_1)} + \frac{(P_3-P_4)}{(Age_4-Age_3)} + \cdots + \frac{(P_9-P_{10})}{(Age_{10}-Age_9)}\right) \quad (12.3.1)$$

The depreciation rate '$\delta\ Model\ A, Age\ class\ Age$' can be interpreted to be the absolute monetary value of one month of age for the considered primary model in the considered age class.

Analogously, to calculate a depreciation rate for the mileage of a particular primary model and in a particular age class, a second sample of 10 second-hand car prices should be selected. These 10 price observations again consist of five pairings. Each should be of the same sub-model, identical age in months but of different mileages. Thereby the age between the pairs can differ within the range of the age class.

Based on the second sample, a depreciation rate for the mileage can be calculated as follows:

$$\delta\ Model\ A, Age\ class\ Mileage = \frac{1}{5}\left(\frac{(P_1 - P_2)}{(Mileage_2 - Mileage_1)} + \frac{(P_3 - P_4)}{(Mileage_4 - Mileage_3)} + \cdots + \frac{(P_9 - P_{10})}{(Mileage_{10} - Mileage_9)}\right) \quad (12.3.2)$$

The depreciation rate '$\delta\ Model\ A, Age\ class\ Mileage'$ can be interpreted as the absolute monetary value of an additional mileage of 1 000 kilometres for the considered primary model in the considered age class.

These model and age-class-specific depreciation rates can be used to adjust observed second-hand cars with different ages and mileages between months of observation.

Caveats concerning supported expert judgement

Supported expert judgement for quality corrections for changes in mileage and age of second-hand cars are considered an acceptable approach. Caveats concerning the method are:

1. The sub-samples collected for the calculation of the depreciation rates for age and mileage refer to the specific primary model and age class. Therefore, these sub-samples are rather small (10 observations), possibly resulting in unreliable depreciation rates. The reason for this is that the collected offer prices can vary significantly, even for cars with very similar characteristics.
2. Unavailability of observations with precisely defined characteristics (sub-model, equipment version, age and mileage) makes approximations necessary.

If data is obtained by a market research institute, no variations of the characteristics age and mileage may occur and, if so, no supported expert judgement must be applied.

Using hedonic methods for compilation of second-hand cars sub-index

The hedonic methods (see Chapter 6) can deal with the quality adjustments for both new and second-hand cars. A large data set with information on each product characteristic is needed. This data can be obtained, for example, from web sites using web scraping, from market research or a trade body.

The size of the data set depends on the country. As a rule of thumb, at least 15 to 20 observations should be collected per characteristic in the regression model.

To ensure a reliable regression, all variables that influence the price should be in the data. Many variables are categorized as for example:

- *make* - categories related to the prestige or price range of the brand. This variable serves as a proxy variable for the overall quality of the models to reflect differences across makes.
- *size class* - categorises the selected primary models within an elementary aggregate according to the size of the vehicle.

Stratification is usually not needed as the regression equation handles differences that occur in the most important price-determining characteristics.

Annual resampling (Recommendation 6)

In addition to the representativity checks conducted within the scope of manual price collection within a year, the representativity of the sample should also be checked during the annual resampling in December.

12.4 Actual rentals

12.4.1 Introduction

The treatment of actual rentals must recognise that real estate markets are heterogeneous across Member States. These differences are, for example, in the weight of rents in the HICP, in the characteristics of the dwellings, in the terms and conditions of the rental contracts, etc.

HICPs for actual rentals should cover all types of properties, including private, public and social rental units, as well as new and existing rental contracts. For example, rentals may or may not be freely negotiated between the landlord and tenant, and they may or may not be subsidised. Note that imputed or estimated rentals for owner-occupied housing are not within the scope of the HICP, as they do not involve any monetary transaction.

The following recommendations specify how to measure changes in prices of actual rentals in the HICP. The explanatory text elaborates on the identification of elementary aggregates, the construction of a representative target sample, and quality adjustment methods and replacement strategies.

12.4.2 Legal requirements

Actual rentals are the rents paid by tenants regardless of whether the dwelling is publicly or privately owned. This includes the full amount of the rental the tenant pays to the landlord regardless of any social benefits the tenant receives from public authorities. According to the definition of household final monetary consumption expenditure used in the HICP, housing payments made by public authorities to tenants to reduce their rentals are social benefits in cash and therefore enter household’s disposable income. This means that the full rental should be covered by the HICP, without deducting the cash benefits.

In principle, the price that enters the index should, if possible, exclude additional charges, such as charges for water supply (ECOICOP 04.4.1), refuse collection (ECOICOP 04.4.2) and sewerage collection (ECOICOP 04.4.3); co-proprietor charges for caretaking, gardening, stairwell cleaning, heating and lighting, maintenance of lifts and refuse disposal facilities, etc. in multi-occupied buildings (ECOICOP 04.4.4); charges for electricity (ECOICOP 04.5.1) and gas (ECOICOP 04.5.2); charges for heating and hot water supplied by district heating plants (ECOICOP 04.5.5). In practice, the rental in some countries may include some of these charges. In such cases, the weights and indices concerned should, if possible, be adjusted according to the principles stated in Section 7.6 (on the treatment of bundles). If the prices of additional services cannot be identified separately, then no adjustments are to be made.

In ECOICOP, actual rentals for housing are defined as follows:

04.1.1 Actual rentals paid by tenants

04.1.1.0 Actual rentals paid by tenants

***Includes*:**

- Rentals actually paid by tenants or sub-tenants occupying unfurnished or furnished premises as their main residence.

- Payments by households occupying a room in a hotel or boarding house as their main residence.

***Excludes*:**

- Garage rentals (04.1.2.2).
- Accommodation services of educational establishments and hostels (11.2.0.3).
- Retirement homes for elderly persons (12.4.0.2).

04.1.2 Other actual rentals

04.1.2.1 Actual rentals paid by tenants for secondary residences.

Includes:

- Rentals actually paid for secondary residences.

Excludes:

- Accommodation services of holiday villages and holiday centres (11.2.0.2).

04.1.2.2 Garage rentals and other rentals paid by tenants

Includes:

- Payment for the use of a garage to provide parking in connection with the dwelling. The garage does not have to be physically contiguous to the dwelling, nor does it have to be leased from the same landlord.

Excludes:

- Payment for the use of garages or parking spaces not providing parking in connection with the dwelling (07.2.4).

Actual rentals cover expenditures for a housing service, including a room in a hotel or boarding house if the purpose is to occupy it as a main residence. Rentals or payments for accommodation services in holiday centres and villages are excluded. These are classified in ECOICOP 11.2.0.2.

12.4.3 Definitions and concepts

The following guidance on rentals applies equally to all types of rental units, whether owned privately, by government bodies or by non-profit organisations, and whether or not the rentals are social (i.e., subsidized) rentals which are set with the intention to be affordable for some categories of tenants (e.g., low-income households).

For actual rentals for shelter, the following definitions apply in line with Implementing Regulation (EU) 2020/1148 of initial implementing measures for Regulation (EU) 2016/792 concerning harmonised indices of consumer prices:

Product offer: means a product specified by its characteristics, the timing and place of purchase and the terms of supply, and for which a price is observed.

Homogeneous product: means a set of product-offers among which there are no significant quality differences and for which an average price is calculated.

Individual product: means a product specified by its characteristics, the timing and place of purchase and the terms of supply, and for which a price is observed.

Target sample: means a set of individual products that pertain to transactions from the target universe and for which price data are to be used for HICP compilation.

Quality difference: means a difference between the characteristics, timing, place of purchase or terms of supply of two individual products, where this is relevant from the consumer's perspective.

Furthermore, the following non-regulatory definitions apply:

Social rentals: Rentals that are not freely negotiated between tenant and landlord but are subject to public regulation in some form, usually put in place to provide affordable shelter for some categories of tenants.

M*aintenance and repair*: Maintenance and repair of dwellings are distinguished by two features: first, they are activities that must be undertaken regularly to maintain the dwelling in good working order; second, they do not change the dwelling's performance, capacity or expected service life.

There are two types of maintenance and repair of dwellings: those which are minor, such as interior decoration and repairs to fittings and these are often carried out by tenants; and those which are major, such as replastering walls or repairing roofs, and which are carried out by owners only.

Only expenditures which tenants incur on materials and services for minor maintenance and repair are part of individual consumption expenditures. Expenditures incurred on materials and services for major maintenance and repair are not part of individual consumption expenditure of households as they are usually the responsibility of the owner and not the tenant.

Purchases of materials made by tenants with the intention of undertaking the maintenance or repair themselves should be shown under (04.3.1). If tenants pay an enterprise to carry out the maintenance or repair, the total value of the service, including the costs of the materials used, should be shown under (04.3.2).

Expenditures that provide improvements in the functionality of the dwelling or the building (i.e., functional improvements), which are typically carried out by the landlord, are considered quality change.

Examples of such activities are:

- modernisations that add new features;
- improvements;
- reconstruction; and
- enlargements.

Table 12.4.39 summarises the distinction between repairs and maintenance, and modernisation and additions.

Table 12.4.39

Summary of distinction between repairs and maintenance and functional improvements

Type of activity	Frequency	Aim	Carried out by	Examples
Repairs and maintenance	Regular	To maintain functionality	Landlord and/or tenant (depending on national customs and the rental contract)	Painting; changing wallpaper; replacing worn carpets and furniture; replacing broken light fittings; replacing a broken windowpane.
Functional improvements	Occasional	To improve functionality	Landlord	Replacing a kitchen or bathroom; adding air conditioning; adding fixed solar panels.

The various methods used for applying quality adjustment are described in Chapter 6.

12.4.4 Recommendations

The target samples shall have sufficient elementary aggregates to represent the diversity of items within the category.

Extending this rule to actual rentals, means that collected rentals should cover all types of rental properties for housing, i.e., social rentals and market rentals, new and existing rental contracts.

Recommendation 1: Stratification

There can be stratification according to the regional dimension or other variables to create sub-indices of economic meaning or if lower-level weights are available.

Recommendation 2: Elementary aggregates

The variables:

- type of dwelling;
- size category; and
- type of contract

are appropriate for the definition of elementary aggregates.

Recommendation 3: Sampling

Sampling of rental contracts for housing can be conducted by tracing dwellings, landlords or households. Once the sample has been selected, rents need to be collected. One often used approach, is having the household report how much they pay in rent. Another approach is to obtain the rents from the landlords. Random sampling with at least partial annual renewal (resampling), which is distributed more or less equally within the sample during the year, should be applied.

Recommendation 4: Replacements of dwellings

When a dwelling is replaced, the replacement should belong to the same stratum and elementary aggregate and should be like the replaced dwelling with regards to its features.

Recommendation 5: Quality adjustments

Price (rental) changes that occur together with tenancy changes should be reflected in the index.

If a quality adjustment is needed, a hedonic approach is a superior option compared to bridged overlap. When using bridged overlap, the targeted mean imputation approach is preferred. The supported judgemental quality adjustment method can be used under the condition that it is possible to determine the absolute monetary value of the quality change.

Recommendation 6: Secondary residences

Rentals paid by tenants for secondary residences based on long-term contracts should be allocated to COICOP 04.1.2, while rentals paid by tenants for short-stay accommodation in secondary residences should be allocated to COICOP 11.2.0.

12.4.4.1 Stratification (Recommendation 1)

Strata should be designed so that the dwellings within strata are relatively homogeneous. It is recommended to stratify the sample at least along a regional dimension, using a sufficiently detailed breakdown of locations, and to include all geographical divisions of the country in the sample. Additionally, social rental units should be separated from market rentals. Strata should be weighted in relation to their relative expenditure shares.

Weights for strata should preferably be calculated from national accounts expenditure data if available. If national accounts data cannot be broken down to the stratification, approximate weight calculations can be made from other data sources, such as population census data, household budget surveys or household economy data, e.g., from EU-SILC ([277]). For example, estimated stratum weights could be taken in proportion to the stratum population multiplied by an estimated proportion of renters in the stratum population, and an estimated average rental value in the stratum.

12.4.4.2 Elementary aggregates (Recommendation 2)

The definition of elementary aggregates is generally determined by the type and size of dwellings and may depend on consumer perception and the market environment in the country in question. As a rule, the following criteria are likely to be relevant for defining the elementary aggregates:

- **type of dwelling** – apartment, terraced house, semi-detached house, detached house etc.
- **size** – in either number of rooms, number of bedrooms, or floor area.
- **rental conditions** – social rental, market rental, student homes, rentals aimed at non-national residents (expatriates), etc.

([277]) Database - Income and living conditions - Eurostat (europa.eu).

- **location** – is the location of the unit within the geographical area or areas targeted for the HICP. Access to public transport, proximity to city centre and schools, overall quality of the neighbourhood, and available amenities such as parks are but a few of the elements that help explain why location is one of the main characteristics that influences the rental price of a dwelling.

The definition of the elementary aggregate determines where replacement dwellings should be selected.

12.4.4.3 Sampling (Recommendation 3)

Sampling frame

Generally, there are three possible sources of data from which a sampling frame can be created:

1. from a register of dwellings (addresses);
2. from a register of households (tenants); or
3. From a register of landlords.

A *register of dwellings* may in many cases be obtained from land registry offices, a dwelling census or tax offices. These data sources often contain information on some of the criteria that can be used for defining the elementary aggregates such as type of dwelling and size in addition to geographical location, normally down to micro-location of the dwelling, as defined by street address or postal code. Random sampling can be used. An important drawback with a register of dwellings is that it may not distinguish rented from owner-occupied dwellings except from the tax office data. Consequently, the sample must be filtered.

The precise form and contents of a sampling frame based on a register of dwellings may vary among countries according to the available data. For a rough approximation, see Table 12.4.40.

Table 12.4.40

The form of a typical register of dwellings

Region 'X'							
Identity Number	Address	Type of building (apartment, house, etc.)	year built	Number of rooms	Floor area	Number of bathrooms	…
…							
…							
…							
…							

A *register of households* may sometimes be a practical solution as the sampling frame could be obtained from a register of residents, from a recent population census or other household-type survey (e.g., micro-census) where questions related to the rental units are added to the questionnaire. Random sampling can then be used. However, it should be emphasized that it is the individual product that is to be followed (i.e., the dwelling) not the tenant. If the tenant should move, the dwelling unit with the new tenant remains in the sample.

A sampling frame of this kind may contain only a limited amount of regional information but no other important information, such as the size of the dwelling. A first survey must be implemented to the gather information on the characteristics of the dwelling.

A drawback is that these registers may not be current if the locations happen to be characterised by high turnover rates, which is often the case among young, single, and unattached tenants or in areas where short-term lettings predominate. However, the approach of following a sample of tenants has been proven to be cost-effective in some countries.

An alternative to registers of dwellings and households, which may also include owner-occupied dwellings, is a *register of landlords*. This has the practical advantage that it is directly applicable as a sampling frame as it refers only to rental units.

A drawback may be that private households who rent dwellings directly to the household sector, which can be a significant portion of the rental market in some countries, are often not covered by such registers. Companies or other bodies that rental buildings to the business sector must be filtered out, so the register cannot always be used as a sampling frame without some intervention. Additionally, a register of landlords may not provide information on the locations of dwellings, which would limit the possibilities for efficient sampling. Finally, a sample of dwellings from large property rental companies may be too homogeneous compared with the actual rental market to provide a representative sample, and so may not fully reflect true price developments in any specified region or location.

The three different approaches to designing sampling frames have various advantages and disadvantages and probably no single approach can be described as *best practice* owing to the different market environments in each country.

Selection of sample units within selected strata

Selecting sample units (i.e., rental contracts) by *probability samplin*g requires the availability of a sampling frame, which is in this case a complete register (list) of sampling units within each stratum. A practical limitation is that the register may not include all relevant stratification variables, so proxy variables may have to be used instead. For example, a coarser geographical sub-division may have to be used instead of a preferred finer one.

Probability sampling provides a truly representative selection, but only if the coverage of the sampling frame is accurate. It does not eliminate the need to filter the sample if the frame includes irrelevant units, such as the contracts of non-household tenants (e.g., commercial tenants) or owner-occupied dwellings.

Purposive sampling may be advisable if the rental market is very small and geographically dispersed and a sampling frame is not available. For example, in countries where a large majority of households are owner-occupiers, a complete list of rented dwellings, tenants or landlords may not be available.

A pre-condition for purposive sampling is that the price statistician has a general idea of the rental market within the strata. A significant weakness of purposive sampling is that the selection of dwellings is determined by the decision maker, therefore running the risk of *convenience sampling*, i.e., selecting rental units that are easy to observe, leading to a selection bias problem.

Cut-off sampling appears to be less appropriate if the sampling frame is based on a register of dwellings or a register of households.

Cut-off sampling should normally only be considered if the sampling frame is based on a register of landlords where the market is dominated by a few major landlords. For example, in the case of student lodgings or some types of social housing. The choice of which large landlords to include in the sample could be based on the number of dwellings or the total floor area of all dwellings provided by the landlord. Such a method may be sufficient in market environments where rentals move similarly for both smaller and for larger landlords within both the market and social rental sectors respectively. However empirical evidence, particularly for the market rental sector, may be needed to verify this assumption if this approach is used. The method may also be suitable if the excluded part is obviously of very little importance in the elementary aggregate.

Frequency of sample refreshing

To ensure that the sample of rentals remains representative, it should be reviewed and updated annually.

Other sampling options — cases of small rental markets, lack of sampling frames

In some countries, the rental market may be of relatively minor importance and consequently the weight for rentals is relatively small. In these markets there may not be any registers of rental units or tenants. In such cases, a coarser approach can be considered, such as using an area frame and purposive sampling. For example, one possibility is to use a purposive sample of publicly advertised rentals in a sample of locations or residential districts (area sampling).

Coarser approaches such as this naturally add some undesirable uncertainty, but the impact of the latter is limited if the rental weight is small and the market mechanisms for setting rentals are free from regulation.

The following table gives a very basic overview of the main options for sampling frames and sampling methods. Regardless of the method chosen, it is important to ensure adequate coverage of new and existing contracts, social rentals, market rentals, rentals made to residents and to non-residents and agreements with private landlords. Table 12.4.41 also includes replacement strategies, which are discussed in the next section.

Table 12.4.41

Options for sampling frames and sampling methods

Sampling frame	Sampling frame variables	Typical sampling method	Replacement strategy	Notes
Register of dwellings	Dwelling characteristics	Probability sampling	Tracing (tracking) dwellings	Often preferable
Register of households	Household characteristics	Probability sampling	Tracing (tracking) tenants or dwellings	May be less efficient
Register of landlords	Does not have all the desirable variables	Cut-off sampling	Tracing (tracking) dwellings	For student lodgings, etc.
Other: area frame, etc.	Does not have all the desirable variables	Purposive sampling	Tracing (tracking) tenants or dwellings	Can be considered for countries with small rental market

12.4.4.4 Replacements (Recommendation 4)

Dwellings must be replaced due to building modernisations, demolition, rededication to other uses, permanent non-response or when tenants have either moved to another rented property, cannot be tracked anymore, or have become owner-occupiers. A replacement dwelling should belong to the same elementary aggregate and stratum. Differences in the price-determining characteristics (e.g., in the size of the usable floor area), should be dealt with by applying one of the quality adjustment methods described above. In this case, the usual rules for replacement apply.

A change in the rental price is often linked to a change in tenancy. The price change that is observed in such situations — which may or may not be quality-adjusted to reflect any improvements made by the landlord before a new tenant moves in – can be significant and must be reflected in the price index. If prices for temporarily vacant dwellings are imputed, then it is advisable to use the prices of new rather than existing rental contracts to capture this type of price dynamic.

12.4.4.5 Quality adjustment (Recommendation 5)

A quality adjustment may be needed when there is a replacement situation or when the quality of the sampled dwelling changes. To enable quality adjustment, information on the quality change should be collected in the price survey.

A particular challenge is distinguishing between minor repairs, major repairs and maintenance, and major renovations. The Owner-Occupied price index manual gives some guidance on the matter ([278]):

'… the maintenance and repair of dwellings, whether minor or major, is distinguished by two main characteristics. First, they represent activities that have to be taken regularly in order to maintain the dwelling in good working order. Second, they do not change the dwelling's underlying standard of accommodation, capacity or expected service life.'

In the explanatory notes to ECOICOP it is mentioned that minor repairs are often (but not always) carried out by the tenant. None of these change the quality of the dwelling and thus no quality adjustment needs to be performed.

On the other hand, major repairs and maintenance, and major renovations are typically carried out by the landlord. Major renovations imply that a significant improvement was made extending the life expectancy of the dwelling and/or improving its functionality. Consequently, when a major renovation happens a quality adjustment must be made.

Examples of such renovations are the installation of solar panels, the addition of a bathroom or toilet, the addition of a conservatory or garage, improvements to the heating or ventilation system by adding more radiators or air-conditioning units, etc., improvements to heat or noise insulation, or renovations to the balcony where a glass enclosure is added, etc. For rented dwellings, as for any other consumer product, fashion trends are not considered a quality change.

Over time, the technology used for heating, cooling, and lighting systems and home appliances has evolved. Modern appliances are more energy efficient. If new, more efficient appliances replace the old ones as part of the regular maintenance of the dwelling, there is an implied modernisation.

Another dimension of quality when measuring rental prices that the practitioner needs to be aware of is the issue of depreciation. With time, the sampled rental units deteriorate, thus losing some value. Consequently, these units provide less shelter service to the occupants. This phenomenon should be accounted for in the index otherwise the HICP would suffer from a downward bias. A hedonic regression can be used to estimate the effect of this depreciation, which can then be used to adjust the rental prices for this quality change.

Ideally a hedonic method is used for the compilation of the rentals index in which all quality changes are accounted for. When the use of hedonic methods is not an option then other explicit quality adjustment methods should be use.

Table 12.4.42 summarises the conditions for, and suitability of, different quality adjustment methods for rentals.

([278]) Technical manual on Owner-Occupied Housing and House Price Indices (europa.eu).

Table 12.4.42

Conditions and suitable quality adjustment methods for rental

Conditions		Suitable quality adjustment method
If there is no quality change		Use direct comparison
If quality changes occur	If a hedonic approach is feasible and practical	Use a hedonic approach
	Otherwise: if rentals are freely negotiated	Use bridged overlap or, if feasible, use a supported judgement approach
	Otherwise: if rentals are regulated	Use a supported judgement approach

12.4.4.6 Secondary residences (Recommendation 6)

According to the explanatory notes of ECOICOP rentals paid by households for a *secondary residence* for the duration of a holiday are allocated to 04.1.2, while all other expenditures concerning accommodation services for holiday purposes are allocated to 11.2.0.

To avoid this classification rule being interpreted differently across countries, the following guidelines should be followed:

- Rentals actually paid for short-stay accommodation for the duration of a holiday (covering both main and secondary residences) based on a short-term contract are allocated to 11.2.0.
- Rentals actually paid for secondary residences based on a long-term contract, such as on an annual basis, are allocated to 04.1.2.

12.5 Flights and package holidays

12.5.1 Introduction

Flights and package holidays present a challenge to index compilers as they are subject to a type of sliding pricing structure, dependent on how far in advance they are booked and on availability. Strong seasonal patterns in both package holidays and some flight routes further complicate the measurement of prices for these services.

For the purchase of flights and package holidays the recommendations on the treatment of cross-border internet purchases (see Section 7.2) apply.

In some countries, tickets for rail travel, coach travel or for sea fares/boat trips can also be subject to a type of sliding pricing structure, dependent on how far in advance tickets are booked and on seat availability. As such many consumers choose to book in advance either in person or on the internet to obtain the best fare. These websites often charge booking, delivery, and text notification fees etc. Thus, the recommendations for flights and package holidays and the practical advice given in this chapter are also pertinent to train fares and sea fares.

12.5.2 Definitions

Airfares are that part of the price which accounts for the flight excluding fuel surcharges and taxes. In this chapter *flights* (and their prices) refer to the total cost of the service including any additional charges directly associated with the delivery of the service such as taxes, fuel surcharges, booking and credit/debit card fees etc.

Package holidays are defined as those holidays where the cost of travel and accommodation are ‘bundled’ and sold in *one transaction*. Travel and accommodation bought in separate transactions do not represent a package holiday and their relevant prices and weights should be allocated to ECOICOP 07.3.3 (Passenger transport by air) and ECOICOP 11.2 (Accommodation services) respectively. Most package holidays will start with travel from the country of residence, while the consumption of the respective services can take place in multiple countries (see also Section 12.5.4).

Last-minute deals are a marketing approach more typical for package holidays than flights, where tour operators try to sell unsold holidays, often at large discounts close to the date of departure to minimise their losses arising from unsold flights/holidays. There is no agreed definition of what period in advance of departure *last minute* represents. A working definition could perhaps be — departure within 3 weeks of the price collection day. However, further research at national level is required to assess the practicality of this definition.

Price concept: it is common practice within much of the travel industry that advertised prices of both flights and package holidays are generally less than the actual final prices paid by most consumers. This is because, additional services such as baggage fees, priority boarding, extra legroom seats and in-flight meals etc. are often optional and are subject to additional fees. All additional charges for some travel-related services which are often bought by consumers (e.g., trip cancellation insurance, health insurance, additional luggage charges, and other travel related costs), should be part of the product description to ensure that the observed prices are representative of the total price paid by consumers.

12.5.3 Recommendations

Recommendation 1: Coverage

The expenditure (weight) and the price for flights and package holidays booked and paid for in a travel agent should be entered in the HICP of the Member State where the purchase is made.

The expenditure (weight) and the price for flights and package holidays booked on internet should be entered in the HICP of the Member State from which the trip first departs.

Recommendation 2: Price collection

The prices should be recorded sufficiently in advance of departure to ensure they are representative of consumers' expenditure and behaviour. In addition, the expenditure share of last-minute deals should be investigated and, if found to be significant, included in the index as additional items.

Price collection should occur over a period of more than one working week if prices are known to be volatile within the month.

Recommendation 3: Price definition

Prices to be recorded should be the total cost of the service. This is the basic price of the service plus any additional costs necessarily included with the delivery of the service, such as booking fees and fees for using debit or credit cards — where the latter characterises a representative observed price. The item descriptions should clearly specify which additional costs are to be included.

12.5.3.1 Coverage (Recommendation 1)

The coverage concept of the HICP is set out in Regulation (EU) 2016/792 of the European Parliament and of the Council of 11 May 2016 on harmonised indices of consumer prices and the house price index. The coverage of Household Final Monetary Consumption Expenditure as adapted for use in the HICP is termed the *Domestic concept or Domestic principle* (see Chapter 2 for a full description).

While the application of the domestic concept poses significant challenges in practice, its application is important to ensure that meaningful and consistent aggregate indices are made. In terms of the correct allocation of both expenditures and prices for flights and package holidays this concept is important and has a direct bearing on where such expenditures should be allocated.

The recommendations on the treatment of cross-border internet purchases (see Section 7.2) in the HICP state that for goods, the HICP should cover all internet purchases which are available for purchase within the economic territory of a country (prices and expenditures) regardless of the residential status of the seller. On the purchase of services, the recommendation is as follows:

> *'The expenditure and the price observations for services of a tangible nature (services connected to immovable property, passenger transport, services in respect of admission to cultural, artistic, sporting, scientific, educational, entertainment and similar events, restaurant and catering services) booked through internet shall be accounted for in the country where the service is supplied.'*

Following the above, for purchases made via the internet, Recommendation 1 states that:

> *'The expenditure (weight) and the price for airfares [and package holidays] booked on internet should be entered in the HICP of the Member State from which the flight [or holiday] first departs'.*

In most — but not all cases, this will equate with the country of residence.

For all travel and holiday services booked through travel agents, both the expenditures (weight) and the prices should be entered in the HICP of the Member State where the purchase is made.

In addition, traditional travel agents also provide value-added services to consumers by offering advice and searching for the best deals and making bookings on their behalf. For their services, agents charge, implicitly or explicitly, a booking fee which forms a component of the recorded price.

Thus Recommendation 1, for both airfares and package holidays, states that:

> *'The expenditure (weight) and the price for airfares [and package holidays] booked and paid for in a high street travel agent should be entered in the HICP of the Member State where the purchase is made.'*

Flights from smaller Member States to long-haul destinations such as the USA or Australia etc. or flights to a remote region within a larger country, for example a flight from London to the Outer Hebrides in Scotland, may involve multiple flights either within a Member State, or in more than one Member State. In which Member State should the expenditures and prices for these flights be recorded?

- If all flight segments of the flight are booked at a travel agent, then the expenditures and prices should be recorded in the country in which the travel agent's business is based.
- If all flight segments are booked via the internet as *one* transaction, then the expenditures and prices should be recorded in the Member State where the first flight segment starts.
- If the flight segments are purchased on the internet in separate transactions, then the expenditures and prices should be recorded in the country in which each flight segment starts (See below for examples).

This differential clearly has impacts on the definition of representative product offers and for price collection (see also Section 12.5.5.2 Sampling).

Examples of where prices and expenditures in terms of flights and package holidays should be allocated are given below.

Coverage examples: in which country should prices and expenditures be recorded? Some examples.

The examples below are taken from the recommendations and give some practical guidance:

1. A Danish consumer purchases via the internet a flight from Kastrup Airport (DK) to Paris-CDG (FR), the expenditure and price observation form part of the Danish HICP.
2. A Danish consumer purchases via the internet a flight from Kastrup Airport (DK) to JFK (USA) via Paris-CDG (FR), the expenditure and price observation form part of the Danish HICP.
3. A Danish consumer purchases via the internet a flight from Paris-CDG (FR) to JFK (USA), the expenditure and price observation form part of the French HICP as this is where the service first commences.
4. A Danish consumer purchases at a high street travel agent in Berlin a flight from Paris-CDG (FR) to JFK (USA), the expenditure and price observation form part of the German HICP as this is where the purchase is made.

5. A French consumer purchases via the internet a package holiday to Disneyland in Florida (USA) departing from Paris, the expenditure and price observation form part of the French HICP.
6. A French consumer purchases via the internet a Mediterranean cruise departing from Nice (FR). The expenditure and price form part of the French HICP.
7. A French consumer purchases via the internet a Mediterranean cruise departing from Athens (EL) and books flights to Athens separately. The expenditure and price for the flight form part of the French HICP while the expenditure and price of the cruise forms part of the Greek HICP.
8. A French consumer purchases from a travel agent in Italy (IT) a Mediterranean cruise departing from Barcelona (ES) and purchases via the internet a flight from Paris (FR) to Barcelona separately. The expenditure and price for the flight form part of the French HICP, while the expenditure and price of the cruise forms part of the Italian HICP.

In each of these examples the potential data sources should always be kept in mind. See Section 12.5.4.1.

Coverage in ECOICOP

Flights (Airfares)

07.3.3 Passenger transport by air

07.3.3.1 Domestic flights

07.3.3.2 International flights

As specified above, the following ECOICOP sub-classes should also be covered by the Recommendations outlined here:

07.3.1.1 Passenger transport by train

07.3.4.1 Passenger transport by sea

Package holidays

09.6.0 Package holidays

All-inclusive holidays or tours, which provide travel, food, accommodation, guides, etc. This includes half-day and one-day excursion tours, and pilgrimages.

09.6.0.1 Package domestic holidays

Holidays taking place on the economic territory where the holidaymaker resides.

09.6.0.2 Package international holidays

Holidays taking place in other countries.

An additional definition in NACE is relevant in this context:

79.12 Tour operator activities

This includes arranging and assembling tours that are sold through travel agencies or directly by tour operators. The tours may include any or all the following:

- Transportation,

- Accommodation,
- Food, and
- Visits to museums, historical or cultural sites, theatrical, musical or sporting events.

12.5.3.2 Price collection (Recommendation 2)

Temporal coverage

Implementing Regulation (EU) 2020/1148 as regards to the observation of prices in the Harmonised Index of Consumer Prices, Article 8 states that:

'3. If the price of a service depends on the time between the purchase and the commencement of the service, Member States shall take into account the prices that are representative for purchases of the service.

4. Observed prices shall refer to at least 1 working week at, or around, the middle of the month.

5. If prices for an individual product are known to be volatile within a month, the observed prices shall refer to more than 1 week.'

This is of relevance to the pricing of airfares, the prices of which constantly change, in reaction to changing demand conditions and other factors. Thus Recommendation 2 (Price collection) for airfares states that:

> *'Price collection should occur over a period of more than one working week if prices are known to be volatile within the month.'*

Price fluctuations are caused by a *yield management* approach to flight pricing introduced by airlines since the deregulation of the industry. Yield management is a flexible pricing strategy that anticipates and influences consumer behaviour with the aim of maximising revenue. The differentiation of prices is generally related to various factors of supply of and demand for air transportation services. Airlines provide a scheduled transport service using assets with high fixed costs, they have a fixed capacity and a perishable inventory (once a flight takes off, empty seats can no longer be sold and have no value). While supply is fixed, demand fluctuates depending on the destination, the time of departure and how many tickets have already been sold in advance. As such, customers are willing to pay different prices for essentially the same service and it is therefore possible for airlines to estimate future demand to some extent.

Airlines differentiate prices in various ways. The seats in an aircraft are divided into booking classes that have different prices and a limited number of seats. As a flight fills up, the prices are changed to maximise revenue. Travellers pay different prices, and in general the later you wait to book a flight the chances of getting a cheap ticket diminish. Essentially revenue management is *time-slot* management: filling up a plane is not the problem; the issue is to maximise revenue. These factors also apply for flights that form part of package holidays.

Specific events like major public holidays, trade fairs, major conferences and international sporting events etc. may also cause an increased demand. Many additional factors complicate this process and the models used by airlines can become very complex.

Given the above factors, Recommendation 2: Price collection, for both flights and package holidays states that:

> *'The prices should be recorded sufficiently in advance of departure to ensure they are representative of consumers' expenditure and behaviour.'*

Making a schedule for the price collection of flights rests on a series of assumptions that must be adapted to the specific situation in each Member State. Input from professionals from within the airline industry could be very useful when setting up such a schedule.

Below are two general considerations which should be kept in mind when developing price collection schedules:

1. As intercontinental flights are often more expensive, it can be assumed that they would generally be for longer holidays which are booked well in advance. European flights are generally booked closer to the date of departure and are often for just a few days, like a weekend trip.
2. As flights can be booked up to one year in advance it can be assumed that they do not sell out in days and that it is more important to collect prices in several different months prior to the flight rather than days ahead. This also reflects actual consumer behaviour, where most holidays or weekend trips are often booked well in advance of travel.

Timing of entering prices

Currently there are no regulations that specifically refer to the treatment of flights and package holidays in the HICP. However, Article 8 of Implementing Regulation (EU) 2020/1148 deals with the issue of the timing of the pricing of services in the HICP:

'3. If the price of a service depends on the time between the purchase and the commencement of the service, Member States shall take into account the prices that are representative for purchases of the service.

5. If prices for an individual product are known to be volatile within a month, the observed prices shall refer to more than 1 week.'

In the case of flights and package holidays, the consumption of the service, i.e., the start of the flight or the holiday, is in general well after payment has been made.

Implementing Regulation (EU) 2020/1148 concerning harmonised indices of consumer prices, Article 2(4) defines a product offer as:

> *'…means a product specified by its characteristics, the timing and place of purchase and the terms of supply, and for which a price is observed.'*

In practical terms this means collecting in advance the prices to be paid for the consumption of a specified service at a given date in the month. Illustrative examples of product offers, and price collection schedules are provided below.

The same principle applies to rail fares; however, most consumers are likely to book rail fares closer to the planned date of travel than is the case for flights. As such, it may be assumed that most consumers will buy individual tickets for travel within a few weeks of travel. In such cases, the date of purchase should be specified in terms of weeks or days, in advance of travel within the reference month, as in some countries purchasing tickets at the train station on the day of travel is often significantly more expensive.

Considering the specific timing and price-determining characteristics of flights, example product offers and an illustrative price collection schedule for flights for both European and intercontinental destinations are given below. The illustrative price collection schedule is also pertinent to package holidays, rail and sea fares. However, national circumstances and marketing practices should dictate the design of the price collection. Examples of product descriptions for both flights and package holidays are also given.

Definition of product offers

Product offer I is either known or assumed (on the best information available) to be purchased by consumers typically four months in advance (40 %), two months in advance (40 %), and one month in advance (20 %) of departure:

- A European weekend trip for one adult person
- Economy ticket — changes for a fee allowed up to 24 hours before departure — on airline X
- One checked-in piece of luggage
- Using a credit card for payment
- From airport B to airport C
- On the second Thursday (in month M) at approx. 6 pm
- With a return on the following Sunday at approx. 8 pm

Product offer II is either known or assumed (on the best information available) to be purchased by consumers typically four months (50 %), and two months (50 %) ahead of departure, and is known to typically show sharp and irregular price changes within the same month. Hence, in the price-collection schedule given below, two collections are undertaken two months in advance:

- A European flight for one adult person
- Economy ticket — no changes allowed– on airline Y
- No checked luggage / hand luggage only
- Using a credit card for payment
- From airport D to airport E
- On the second Wednesday (in month M) at approx. 6 pm
- With a return on the Wednesday of the following week at approx. 8 pm

Product offer III is either known or assumed (on the best information available) to be purchased by consumers typically nine months (30 %), six months (40 %) and three months (30 %) ahead of departure:

- An intercontinental flight for two adult persons
- Economy ticket — fully flexible — on airline Z
- One checked-in piece of luggage per passenger
- Using a credit card for payment
- From airport F to airport G

- On the second Friday (in month M) at approx. 8 pm
- With a return two weeks later at approx. 6 am
- Total price for two persons

The price collection schedule

The tables below give an example of how a price collection schedule/frame could be organised using the product offers described above. Note that collection can be specified on either a single or on multiple days to better capture potentially volatile prices.

Table 12.5.43

Product offer I

Index month: *E.g. September 2022*	Price collection week	Collection day	Time of collection
M-4 — *May*	Second	Mon. — Tue.	9am
M-2 — *July*	Second	Wed. — Thu.	1pm
M-1 — *August*	Second	Fri.	3pm

Table 12.5.44

Product offer II

Index month: *E.g. September 2022*	Price collection week	Collection day	Time of collection
M-4 — *May*	Second	Mon. — Thu.	9am
M-2 — *July*	Second	Fri.	1pm
M-2 — *July*	Third	Mon. — Wed.	3pm

Table 12.5.45

Product offer III

Index month: *E.g. September 2022*	Price collection week	Collection day	Time of collection
M-9 — *January*	Second	Mon. — Thu.	9am
M-6 — *March*	Third	Fri.	1pm
M-3 — *June*	Second	Mon. — Wed.	3pm

Illustrative examples of product offer descriptions for package holidays

Product offer I

- A package holiday for two adults to Destination A, booked with tour operator B
- In hotel C

- Board type: All / fully inclusive (food and drink)
- Duration: 14 nights
- Flights: departure: around 7 am on the second Saturday of the month from airport X to airport Y
- 15 Kg luggage allowance for each traveller
- Transfers to and from hotel included
- Paid by credit card
- Total price for two persons

Product offer II

- A package holiday for two adults and two children (under 12 years old), booked with tour operator C
- Destination D
- In hotel E
- Board type: Self-catering
- Duration: 7 nights
- Flights: departure around 10 am on the second Monday of the month from airport X to airport Z
- 15 Kg luggage allowance for each traveller
- Transfers to and from hotel included not included
- Paid by credit card
- Total price for two adults and two children

The above are just two examples of potential product offers. The price collection schedule/frame would be like that given for flights above, except that holidays are generally booked further in advance and prices — with the exception of last-minute deals, are generally less volatile, thus a single collection in a specified week per product offer should be generally sufficient.

The schedule given above assumes that prices are collected from internet *by hand* by a price collector playing the role of a consumer ([279]). This is a reliable method to ensure that all additional costs are included in the final price, but it is resource intensive. The use of web-scraping as a method of price collection could be used to increase the frequency of price collection and the number of flights and holiday destinations. However, care must be taken to include all additional costs included in the final price.

([279]) When collecting prices from the Internet, practitioners should be aware of the possibility of the phenomenon of ‘Browser fingerprinting’, which can affect how the online merchant sets its price. If this is considered a serious concern, then steps can be taken to minimize Browser fingerprinting such as Private Browser Method and the use of a VPN.

12.5.3.3 Definition of prices (Recommendation 3)

Recommendation 3 states for both flights and package holidays that:

> *'Prices to be recorded should be the total cost of the service. This is the basic price of the service plus any additional costs necessarily included with the delivery of the service, such as booking fees and fees for using a credit card — where the latter characterises a representative product offer. The item descriptions should clearly specify which additional costs are to be included.'*

While travel agents may charge a booking fee which should be included in the total price, internet purchases, especially for low-cost airlines, can attract several obligatory charges such as, booking / administration fees, checking-in fees and card-payment fees etc. There are often other options, which are chosen by many consumers which are also charged for e.g., checked luggage, increased flexibility, meals etc. which at the discretion of the index compiler, may or may not be included in product descriptions.

Important price-determining characteristics should be included in the product specification, as both the obligatory booking and card fees along with discretionary services such as checked luggage, together can form a significant part of the total price — particularly for low-cost airlines.

The aim for the index compiler is to construct product descriptions that are representative/characteristic of a typical consumers' purchases. Alternatively, all additional charges (whether compulsory or optional) may be comprehensively incorporated into the index by weighting these charges in accordance with their actual expenditure shares if these data are available.

How far in advance a flight is booked can directly affect the prices consumers pay which directly influences consumers' behaviour, and therefore forms an integral part of the product-offer description. This issue is elaborated in the following sections.

In practical terms this requires tight product descriptions, including all the characteristics, which define the cost of the flight. It is particularly important to differentiate between flexible (the option of changing a flight and/or claim a refund when the flight is not taken) and non-flexible fares, as this is a key price-determining characteristic of flights.

In general, insurance should be recorded as such in ECOICOP 12.5.4.2 — Travel Insurance. But, if the insurance in question is obligatory and exclusively connected to the individual purchase of the travel in question and the cost of the insurance cannot be separated from the price of the flight, then it should be part of the total cost of the flight. If such insurance is not mandatory, then it should not be included in the cost of the flight. The cost should be covered in the index for travel insurance.

In some countries, national regulatory authorities run schemes, which protect consumers should a tour operator or airline cease operation either before or during travel. This protection is often financed by the travel industry through levies on each passenger. Such levies are generally mandatory and as such should be included in the total cost of the flight or holiday. Again, national practices will vary, and as such the treatment of such schemes will depend on national circumstances.

12.5.4 Practical implementation [280]

12.5.4.1 Data sources

The price collection for flights and package holidays should be centred on internet price collection at head office or in transaction data such as 'Amadeus'.[281] Traditional travel agents still exist but since they advertise their prices on-line there is no need for manual price collection. This is elaborated further in Section 12.5.5.2 sampling.

The main data sources that could be useful for both sampling airfares and estimating weights are:

- National accounts
- National regulatory/civil aviation authorities
- Airports
- Airlines/tour operators
- Tourism statistics
- Household budget surveys
- Trade bodies
- Market research companies
- Bespoke travel surveys
- API for Amadeus
- And web scraping [282]

While, in theory, a well-constructed household budget survey should provide accurate expenditure weights for travel/holiday expenditure that starts from the country of residence, a revised household budget survey or other data sources are needed in to separate out travel and accommodation services commencing abroad.

The tight security involved in undertaking international air travel has resulted in the collection of data for every journey taken. At the very least airports should be able to provide the numbers of passengers that have flown to each destination they serve. Airlines should also be able to provide information on the number of passengers they have carried by destination too. Together or individually, these data sources should allow index compliers to select representative destinations and provide an input for estimation of detailed weights. It should be noted that using the number of aircraft movements as a proxy of the above is a sub-optimal approach and should be avoided. NSIs shall have this information in-house – Tourism Statistics – or shall approach airports directly.

[280] Annex 12.9.5 in this chapter presents the practical case from Norway on how their index for airline flights is produced using scraped data.

[281] The practitioner should be cognizant that Internet prices for package holidays are advertised prices and are not transaction prices. In some cases, advertised packages may not sell at all and are therefore not reflective of what consumers are purchasing. This issue is not as prevalent for airfares.

[282] Examples of airfares collected with web scraping tools can be found in the Practical guidelines on web scraping for the HICP.

An alternative source for selecting representative destinations for flights, are national civil aviation authorities, which often collect detailed data covering the entire country. Such databases may be a good place to start for larger Member States which have several international or hub airports. For example, France Aviation Civile Services publishes detailed information on the number of passengers travelling on each scheduled flight route. Such data sources likely exist in other Member States too.

For package holidays, in addition to the Tourism Statistics, the tour operators themselves, may have data that can help in selecting destinations. There are also market research companies and tourism trade organisations, which collect data as well. Additionally, as some regional airports largely serve the package holiday market, regional airports may also be able to provide information on the most visited tourist destinations.

In terms of sampling destinations for both flights and package holidays, the data that are most likely to be available is the number of passenger flights taken. This is sub-optimal as these data may not exclude business travellers and will normally not reflect the fact that the cost of both flying and package holidays varies considerably between destinations. Nonetheless, using such data is far superior to using a completely subjective approach.

12.5.4.2 Sampling

The above data sources may allow Member States to perform some type of probability sampling rather than purposive sampling (see Chapter 4).

For ECOICOP, the only distinction that needs to be made is between domestic and international flights and package holidays. However, it is sensible to distinguish between domestic, intercontinental, European, and seasonal holiday destinations to ensure that the range of flights and package holidays purchased by households is covered. Flights with connections should not be disregarded. These flights should be priced as part of an international flight. This also applies for smaller countries where consumers purchase flights to one of the major European hubs to travel to intercontinental destinations.

In some countries, seasonal holiday flights are also representative and should be included in the sample if its expenditure share is significant. Seasonal holidays can happen both in summer and winter for different destinations. These types of flights have grown in importance in recent years as many consumers now choose to book travel and accommodation separately to personalise their holidays. The growth of low-cost carriers, which now serve these seasonal destinations, has also added to their significance.

In general, index compilers should restrict product offers to economy class tickets, as this is the most frequent class of travel for both flights and package holidays.

The distinction between business and private household customers is difficult to make. Being selective in choosing destinations could be an easier way to exclude business passengers. For example: the flight on its own from Amsterdam to Frankfurt makes hardly any sense for a private Dutch consumer. However, some caution must be exercised, as flights to destinations such as New York and London, while clearly serving business travellers, are also popular tourist destinations. Looking at the number of business class passengers on various flights is not particularly helpful in identifying which flights are mostly business oriented. This is because not all travellers who fly business or first class are necessarily travelling on business, and not all passengers who fly economy are tourists, as many companies will only pay for economy tickets for employees travelling on business — particularly on short-haul flights.

If there are multiple flights on a day, it can be assumed that a typical private household will opt for the cheapest possibility while business passengers generally favour early morning and late afternoon flights.

The sample for both flights and package holidays should reflect national circumstances and preferences. Package holidays also include holidays where the inclusive travel is by coach or train (e.g., European coach tours and Eurostar holidays to Euro Disney etc.). The sample should also include regional as well as national hub airports if their market share is significant. For smaller Member States, where direct intercontinental flights may not be available, booked fares should be sampled according to the most usual flight connections, e.g., Ljubljana to New York via Frankfurt etc.

12.5.4.3 Quality adjustment

Quality adjustments may be needed when the key characteristics of a flight of a package holiday change or when a replacement is made. While it is unlikely that a specific holiday package remains exactly the same from season to season, then a similar holiday in terms of destination, time of flight, and class of accommodation should be selected from the same holiday resort (where possible).

Many factors play a role in the quality of a flight/package holiday and may change over time. These are often difficult or impossible to quantify. Some examples are:

- Number of connections
- Duration of the journey
- Time of arrival and of departure
- Flexibility to change flights, and refundability

Other relevant aspects can be easily quantified like a free meal and baggage allowance, which were previously included in the price, became chargeable.

Moreover, efficiencies in the airport such as the ease of checking in, and the time needed to pass through security are factors that are difficult to quantify and can be ignored without significantly biasing the index.

Hedonic methods are usually appropriate and feasible for flights and package holidays since data can be obtained by web scraping or API from sources such as Amadeus.

12.5.4.4 Seasonal flights and package holidays

Flights and package holidays both demonstrate seasonality in terms of their availability and price. Implementing Regulation (EU) 2020/1148 as regards minimum standards for the treatment of seasonal products in the Harmonised Index of Consumer Prices does not mention flights or package holidays per se. However, Article 14 states that:

'If seasonal products are sampled in an elementary aggregate, Member States shall use the seasonal imputation method or the seasonal weights method to compile a price index for that aggregate.

This Regulation only relates to strongly seasonal products i.e., products that are not available for purchase during certain months, or the numbers purchased are zero or negligible, and the periods of non-availability have some typical annual cyclical pattern. For flights/package holiday (destinations) there are three situations:

1. Destinations that are not seasonal, e.g., flights between Amsterdam and London
2. Destinations that are weakly seasonal (flights are available throughout the year but the number of flights/capacity of planes vary)
3. Destinations that are strongly seasonal (for example summer flights to the Greek Islands or ski holidays in the Alps during the winter).

Section 7.1 discusses in detail the treatment of seasonal products. In the following paragraphs, guidance is given on how to apply seasonality for flights and package holidays in relation to Implementing Regulation (EU) 2020/1148.

Strongly seasonal products, such as clothing and fruit and vegetables, have the last observed price atypically low. That is not the case for seasonal flights, and package holidays. There are no atypical prices for flights. Thus, there is no need to estimate a typical as required by Implementing Regulation 2020/1148.

Consequently, if a fixed weights method is used, the last price observed is used to estimate the out-of-season price. The rate used can be either the price changes from either all available flights and package holidays (all-seasonal estimation) or all in-season flights and package holidays (counter-seasonal estimation) from the *first* month of unavailability.

Where a class-confined seasonal weights method is used, the definition of the in-season and out of season months is clearly defined as the flights/package holidays either are or are not available. When fights or package holidays are no longer available, their weights are set to zero. The estimation of in-season weights under this approach is described in Section 7.1. As with the fixed weights approach, the overlapping seasonality of holiday destinations should allow for the collection of representative product offers in every month.

Whichever approach is followed, it is recommended that year-round city breaks to destinations such as London, Rome and Paris etc. are included in the sample. This will allow the imputation of missing prices throughout the year, especially if the range of package holiday destinations during the low season (typically the winter months) is limited.

An additional seasonal issue, which can affect both flights and package holidays, is the timing of some holidays which differ from country to country. Flights and holidays taken at these times can be atypically expensive due to higher demand. However, these are actual seasonal price effects experienced by consumers. As such, the pre-specified price collection schedules should be observed and not amended, as this would bias the index.

For flights to certain destinations, one-off international conferences, or events (concerts, major sporting tournaments etc.) can lead to increased demand and hence atypical price behaviour. In general, the price collection schedule should be observed and not altered unless the observed price is very extreme. As the sample of flights should be sufficiently large to represent consumer's behaviour, the occasional atypical price should not disturb the overall price index for flights. In this context it should be remembered that the price to be followed is for a product offer sold under *specific conditions*, which includes the day of travel, which is integral to the product specification, and not the flight a particular consumer may choose when faced with such one-off situations.

12.6 Telecommunication services

12.6.1 Introduction

The telecommunications industry is very dynamic, new products and services being introduced frequently alongside with bundles for which the composition may change. Additionally, the way in which consumers are charged for these services also varies considerably. For example, a consumer may purchase a mobile phone separately from the service, or the phone can be included in the monthly price together with the service provision. Finally, the pricing strategies often change over time.

Recommendations have been produced to provide guidance on the methodological treatment of these services in the HICP ([283]).

The recommendations cover all types of telecommunication services including fixed line, mobile telecommunications services, along with internet provision and bundled phone, internet, and TV packages.

These recommendations recognise that any single approach may not be suitable or generally applicable for all market sectors (i.e., fixed line and mobile telecoms) or all telecommunication services, which are offered today in any Member State (e.g., phone, internet, and TV packages etc.). A mix of methods may be required depending on the unique circumstances of each country.

12.6.2 Legal requirements

Telecommunication services are treated in the HICP according to Article 5(3) of Implementing regulation (EU) 2020/1148:

> *'Changes in the observed prices or conditions of a tariff shall be shown as price changes in the HICP.'*

Note that the objective is to achieve a measure of *pure price change.* That is achieved by maintaining unchanged the price reference period consumption pattern even though the consumption pattern in the current period may change due to changes in the tariff structure.

([283]) Recommendations on the treatment of telecommunication in the HICP (europa.eu)

Complying with Article 5 as described above is key in evaluating the possible approaches to measuring the array of telecommunication services offered to consumers. Compliance with this Regulation is also essential for ensuring that the European comparability requirement of the HICP is respected — as defined in Regulation (EU) 2016/792 of the European Parliament and of the Council of 11 May 2016 on harmonised indices of consumer prices and the house price index.

12.6.3 Definitions

Call plans: Packages or bundles of services e.g., a certain number of call minutes, text messages and internet usage per month for a certain price.

Binding contracts: Contracts in which consumers are legally bound to a provider for a pre-defined period, for example 12 to 24 months, during which changes are generally not allowed.

Non-binding contracts: Contracts where consumers are free to change their tariff or end their contract with no financial penalty. Generally, these contracts are short term (monthly) as is the case for many pay-as-you-go call plans.

Migration rates: In between annual resampling, they describe the transition of consumers from one tariff to another (from the same provider) in terms of what proportion of consumers change and at what pace.

Stable markets: refer to services which have broadly remained unchanged or have evolved relatively slowly. Examples are fixed landline telecommunications services.

Dynamic markets: refer to those services and products that change rapidly. Examples include mobile telecommunications and bundled packages.

12.6.4 Recommendations

12.6.4.1 Coverage (Recommendation 1)

The price index for telecommunication services (ECOICOP 08.3.0) should cover all significant (in expenditure terms) sectors of the telecoms market i.e., wired and wireless telephone services, internet services, and bundled telecom services (e.g., phone, internet and cable TV packages) for new and existing contracts.

12.6.4.2 Weights and data sources (Recommendation 2)

The weights for the ECOICOP 08.3.0 sub-classes should be obtained from the national accounts and updated annually. Below ECOICOP sub-classes the market for telecommunication services may be stratified and weighted, depending on national circumstances.

Telecommunications services are generally subject to strict regulation and/or very close supervision by national regulatory bodies, in addition, as all types of usage are recorded and charged for.

Service providers and regulatory bodies are therefore the obvious and recommended sources for detailed information on consumption patterns, weights, and market developments in general. Additionally, data on market shares of providers and information about typical usage of telecommunications services may also be available from market research companies.

It is important for index compilers to first understand the dynamics of their market before requesting data to minimise the burden on data suppliers by asking only for the information that is strictly required.

The national regulator may be best placed to provide information on the market shares of all providers operating on the economic territory. These data can be used for estimating the respective weights of the providers for each market sector (fixed line, mobile services etc.), as different providers may dominate different sectors of the market. For example, former state telephone companies that have been privatised may dominate the fixed telecommunications market but may be less dominant in the mobile market. National regulators may also have information on national average consumption patterns for use in identifying consumer profiles etc.

Individual providers will hold detailed information on their product offers, and they may be the best source of information for both sampling representative call plans and tariff packages, and for providing information on the migration from old to new tariffs etc. (see Recommendation 4) They may also be able to help in identifying those packages which are mainly used by businesses, so that these can be excluded from the HICP. Caution should be taken in assuming that business users dominate high use profiles, as this may not always be the case given the rapid rise of social media and the downloading of music and video streaming etc., all of which can be data intensive.

The data available to index compilers will be dependent on both the prevailing market environment and the willingness of service providers to supply detailed data. As both these factors are likely to vary from one country to another, it is simply not possible to specify in detail what data sources should be used for each aspect of index construction for all countries. However, in general, a dual approach using information from national regulators for the higher-level weights (i.e., the market shares of service providers in each market sector), supplemented with information from service providers to both estimate detailed weights and to identify representative tariff packages, consumption profiles, and migration rates etc. should be used.

While revenue shares are the ideal, the number of subscribers for each provider could be used as a proxy if information on revenue shares from national regulators is not available.

If mobile telecommunication service providers are unwilling to provide information centrally, an alternative, but less than ideal, approach would be to consult the sales staff in the provider’s outlets to identify the most popular service plans etc.

For price collection, the use of the internet is invaluable as all service providers and retailers maintain up-to-date websites in addition to physical outlets. Due to deregulation, it should also be noted that there may also be several large independent retailers, which sell telecommunication services from a range of providers. When investigating data sources for pricing telecommunication services, it is important that all retailers of such services are included in the sample if their market share is significant.

While the websites will advertise current prices, the prices that are still being charged to existing customers for older service packages should be collected directly from the service providers, as these prices may be subject to change. This is particularly important where binding contracts exist and where new service packages or tariffs are phased in using migration rates.

12.6.4.3 Sampling (Recommendation 3)

Recommendation 3 is closely linked to Recommendation 1 Coverage, in so far that the sample should include all significant (in expenditure terms) ECOICOP sub-classes. The sampling frame and sample (which could be in terms of consumer profiles, tariff elements, actual bills or a homogenous unit of consumption — for unit values) should be reviewed at minimum annually to keep the sample representative. In addition, because the telecommunication services and in particular the mobile telecommunications market, can be very dynamic, it is recommended to keep the sample updated during the year. Chapter 4 gives more advice on sampling strategies.

As data collection is normally undertaken using the websites of providers, it is generally very clear when new tariffs appear on the market and when old ones become unavailable to new customers. When a new tariff appears, they may be included in the index through resampling if expenditure on them becomes significant (see Recommendation 4). In general, replaced tariffs are not offered to new customers who only have the option of the new replacement tariffs. Thus, price collectors, as part of the monthly price collection, should be trained to look out each month for both new and discontinued tariffs.

New product offers may replace existing product offers, due to the presence of binding contracts, the prices of the replaced product offers are still relevant to many consumers. How to treat these replacements is the subject of Recommendation 4.

It is important to gain an understanding of typical consumer behaviour within their country. This is of particular importance in defining representative consumption patterns (consumer profiles).

Ideally as with the weights (Recommendation 2) the sample frame and sample should be based on relative revenue shares of providers/tariffs. However, if this is not available, then as with the weights, the number of subscribers to a service provider could be used as a proxy.

It is important when developing the sampling frame and during its review that all current providers are investigated to ascertain if their market share is or has become significant to warrant their inclusion in the sample.

12.6.4.4 Index compilation methods (Recommendation 4)

Introduction

The fixed sample approach with weights at a very detailed level appears to fail in such situations, as it is not able to capture the dynamics of the telecommunications market and the complexity of pricing schemes within a rapidly developing sector. The large number and the continuous change of price-determining characteristics caused by the rapid changes and growth occurring in this market and driven by continued technological development in this sector requires an approach to index compilation which affords maximum flexibility to capture actual price trends.

There are four methods/approaches to compile the sub-indices for telecommunication services: the tariff (or matched pairs); consumer profile; unit value; and actual usage (sample of bills) approaches. Section 7.4 discusses each of these approaches in more detail. One or several of the methods may be used in combination to measure the overall telecommunication services index. The tariff and consumer-profile methods are, however, the most used methods by Member States.

If samples are only updated during the annual resampling exercise the use of additional information about market shares and substitution behaviour (migration rates) is necessary.

In the following paragraphs each of the methods will be described and rated in terms of their applicability for measuring telecommunications services.

The tariff or matched pairs method

Tariffs are a pre-determined set of specified costs for a specific set of services. Under this approach, prices are taken from the full tariff list (package) or an element of the tariff structure in both periods being compared as a matched pair. In effect, each tariff package is treated as a single product (i.e., a product specification). The most popular/representative tariff packages are selected at the price reference period (December of each year) and they are tracked as long as some customers subscribe to them.

When a new comparable tariff package is introduced on to the market to replace a discontinued tariff package, the new one is linked into the sample and prices can be compared directly. When the new tariff package is not comparable a quality adjustment must be performed.

This method is particularly suitable for services based on flat rates instead of pay-per-use plans or charges for actual usage and where old and new tariffs do not co-exist on the market and the customers must adopt the new tariff plans as soon as they are introduced. Where old and new tariffs co-exist on the market — which can be the case with binding contracts, then the new tariffs should be phased in, preferably by using migration rates.

Table 12.6.46 gives a small and simplified numerical example of the tariff method over two periods (t = 1 and t = 2). In this scenario, new and old tariff packages do not co-exist on the market in any period. There are two providers A and B, and three tariff packages (i.e., product offers) in each period. Provider A offers two tariff packages (p = 1 and p = 2) while Provider B offers only one tariff package (p = 3). Each tariff package includes three distinct tariff items/elements: 1) X; 2) Y; and 3) Z .

For provider A, tariff package 2 exists only in period 1 and it is replaced by tariff package 4 in period 2. The relative turnover or expenditures for the three elementary aggregates are the weights.

In period 1, a price index for each elementary aggregate (tariff element) is computed. Then following a Laspeyres approach, a weighted price index per provider is calculated with the relative shares of the tariff packages from the weight reference period as weights, and the total index for each item is computed for each period by weighting together each provider's price indexes with the provider's respective weights from the base period (see Chapter 8 — Index calculation).

In Table 12.6.46 the price indices for the providers were computed with the Jevons index, and the aggregation for a common price index is undertaken with provider weights (provider A:66 % and provider B: 34 %). The weights of the tariff packages and those of the providers are kept constant over time in accordance with the treatment of tariffs as per the Regulation. Then the price indices for the single items are aggregated by a weighted average with the turnover shares as weights. The resulting index is 100.78 in the second period.

Table 12.6.46

The tariff method — telecommunication services

Period		1				2			
Provider		**A**	**A**	**B**	**Total**	**A**	**A**	**B**	**Total**
Tariff		**1**	**2**	**3**		**1**	**4**	**3**	
Item	*Weights*	36.4 %	29.3 %	34.3 %	100.0 %	36.4 %	29.3 %	34.3 %	100.0 %
X	73.7 %	EUR 15.00	EUR 10.00	EUR 13.00		EUR 15.00	EUR 11.00	EUR 13.00	
Y	16.2 %	EUR 0.25	EUR 0.30	EUR 0.30		EUR 0.25	EUR 0.25	EUR 0.30	
Z	10.1 %	EUR 0.10	EUR 0.15	EUR 0.10		EUR 0.10	EUR 0.12	EUR 0.10	
Index values for each tariff package									
X		100.00	100.00	100.00		100.00	110.00	100.00	
Y		100.00	100.00	100.00		100.00	83.33	100.00	
Z		100.00	100.00	100.00		100.00	80.00	100.00	
Provider, Items and total aggregation									
Provider weights			65.7 %	34.3 %	100.0 %		65.7 %	34.3 %	100.0 %
X	73.7 %		100.00	100.00	100.00		104.46	100.00	102.93
Y	16.2 %		100.00	100.00	100.00		92.56	100.00	95.12
Z	10.1 %		100.00	100.00	100.00		91.08	100.00	94.14
Total	100.0 %				**100.00**				**100.78**

Evaluation and recommended use of this method: This method is more appropriate when markets are stable; particularly if justified (i.e., evidence-based) weights and migration rates are used.

The consumer profiles method

Consumer profiles are defined independently of providers’ tariff structures and resemble typical or average consumer usage patterns. Under this approach, the measurement target is the minimum cost of a pre-defined and fixed pattern of use. It is the price of a fixed volume of use from a specified provider which is followed and not the change in price of a specific tariff (product offer), which is the approach normally used for most goods and services in the HICP.

Key points to note:

- The specifications of the profiles should be based as far as possible on data supplied from either the service providers or the regulator, in order that the specified profiles are as representative as possible of consumer behaviour.
- As there is no *one* typical pattern of use, it is necessary to develop several profiles which represent different volumes of use. A popular approach is to define at least three profiles for high, medium, and low-use users. The actual number of profiles, however, should be guided by the market environment in each Member State.
- The profiles should remain fixed between annual resamplings, regardless of what new tariffs appear on the market. Both the selected profiles and their associated weights should be reviewed and updated annually as required to reflect the dynamics of the market. However, the sample of tariffs priced in the price reference period should be reviewed in between annual resampling to ensure their continued representativity (see Recommendation 4).
- In the telecommunication sector, binding contracts are typical. As such, new tariffs which appear in between annual resampling should not automatically replace existing tariffs in the sample. They should be phased in using migration rates which are preferably based on data supplied by service providers. Where no evidence-based migration rates are available, a rational consumer approach should be used (see the explanation to Recommendation 4 on replacing tariffs).
- Replacement tariffs should be selected from the same provider as the replaced tariff. In-year replacements between providers should not be undertaken unless a sampled provider no longer provides the specified service.
- New service providers that emerge on the market should be included in the sample in accordance with their market share (if significant) in December after their emergence.
- Each month, for each specified profile, the prices of the tariff which meets the minimum usage requirements of the specified profile is priced from each of the sampled providers.

The weights for individual profiles and providers may be estimated using sales information to determine the relative importance of the different tariffs.

Following a Laspeyres approach the overall index is then derived by weighting together the average cost changes for these user profiles according to the relative importance of each category of consumers. In practice, however, to be reliable for all the elements of the tariff, the segmentation of the users may require a large volume of information and detailed specification on the usage patterns. There are many advantages to the consumer profile method. If the method is well established and defined, the identification of appropriate packages from each supplier and for each user profile is easier. The method is also sufficiently flexible to react to current developments in a changing market. Where the process of price collection is supported by the application of migration rates between existing and new tariffs, the results will be even better.

A fully annotated example of the method is presented in Annex 12.9.6.

In Table 12.6.47 below a simpler presentation of the method is given. In this example, two profiles are defined, a low and a high user. In period 1 for each profile the *cost for the specified pattern of use* is estimated. The same is done for period 2 (top section of the table). In both periods, the tariffs that yield the minimum price (i.e., the lowest bill) for each profile and provider are then selected. These selections are found in the middle section of the table. From these values the aggregates with fixed profile and provider weights are calculated (bottom section of the table). In this example, tariffs A2 and A4, which were selected in period 1, were replaced by tariff A4 in period 2, as this tariff yields a lower bill for the specified use profiles. It is assumed that the profiles are evenly distributed among the population and therefore the average bills from the weight reference period are used for the profile weights. The example also assumes that it is easy to move between tariffs within the same provider, which is not always the case.

Table 12.6.47

The consumer profile method — mobile call plans

Period			1				2			
Provider			A	A	B	Total	A	A	B	Total
Item	Profiles		1	2	3		1	4	3	
	Low	High								
X			EUR 15.00	EUR 10.00	EUR 13.00		EUR 15.00	EUR 11.00	EUR 13.00	
Y	20	60	EUR 0.25	EUR 0.30	EUR 0.30		EUR 0.25	EUR 0.25	EUR 0.30	
Z	10	180	EUR 0.10	EUR 0.15	EUR 0.10		EUR 0.10	EUR 0.12	EUR 0.10	
Profile sum low			EUR 21.00	EUR 17.50	EUR 20.00		EUR 21.00	EUR 17.20	EUR 20.00	
Profile sum high			EUR 48.00	EUR 55.00	EUR 49.00		EUR 48.00	EUR 47.60	EUR 49.00	
Minimum Selection										
Provider			A		B		A		B	
Low			EUR 17.50 (A2)		EUR 20.00 (B3)		EUR 17.20 (A4)		EUR 20.00 (B3)	
High			EUR 48.00 (A1)		EUR 49.00 (B3)		EUR 47.60 (A4)		EUR 49.00 (B3)	
Provider, Items and total aggregation										
Provider weights			65.7 %		34.3 %	100.0 %	65.7 %		34.3 %	100.0 %
	Weight		A		B		A		B	
Low	19.50	27.79 %	100.00		100.00	100.00	98.29		100.00	98.87
High	50.67	72.21 %	100.00		100.00	100.00	99.17		100.00	99.45
Total	70.17	100.00 %				100.00				99.29

Evaluation and recommended use of this method: This method is recommended for both dynamic markets and markets where pure bundles are commonplace.

The Unit Value Method

The unit value method relies on the assumption that the content of a tariff-based service is well-defined and homogeneous. A unit value is then used to track price developments. It is applicable where service providers have a clear structure of usage charges, as is found in some fixed telecommunication services. Its applicability is limited with mobile telecommunications services if the costs of individual tariff elements are not identifiable. With this method, the revenue of a specified service is divided by the amount of time the service is consumed. Subsequently, the resultant unit value is multiplied by its weight at the weight reference period and aggregated within the tariff structure. An advantage of this approach is that the emergence of new tariffs does not affect the method. Another advantage is that by calculating unit values using revenue data, the potential discounts are included in the index calculation, since they are already incorporated in the reported revenue data of the responding enterprise. A drawback to this approach is that the use of unit values will not guarantee a measure of pure price change. Rather, it will provide only an approximation, as the use of each service may vary from one month to the next.

To implement the unit value method, the service categories priced should be as precise and homogenous as possible, which may not always be the case. Service categories can be defined for example by:

- Call price by distance
- Call price by time slot
- Call price by length of the calls
- Cost of line rental

Cooperation with the national telecommunications authority and service providers is important if the benefits of the unit value method are to be fully realised. Service providers will have information about the revenue of a specific service and the amount sold. If this method is applied to the mobile market, which is generally more complex than the fixed line market, information on more homogeneous sub-groups is needed for separating fixed and variable charges to re-price sub-services from one period to another period. Otherwise, a pure price change cannot be reliably estimated. In practice, it might prove difficult to apply this method in a timely fashion, as the required data from the company may not be available.

A potential disadvantage of the unit value pricing approach is through the potential creation of non-homogeneous or heterogeneous product groups covering both price changes and structural changes together.

Table 12.6.48 gives an example for the unit value method with the index calculated following a Laspeyres approach. Instead of using the prices for the tariff elements, unit values are used. This approach considers the migration rates between tariff plans within a provider and of discounts. The main difference is that in the traditional tariff approach, where the relative shares of the different tariff plans is kept constant over time, the use of unit values within a provider takes account of changes in the relative shares of different tariff elements from one month to another. This difference can be problematic if the changes reflect both price changes and structural changes together.

Table 12.6.48

The unit value method in the case of fixed line telephone charges

Period		1			2		
Provider		A	B		A	B	
Item	Weights			Total			Total
Turnover							
X	73.7 %	1 650 000	884 000		369 817	190 512	
Y	16.2 %	363 000	204 000		142 571	117 513	
Z	10.1 %	247 500	102 000		107 468	50 329	
Quantities							
X		132 000	68 000		28 447	14 655	
Y		1 320 000	680 000		760 380	391 711	
Z		1 980 000	1 020 000		976 980	503 293	
Unit Values							
X		EUR 12.50	EUR 13.00		EUR 13.00	EUR 13.00	
Y		EUR 0.28	EUR 0.30		EUR 0.19	EUR 0.30	
Z		EUR 0.13	EUR 0.10		EUR 0.11	EUR 0.10	
Index Values							
Provider weights		65.7 %	34.3 %	100.0 %	65.7 %	34.3 %	100.0 %
X	73.7 %	100.00	100.00	100.00	104.00	100.00	102.63
Y	16.2 %	100.00	100.00	100.00	68.18	100.00	79.11
Z	10.1 %	100.00	100.00	100.00	88.00	100.00	92.12
Total	100.0 %			100.00			97.76

Evaluation and recommended use of this method: The unit value approach assumes that the content of a tariff-based service is well-defined and homogeneous.

Actual usage/sample of bills method

The actual usage or sample of bills method, which is sometimes also referred to as the comprehensive sample method, uses all or almost all transactions in a certain market segment (e.g., mobile telephone call plans etc.) to construct a single profile, which represents the average pattern of use for all consumers. In between annual reviews, the consumption pattern is kept constant; however, the weights used for aggregating the various tariff plans offered by a provider, and the relative market shares of each provider can be variable. With this approach, changes to the features of tariff packages as well as the migration of consumers from one provider to another, are reflected in the index. However, differences in substitution rates between providers in between annual resampling results in a loss of comparability between the figures of individual Member States.

This approach has elements of the consumer profile approach but uses only one profile for compiling the index. It starts with the determination of a single profile (calling pattern) for the entire population, as is the case for weighting purposes in the traditional tariff approach, or the unit value approach. The profile is not dependent on the provider or tariff packages. In the next step the providers are selected by turnover, and within the providers the tariff plans are again selected by turnover. Alternatively, if turnover data are unavailable, then the revenue derived from charges can be used as an approximation. The weight for the product within the HICP sample of goods and services is defined at a higher level (e.g., wireless telecommunications services), to retain maximum flexibility within this approach.

In Table 12.6.49 the weights for the same three items/tariff elements as above: X, Y and Z. The plan includes for item X 200 free units. Within the items/tariff elements the weights for the computation between the tariffs and the providers may vary during the index period, keeping constant the consumption pattern from some base period. The remaining aggregation is undertaken as usual using a Laspeyres approach. In the example, the index is only computed for items Y and Z. , The included 200 free units of item X are excluded from the computation. Therefore, the result is not directly comparable to the other computations in this chapter.

Table 12.6.49

The actual usage method

Period		**1**				**2**			
Provider		**A**	**A**	**B**	**Total**	**A**	**A**	**B**	**Total**
Tariff		**1**	**2**	**3**		**1**	**4**	**3**	
Item	Quantities	55%	44%	100%		58%	42%	100%	
X	200	EUR 15.00	EUR 10.00	EUR 13.00		EUR 15.00	EUR 11.00	EUR 13.00	
Y	300	EUR 0.25	EUR 0.30	EUR 0.30		EUR 0.25	EUR 0.25	EUR 0.30	
Z	3	EUR 0.10	EUR 0.15	EUR 0.10		EUR 0.10	EUR 0.12	EUR 0.10	
Average of calls and SMS		90.3	100.45	103.3		90.3	86.36	103.3	
				Average prices					
Provider weights		65.7 %		34.3 %	100 %	65.7 %		34.3 %	100 %
Average price		EUR 95.4		EUR 103.3	**98.09**	EUR 88.33		EUR 103.3	**95.82**
Index					**100.00**				**97.69**

Evaluation and recommended use of this method: The actual usage method can be applied in both stable and dynamic market situations.

12.6.4.5 Replacing tariffs and resampling (Recommendation 5)

As described above, frequent updating of the sample is needed to maintain the representativeness of the sample. In addition, from time to time completely new tariff elements also appear, which should also be included by resampling.

The need for frequent resampling is also influenced by the dynamics of the telecommunication markets. In more stable mature markets, the choice of the price measurement method and the sampling frame is less sensitive than in dynamic markets.

It is important to note that new call plans or tariffs should not automatically replace existing call plans and tariffs in the sample.

The existence of binding or semi-binding contracts restricts the ability of consumers to switch or *migrate* from their existing call plan to a newly offered call plan, even if their existing call plan is no longer available to new customers. As a result, both existing and new call plans and tariffs co-exist in the market and as such should be reflected and included in the sample. Over time, consumers will switch to the best available call plan or tariff as their contracts expire. If there is an absence of binding contracts, the reaction of consumers to market developments can be instantaneous.

According to Recommendation 4, the new tariff should be phased in preferably with the use of migration rates. Migration rates are the rates at which consumers switch from their existing tariff to a new tariff. The use of migration rates greatly improves both the traditional tariff method and consumer profile methods where binding contracts exist. They are not needed for either the unit value or actual usage methods as migration rates are taken care of as part of these methods (see next section). Preferably, migration rates should be evidence-based estimates i.e., are estimated from either data or advice supplied by service providers, rather than based on unsupported judgements. In general migration rates that are either supplied by, or are based on advice from providers, will reflect previous consumer behaviour rather than the current migration to a newly offered tariff from the tariff it replaced. If such advice or information is not available, then the use of a *rational consumer* approach is allowed as an alternative. If binding contracts are used, e.g., for a 12-month contract, it could be assumed that each month one-twelfth of the consumers switch to the new tariff. The length of time over which a new tariff plan fully replaces an older tariff is a matter of choice for the index compiler. Compilers should consider both the length of the binding contract and in which month the new tariff replaces an old tariff, as the tariffs priced should be completely resampled every December (see Recommendation 3). In practice this means the migration period cannot exceed 12 months. While this approach is clearly second best compared to evidence-based estimates, it remains preferable to not using migration rates at all.

An important point to note in replacing tariffs and applying migration rates under the consumer profile approach is that the cheapest newly available tariff must meet the minimum requirements of the consumer profile of the existing tariff (regardless of whether it perhaps includes more free minutes than the tariff it replaces), as sampled in the price reference period (i.e., the previous December). A new tariff which either does not meet the minimum requirements of the existing consumer profile or meets the requirements of another sampled (higher usage) consumer profile should not be selected as a replacement tariff. Annex 12.9.6 gives an illustrative (numerical) example of using migration rates when using a consumer profile approach.

The quality adjustment procedures used will be dependent on the differences between the old and new tariff and should be consistent with Article 5(3) of Implementing Regulation (EU) 2020/1148 (see Recommendation 8, Chapter 6 and Section 7.4).

It is important to note that replacements in this context should only be made within the *same* provider and not *between* providers, as consumers generally can only switch providers or packages when the commitment period of their contracts has ended.

12.6.4.6 The treatment of bundles and classification issues (Recommendation 6)

The treatment of bundled products is intrinsically linked with their classification within COICOP. The Information and Communications Services market, COICOP 08.3.1, includes the following sub-class:

- **08.3.4.0** Bundled telecommunication services: i.e., telephony/Internet/TV packages/mobile, any combination of telecommunication package.

There are two types of bundles frequently occurring within the telecoms market and gives guidance for the classification of telecommunication product offers which cover more than one sub-class.

Pure bundles are bundles of services that are only available as a bundle and for which the constituent services are not sold separately. The expenditure should be allocated to the COICOP sub-class according to the purpose of the main component.

The main component is that part of the bundle which accounts for *primary* purpose of the service. The primary purpose may be either based on the product itself e.g., mobile phone call plan, where the primary purpose for most consumers is making calls, even if a data allowance is included. Alternatively, the primary use may be derived from information supplied by service providers.

There are two exceptions. Mobile call plans often include mobile internet, and these bundles are to be included in wireless telephone services.

Mixed bundles are products which are sold both in bundles and separately, as stand-alone products. The expenditure on stand-alone products belongs in their respective ECOICOP sub-classes.

The expenditure of mixed bundles should be allocated to the ECOICOP sub-class according to the purpose of the main component. Chapter 7.6 discusses the treatment of bundles in detail.

Mixed bundles that include combinations of telephony, internet and television are allocated to ECOICOP 08.3.0.4 Bundled telecommunication services, regardless of whether the constituent services can be itemised.

Any further subdivision of ECOICOP may not be needed or feasible due to a lack of information. Whether or not elementary aggregates are used for initial sampling and replacement depends on the information available to the Member State and the compilation method used. As the methods generally use either consumer profiles or tariff structures, the actual information available to make those profiles and structures will determine the level of segmentation that is possible to achieve.

12.6.4.7 The treatment of discounts (Recommendation 7)

Often providers will offer various inducements and promotions to attract customers that do not bear directly on the main service provided, e.g., a temporary free use of music streaming etc. As with all other goods and services in the HICP, price discounts for telecommunication services should be reflected in the HICP (HICP rules on the treatment of discounts are given in Chapter 5). However, without information on actual usage it may be difficult to estimate the necessary adjustments. It is recommended to focus on those discounts directly related to the principal service, i.e., that have either a direct effect on the price (e.g., EUR 10 discount on the monthly fee for the first 6 months) or have a direct effect on the main components of the service (additional free download allowance, free minutes etc.). Other discounts should only be included if they have an empirically justified significant impact on the price.

Table 12.6.50 gives a typical example of such a discount. In this example home internet is offered at half price for six months and full price after that, within a 12-month home net and Tv service contract. While such examples are common, they are also relatively easy to capture in the index.

Table 12.6.50

12-month home net and TV service contract with six months half price for home net

	Euro per month, for the first 6 months	Euro per month, thereafter
home net	5	10
TV 250 channels	10	10
Total cost	15	20
Index	100	133.3

Where *free GB* are temporarily offered by way of a discount, as opposed to a permanent change to the tariff usage allowance i.e., they are not normally a part of the call plan, then adjustments should be made to the calculation to reflect the discount. If an average consumer-profiles approach to index calculation is used, then the average discount must be estimated and included into the aggregation. Implicit assumptions may be required to apportion discounts appropriately between the profiles included in the index. In general, discounts tend to be offered for limited time periods and adjustments to the index calculation must be reversed as and when discounts are no longer offered.

12.6.4.8 Quality changes (Recommendation 8)

In the telecommunications sector, there are two kinds of quality changes: horizontal and vertical quality changes.

- *Horizontal quality changes* are changes that affect all customers or the entire network. For example, the implementation of 5G. In principle, quality adjustments should be made if such changes are perceived as improvements for which the customers will derive an added benefit. However, for practical reasons, adjusting for these improvements is not feasible, as the service received by consumers is often dependent on their current location. In addition, network improvements are often rolled out sequentially over several years.

- *Vertical quality changes* are changes in the characteristics between a replaced and a replacement tariff package. Dependent on the pricing method used, quality adjustments should be made for such changes. Examples include a higher number GB of mobile net. Not everyone considers these types of changes as quality changes but alternatively describe them as quantity changes. It should be noted here that some changes have little or no impact on consumers, and are more marketing strategies than effective quality changes, introduced to sweeten the effects of other underlying changes. For example, if a mobile call plan's allocation of included SMS increases from 5 000 per month, to unlimited and the average number of texts made by a customer is 300 a month, then there is no real benefit that is derived from the change in the plan and as such the change in allocation could be ignored.

In both cases, the use of overlapping linking methods between new and replaced tariffs to show no price change should generally be avoided unless it can be justified.

From the above the term *quality change* covers both real differences in quality, and changes in service plan characteristics between the replaced and replacement tariffs.

For telecommunication services, clearly both horizontal and vertical quality changes are occurring on a continuous basis. While it may not be practical in all cases to adjust for horizontal changes, vertical quality changes should be considered following the general rules of quality adjustment (see Chapter 6). For both types of quality change a variety of explicit and implicit quality adjustment methods are available; the chosen method will depend on the information available to make the adjustment. As with other index areas, explicit methods are preferred over implicit methods where feasible.

The coexistence of old and replacement call plans, which can overlap for many months, further complicates any potential quality adjustment when replacing tariffs. Where feasible, quality adjustments that can be made, should be made. The frequent updating of the sample should not be seen as an alternative to quality adjustment but is an integral part of quality adjustment.

12.7 Clothing and footwear

12.7.1 Introduction

The clothing and footwear division is generally regarded as a challenging area for price measurement. The reasons for this are seasonality, the role of fashion and style, and frequent promotional discount events.

This section describes the treatment of clothing and footwear in the HICP, focusing particularly on product replacements, quality adjustment, seasonality, and sales prices.

For easy reading, this section primarily mentions clothing less than footwear, though the methodology for approaching both product groups is similar.

12.7.2 Legal requirements

Apart from Implementing Regulation (EU) 2020/1148 as regards minimum standards for the treatment of seasonal products in the Harmonised Index of Consumer Prices (see Section 7.1), which can apply to clothing and footwear, there are no other HICP legal rules specifically relating to these product groups.

Clothing and footwear are included in ECOICOP Division 3: Clothing and Footwear.

12.7.3 Definitions

Fashion in general means temporarily varying consumer preferences (as treated in Section 6.3.5), especially in clothing, footwear, accessories, cosmetics, and the like, typically featured in media and advertising.

Style means a manner of doing or presenting things, typically modified and customised on an individual level to suit each person's preferences.

12.7.4 Recommendations

In 2005, standards for treating clothing and footwear in the HICP were agreed by the Price Statistics Working Group. These standards (see below) have not been published and are not legally binding, but they can serve as guidance on good practices and how to fulfil the requirements of relevant HICP regulations.

The aim of the standards:

> *'… is to specify aspects of the treatment of clothing and footwear (COICOP 03) in the HICPs, in particular concerning sampling and quality adjustment, to ensure that the HICPs are reliable and relevant and meet the comparability requirements laid down in Article 4(1), (2) and (4) of Regulation (EU) 2016/792.'*

Quality adjustment methods commonly used for clothing and footwear and their potential use are described and discussed in detail in Chapter 6.

12.7.4.1 Coverage (Recommendation 1)

> *'1. […] When it is in-season and available for purchase by consumers, seasonal clothing and footwear shall not be excluded from price collection for the HICPs, as the HICPs shall be representative of households' expenditures on all types of clothing and footwear.'*

Clothing and footwear products should be included in the HICP regardless of having or not a seasonal pattern.

For many, but not all types of clothing and footwear, there is a regular seasonal pattern of price movements and products availability where winter clothes and footwear follow summer clothes and footwear, and vice versa.

12.7.4.2 Fashion and obsolescence (Recommendation 2)

> *'2. For clothing and footwear, the decline over time in prices for models or varieties due to increasing obsolescence or by becoming out-of-fashion shall be treated as a genuine price change and not as a decline in quality. Symmetrically, the increases in prices that may be seen at the introduction of a new model or variety shall be treated as genuine price changes and not as changes in quality.'*

Fashion generally declines as the months pass after a garment first appears. These standard states that fashion changes are not quality changes. The reason for this is explained in Section 6.3.5. Therefore, when an apparel item is no longer in fashion, its discounted price should not be adjusted for quality change but treated as a genuine price change. Consequently, the resulting price reductions that occur through the season should be reflected in the HICP. Likewise, new season fashion lines are also not to be treated as an improvement in quality, but rather their prices should be recorded as genuine price increases.

The clothing sub-indices should cover fashion clothing on the grounds of both comparability and representativity. Their sales volume is significant, and their price development could differ from basic clothing items.

The overlap period between seasons can be problematic because both old and new season's products co-exist, often with very different prices. New season fashion products are typically sold at regular (non-discounted) prices while the previous season fashion items are mostly sold at discounted prices (see below — discounted prices). In these circumstances there is a risk of a downward bias in the index unless the price increase in the seasonal shift is fully shown in the index. To prevent this potential bias prices must be collected for all products of the new season and the old season without and with discounts, respectively. (See the last paragraph of the explanation to paragraph 4 below, and Sections 12.7.4 quality adjustment, and 12.7.5 seasonality). As December — the link month for the HICP — does not normally coincide with the start of a new season this potential source of bias is generally not an issue.

Treatment of discounts

Sales prices in clothing and footwear should be included in the HICP following the Implementing Regulation (EU) 2020/1148 applies (see Section 5.3.3).

Regularly occurring sales prices in clothing and footwear are observed once or several times a year. In the EU, the timing of sales prices is fixed by legislation, but other types of discounts can occur at different times.

A new season's clothing range may appear in outlets either immediately after the end of a seasonal sale, or after an intermediate period, or while the sale is still active. In addition to end-of-season sales, there may be minor sales, mid-season sales, campaigns and promotions at other times, which can vary from year to year. The timing of sales and the introduction of a new season's clothing range may not be synchronised among outlets.

12.7.4.3 Sampling, stratification and replacements (Recommendation 3)

'3. In order to select comparable replacements, and in order to decide which models are essentially equivalent and which are not, broad segments of the clothing and footwear markets shall be defined by identifying the most important quality and price determining characteristics. Hedonic methods offer a potentially useful tool for deciding which characteristics may be used for this.

4. Replacements shall as far as possible be essentially equivalent, so that direct comparison may be used. It is usually possible, when newly introduced fashion models replace previous models, to select in a particular outlet a new model or variety that is directly comparable, that is essentially equivalent to the previous one and broadly equivalent in fashion wise as the old model or variety was when it entered the sample.'

When a specific product offer has been selected for pricing, and if it disappears from the shelves within a few months (which is often the case), it is common practice that a replacement is selected in the same outlet. The replacement product should be both representative (well sold) and the most similar with the disappeared one. As with other product areas, the replacement should be selected from the same stratum as the replaced (see Section 4.2.3). For example, casual and luxurious garments are likely to be found in a different strata and should not be selected as direct replacements for each other. If the replaced and the replacement are judged to be non-comparable, some quality adjustment should be made. (See Chapter 6 — quality adjustment and replacements).

When the new winter season collection is introduced, it is possible to select in a particular outlet a new item to replace the sampled item in the previous winter season just as fashionable. The same stands for all seasons.

The definition of *similar* should be assessed from a consumer's perspective. Often outlets sell products within a specific *quality range*. Then replacements within the same outlet are often viewed as similar from the consumer's point of view even if the style, fashion dimension, or even fabric changes, which is often the case. If a replacement must be made from a different outlet, care should be taken to select an outlet which sells clothing of a similar perceived quality as the replaced outlet. Although price collectors may be uncertain about what is essentially equivalent at times, their decisions should be supported by the opinion of the store manager.

To help the price collector with this demanding task, appropriate product specifications are needed for price collection in physical outlets, for central price collection, and price collection from the internet or catalogues etc. (see Chapter 5), which are provided by the central office. This is not an issue for web-scraped and transaction data since these do not rely on a sample.

The product specifications should reflect the most important price and quality determining characteristics. However, if product specifications are too detailed there is a risk that price collectors cannot find models fitting the specifications. During price collection, the prescribed product specifications should normally be augmented by the price collectors (whether local or central) with more detailed descriptions of the products which are priced, to make sure that identical or comparable models are tracked over time (see Chapter 5). This additional information is also required for replacement and quality adjustment purposes (see Chapter 6). If the product specifications are tight enough, models fitting the specifications could in principle be regarded essentially equivalent and prices could be directly compared and any quality changes falling within the specification could then be ignored.

Too loose specifications may lead to accepting too much qualitative variation and the risk of introducing some quality bias into the index. Perhaps more importantly, the market may evolve; for example, materials may change between seasons – pure cotton fabrics are succeeded by recycled plastic fabrics. In such cases, the use of overly tight specifications can lead to a reduced or complete loss of representativity.

Specifications of *representative products* serve to define the sets of products within which models are to be selected for price collection. They should be related only to characteristics that price collectors can readily identify. What these are depends partly on the training given to price collectors and partly on the time available for the collection.

Brand class and outlet type are among the most important characteristics. One possibility is to classify brands into quality groups (using market intelligence) and instruct the price collector to replace a discontinued product offer with a product offer within the same brand/quality segment, as much as possible.

Chain-linking and replacements

When periodic resampling and revision of product specifications is undertaken, the usual procedure links the newly selected sample to the preceding one using an overlap between the two. This entails a potential risk of a downward bias if the preceding sample is dominated by sales prices, and the newly selected sample is dominated by high introductory prices. Therefore, resampling in sales periods should be avoided to prevent chaining out the true price development at that time of the sample renewal. Furthermore, a correction for the different amounts of sales prices may be needed to compensate for potential bias.

12.7.4.4 Quality adjustment

Methods for quality adjustment and related concepts such as replacements are defined in Chapter 6. Concepts related to seasonality are defined in Section 7.1.

Clothing and footwear present a particular challenge for quality adjustment. This is due to the delineation of quality with respect to fashion or style, where the same product over time would not be of *constant quality*. A fundamental principle of a price index is that products priced should be of constant quality.

As noted above, the *change* in fashion of a specific garment through time is not considered a quality change and should not be subject to an adjustment (see also Section 6.3.5).

A quality adjustment is only appropriate when changes in product characteristics imply a permanent improvement or worsening of their functionality as perceived by the consumer. For example, this can be the case when the material of the replacement model is of superior or inferior quality to that of the replaced model with respect to durability or user functionality e.g., if a breathable fabric replaces a non-breathable fabric in a raincoat.

Where changes in product characteristics in the replacement model do not change user functionality, quality adjustments are not required.

Chapter 6 describes in detail the quality adjustment methods that are commonly used. The quoted article above classifies (rates) the available methods in terms of their applicability to the clothing and footwear area. These are discussed in turn below.

Hedonic methods

Hedonic quality adjustment methods remove the price change attributed to the quality change by multiplicatively or additively modifying the price reference or (alternatively) the current price for the value of the quality change. Hedonic methods assume that prices of products are affected by the product's characteristics.

Hedonic methods require relatively large datasets that contain a minimum number of characteristics. Although there is no set rule for the number of characteristics to be used in the model, the aim should be to have a sufficient number to satisfy the basic level of statistical robustness. Some countries have even had good results with as little as two characteristics acting as independent variables in the clothing area. Web scraping and transaction data offer an opportunity to obtain larger datasets needed for hedonic regressions.

Direct comparison method

This method compares prices of the replaced and the replacement individual product without adjustment. Any price change between the replacement and the replaced model is assumed to arise from pure price change and not quality change. Accordingly, the method is applicable where quality differences are insignificant or considered so by convention.

Bridged overlap

With bridged overlap it is assumed that the price difference between a replaced and a replacement model is captured by the price difference of a similar product or a group of similar products.

A key question is whether the last observed (reduced) price of the replaced product offer should be imputed or the last observed normal price. If the last observed (reduced) price is used, this may introduce a bias when the seasonal pattern of the other products in the group is different. It is not unlikely that products that are less affected by fashion and that continue to be available are less heavily discounted during sales periods, because of which a downward bias is introduced if sales prices are imputed. Another possibility is that some products continue to be available, but gradually fall out of fashion, as a result for which their price movement over time stays below the price movement of the latest fashionable (in season) products. If this is the case, the bridged overlap method will bias the index downward.

If this method is used, then the last observed normal price should be used to minimise any potential downward bias in the index.

Bridged overlap is sometimes useful but it has pitfalls ([284]). This method should be used only in exceptional cases. A problematic point is the dependence on the assumption that price differences at a given time correspond to quality differences, as this is easily severely distorted by changes in fashion.

([284]) A more detailed discussion about situations when and when not to apply bridged overlap, can be found HICP recommendations on bridged overlap (2021).

12.7.5 Seasonality in clothing and footwear

Many products in clothing and footwear are seasonal in nature. Winter clothes may, for example, be available in shops from September until March, after which they are followed by summer clothes and so on. Clothing products at the beginning of a new season which follow those of the previous season are often very different; for example, winter coats and dresses follow summer coats and dresses, making quality judgements between them challenging. Some clothes or shoes may disappear for seasonal reasons from some shops, e.g., when ski wear follows swim wear or boots follow sandals. However, it is important to understand that seasonal unavailability does not affect the whole range of clothing items. For example, jeans, underwear, or long-sleeved shirts are usually available throughout the year (see also below).

For clothing, in particular, discount sales generally occur at the end of seasons. However, this can vary by country. Climatic differences and changes in retailing practices do affect both the seasonal pattern of these sales, and the frequency at which seasonal collections are introduced during the year. As such it is important that each Member State be cognizant of the seasonal patterns and retail practices which prevail in their county.

As described in Sub-section 7.1.4.2, Implementation Regulation (EU) 2020/1148 explains the treatment of seasonal products in the HICP. This same Regulation (Article 2(22)) also defines a seasonal product as:

> *'…an individual product that is available for purchase or purchased in significant amounts only part of a year in a recurring pattern. In any given month, the product is either in-season or out-of-season. The in-season period may vary from one year to another.'*

The rules allow for the application of two calculation methods: 1) the *Seasonal imputation method*; and 2) the *Seasonal weights method*.

Counter-seasonal estimation is one of the two options within the seasonal imputation method. It uses only those products that are in season to estimate the price development of products that are out of season. This method is most suitable when the year has two or more clearly defined seasons. For example, where summer products follow winter products and vice versa, and where in each month of the year there are sufficient seasonal products available on which to base the estimation procedure. This is a particularly appropriate method for the treatment of seasonal clothing and footwear.

As noted above, the prices of some types of clothing are available all year; e.g., jeans, underwear, socks, baby clothes, and sports shoes, etc. However, it is generally preferred to use in the estimation strategy only the prices of those seasonal products that are in-season to estimate the index for out-of-season products, and thus disregard the products that are available all year. This approach provides a better estimate for the price movements of out-of-season seasonal products. This helps to improve the comparability with those results obtained from using the seasonal weights method.

According to Implementing Regulation (EU) 2020/1148, when using a seasonal imputation method, the price for the first month of unavailability should be a *typical* price so that subsequent estimations are not biased by using atypical prices, which are often observed for many seasonal products in the last month of their availability. This is particularly true for seasonal clothing and footwear, where at the end of each season unsold products are often *sold* at heavily discounted prices. To avoid a potential downward bias in the index, the typical price used in the first month of unavailability should relate to the normal or average in-season price.

The seasonal weights method is another way to deal with products that are out-of-season and for which prices cannot be observed. While the weight for the elementary aggregated is fixed each year, on the strata below, the weights vary and are set to zero in the months when the products are out-of-season. However, the use of variable weights should not reflect any fluctuations in the monthly consumption patterns of products during their in-season period (see Section 7.1).

12.8 Financial services

12.8.1 Introduction

Financial and banking services include services such as handling payments, credit cards fees, cash withdrawals, money transfer, foreign currency exchange, stockbrokerage services, and investment funds. These services often involve fees which can be charged at a flat amount, be proportional to the value of the transaction, or a combination of both, e.g., a flat minimum charge up to small transaction amounts and a proportional charge on higher values.

Starting in 2001, the coverage of financial services in the HICP was extended to include not only flat fees but also explicit fees proportional to transaction value. Implementing Regulation (EU) 2020/1148 Article 7 provides general rules for service charges which are proportional to transaction values (see Section 7.3). However, an exclusion from the HICP is FISIM (Financial Intermediation Services Indirectly Measured, ECOICOP 12.6.1), which comprises those parts of financial services where the implicit charge involved is the net interest earned by financial institutions. FISIM is excluded because the scope of the HICP is restricted to monetary transactions by Regulation 2016/792 Article 2(20) — see Sections 2.3.1 and 2.3.3.

The way in which financial services are delivered to consumers varies among countries. For example, in some cases, transaction (i.e., chequing) accounts are provided free of charge under conditions. In other countries, similar accounts are subject to monthly or annual fees. Even within countries, different financial institutions may adopt either one or both approaches. Such complex pricing structures entail difficulties in the design and application of harmonised methodologies for the HICP at the level of financial and banking services sub-indices (ECOICOP 12.6.2). In particular, the borderline between explicit and implicit charges is not always clear-cut. These issues cannot be eliminated but must be kept in mind when using these indices.

The dynamic nature of the financial sector needs to be closely monitored by HICP compilers to keep the sample of financial services properly updated and representative of current consumer behaviour. In-person banking has partly been replaced by online banking where different fees apply. Furthermore, the range of options has widened for households investing their savings, with innovations in traditional banks such as index-linked investment funds and ETFs, as well as online financial services providers such as TransferWise and trading apps.

This section provides practical advice for defining a price and a representative transaction for both flat and proportional fees in the context of financial and banking services, while respecting the fixed-sample (Laspeyres) principle on which the HICP is based.

12.8.2 Legal requirements

Implementing Regulation (EU) 2020/1148, Article 7(1), lays down the methodological and technical specifications in accordance with Regulation (EU) 2016/792 of the European Parliament and of the Council, regarding harmonised indices of consumer prices and the house price index. The following rule is stated:

> *'1. The HICP shall include charges that are levied directly on consumers in exchange for the service provided and can be expressed as a flat fee or a proportion of the transaction price. If the price of a service is determined as a proportion of the transaction price, the proportion multiplied by the price of a representative unit transaction shall be used as an observed price'*

Article 5(3),(5) and (7) of the same regulation can also be relevant at times for treating financial services in the HICP. It states the following rules:

> *'3. Changes in the observed prices or conditions of a tariff shall be shown as price changes in the HICP.'*

> *'5. If household income is a condition determining the price, changes in the observed prices resulting from changes in household income shall be shown as price changes in the HICP.*

> *'7. If an individual product has been made available to consumers free of charge and a price is charged subsequently, this shall be shown as a price increase in the HICP. Conversely, if a price has been charged for an individual product that is subsequently made available to consumers free of charge, this shall be shown as a price decrease in the HICP.'*

In accordance with Regulation (EU) 2016/792 of 11 May 2016 on harmonised indices of consumer prices and the house price index, the following ECOICOP categories of financial services are included in the HICP:

12.6 Financial services n.e.c.

12.6.1 FISIM — *Excluded*

12.6.2 Other financial services n.e.c.

12.6.2.1 Charges by banks and post offices

12.6.2.2 Fees and service charges of brokers, investment counsellors

Excluded

Regulation (EU) 2016/792, Article 2(4) states that interest charges are excluded from the HICP. This is because interest charges, although they are monetary transactions, are considered current transfers between households (see the Annex (3) in Implementing Regulation (EU) 2020/1148).

12.8.3 Principles

The following four ([285]) general principles are useful to ensure compliance with the legal requirements of the HICP:

1. Country of recording of credit and debit card fees, etc.
2. Annual resampling
3. Weights
4. Exclusion of FISIM and interest and interest-like charges

12.8.3.1 Principle 1: Country of recording of credit and debit card fees, etc.

The use of credit and debit cards while abroad to purchase goods and services, or to withdraw cash, often attracts explicit fees and charges. The following clarifies in which economic territory these fees and charges should be recorded.

The fees levied on the use of the card abroad are not part of the prices of the goods or services purchased as these fees are taken directly from the consumer's bank account or are charged to the credit card and are not invoiced by the outlet where the good or service is purchased. These charges should be allocated to the country of residence of the card owner.

Companies providing various goods and services, e.g., for internet purchase (see Section 7.2) sometimes charge a fee for payment by credit or debit card. However, these fees may partly result from costs of the retailer for bank charges which are passed on to the consumer. They should be included in the prices of the goods or services in question as they are unavoidable charges directly linked with the purchase.

The representative transactions for using credit and debit cards abroad typically include:

- The service fee charged for withdraw local currency (on a ATM machine) e.g., the fees for withdrawal of the amount of USD using a Bulgarian card currently equivalent in purchasing power to EUR 100 of the preceding December.
- The service fee charged when purchasing abroad a good or service of a given value in foreign currency expressed in the currency of the consumer's residence, in the price reference period.

The value of the reference transaction (e.g., EUR 100) should be kept constant in nominal terms.

12.8.3.2 Principle 2: Annual resampling

The coverage and internal weights of ECOICOP 12.6.2 should be reviewed and updated annually using the latest available information. Similarly, the reference transactions for proportionally

([285]) Principles 1-3 while having no legal basis are nonetheless useful for ensuring compliance with HICP Regulations. Principle 4 on the exclusion of Financial Services Indirectly Measured, has a legal basis in that Regulation 2016/792, Article 2(20) restricts the coverage of HICP to monetary transactions only.

charged financial services should be either completely resampled, or as a minimum they should be revalued, i.e., price updated using the all-items HICP (see Section 12.8.7).

12.8.3.3 Principle 3: Weights

The weights for financial services, both for fixed and proportional charges, should reflect the actual charges paid by consumers for obtaining the service, and not any estimated values, such as those obtained from using modelled reference transactions which are required for compiling the index. For example, for stockbrokers, the weight should reflect their observed revenues from consumers in the weight reference period and not an estimated weight based on the reference transactions used to estimate the price index for stockbroking.

Weights at the aggregate level should preferably be derived from national accounts data. Data for use in compiling weights at the detailed level may be obtained from other sources, notably financial service institutions or regulatory agencies (see Section 12.8.8).

12.8.3.4 Principle 4: Exclusion of Financial Intermediation Services Indirectly Measured (FISIM) and interest and interest-like charges

In much of the financial sector, the provision of financial intermediation services does not attract an explicit charge. Instead, revenues from these services, known as Financial Intermediation Services Indirectly Measured (see Section 12.8.1), are derived from the spread between the interest rate charged on loans and that paid out on deposits. As no monetary transaction occurs, Financial Intermediation Services Indirectly Measured is excluded from the HICP (see Regulation 2016/792 Article 2(20) and Sections 2.3.1 and 2.3.3).

The exclusion of Financial Intermediation Services Indirectly Measured means that some of the intermediation services that customers benefit from are not covered in the HICP. A possible consequence of this convention is that movements in the index (and changes in weights) can occur if providers of financial services change their pricing strategy by shifting away from implicit charges towards charging more explicit fees (or vice versa).

Additionally, as previously stated, interest and interest-like charges, although they are monetary transactions, are excluded from the HICP. This is because these charges are outside the HICP's scope. They are regarded as distribution of primary income (property income) which is receivable according to the property rights of the owners of financial assets and are excluded from the scope of Household Final Monetary Consumption Expenditure (see Section 2.3.1).

12.8.4 Coverage of financial services

The range of products included in ECOICOP 4-digit class 12.6.2 — Other financial services n.e.c. are sub-divided into two 5-digit sub-classes:

> 12.6.2.1 — Charges by banks and post offices, including actual charges by savings banks, money changers and similar financial institutions.

12.6.2.2 — Fees and service charges of brokers, investment counsellors, including charges for financial services of tax consultants and the like.

The services provided by banks, post offices, savings banks, currency exchange offices, and other financial institutions include the following products:

- Cashing of cheques or money orders, money transfers, payments, and currency exchange services
- Investment services: investment in various kinds of securities, funds etc.
- Custody services (deposit services)
- Safe-deposit services
- Dealing in precious metals
- Property or assets management
- Consultancy and brokerage
- Management and processing of customer accounts (e.g., book and record keeping)
- Settlement of financial intermediation services and other financial services.

12.8.5 Prices of financial services

Flat fees

Some fees for financial services are flat fees. Like most prices, they are stated as a given monetary amount charged for a specified service, not depending on a transaction value ([286]). Examples are fees for deposit services, and fees for opening an account or obtaining a loan. Such flat fees are in principle treated like any prices in the HICP.

One important matter is the treatment of different prices for various customers. In many financial institutions, not all customers pay the same charges for the same level of services, depending on pricing policy of the financial institution and the type of account held by the consumer. For example, some bank accounts may be free if the consumers deposit a fixed amount of money into their accounts each month; for consumers who do not deposit this minimum amount, fees may be charged for operating the account. Furthermore, new fees can be levied when service providers redesign their fee structures. For example, customers of a bank may have to suddenly pay for cash withdrawals in cash machines not belonging to the customer's bank. In such situations, the challenge is obtaining the percentage of transactions affected by the fees, and an approximation may be necessary for this.

In practice, complex structures of fees may occur. For example, loyalty discounts may apply, so that customers with a record of well managing their accounts qualify for premium customer status, which entitles them to some services at a reduced price or even for free. Bundling may apply, e.g., with a package that includes withdrawals and transfers within stated limits above which additional withdrawals or transfers are charged for separately.

([286]) Flat fees are sometimes called *fixed* fees in contrast to proportional fees, see Section 12.8.6, but not to be confused with fixed in the sense of administered.

Such complex fee structures can, in principle, be treated as tariffs, either using the tariff element components involved or by a consumer profiles approach, as for electricity or telecommunication services (see Sections 7.4 and 12.6), and for bundled services (Section 7.6). The detailed design of the price measurement should be devised pragmatically in view of the complexity of the pricing and the weight in the HICP.

Charges proportional to the transaction value

Charges proportional to the transaction value, known as ad valorem charges, apply for various financial and banking services, such as payment services, money transfers, foreign currency exchange, and stockbrokerage (see also Section 7.3).

The observed prices for proportional service charges are explained in Implementing Regulation (EU) 2020/1148, Article 7(1):

> *'1. The HICP shall include charges that are levied directly on consumers in exchange for the service provided and can be expressed as a flat fee or a proportion of the transaction price. If the price of a service is determined as a proportion of the transaction price, the proportion multiplied by the price of a representative unit transaction shall be used as an observed price.'*

Thus, the price for the service is the amount paid by the consumer for a transaction (the representative transaction) expressed in value terms (monetary).

Annex 7.3 gives a technical description and sets out the algebra for pricing such charges.

Definition of a unit transaction

The prices of proportionally charged services, in the form of percentage charges, are normally observable from published price lists or collected replies from the service providers or the internet. By contrast, defining the representative transactions is less straightforward. Below are some specific examples of typical unit transactions for common proportionally charged financial services.

As will be described below, the value of the representative transactions should be continually updated annually. This serves to keep the quality, in the sense of user functionality, of the priced service. Namely, the user functionality of the service can be seen as proportional to the value of the transaction — i.e., the monetary amount in real terms that is handled by the service.

Foreign currency exchange

Charging for the purchase of foreign currency may be *explicit* — i.e., with a visibly stated commission fee, or it may be *implicit* — i.e., with no visibly stated commission fee charged for the service (i.e., commission-free currency exchange). In the latter situation, a commission is implicitly charged by way of the differences between the service provider's selling and buying rates. As there is no visible monetary transaction (for the exchange service itself), commission-free currency exchange is excluded from the HICP (see Principle 4).

Where explicit commission fees are charged (see element 1 above), these are calculated as a proportion (percentage) of the value of the transaction. For example, if the commission rate is 1.80 %, and the *unit transaction* in the price reference period is defined as purchasing the 100 euros worth of US dollars (see element 2 above), then the price to be recorded in the price reference period is 1.80 euro.

This representative transaction deserves two further comments. First, the example assumes the dominance of the consumers' perspective in the euro area. For non-euro area countries, the national currency should be used and not the euro. Second, the representative transaction could theoretically have been defined as acquiring 100 USD against the equivalent in euros, rather than purchasing USD against 100 euro. But the alternative would be less practical, as it would involve adjustments for inflation in various countries and currencies.

When following the unit transaction over time, it must be adjusted for both inflation and changes in the exchange rate. This is needed for the exchange service to be comparable over time by retaining its user functionality, which corresponds to the purchasing power of the amount exchanged. For example, in a period of high inflation, not adjusting for inflation would bias the index downward.

Thus, the unit transaction should be adjusted monthly using the relevant exchange rate and the all-items HICP. For the all-items HICP, the number for the preceding month can be used, as that for the current month is not yet available for the index calculation.

It should be noted that in applying these adjustments, the value of the representative transaction in the comparison period may not reflect an actual transaction. For example, if inflation from the price reference period was 1.5 % and there have been no changes in the exchange rate, then the uprated value of the representative transaction in the comparison period would be 101.5 euros. This is clearly not a value that a consumer face as generally only notes can be exchanged. However, it should be remembered that the aim is to *model* the price change of the service for a notional transaction of a constant purchasing power, and not the price change of an unadjusted transaction of a fixed value. e.g., 100 euros as both inflation and changes in exchange rates will change the purchasing power of the transacted value.

It is also important to bear in mind Principle 2, annual resampling (Section 12.8.3 above). Each December the chosen representative transactions should be reviewed as part of the annual resampling exercise to ensure that the values set reflect typical purchases.

For example, suppose that the central bank exchange rate ([287]) is USD 1.1122 for one euro in the price reference period, and USD 1.1544 for one euro in the current (comparison) period. Suppose further that the all-items HICP for the country of residence has changed from 101.23 to 102.45 between the price reference period and the period prior to the current (comparison) period, and that the commission fee then changed from 1.80 % to 1.75 %. The appropriate price relative (or index) for the current period is then calculated as:

$(1.75/1.80) \times (1.1544 / 1.1122) \times (102.45 / 101.23) = 102.12725.$

In this calculation, the first factor is the change in commission rate, the second factor adjusts for the change in exchange rate, and the last factor adjusts for the change in HICP for the country of residence. It can be noted here that month-to-month changes in the index are in practice often due to changes in exchange rate and inflation rate of the previous month, rather than to more infrequent changes in the commission rate.

In real-world situations, it is normally necessary to specify a larger reference representative transaction than 1 euro. This is because some money exchangers, in addition to charging a

([287]) Commission-free exchange rates, as advertised by some currency providers, should not be used, as their advertised rates include an implicit commission/service charge.

percentage commission rate, also impose a minimum charge. In such situations, care should be taken to define the representative transaction to represent a typical transaction amount, so that changes in the commission rate and in the minimum charge are duly reflected in the index.

Investment funds

Investment funds are subject to the rules of Parliament Regulation (EU) No 1286/2014 on key information documents for packaged retail and insurance-based investment products (PRIIPs). While not an HICP regulation, it is relevant as part of the trading environment for investment products. The providers of such products are obliged to publish a *key information document* (KID) constituting pre-contractual information on costs and various characteristics of the product.

Investment funds often apply an annual management charge (AMC) defined as a given percentage of the current asset value. For example, the charge can take the form where 1.50% of the asset value is deducted annually from the latter. This charge can be applied either instead of or in addition to charges applied to the buying or selling of fund shares.

In the HICP, the annual management charge proportional to asset value is treated as a charge proportional to the transaction value. Funds can be discontinued from time to time, and in the price collection they should be replaced with similar funds to ensure that they reflect actual price developments.

The representative transaction for annual management charges can be defined as the annual management of shares worth a given amount in monetary terms in the price reference period. The value of the representative transaction is updated by the all-items HICP.

The use of the all-items HICP as the updating index is because the user functionality of the service deteriorates with inflation, which makes the monetary value of the assets handled less useful to the consumer. The updating with the all-items HICP adjusts for this change in user functionality (see also Section 7.3). A stock price index such as the FTSE 100, DAX or Dow Jones indices etc. should not be used as these do not keep the user functionality of the service constant. Namely, the more the investment is worth, the greater the user functionality of the service managing it. Also, stock price indices follow asset price values, which can be volatile and asset price movements would dominate the modelling of the service charge.

For example, suppose that between the price reference period and the current period a fund with 1.60% annual management charge was replaced by one deemed essentially equivalent, with 1.50% annual management charge, while the all-items HICP changed from 101.23 to 102.45. Neither of the two funds levies any other charges than the annual management charge. The price relative for the replacement fund is then calculated as:

$$(1.50/1.60) \times (102.45 / 101.23) = 0.948798.$$

More explicitly the calculation can be stated as follows. Let the representative transaction be specified as the management of EUR 1 000 of asset value in the price reference period. In the price reference period, the charge for the representative transaction is then:

$$\text{EUR } 1\,000 \times 1.60 = 1\,600.$$

In the comparison period, the asset value is updated to:

$$\text{EUR } 1\,000 \times 102.45 / 101.23 = 1\,012.0517,$$

and the charge is:

$$1\,012.0517 \times 1.50 = 1\,518.0775$$

This results in a price relative of:

$$1\,600 / 1\,518.0775 = 0.948798$$

as before.

Stockbrokerage, purchasing or selling of shares, unit trusts or other securities

Stockbrokerage covers the purchasing or selling of shares, unit trusts or other securities. Stockbrokers buy or sell shares or other securities on behalf of their clients. The service provided consists of arranging for a transaction to take place on conditions specified by the client, e.g., a certain block of securities that are being bought or sold. Usually, consumers are charged proportionally to the value of the traded block of securities. The proportional charge is often combined with a minimum charge.

For stockbrokerage and similar services, the representative transaction should be the trading of a sample of securities, defined in value (monetary) terms, that is representative for such services used by consumers in the price reference period (i.e., the December of the previous year). The volume of the representative transaction in the price reference period is the amount invested in stocks (i.e., the value of the investment, e.g., EUR 1 000) which should be kept constant between annual sample updates.

The all-items HICP should be used for the adjustment of the representative transaction values to reflect the changes in percentage charges arising from the change in purchasing power of the representative unit transaction through time due to inflation. The reasoning behind this is like that in the preceding section on investment funds. Stock market or similar price indices should not be used. The price reference period expenditure is therefore held constant in real terms (see also Section 7.3).

Financial advisers and tax consultants

The services of financial advisers, who may charge flat fees, proportional fees, or both, should be treated in the same way as stockbrokers. In other words, an investment of a given value in monetary terms is defined for the price reference period, and then the index is updated every period by any change in the fees charged by the advisor for advice on an equivalent value of investments.

Fees for tax or investment consultancy are sometimes determined as a given proportion of the total assets that are subject to the consultancy.

The representative transaction can therefore be defined as consultancy concerning a given set of assets, worth a given monetary amount in the price reference period. This set of assets is assumed to be of a given level of complexity from a consultancy view, in terms of diversity, risk etc. The sample of services to be priced consists of the set of consultancy services that are required for this set of assets. The value of the representative transaction is updated by the all-items HICP. The HICP, not stock market or corresponding indices, should be used to maintain the value of the representative transaction in the price reference period, so that only changes in the service charge are captured. The reasoning is like that for investment funds and stockbrokerage in the preceding sections.

The precise definition of the unit transaction depends on the consultants’ pricing strategies. For example, a tax consultant could charge clients in proportion to their taxable income. If so, the unit transaction can be defined as consultancy for a client with a given income level in the price reference period. The value of the representative transaction can then appropriately be updated in relation to the development of average incomes as measured by income statistics. The all-items HICP could be used as a proxy for the latter.

12.8.6 Sampling

Financial and banking services are subject to continual change, with new products entering the market. The ways in which services are paid for can also change, with implicit charges replacing explicit charges and vice versa, as has been the case for currency exchange and some bank account charges. How financial services are delivered can change. For example, cheques have almost disappeared with the increased use of debit cards and online payment services. The number of physical bank branches has declined substantially.

These developments confirm the importance in price index work to monitor financial services markets and to regularly update the samples of providers and products accordingly. New providers of financial services may appear on the market and rapidly gain significant market share, as supermarket chains and independent banks have done. The coverage of ECOICOP 12.6.2 should be assessed for structural changes to the market and products, preferably annually, to maintain representativity (Principle 2, Section 12.8.3 above).

The first step in establishing a sample frame is to understand the universe of financial service providers — banks, post offices, credit card companies, stockbrokers, financial advisers, accountants, tax consultants, currency exchange offices, etc. — and the potential universe of services (product offers) available. It is also important to consider the fee structures and pricing strategies for these financial services, as they can vary considerably among countries.

For example, in some countries, the day-to-day operation of bank accounts is free of explicit charges. Nonetheless even these accounts often charge explicit fees for a range of services such as purchases and cash withdrawals abroad, overdraft fees, supply of documents (e.g., replacement statements) and other additional services such as balance alerts via SMS. Some non-bank providers also operate automated teller machines in convenience stores, bars etc. which attract fees for cash withdrawals. These charges can be flat, proportional, or a combination of both.

Table 12.8.51 below gives an overview of types of services that financial intermediaries provide and can be used as a starting point in developing a sampling frame for banking services. Probably not all the services below attract considerable consumer expenditure everywhere and as such they do not need to be explicitly priced (e.g., opening of accounts), and the exact range of relevant specific services to be priced depends on the fee structures and pricing strategies occurring within each Member State.

As with many other services, such as telecommunications, financial institutions often bundle services into packages for which a single monthly fee is applied. Where they do occur, they should be treated in accordance with the guidance given in Section 7.4 — Tariffs and Section 7.6 — Bundles. Care is needed when such bundled packages include non-financial services, such as for travel insurance or motor vehicle assistance (breakdown) services. The table shows that ECOICOP 12.6.2 covers more than just day-to-day banking.

Table 12.8.51

Types of services provided by financial intermediaries

Types of financial services	Examples/Comments
Bill payment services	Direct debits, standing orders etc.
Stop payment services	Stopping the above
Bank to Bank domestic and abroad	Money transfer services
Transfers, and cash withdrawals	Abroad
Money withdrawal services	Automated teller machines
Issuing and closing accounts	Not often charged for
Borrowing services	Loan arrangement fees etc.
Provision of documents	Duplicate statements etc.
Current and savings bank explicit charges.	Direct banking services
Credit card services	Cash advance fees, overseas transaction fees, overdue payment penalties etc.
Foreign currency transactions	Commissions
Brokerage services	Stockbrokers' fees
Safe custody of securities	Storing of documents
Safe custody of valuables	Safe deposit services
Security broking	Securities trading
Fund management services	Unit trust management fees
Cheques	Travellers cheques, Cashing cheques in a bank other than the issuing bank
Financial advisory services	Financial advisers fees & charges
Accountancy and tax advisory Bundled financial services	Tax planning and accountancy Packages with e.g., transfer, management and advisory services

Sampling stages and procedures

When developing a sampling frame, it is advisable to first identify the elementary aggregates that attract significant consumer expenditure, and then to identify the main providers within each elementary aggregate. If there are many providers of financial intermediation services, it may be appropriate to use cut-off sampling to identify the most representative ones.

The sampling of specific products for price collection could normally be undertaken by purposive selection (see Chapter 4) of products that apparently attract considerable consumer expenditure. Websites of the sampled service providers can be used as an informal frame for purposively sampling specific products, and providers of these can be asked for supplementary information on actual consumer demand for their products.

Sampling of investment funds from long lists can pragmatically be undertaken by a simple form of probability sampling, such as systematic sampling with a randomly selected starting point and a constant interval between selected elements.

In all countries, the provision of financial and banking services is tightly regulated, often by central banks or other public institutions. Hence, these institutions offer a potentially rich data source from which providers and services with large market shares in terms of expenditure can be identified. This could help in developing an adequate sampling frame. However, some caution is required, as financial intermediaries supply services to all sectors of the economy, not households exclusively.

When service providers and products have been sampled, it is then necessary to select or define the representative transactions to be priced. This is normally done judgementally by purposive selection. For more complex products, such as investment products, assistance from the sampled service providers or independent financial advisers can be useful to ensure representativity.

The fees levied by financial service providers are typically tariffs, with a list of charges for specific transactions (e.g., withdrawing money from an automated teller machine, monthly or annual charges for holding an account, charges for balances alerts by SMS, and charges for a replacement statement). As with other tariffs, it is not necessary to price every tariff element. The service providers sampled should be able to identify the most important elements (in expenditure terms). Where they are unwilling to do so, a judgement-based approach may be necessary. Guidance on the treatment of tariff prices is given in Section 7.4.

Bundled financial services, e.g., packages including several components such as transfers, savings management, free overseas cash withdrawals, and advisory services, should also be sampled in proportion to their relative market shares (see Section 7.6 on bundled products).

12.8.7 Data sources for weights

As with the treatment of other goods and services in the HICP, weights for financial and banking services should relate to actual expenditures by households (resident and non-resident) on the economic territory of the Member State. For flat fees, estimating their weight is generally not problematic. Likewise, for proportionally charged financial and banking services, the weights should reflect actual expenditures that relate to the weight reference period. For example, for foreign currency exchange services, the actual amount of commission paid, and not the value of the estimated representative transactions used in computation of the index, should form the basis of the weights.

For financial services and banking there are generally three possible sources of weights:

1. National accounts.
2. Household budget surveys (HBS)
3. Financial enterprises / Financial regulators.

As discussed below, these sources are often not consistent with each other and can yield different results. Household budget surveys are subject to measurement difficulties in relying on questionnaires to households where the recording of actual expenditures may not always be complete or accurate.

The weights for financial services can vary considerably among countries; this reflects not only the data sources used but also reflects the ways in which services are charged for. For example, banks in some countries do not charge explicit fees for operating an account that is in credit, while in other countries the operation of an account is explicitly charged for regardless of the amount of funds in the account.

ECOICOP subindex weights

For the *subindex weight,* the national accounts should be the preferred source of data, as they are derived from data deemed most accurate for estimating total expenditure. Namely, to the extent deemed appropriate, the national accounts use data from both financial enterprises and the household budget survey. However, the national accounts are unlikely to provide sufficient detail for calculating weights at the elementary aggregate level.

Elementary aggregate weights

After the estimation of the class and sub-class weights, elementary aggregate weights need to be estimated and the representative transactions chosen. The basic steps to achieve this are the following:

1. Define the relevant elementary aggregates within the ECOICOP sub-class 12.6.2 (e.g., banking services, currency exchange, financial advice etc.),
2. Estimate the weights for each elementary aggregate,
3. Define the representative products for fixed charge services and the representative transactions for proportionally charged services, in each elementary aggregate,
4. Select the most representative service suppliers from which prices should be collected.

The order in which these steps are performed could be modified according to local conditions. For example, it can be useful to select service providers first (step 4), and then using information from the sampled providers, define representative products and representative transactions (step 3), where this is feasible.

For the estimation of elementary aggregate weights, there is some discretion in terms of the data sources that can be used. There are two general approaches:

1. Use of specific data from financial institutions on the kind of services supplied to the household sector, or,

2. Use of the household budget survey if it provides sufficient detail so that weights for specific financial services can be estimated.

Data from financial intermediaries (1) should in principle contain a great deal of detail regarding categories of expenditure, though some of this detail may be lost if data are reported to regulators in aggregate form. Another disadvantage is that as financial intermediaries serve all sectors of the economy, the data they provide may include business as well as household expenditures. Although most of them should be able to separately identify business accounts from household accounts. Regulators may also be able to provide information on the market shares, in terms of revenue, of the major banks etc. which can be useful in constructing appropriate sampling frames and weighting schemes of service providers.

Data from the household budget surveys (2) are generally problematic and likely to suffer from under-reporting of expenditures for financial and banking services, as such expenditures are generally not well captured in household budget survey questionnaires. In various ways, under-reporting of expenditures could particularly affect the recorded expenditure of relatively wealthy households, as they are likely to use more financial services than less wealthy households, and therefore biasing the weights. Furthermore, the household budget survey uses the residential concept, and not the domestic concept, which is for the basis of the HICP (see Chapter 2). This can be a problem, for example, in countries with many overseas visitors, or frequent cross-border shopping trips to or from countries with another currency.

Consequently, the choice of data source for weights can potentially have a large impact on the quality of the weights regarding risks of substantial bias. In particular, the household budget survey has various measurement pitfalls which need scrutiny.

To follow the domestic concept (Principle 1), the fees paid by non-resident households for services such as the conversion of foreign currency should be included in the weights of the Member State where the expenditure occurs. Accordingly, the use of resident-only based surveys such as the household budget survey will not capture all these expenditures leading to an underestimation of the weights. Where household budget surveys are used, these need to be supplemented with data from other sources such as those described above.

12.9 Electronic goods

12.9.1 Introduction

Electronic goods are not formally defined, but they are commonly recognized as articles such as mobile telephones, audio-visual products, digital cameras, speakers, headphones, laptops, tablets, and corresponding accessories. A list of the ECOICOP categories which cover most goods of a predominantly electronic character is included in Annex 12.9.1, although it should be noted that other goods containing electronic components also occur in several other ECOICOP categories.

The fast technological development of electronic goods has two important implications for the compilation of HICPs. First, product development can result from time to time in the introduction of radically new products, sometimes referred to as revolutionary products such as smartwatches, portable solar panels, etc. Such innovative products must be identified and monitored to be treated as newly significant and introduced into the HICP when their expenditure becomes significant. Second, from a customer perspective product development can lead to improvements in the performance of existing products. For example, more computers that are now capable of handling ever more sophisticated software that can run more processor intensive applications such as games optimised for higher resolution monitors. This evolutionary trend must be addressed in the HICP with replacements which will require a quality adjustment.

12.9.2 Legal requirements

There are no HICP rules specifically relating to electronic goods, but the treatment of electronic goods in the HICP should comply with all the rules laid down in the HICP Framework Regulation and other regulations, including the comparability criterion ([288]).

Radically new products — which often characterise electronic goods — are to be treated as newly significant goods and services. Implementation Regulation (EU) 2020/1148, Article 4 on sampling and representativity states:

> *'3. Member States shall ensure that the target sample remains representative of the target universe over time by conducting at least an annual review and update of the target sample, and selecting replacement products.*
>
> *'4. Products for which the expenditure share is at least one part per thousand shall be represented in the target sample.'*

This Regulation implies that Member States should actively seek to identify newly significant goods and services. They should also consult with other Member States about their own experiences with identifying newly significant goods and services.

It is highly recommended that the newly significant goods and services should be introduced in the HICP as soon as they become relevant. It can be made during the year by adjusting the weights or by assigning part of an existing weight specifically to the newly significant good or service (see Chapter 3). The choice of approach is dependent on market trends, i.e., how the newly significant good or service impacts consumer expenditures — an issue that is very difficult to determine in a timely manner as early sales can be very volatile and there is generally little expenditure information available on newly introduced products until sometime after the product enters the market.

12.9.3 Sampling

For any given ECOICOP category, the aim is to price the universe of the products which can broadly be achieved by web scrapping, API or transaction data. When that is not possible a sample of representative products within an elementary aggregate (see Chapter 4), which are resilient to changes in retail practices and to product turnover in the retail market must be drawn.

([288]) Regulation No 2016/792 Article 4(2a): HICPs are deemed comparable if they do not differ systematically by more than one-tenth of one percentage point on average over one year against the preceding year due to their methods of compilation.

Achieving a representative sample is dependent on:

- The procedures for the initial sampling of product offers, which is usually purposive.
- The procedures used for selecting replacements when a model disappears from the outlet or the online store.
- The procedures in place to update the sample to reflect the turnover in product models and the introduction of revolutionary products.

These issues are discussed in a more general context in Chapters 4 to 6. Electronic goods are characterised by high turnover in the models being sold, and the value of the price-determining features can rapidly change in a short period. This is because as the underlying technology improves existing product offers become increasingly outdated and therefore, their features are less valued by the consumer. Consequently, this has implications for the of methods for quality adjustment such as hedonic methods where the price-determining characteristics need to be assessed on a regular basis; in this case by re-estimating the hedonic function (see Chapter 6).

It should also be noted that for electronic goods there can be quality changes in a model which superficially appears to be the same as the one which was previously priced. This can be the case even where the model number or name has not changed. During price collection the price collector should always inspect the product for such cases. For example, the collector can verify whether the model number or name is suffixed by a different code or letter or whether the product includes a label advertising an additional or improved feature. For instance, a letter ‘A’ added as a suffix to the model number of a computer may indicate that a feature has improved or been added.

Given the dynamics of the retail market, the sampling techniques used to select and maintain a sample of electronic goods are of particular importance in ensuring that the index accurately reflects price movements. Up-to-date sampling frames for probability sampling of electronic goods were in the past rarely readily available. In the absence of big data, the more traditional purposive sampling approach can be used whereby the frame can be constructed using, for example, sales information supplied by a sample of retail outlets, retail chains, or trade organisations. However, the application of probability sampling will still require that the frame be up to date. Otherwise, the results can lead to an over-representation of models with declining sales due to increased competition from rival brands. It is for the above reasons that most statistical offices rely on purposive sampling.

However, traditional sampling and price collection techniques involving visiting outlets to collect prices can be problematic. Given the dynamic nature of the electronic goods market, a large volume of price observations is recommended to ensure a sufficiently high matching frequency of products every month, thus ensuring a robust sample. The extent to which this becomes a problem increases the more the product is narrowly defined.

Price collection from online retailers using web-scraping or API may contribute to overcoming some of the problems mentioned above, as it has the potential to generate a product sample and the corresponding prices for narrowly defined products such as a particular brand and model number of an electronic good (see Section 5.5.2).

It should be noted that prices for the same product bought online or in the shop may differ. In that case, both prices should be collected.

Maintaining the sample of electronic goods can benefit from sales data collated by market research companies or data collected directly from retail outlets by the Member State, for example, as part of a retail enquiry undertaken for other purposes. The latter data can provide useful quality checks on the achieved sample. Depending on the characteristics of the data sources and local circumstances, the same data can also be used for probability sampling. A systematic analysis of the price's dataset and feedback from price collectors can also prove instructive and may indicate the need for a re-drawing of the sample.

Diversity in the selection of the sample should help to ensure that, even with apparently homogeneous product groups, the resulting sub-index is representative and free, for instance, from the downward bias that can arise from over-sampling out-of-date products whose prices may fall significantly and relatively quickly as the result of liquidation sales.

Replacement selection by price collectors can involve a risk of loss of diversity in the sample. This is because price collectors tend to be conservative in their choices of brands or variants, e.g., they can often select a certain brand even if its sales are in decline. Consequently, there is a strong case for head office to be proactive in the sample selection of electronic goods by including this aspect when training price collectors and by making available to them more prescriptive instructions. For example, the introduction of some form of probability sampling or quota sampling, based on sales data, may act as a useful control for representativity in cases where price collectors are given generic price descriptions and asked to select the most representative product variety in the shop being visited. Such a control would, for instance, provide a mechanism for ensuring better representation of different brands. Alternatively, head office could determine the product descriptions, with price collectors having no role in the selection of items for pricing.

The extent to which a sample remains representative is highly dependent on the rules used for product replacements (see Chapters 4 and 5). It is recommended that when traditional price collection methods involving visits to physical outlets are used for electronic goods, the product replacement strategy should follow the principle of selecting the currently *most representative* (most sold) product offer. Compared with the option of replacement with the *most similar* product, replacement with the most representative product offer has the benefit of maintaining the up-to-datedness of the sample with respect to product characteristics. However, the increase in non-comparable replacements that will arise will necessitate more quality adjustment and the imputation of prices so that the index becomes more dependent on effective quality adjustment.

When the choice of a replacement product offer is made by a price collector, the choice of replacement should ideally be reviewed by commodity experts at head office. They should use expert knowledge of the market and benchmark information, such as any available sales data, to test whether the product offers being priced are representative of current purchases. This could be done via occasional studies to assess the suitability of the sample.

12.9.4 Newly significant goods

From time to time radically new kinds of products appear on the market, products that are not even by quality adjustment equivalent or comparable to existing products. Electronic goods typically dominate newly significant products. New elementary aggregates for revolutionary products should be included in the HICP by resampling and not by replacement (see Chapter 4).

When a product with a thoroughly new technology first appears on the market, such as when smartwatches first appeared, typically the price is high with a corresponding small volume of sales. Subsequently, prices start to gradually fall, the volumes of sales increases, while existing features improve, and new features are added.

It is not self-evident when the price collection for the product should start. This is a matter of judgement. Guidance cannot be prescriptive as the most appropriate course of action depends on the circumstances and characteristics of the marketplace and, most particularly, on the volume of sales and whether the price being charged has stabilised or not. A middle way is that Member States monitor the market situation continuously and are ready to start price collection for the product as soon as it achieves a significant volume of sales and the price has stabilised around its market equilibrium. The detection of price movements will probably be a matter of comparison with other electronic goods plus the change in price of the newly significant product over a certain period using various sources of information including, possibly, sales data provided by businesses. Although some element of judgement is needed in deciding when to introduce a newly significant good into the HICP, web-scraped data offers a more comprehensive way for identifying newly significant products. Annex 12.9.2 provides a case study from Finland on their approach to using web scraped data to identify newly goods.

There is a converse issue concerning when the price collection for electronic goods with previously new technology should be discontinued. For example, with compact digital cameras, prices and volumes have fallen due to the emergence of smart phones which have built in cameras. Similarly with CDs and DVDs which have been overtaken by growing market for streaming services and smart TVs. However, this issue is not generally problematic, as such goods can be replaced as part of the usual annual resampling exercise.

12.9.5 Recommended quality adjustment methods

12.9.5.1 Quality adjustment and replacement sampling

Chapter 6 discusses quality adjustment methods in more depth.

Quality adjustment methods should be considered when managing and maintaining the sample. For example, when purposive sampling is used to select product offers for pricing, there are compelling reasons to limit the selection of products that are not likely to change in subsequent periods, with the aim of reducing the need for quality adjustment. Namely, a purposive sampling strategy aimed at minimising the incidence of quality change can compromise the representativity of the sample. This has the potential to introduce a bias particularly with electronic goods where there is a high turnover rate because of technological innovation. Therefore, clear and precise guidelines for the drawing the initial sample and for the replacement of product offers are important, especially in a dynamic market such as that for electronic goods.

It is important to choose outlets which are relevant for a specific electronic good. For electronic goods, it is likely that the market is highly competitive and very transparent as consumers can use the internet to make price comparisons as well as for purchasing products. Central price collection, namely by web scrapping may be suitable for most electronic goods. It may be necessary to stratify according to large and small retailers and between online and physical outlets, all of which should be covered in the index.

Given the rapid technological changes occurring for electronic goods, replacing models is a relatively frequent occurrence. When a model is judged to be no longer representative, for example, due to a loss in market share and the increasing sales of competitors' products, it should be replaced, even if it is still available (see Chapters 4, 5 and 6).

Note the particular importance of keeping the outlet sample representative of where customers purchase electronic goods, including online which has grown significantly in importance.

12.9.5.2 Quality adjustment methods — overview

The choice of the quality adjustment techniques deployed is especially important given the frequency of quality adjustments being applied for electronic goods. The influence on the affected sub-index, as indicated by implicit quality indices (IQIs, see Chapter 6) can be considerable, so quality adjustment procedures must be adopted and applied rigorously and with care.

As described in Chapter 6, there are various *implicit* and *explicit* methods for determining the difference in monetary value associated with a quality difference. The most reliable approach is the use of hedonic modelling to best assess the value of the quality change. This method will be explained with more detail in the next sub-section.

For electronic goods the standard implicit method of bridged overlap ([289]) is often used by many countries. It is popular because of its simplicity, but with this simplicity comes the real possibility of biasing the index when prices are falling at the same time as the quality of the electronic good is improving. This is because the method assumes that the pure price change between the replaced and replacement product is the same as that for similar products. This assumption can be questionable for electronic goods given their typical pattern of improving quality with concomitant falling prices. For electronic goods, significant price changes frequently occur at the time newly arrived models are launched and retailers discount the previous models to clear the remaining stock. Therefore, using the price changes of the preceding models to impute the price changes for newly introduced ones can systematically result in an incorrect estimate of the true price change for the newly introduced models and cause a bias in the price index.

Monthly chaining and replenishment (MCR) is yet another option, which is similar to the bridged overlap method. Each month-to-month index shows the change in the index from one month to the next. The sample is then updated in subsequent monthly comparisons. The chained monthly indices (Jevons) link together these month-to-month changes by successive multiplication of the price relatives. Monthly chaining has the advantage of maintaining representativity in cases where there is a high turnover of products, which is often the case with some electronic goods such as computers. Monthly chaining using the Carli formula (the average of price relatives), which is generally, by regulation, not supported and should therefore be avoided due to its potential to produce perverse results generated by the effects of price bouncing ([290]). The Dutot

([289]) For more information and examples about the bridged overlap technique the reader can consult Eurostat's document: HICP recommendation on bridged overlap (2021). The CPI Manual: Concepts and Methods also discusses the bridged overlap methods in paragraphs 1.127 to 1.129 and 6.47 to 6.55 where an example is provided. Note that the CPI Manual refers to the bridged overlap method as Overall mean imputation.

([290]) See the Consumer Price Index Manual: Concepts and Methods, 2020, paragraph 8.25.

and Jevons indices, the two elementary aggregate formulas laid down in HICP regulations, do not suffer from this problem (see Chapter 8).

Another option is the supported judgement method, whereby experts equipped with their knowledge and market intelligence to assess the monetary value of changes in product specifications. Because some subjectivity may be involved, the estimates may sometimes be inaccurate. However, the supported judgement method may be suitable for highly complex products where alternative methods are not practical to apply or fail. It is advisable when adopting this approach to draw on the expertise of more than one expert. Clear guidance should be given on what the experts are being asked to estimate i.e., a market valuation from a consumer perspective of the quality difference resulting from a change in specification, that is, how this change affects the consumer's perception of the product.

The use of hedonics methods (below) for quality adjustment are an option provided the compiler has access to a large dataset.

12.9.5.3 Hedonic regression

A hedonic regression equation relates the price of a product model to its characteristics — see Chapter 6 and, for more detailed explanations about hedonics, consult the Handbook on Hedonic Price Indexes by Jack E. Triplett and the CPI Manual: Concepts and Methods (2020). Hedonic methods have been proved useful for quality adjusting some electronic goods but there are some downsides. Hedonic methods require comprehensive and up-to-date data on product characteristics, such as can be obtained from transaction data and from web-scraping. Hedonic methods also require a certain level of statistical expertise and the knowledge of diagnostic tools to identify potential biases. For example, inter-dependency among different product characteristics, can lead to multicollinearity and imprecise coefficients. This is the case for smart phones where specifications are highly collinear. For example, smart phones with high RAM normally also have higher number of camera megapixels and better screen resolution. When these three variables are taken in the model can cause multicollinearity. In addition, there are judgements to be made in the application of hedonics, such as the choice of the model's functional form, the issue of weights in the regression and the hedonic method used e.g., the time-dummy approach or the re-pricing method. There remain several unresolved issues or, at the very least issues which been known to be controversial, which means that the practitioner will need to make choices ([291]).

A crucial step in the estimation process is the selection of quality variables (independent variables) in the regression equation. These variables should be carefully selected so that they represent those product characteristics that matter to consumers. Examples are the screen size of a TV, and the hard drive of a computer. Challenges arise when applying hedonics to electronic goods where the characteristics of the models can change significantly in a short time leading to the hedonic function rapidly becoming obsolete and over-estimating the value of those price-determining characteristics that are not new and ignoring the new characteristics.

([291]) Erwin Diewert, (2003), 'Hedonic Regressions: A Review of Some Unresolved Issues'.

The hedonic function should be annually updated before it becomes obsolete and biasing the index. The index compiler should also be proactive in updating the hedonic model by re-running it when new features enter the market to pre-empt when the model might get out-of-date.

Hedonics are considered by some to be the ideal quality adjustment method if data and resources are available. However, in practice, other methods of quality adjustment are more commonly used, reflecting in part the practical challenges of undertaking hedonic methods.

Access to large data sets provides the opportunity to apply hedonics. For instance, automated web-scraping of online data gives the potential for timely and high-frequency price measurement.

It should be noted that for some types of electronic goods, e.g., digital cameras, the expenditure weight within an HICP may be so low that hedonics may not be a cost-efficient solution and implicit methods are likely adequate. Depending on country market conditions, for other goods such as smart phones, their cost is often included as a non-identifiable part of the price of a mobile phone plan. As such the weight for independently purchased phones can be very low. In these circumstances care should be taken to evaluate the cost of the quality adjustment method used against the likely impact on the index.

The identification of product categories that would benefit from hedonic quality adjustment is not straightforward. For example, the use of Implicit Quality Indices to identify quality change (see Chapter 6) is not helpful, as they do not reflect the actual quality change in the market, but rather the adjustment for quality change made in the index.

Another indicator for assessing the benefit of a hedonic quality adjustment is to examine the turnover of models and the rate of technological change. The turnover rate can be assessed from the number of replacements made using survey price collection or measured from transaction or web scraped data, i.e., the number of models leaving vs the number of models entering the market. The rate of change in quality can be derived from transaction data or web scraping attribute variables.

12.9.5.4 Evaluation of quality adjustment methods

Some methods of quality adjustment can tend to be less robust in the compilation of indices for electronic goods due to the high turnover of models and the magnitude of change in the technical features. But this depends on the state of the market — most particularly the pace of technological change — and this should be tested.

Monthly chaining and replenishment (MCR) is a practical variant of bridged overlap and, in principle, is also suitable for electronic goods. But again, care must be taken regarding old or discontinued models being sold at stock-clearance discounts: however, this is a problem that can normally be overcome by replacing product offers in the sample as and when new models appear on the market and before preceding models are discontinued.

The alternative methods of estimating the value of quality differences and the basic procedures associated with carrying out these methods are described and evaluated in some detail for some specific products in the CENEX HICP Quality Adjustment Handbook[292]. Explicit methods, such as

(292) CENEX: Handbook on the Application of Quality Adjustment Methods in the Harmonised Index of Consumer Prices. Statistisches Bundesamt, Germany. 2009.

hedonic methods, serve to identify a monetary value of the quality difference between a replacement product and its predecessor. This value can then be removed from the directly observed price difference between the two subsequent products. What remains is the pure price change which should finally enter the index calculation. The CENEX Handbook also indicated that hedonic re-pricing was more suitable than bridged overlap for desktop computers, whereas both methods yield similar results for notebooks. Furthermore, the empirical studies in the Handbook showed some difficulties regarding the application of 100 % option pricing for both desktop and notebook computers. These conclusions, however, cannot necessarily be generalised and may change with time given the rapidly changing markets involved.

A tentative conclusion to be drawn from these studies is that some experimentation should be undertaken on a case-by-case basis to identify the most appropriate method of quality adjustment for an electronic good, considering the validity of the results, the availability of data and resources, and the operational demands of each method.

Annexes 12.9.3 and 12.9.4 provide two case studies of how Sweden and France quality adjust their electronic goods.

Annex 12.9.1: ECOICOP categories consisting of goods of a predominantly electronic character

08.2 Telephone and telefax equipment

08.2.0 Telephone and telefax equipment

08.2.0.1 Fixed telephone equipment

08.2.0.2 Mobile telephone equipment

08.2.0.3 Other equipment of telephone and telefax equipment

09.1 Audio-visual, photographic and information processing equipment

09.1.1 Equipment for the reception, recording and reproduction of sound and picture

09.1.1.1 Equipment for the reception, recording and reproduction of sound

09.1.1.2 Equipment for the reception, recording and reproduction of sound and vision

09.1.1.3 Portable sound and vision devices

09.1.1.9 Other equipment for the reception, recording and reproduction of sound and picture

09.1.2 Photographic and cinematographic equipment and optical instruments

09.1.2.1 Cameras

09.1.2.2 Accessories for photographic and cinematographic equipment

09.1.2.3 Optical instruments

09.1.3 Information processing equipment

09.1.3.1 Personal computers

09.1.3.2 Accessories for information processing equipment

09.1.3.4 Calculators and other information processing equipment

09.1.4 Recording media

Annex 12.9.2: Identifying newly significant goods in Finland

Since 2012, Statistics Finland has been using web-scraped data to identify newly significant goods. They apply this technique to a wide range of products, for example, daily products, clothing, furnishing, and hardware-store products. In the case of Finland, the annual update of the HICP weights is typically started at the end of the year so that they can be finalised by January. The primary data for this update are national accounts' consumption expenditures at the 4- and 5-digit COICOP levels. Detailed level weights (6- and 7- digit) are derived using supplementary datasets that cover annual sales by product.

The product-specific annual data can also be used for identifying newly significant goods. In the following example, hardware-store data that contain products for building, renovation and interior decoration are used. The same procedures could also be used in other product groups, such as electronic goods.

The process for identifying newly significant goods follows the steps below:

1. Collect product specific data (monthly or annual) preferably for the entire year (see below for an example of an annual dataset). Note that all detailed level large datasets are very sensitive, so the item specific values are suppressed.

Level2 name	Level3	Level3 name	Level4	Level4 name	ID	Product name	annual sales value in EUR
Home decoration	205	Ceramic tiles	20515	Floortiles	not available due to disclosure control	AVENUE WHITE 30X60	not available due to disclosure control
Home decoration	205	Ceramic tiles	20515	Floortiles		AVENUE WHITE 10X10 PC	
Home decoration	205	Ceramic tiles	20515	Floortiles		MOUNT EVEREST STRUCTURE 30X30 G1	
Home decoration	205	Ceramic tiles	20515	Floortiles		CERAMIC TILE 10X10 SILICY GREY/HALL	
Home decoration	205	Ceramic tiles	20515	Floortiles		FLIS 10X10 SIRENE BLACK 1,44 KVM/P	
Home decoration	205	Ceramic tiles	20515	Floortiles		FLOORTL 10X10 SIRENE GREY 1,44 KVM/PKT	
Home decoration	205	Ceramic tiles	20515	Floortiles		FLOORTL 10X10 SIRENE MOCA 1,44 KVM/PKT	
Home decoration	205	Ceramic tiles	20515	Floortiles		FLOORTL 10X10 SIRENE L.GREY 1,44 KVM/PKT	
Home decoration	205	Ceramic tiles	20515	Floortiles		AVENUE BLACK 30X30 FLOOR TILE	
Home decoration	205	Ceramic tiles	20515	Floortiles		AVENUE WHITE 30X30 FLOOR TILE	
Home decoration	205	Ceramic tiles	20515	Floortiles		FLOOR TILE AVENUE 10X10 BLACK	
Home decoration	205	Ceramic tiles	20515	Floortiles		VANITY 10X10 WALL TILE BLACK	
Home decoration	205	Ceramic tiles	20515	Floortiles		FLOOR TILE FIESTA 9,7X9,7 MOCA	
Home decoration	205	Ceramic tiles	20515	Floortiles		FLOOR TILE FIESTA 9,7X9,7 WHITE	
Home decoration	205	Ceramic tiles	20515	Floortiles		FLOOR TILE FIESTA 9,7X9,7 ANTRACITE	

2. Classify all products to the desired ECOICOP-categories (below annual data classified to ECOICOP)

Level2 name	Level3 name	Level4 name	Product name	coicop5	coicop5 label	coicop6	coicop6 label
Home decoration	Ceramic tiles	Floortiles	CMA FLOOR TILES	04.3.1.0	Materials for the maintenance a	04.3.1.0.3	Surfacing materials for floor
Home decoration	Ceramic tiles	Floortiles	FLOORTL SALLA 10X10 BLACK 1,44M2	04.3.1.0	Materials for the maintenance a	04.3.1.0.3	Surfacing materials for floor
Home decoration	Ceramic tiles	Wall tiles	CMA WALL TILES	04.3.1.0	Materials for the maintenance a	04.3.1.0.2	Wallpaper and interior wall coverings
Home decoration	Ceramic tiles	Wall tiles	CMA TILES OTHERS	04.3.1.0	Materials for the maintenance a	04.3.1.0.2	Wallpaper and interior wall coverings
Home decoration	Ceramic tiles	Wall tiles	WALLT KIDE 25X40 WHITE GLOSSY	04.3.1.0	Materials for the maintenance a	04.3.1.0.2	Wallpaper and interior wall coverings
Home decoration	Ceramic tiles	Wall tiles	WALLTILE 20X40 WHITE GLOSSY	04.3.1.0	Materials for the maintenance a	04.3.1.0.2	Wallpaper and interior wall coverings
Home decoration	Ceramic tiles	Wall tiles	WALL TILE RHEIN 25X40 WHITE MATT 1M2	04.3.1.0	Materials for the maintenance a	04.3.1.0.2	Wallpaper and interior wall coverings
Home decoration	Ceramic tiles	Wall tiles	WALLT KIDE 25X40 WHITE MAT	04.3.1.0	Materials for the maintenance a	04.3.1.0.2	Wallpaper and interior wall coverings
Home decoration	Ceramic tiles	Wall tiles	WALLTILE CORFU 25x40 WHITE MATT 1m2	04.3.1.0	Materials for the maintenance a	04.3.1.0.2	Wallpaper and interior wall coverings
Home decoration	Ceramic tiles	Wall tiles	WALLTILE 20X40 WHITE MATT	04.3.1.0	Materials for the maintenance a	04.3.1.0.2	Wallpaper and interior wall coverings
Home decoration	Ceramic tiles	Wall tiles	WALLTL ICON 30X60 GLOSSY 1,44M2	04.3.1.0	Materials for the maintenance a	04.3.1.0.2	Wallpaper and interior wall coverings
Home decoration	Ceramic tiles	Wall tiles	WALLTILE CORFU 25x40 BLACK MATT 1m2	04.3.1.0	Materials for the maintenance a	04.3.1.0.2	Wallpaper and interior wall coverings
Home decoration	Ceramic tiles	Wall tiles	FLIS PRIMUS 001.2 10X20 WHITE FA	04.3.1.0	Materials for the maintenance a	04.3.1.0.2	Wallpaper and interior wall coverings
Home decoration	Ceramic tiles	Wall tiles	WALLTL DINAMO 25X40 GREY 1,6M2	04.3.1.0	Materials for the maintenance a	04.3.1.0.2	Wallpaper and interior wall coverings
Home decoration	Ceramic tiles	Wall tiles	WALL TILE MIST 25X38 WHITE 1,33M2	04.3.1.0	Materials for the maintenance a	04.3.1.0.2	Wallpaper and interior wall coverings
Home decoration	Ceramic tiles	Wall tiles	WALLTL YONNE 20X40 SNOW 1,2M2	04.3.1.0	Materials for the maintenance a	04.3.1.0.2	Wallpaper and interior wall coverings
Home decoration	Ceramic tiles	Wall tiles	WALLTL DINAMO 25X40 BROWN 1,6M2	04.3.1.0	Materials for the maintenance a	04.3.1.0.2	Wallpaper and interior wall coverings

3. Aggregate annual sales of products by ECOICOP categories to get total sales for 5-, 6- and 7-digit ECOICOP and derive value shares to identify the most representative sub-sub-classes.

coicop5	coicop6	Share of coicop5 value, -%
04.3.1.0	04.3.1.0.1	53 %
04.3.1.0	04.3.1.0.2	7 %
04.3.1.0	04.3.1.0.3	12 %
04.3.1.0	04.3.1.0.4	29 %
		100 %

4. Check ECOICOP-sub-sub-classes to identify most sold, representative products in each one of them.
   a. In this example we dig deeper to the sub-sub-class 04.3.1.0.3. What is the value share of products of the total annual sales of sub-class 04.3.1.0.3? Are there products that should be added to the HICP sample as currently sub-sub-class 04.3.1.0.3 contains Laminates only.
   b. We notice that the first products in the list are parquet, floor tiles, laminates, and hybrid floorcoverings (wood-based like laminate but also water-repellent) ([293]).

Level2 name	Level3 name	Level4 name	Product name	coicop5	coicop6	Share of value,-%
Home decoration	Floor coverings	Mosaic- and planic parquettes	CMA PARQUETTES OTHERS	04.3.1.0	04.3.1.0.3	17,4 %
Home decoration	Ceramic tiles	Floortiles	CMA FLOOR TILES	04.3.1.0	04.3.1.0.3	10,8 %
Home decoration	Floor coverings	Laminates	LAMIN GOODIY SOUTH HAMPTON OAK 8461 7MM	04.3.1.0	04.3.1.0.3	6,5 %
Home decoration	Floor coverings	Other wood base floorcoverings	HYBRID FLOOR KL338mm TAM STOCKHOLM 1536	04.3.1.0	04.3.1.0.3	7,8 %
Home decoration	Floor coverings	Laminates	CMA LAMINATES OTHERS	04.3.1.0	04.3.1.0.3	5,1 %
Home decoration	Floor coverings	Laminates	LAMIN GOODIY 7MM ROCK RIDGE 4009	04.3.1.0	04.3.1.0.3	8,0 %
Home decoration	Floor coverings	Mosaic- and planic parquettes	PARQUET OAK MATT LAC MOLTI 3S 5GC	04.3.1.0	04.3.1.0.3	5,8 %
Home decoration	Floor coverings	Laminates	LAMIN GOODIY 32 8MM OAK NAUVO H2709	04.3.1.0	04.3.1.0.3	7,1 %
Home decoration	Floor coverings	Other wood base floorcoverings	HYBRID FLOOR KL33 8mm TAMM STRATOS 1535	04.3.1.0	04.3.1.0.3	4,5 %
Home decoration	Floor coverings	Laminates	LAMIN GOODIY OAK 8MM 32 STUDIO ELEGANT	04.3.1.0	04.3.1.0.3	3,5 %
Home decoration	Floor coverings	Other wood base floorcoverings	HYBRID FLOOR KL33 8mm TAMMI MAYAN 1523	04.3.1.0	04.3.1.0.3	2,5 %
Home decoration	Floor coverings	Laminates	LAMINATE BASIC KL31 6MM H2341 EBL013	04.3.1.0	04.3.1.0.3	3,3 %
Home decoration	Floor coverings	Mosaic- and planic parquettes	PARQUET OAK WHITE MATT LAC MOLTI 3S 5GC	04.3.1.0	04.3.1.0.3	2,0 %
Home decoration	Floor coverings	Mosaic- and planic parquettes	PARQUET GOODIY ASH 3S 5GC	04.3.1.0	04.3.1.0.3	2,9 %
Home decoration	Floor coverings	Laminates	LAMIN GOODIY 7mm KL31 HANKO H2233	04.3.1.0	04.3.1.0.3	2,0 %
Home decoration	Floor coverings	Laminates	LAMIN GOODIY 32 8mm OAK KALLBÅDA H2063	04.3.1.0	04.3.1.0.3	2,2 %
Home decoration	Floor coverings	Mosaic- and planic parquettes	PARQUET PURE OAK NATURE DUOPLANK	04.3.1.0	04.3.1.0.3	2,7 %
Home decoration	Ceramic tiles	Floortiles	FLOORTL SALLA 10X10 BLACK 1,44M2	04.3.1.0	04.3.1.0.3	2,2 %
Home decoration	Floor coverings	Mosaic- and planic parquettes	PARQUET SHADE OAK CREAM WHITE DUOPLANK	04.3.1.0	04.3.1.0.3	2,2 %
Home decoration	Floor coverings	Mosaic- and planic parquettes	PARQUET CELLO OAK FROST MATT 3S	04.3.1.0	04.3.1.0.3	1,6 %
						100,0 %

5. Hybrid floor cover seems to be new product that needs to be investigated to see whether it should be included or not to the HICP sample.
   a. Browse the web to learn more about this type of products. Discuss with other experts.
   b. Decide whether to include or not to the HICP sample.
6. All other products in the list are used for the update of current HICP sample.
   a. Parquetted and floor tiles seem to be the high sellers and thus representative products that could be added to the HICP sample.

Same procedure (as given here in points 1 to 6) is used for other big datasets obtained from other companies.

([293]) Actual sales values are slightly altered due to disclosure control.

Annex 12.9.3: Quality adjusting electronic goods in Sweden

At Statistics Sweden there is a subgroup of the CPI team working specifically with quality adjustments in the monthly production for electronic goods.

The sample analysis

Today almost all price collection for electronic goods comes from scanner data and the work starts each month with the sample analysis, where products exiting the market are identified. A product is identified as exiting when there is no or little sales volume in the latest month. Once a product is identified as exiting, a replacement product is chosen based on similarity and sales volume. When it comes to similarity there are some guidelines to follow:

- The replacement product should be within the same subcategory.

Some examples could be an in-ear headphone which cannot be replaced by an over-ear headphone, an action camera cannot be replaced by a compact camera and a small size TV cannot be replaced by a big size TV. Product descriptions must be followed.

- If possible, the replacement product should be of the same brand.

For some products, such as mobile telephones, computers and computer accessories, brand strata are used, and replacements of brand are not allowed at all within that stratum.

- Similarity in key characteristics should be balanced with sale representativity

A computer with 16 GB RAM and 512 GB SSD memory size should preferably be replaced by another with equivalent characteristics and a 65’ OLED TV should preferably be replaced by a similar one. However, representativeness measured by the sales volume must also be considered when choosing replacements. An ideal replacement is a product with relatively similar characteristics and high sales compared to other available replacements.

Mapping of key characteristics

Once the sample analysis is done, quality adjustments are performed to ensure that the HICP only reflects pure price changes. This process entails several steps, beginning with the identification and comparison of essential attributes between the outgoing and incoming goods. The identification of these key characteristics is primarily achieved through a hedonic pricing model, supplemented by the documentation of carefully selected key characteristics in a references list. Once differences in key characteristics is mapped, analyst at Statistics Sweden use a toolbox of quality adjustment methods.

Direct comparison

If an analyst determines, based on a hedonic model or a reference list of key characteristics, that no distinctions exist between the products, the substitution will be documented as a direct comparison without any quality adjustments.

Explicit adjustments

When a difference in key characteristics is discovered, an explicit adjustment is primarily made if it's possible. There are several explicit adjustment methods to choose from and the most common are supported judgemental adjustment and hedonic regression. If there is a hedonic regression model available, it will be the first choice. Sometimes a hedonic model is not sufficient and new relevant characteristics which were not part of the regression analysis can be added to the valuation judgementally or with option pricing. Therefore, hedonic models are used as support, and they are not strictly used in every replacement situation. The hedonic models are often updated once a year.

The explicit adjustments are assessed as an estimated absolute value denominated in the local currency that differs from the substitution good and base product in December previous year. This estimated value is subsequently added to the base price recorded in December of the previous year. By consistently assessing the quality adjustment against the base product rather than the product of the preceding month, potential biases are mitigated over time. This approach eliminates the risk of index drift when multiple quality adjustments are applied to the same product offer within a calendar year.

Supported judgemental adjustment or option pricing are also commonly used without the support of hedonic models.

Implicit adjustments

If it is not possible to make a realistic estimate of the quality difference, an implicit valuation method will be used. Methods such as simple overlap or link-to-show-no-price-change will only be used if a replacement must take place and the similarity between products is assessed as low with few replacement alternatives to choose from.

The quality adjustment meeting

During a meeting which is held three times per month each member of the quality adjustment subgroup makes a brief presentation of the quality adjustments that were prepared before the meeting. The meetings focus is on the quality adjustments that proved to be difficult to assess. Uncertainties are discussed and the group members decide how the difficulties should be handled.

During the meeting everything is documented and new valuations for certain characteristics enters a compilation for the specific product group. By documenting and working systematically regarding how specific characteristics should be valued; time efficiency in the long run is gained, person dependency is avoided, and consistency is upheld.

Ongoing development activity

The subgroup for quality adjustments always strives for improvements and resource efficiency in the working process. An ongoing development activity is looking into how the sample analysis can have a better macro perspective and become more proactive. The project also aims at developing automated calculations for quality adjustments based on hedonic models.

Annex 12.9.4: Quality adjusting electronic goods in France (294)

Hedonic Model: principle

When an item is missing and must be replaced, the difference in quality between the disappearing product and the new one must be considered in the HICP so that comparable prices can be measured. Hedonic regressions can be used to estimate this difference, using product characteristics as explanatory variables with the prices as the dependent variable. However, the quality of the models can be insufficient due to the small size of the samples. Web scraping can be used to gather larger volumes of information on prices and characteristics; electronic goods are popular in this area. Hedonic models can be estimated with traditional hedonic regressions or other predictive methods, including machine learning algorithms. This is what Insee is currently doing in production for two electronic goods: laptops and smartphones.

Collecting Data: two sources

France uses data from two sources: data from price collectors as well as data collected on two French e-commerce websites (rueducommerce.com and boulanger.com). Web scraping programs have been developed using Python, there were at first launched manually and now automatically. Price, name, brand, technical characteristics of the product have been collected for laptops first and then for smartphones as well. The website can change over time, which can prevent the initially written program to run and this needs to be corrected.

Maintenance is thus very important with on-going production. For hedonic modelling purposes, this matter is less difficult to overcome, as the robot must be executed only when the coefficients need to be re-estimated (i.e., at each base month (December) for hedonic repricing). Even though web scraping generates better quality results than manual collection due to its systematic aspect and the volume of data which is generated, it also has drawbacks:

- some of the variables are unfilled for an important share of the observations.
- variables may sometimes carry a different name but correspond to the same characteristics.
- modalities can be different for identical or similar products.

Hence, much cleaning and variable selection work has been done for laptops, the cleaning aspect of the code is in Python, but R has been used for smartphones. Infrequent brands and seldom-used colour terms have been grouped to limit sparse modalities. Missing values have been imputed with the most frequent value (qualitative variable) or the mean value (continuous variable) of filled observations. Removing all observations with missing values would have led to the deletion of too many observations (only observations with more than 50% of the missing variables were deleted).

(294) Reference: J.D.Zafar, S. Himpens, *Webscraping laptop prices to estimate hedonic models and extensions to other predictive methods*, 2019.

The data we get from the e-commerce websites are quite exhaustive to describe the products. Many of these characteristics can contain redundant information, for example, the length and width of the laptop and the size of the screen, or the base and turbo frequency, etc. Moreover, there are far too many variables: we do not want to overfit our model; many of the variables may have small importance; in practice, if the manual collection is done monthly, we do not want the collection to cause too much work for the price collectors. A model with all these variables would not be possible in practice. Hence, it is important to select a subset of our set of variables.

Variable Selection

To select a subset of our set of variables we have mainly used two types of methods:

- methods based on trees (the observations are divided into homogeneous price groups according to the values of their characteristics and the predicted value is the average of the prices in each group.
- the variable selection method consists in cutting the tree at a given level and retrieving all the variables (or nodes) that make it up).
- shrinkage methods (Ridge or LASSO penalized regressions make the coefficients of the least predictive variables decrease; it is then sufficient to observe the parameter values to identify the most relevant features of the scraped database).

These algorithms were also used for making predictions, as the goal of hedonic models is to reprice the product chosen at the base month with the technical features of the new product. When estimating the models on a training sample of 80 % of the scraped data and predicting the prices of the remaining 20 %, the results fall between 78% and 85% of accuracy with linear models, and between 83% and 87% for random forests, showing that machine learning prediction methods can be a promising way to reprice substitute products. However, the difference is not very large, and linear models could be used without significant loss of precision. Moreover, the errors can be caused by the high variability of pricing practices by the seller, even for fixed technical characteristics.

Once a year, if possible, the variable selection exercise is redone to ensure that they are still pertinent for the model. This process uses data for the whole year, not only those from the base month. If a new variable needs to be added to the model, the collection form used by price collectors is modified accordingly and will be used next year to have complete data from both sources.

Annex 12.9.5: Flight tickets: The case of Norway

In 2021 Statistics Norway implemented a new data source and data collection method for flight tickets in the Norwegian HICP/CPI. Previously, the data collection was conducted by web scraping different online webpages combined with API solutions offered by the carriers. This approach to data collection was very time-consuming, and the web scrapers often meant that much technical maintenance work was needed.

The purpose of an API is to provide structured and controlled access to specific data or services. API stands for 'Application Programming Interface' and is a set of procedures and communication protocols that provide access to data of an application, operating system, or other services. Extracting API data instead of web scraping or manually collecting data online, often means greater stability and less maintenance work. While web pages suddenly may change their layout requiring adjustments in the code for the web scraper to still function, changes in the API structure occur more seldom and are likely to be announced in advance. Extracting data from an API can be an effective way to obtain a large volume of data with less time spent on data collection.

Some APIs are freely accessible and are available to everyone, but in many cases, access will require formal contracts with data owners and a pay-per-use approach, the latter being the Norwegian case. Statistics Norway downloads weekly data according to a predefined time schedule from an available API of the global booking system Amadeus. The number of records collected is chosen so that it respects the free-quota which is important given that Statistics Norway, as a rule, does not pay for access data. As API data in many cases is not provided for free, it is advisable to customize the requests for defined searches or flight routes to target a cost-effective and manageable data set.

Pre-defined searches or trip specifications, mainly based on information from the airline industry, are used to set the parameters for representative flights specified in the requests sent to the API. Return information consists of prices and additional information related to the tickets, such as flight number, company, airport, departure and arrival times, booking category, ticket types, luggage, time of data collection and more. All requests specify fares for roundtrips, and only economy tickets and direct flights are used. All trips are limited to weekends.

The API provides information for the cheapest available tickets at real-time prices for different destinations at different point in time. Some APIs have so-called 'cached' data which are not actual updated data. Initial test calculations showed the importance of obtaining access to live data. We assume that the collected prices are a good approximation of what is sold to customers. For this assumption, it is not only important to have frequent downloads, but also to start collecting data at the right time in advance. What is measured are available tickets, if the tickets are sold, they are sold at the measured price.

Leveraging available air travel booking APIs has the advantage that NSOs do not have to set up airline-specific extractions; one only needs to deal with one single data provider. At the same time, it is important to be aware of the weight that we put on one single data provider and the potential risk involved.

In the start-up phase, it is advisable to check prices collected from the API against prices on the airline companies' own web pages to explore any discrepancies.

Measuring airfares presents a challenge as they are subject to a dynamic pricing structure, dependent on availability and how far in advance tickets are booked. Furthermore, flights shall be included in the HICP in the period when consumed, not purchased. As airline tickets often exhibit strong price fluctuations, it is important to differentiate between the time of booking and the time of travelling. Defining a schedule for the price collection of flights rests on a series of assumptions that are likely to vary according to each country's specific situation. The prices should be recorded sufficiently in advance of departure to ensure they are representative of consumers' expenditure and behaviour. If available, information from the airline industry may be very useful when setting up such a schedule.

During the pandemic, the behaviour pattern changed, and consumers purchased their tickets closer to departure. After the pandemic, Statistics Norway changed the collection strategy back to a more normalised purchasing pattern and currently chooses to use prices collected up to 3 months ahead of departure for both domestic and international destinations. As there is limited information on how the purchasing pattern is spread out across the 3 months, it is assumed to be evenly distributed.

Data collection in the Norwegian case involves using the Python programming language and software packages that can be downloaded and imported. Once the data is downloaded, further processing is done with the SAS software package. The collected API data is monitored and checked for abnormalities and outliers in the same way as other data collected for the HICP.

Flights are initially stratified into different time intervals, such as morning and evening flights, with unweighted average prices calculated. We assume that the consumers are indifferent across companies for identical destinations; it is assumed that consumers are carrier indifferent and will always purchase the cheapest available ticket all else being equal. These assumptions might not work for all cases and for other countries. They may also for instance perform better for the domestic flight market than for international flights. Either way, such assumptions should be country specific.

Tickets are grouped into different destinations by aggregating across time of booking and time of travelling. Average prices of the current period are compared to prices in a fixed price reference period and weighted based on information from official authorities.

Finally, the indices for domestic and international flights are weighted into an index for passenger transport by air. Given the limited number of airline companies, especially for the domestic market, the index is only published in the aggregate for reasons of confidentiality.

Annex 12.9.6: Mobile telecommunications: the use of migration rates, an illustrative example

In the following simplified example, the use of migration rates within a consumer profiles approach to measuring mobile phone call plans is illustrated.

In this example there are two providers I-Tel and Global. For both providers, binding contracts exist, and customers are not allowed to switch their tariff (call plan) during their contract.

In Table 12.9.52, service provider weights are estimated from each provider's customer base. Ideally, however, weights based on revenues should be used if available; otherwise, as in this example, the number of subscribers can be used as a proxy.

In Table 12.9.53, three consumer profiles are presented: low, medium, and high usage. This information should normally be based on typical patterns of consumption estimated from data supplied from either the service providers or from the regulator. For this example, the profiles consist of three elements that are included in each of the plans: the inclusive number of minutes, SMS/text messages, and mobile data (internet) allowance.

In Table 12.9.54, the packages selected in the price reference month (December) of the index are shown. The plans selected from each provider are the cheapest tariffs that meet the minimum requirements of each consumer profile (even if the number of included minutes changes) while not exceeding the requirements of a higher usage profile. For example, Red 1 and Talk 100 are to be included in the sample since their included minutes is above the 60-minute minimum threshold of the pre-defined low-usage profile, but below the 150-minute threshold of the medium usage profile. In April, both service providers replace some of the existing tariffs with new tariffs, which are only available to new customers. In this example, for I-Tel, the Red 2 tariff replaces the Red 3 tariff. While there is a change in both the SMS allowance and inclusive call minutes, the replacement tariff still meets the minimum requirements of the specified consumer profile for the current year. Likewise for Global, the Talk 100 tariff is replaced by the Talk 60 tariff, which again is the cheapest tariff that meets the minimum requirements of the profile.

In Table 12.9.55 the profile weights for each provider are given. These should ideally be based on their relevant revenue shares, as estimated from data supplied from service providers.

Table 12.9.56 shows the prices charged in each month and for each tariff before migration rates are applied.

Table 12.9.57 estimates the migration rates between the replaced and replacement tariffs. In this example, a rational consumer approach is adopted where over a 12-month contract, one twelfth of existing consumers on the old tariff (call plan) switches to the new tariff. The calculation works as follows: for both the replaced and replacement tariffs, the cost of one twelfth of the monthly cost is estimated. In the first month that the replacement tariff is priced, the price that enters the index is comprised of 11 twelfths of the replaced package and one twelfth of the replacement tariff. After that, in the following months, the proportion of the new tariff in the combined price increases by a twelfth until after 12 months the price used in the index is the total price of the replacement tariff.

In Table 12.9.58 the elementary aggregate price indices are calculated for each service plan. Table 12.9.59 weights the elementary aggregate indices together to produce price indices for each provider. Finally, in Table 12.9.60, the price indices for each provider are weighted together to produce an overall mobile telecoms index.

Table 12.9.52

Provider weights

Providers	Number of customers (thousands)	Market share (per cent)
I-Tel	1 275	58
Global	920	42
Total	*2 195*	*100*

Table 12.9.53

Typical consumer profiles

Based on the typical usage of consumers			
	Low	**Medium**	**High**
Minutes	60	150	500
Texts/SMS	100	500	Unlimited
Data	50 Mb	500 Mb	2 Gb

Table 12.9.54

Selection of packages to be priced

I-Tel	*Low*	*Medium*	*High*	Global	*Low*	*Medium*	*High*
December	Red 1	Red 3	Red 5	December	Talk 100	Talk 180	Talk 600
Minutes	75	250	1 000	Minutes	100	180	600
Texts/SMS	150	Unlimited	Unlimited	Texts/SMS	250	500	Unlimited
Data	50 Mb	500 Mb	2 Gb	Data	50	500 Mb	3 Gb
April	Red 1	Red 2	Red 5	April	Talk 60	Talk 180	Talk 600
Minutes	75	200	1 000	Minutes	60	180	600
Texts/SMS	150	500	Unlimited	Texts/SMS	200	500	Unlimited
Data	50 Mb	500 Mb	2 Gb	Data	50	500 Mb	3 Gb

If a handset is typically included in the package, this must be specified and held constant. Packages to be selected — the cheapest package from each provider that meets the minimum usage profile. Replacement packages must be from the same provider.

Table 12.9.55

Profile (usage) weights

I-Tel	*Low*	*Medium*	*High*		Global	*Low*	*Medium*	*High*
	25	*40*	*35*			*30*	*50*	*20*

Table 12.9.56

Pricing of packages

I-Tel	*Low*	*Medium*	*High*		Global	*Low*	*Medium*	*High*
Price (Euro)	**Red 1**	**Red 3**	**Red 5**		***Price (Euro)***	**Talk 100**	**Talk 180**	**Talk 600**
Dec	20	35	60		Dec	18	30	55
Jan	20	35	60		Jan	18	30	55
Feb	22	35	65		Feb	18	30	55
Mar	22	35	65		Mar	20	32	60
		Red 2				**Talk 60**		
Apr	22	34.83	65		Apr	19.58	32	60

Table 12.9.57

Use of migration rates (if available)

I-Tel Red 3	Price	One-Twelfth	Proportion switching (Twelfths)	Estimated combined price	Global Talk 100	Price	One-Twelfth	Proportion switching (Twelfths)	Estimated combined price
Mar	**35**	***2.92***			**Mar**	**20**	***1.67***		
Red 2					**Talk 60**				
Apr	**33**	***2.75***	1	34.83	**Apr**	**15**	**1.25**	1	19.58
May			2	34.67	**May**	15		2	19.17
Jun			3	34.50	**Jun**	15		3	18.75
July			4	34.33	**July**	15		4	18.33
Aug			5	34.17	**Aug**	15		5	17.92
Sept			6	34.00	**Sept**	15		6	17.50
Oct			7	33.83	**Oct**	15		7	17.08
Nov			8	33.67	**Nov**	15		8	16.67
Dec			9	33.50	**Dec**	15		9	16.25
Jan			10	33.33	**Jan**	15		10	15.83
Feb			11	33.17	**Feb**	15		11	15.42
Mar			12	**33.00**	**Mar**	**15**		12	15.00

Ideally should be based on migration rate information supplied by telecoms companies. The assumption: one-twelfth switch each month.

Table 12.9.58

Index calculation, profile indices

	Red 1	Red 3	Red 5		Talk 100	Talk 180	Talk 600
Dec	100.0	100.0	100.0	**Dec**	100.0	100.0	100.0
Jan	100.0	100.0	100.0	Jan	100.0	100.0	100.0
Feb	110.0	100.0	108.3	Feb	100.0	100.0	100.0
Mar	110.0	100.0	108.3	Mar	111.1	106.7	109.1
		Red 2			Talk 60		
Apr	110.0	99.5	108.3	Apr	108.8	106.7	109.1
Profile weights	*25*	*40*	*35*		*30*	*50*	*20*

Table 12.9.59

Index calculation, provider indices

I-Tel		Global	
Dec	100.0	**Dec**	100.0
Jan	100.0	**Jan**	100.0
Feb	105.4	**Feb**	100.0
Mar	105.4	**Mar**	108.5
Apr	105.2	**Apr**	107.8
Provider weights	*58*		*42*

Table 12.9.60

Overall mobile telecoms index

Dec	100.0
Jan	100.0
Feb	103.1
Mar	106.7
Apr	106.3

Annex I

European classification of individual consumption according to purpose – ECOICOP

Annex I: European classification of individual consumption according to purpose – ECOICOP

01	FOOD AND NON-ALCOHOLIC BEVERAGES
01.1	Food
01.1.1	Bread and cereals
01.1.1.1	Rice
01.1.1.2	Flours and other cereals
01.1.1.3	Bread
01.1.1.4	Other bakery products
01.1.1.5	Pizza and quiche
01.1.1.6	Pasta products and couscous
01.1.1.7	Breakfast cereals
01.1.1.8	Other cereal products
01.1.2	Meat
01.1.2.1	Beef and veal
01.1.2.2	Pork
01.1.2.3	Lamb and goat
01.1.2.4	Poultry
01.1.2.5	Other meats

01.1.2.6	Edible offal
01.1.2.7	Dried, salted or smoked meat
01.1.2.8	Other meat preparations
01.1.3	Fish and seafood
01.1.3.1	Fresh or chilled fish
01.1.3.2	Frozen fish
01.1.3.3	Fresh or chilled seafood
01.1.3.4	Frozen seafood
01.1.3.5	Dried, smoked or salted fish and seafood
01.1.3.6	Other preserved or processed fish and seafood-based preparations
01.1.4	Milk, cheese and eggs
01.1.4.1	Fresh whole milk
01.1.4.2	Fresh low fat milk
01.1.4.3	Preserved milk
01.1.4.4	Yoghurt
01.1.4.5	Cheese and curd
01.1.4.6	Other milk products
01.1.4.7	Eggs
01.1.5	Oils and fats
01.1.5.1	Butter
01.1.5.2	Margarine and other vegetable fats
01.1.5.3	Olive oil
01.1.5.4	Other edible oils
01.1.5.5	Other edible animal fats
01.1.6	Fruit
01.1.6.1	Fresh or chilled fruit
01.1.6.2	Frozen fruit
01.1.6.3	Dried fruit and nuts
01.1.6.4	Preserved fruit and fruit-based products
01.1.7	Vegetables
01.1.7.1	Fresh or chilled vegetables other than potatoes and other tubers

01.1.7.2	Frozen vegetables other than potatoes and other tubers
01.1.7.3	Dried vegetables, other preserved or processed vegetables
01.1.7.4	Potatoes
01.1.7.5	Crisps
01.1.7.6	Other tubers and products of tuber vegetables
01.1.8	Sugar, jam, honey, chocolate and confectionery
01.1.8.1	Sugar
01.1.8.2	Jams, marmalades and honey
01.1.8.3	Chocolate
01.1.8.4	Confectionery products
01.1.8.5	Edible ices and ice cream
01.1.8.6	Artificial sugar substitutes
01.1.9	Food products n.e.c.
01.1.9.1	Sauces, condiments
01.1.9.2	Salt, spices and culinary herbs
01.1.9.3	Baby food
01.1.9.4	Ready-made meals
01.1.9.9	Other food products n.e.c.
01.2	Non-alcoholic beverages
01.2.1	Coffee, tea and cocoa
01.2.1.1	Coffee
01.2.1.2	Tea
01.2.1.3	Cocoa and powdered chocolate
01.2.2	Mineral waters, soft drinks, fruit and vegetable juices
01.2.2.1	Mineral or spring waters
01.2.2.2	Soft drinks
01.2.2.3	Fruit and vegetable juices

02	**ALCOHOLIC BEVERAGES, TOBACCO AND NARCOTICS**
02.1	Alcoholic beverages
02.1.1	Spirits
02.1.1.1	Spirits and liqueurs
02.1.1.2	Alcoholic soft drinks
02.1.2	Wine
02.1.2.1	Wine from grapes
02.1.2.2	Wine from other fruits
02.1.2.3	Fortified wines
02.1.2.4	Wine-based drinks
02.1.3	Beer
02.1.3.1	Lager beer
02.1.3.2	Other alcoholic beer
02.1.3.3	Low and non-alcoholic beer
02.1.3.4	Beer-based drinks
02.2	Tobacco
02.2.0	Tobacco
02.2.0.1	Cigarettes
02.2.0.2	Cigars
02.2.0.3	Other tobacco products
02.3	Narcotics
02.3.0	Narcotics
02.3.0.0	Narcotics
03	**CLOTHING AND FOOTWEAR**
03.1	Clothing
03.1.1	Clothing materials
03.1.1.0	Clothing materials
03.1.2	Garments
03.1.2.1	Garments for men
03.1.2.2	Garments for women

03.1.2.3	Garments for infants (0 to 2 years) and children (3 to 13 years)
03.1.3	Other articles of clothing and clothing accessories
03.1.3.1	Other articles of clothing
03.1.3.2	Clothing accessories
03.1.4	Cleaning, repair and hire of clothing
03.1.4.1	Cleaning of clothing
03.1.4.2	Repair and hire of clothing
03.2	Footwear
03.2.1	Shoes and other footwear
03.2.1.1	Footwear for men
03.2.1.2	Footwear for women
03.2.1.3	Footwear for infants and children
03.2.2	Repair and hire of footwear
03.2.2.0	Repair and hire of footwear
04	**HOUSING, WATER, ELECTRICITY, GAS AND OTHER FUELS**
04.1	Actual rentals for housing
04.1.1	Actual rentals paid by tenants
04.1.1.0	Actual rentals paid by tenants
04.1.2	Other actual rentals
04.1.2.1	Actual rentals paid by tenants for secondary residences
04.1.2.2	Garage rentals and other rentals paid by tenants
04.2	Imputed rentals for housing
04.2.1	Imputed rentals of owner-occupiers
04.2.1.0	Imputed rentals of owner-occupiers
04.2.2	Other imputed rentals
04.2.2.0	Other imputed rentals
04.3	Maintenance and repair of the dwelling
04.3.1	Materials for the maintenance and repair of the dwelling
04.3.1.0	Materials for the maintenance and repair of the dwelling
04.3.2	Services for the maintenance and repair of the dwelling
04.3.2.1	Services of plumbers

04.3.2.2	Services of electricians
04.3.2.3	Maintenance services for heating systems
04.3.2.4	Services of painters
04.3.2.5	Services of carpenters
04.3.2.9	Other services for maintenance and repair of the dwelling
04.4	Water supply and miscellaneous services relating to the dwelling
04.4.1	Water supply
04.4.1.0	Water supply
04.4.2	Refuse collection
04.4.2.0	Refuse collection
04.4.3	Sewage collection
04.4.3.0	Sewage collection
04.4.4	Other services relating to the dwelling n.e.c.
04.4.4.1	Maintenance charges in multi-occupied buildings
04.4.4.2	Security services
04.4.4.9	Other services related to dwelling
04.5	Electricity, gas and other fuels
04.5.1	Electricity
04.5.1.0	Electricity
04.5.2	Gas
04.5.2.1	Natural gas and town gas
04.5.2.2	Liquefied hydrocarbons (butane, propane, etc.)
04.5.3	Liquid fuels
04.5.3.0	Liquid fuels
04.5.4	Solid fuels
04.5.4.1	Coal
04.5.4.9	Other solid fuels
04.5.5	Heat energy
04.5.5.0	Heat energy

05	FURNISHINGS, HOUSEHOLD EQUIPMENT AND ROUTINE HOUSEHOLD MAINTENANCE
05.1	Furniture and furnishings, carpets and other floor coverings
05.1.1	Furniture and furnishings
05.1.1.1	Household furniture
05.1.1.2	Garden furniture
05.1.1.3	Lighting equipment
05.1.1.9	Other furniture and furnishings
05.1.2	Carpets and other floor coverings
05.1.2.1	Carpets and rugs
05.1.2.2	Other floor coverings
05.1.2.3	Services of laying of fitted carpets and floor coverings
05.1.3	Repair of furniture, furnishings and floor coverings
05.1.3.0	Repair of furniture, furnishings and floor coverings
05.2	Household textiles
05.2.0	Household textiles
05.2.0.1	Furnishing fabrics and curtains
05.2.0.2	Bed linen
05.2.0.3	Table linen and bathroom linen
05.2.0.4	Repair of household textiles
05.2.0.9	Other household textiles
05.3	Household appliances
05.3.1	Major household appliances whether electric or not
05.3.1.1	Refrigerators, freezers and fridge-freezers
05.3.1.2	Clothes washing machines, clothes drying machines and dish washing machines
05.3.1.3	Cookers
05.3.1.4	Heaters, air conditioners
05.3.1.5	Cleaning equipment
05.3.1.9	Other major household appliances
05.3.2	Small electric household appliances
05.3.2.1	Food processing appliances

05.3.2.2	Coffee machines, tea makers and similar appliances
05.3.2.3	Irons
05.3.2.4	Toasters and grills
05.3.2.9	Other small electric household appliances
05.3.3	Repair of household appliances
05.3.3.0	Repair of household appliances
05.4	Glassware, tableware and household utensils
05.4.0	Glassware, tableware and household utensils
05.4.0.1	Glassware, crystal-ware, ceramic ware and chinaware
05.4.0.2	Cutlery, flatware and silverware
05.4.0.3	Non-electric kitchen utensils and articles
05.4.0.4	Repair of glassware, tableware and household utensils
05.5	Tools and equipment for house and garden
05.5.1	Major tools and equipment
05.5.1.1	Motorised major tools and equipment
05.5.1.2	Repair, leasing and rental of major tools and equipment
05.5.2	Small tools and miscellaneous accessories
05.5.2.1	Non-motorised small tools
05.5.2.2	Miscellaneous small tool accessories
05.5.2.3	Repair of non-motorised small tools and miscellaneous accessories
05.6	Goods and services for routine household maintenance
05.6.1	Non-durable household goods
05.6.1.1	Cleaning and maintenance products
05.6.1.2	Other non-durable small household articles
05.6.2	Domestic services and household services
05.6.2.1	Domestic services by paid staff
05.6.2.2	Cleaning services
05.6.2.3	Hire of furniture and furnishings
05.6.2.9	Other domestic services and household services

06	HEALTH
06.1	Medical products, appliances and equipment
06.1.1	Pharmaceutical products
06.1.1.0	Pharmaceutical products
06.1.2	Other medical products
06.1.2.1	Pregnancy tests and mechanical contraceptive devices
06.1.2.9	Other medical products n.e.c.
06.1.3	Therapeutic appliances and equipment
06.1.3.1	Corrective eye-glasses and contact lenses
06.1.3.2	Hearing aids
06.1.3.3	Repair of therapeutic appliances and equipment
06.1.3.9	Other therapeutic appliances and equipment
06.2	Out-patient services
06.2.1	Medical services
06.2.1.1	General practice
06.2.1.2	Specialist practice
06.2.2	Dental services
06.2.2.0	Dental services
06.2.3	Paramedical services
06.2.3.1	Services of medical analysis laboratories and X-ray centres
06.2.3.2	Thermal-baths, corrective-gymnastic therapy, ambulance services and hire of therapeutic equipment
06.2.3.9	Other paramedical services
06.3	Hospital services
06.3.0	Hospital services
06.3.0.0	Hospital services
07	**TRANSPORT**
07.1	Purchase of vehicles
07.1.1	Motor cars
07.1.1.1	New motor cars

07.1.1.2	Second-hand motor cars
07.1.2	Motor cycles
07.1.2.0	Motor cycles
07.1.3	Bicycles
07.1.3.0	Bicycles
07.1.4	Animal drawn vehicles
07.1.4.0	Animal drawn vehicles
07.2	Operation of personal transport equipment
07.2.1	Spare parts and accessories for personal transport equipment
07.2.1.1	Tyres
07.2.1.2	Spare parts for personal transport equipment
07.2.1.3	Accessories for personal transport equipment
07.2.2	Fuels and lubricants for personal transport equipment
07.2.2.1	Diesel
07.2.2.2	Petrol
07.2.2.3	Other fuels for personal transport equipment
07.2.2.4	Lubricants
07.2.3	Maintenance and repair of personal transport equipment
07.2.3.0	Maintenance and repair of personal transport equipment
07.2.4	Other services in respect of personal transport equipment
07.2.4.1	Hire of garages, parking spaces and personal transport equipment
07.2.4.2	Toll facilities and parking meters
07.2.4.3	Driving lessons, tests, licences and road worthiness tests
07.3	Transport services
07.3.1	Passenger transport by railway
07.3.1.1	Passenger transport by train
07.3.1.2	Passenger transport by underground and tram
07.3.2	Passenger transport by road
07.3.2.1	Passenger transport by bus and coach
07.3.2.2	Passenger transport by taxi and hired car with driver
07.3.3	Passenger transport by air

07.3.3.1	Domestic flights
07.3.3.2	International flights
07.3.4	Passenger transport by sea and inland waterway
07.3.4.1	Passenger transport by sea
07.3.4.2	Passenger transport by inland waterway
07.3.5	Combined passenger transport
07.3.5.0	Combined passenger transport
07.3.6	Other purchased transport services
07.3.6.1	Funicular, cable-car and chair-lift transport
07.3.6.2	Removal and storage services
07.3.6.9	Other purchased transport services n.e.c.
08	**COMMUNICATION**
08.1	Postal services
08.1.0	Postal services
08.1.0.1	Letter handling services
08.1.0.9	Other postal services
08.2	Telephone and telefax equipment
08.2.0	Telephone and telefax equipment
08.2.0.1	Fixed telephone equipment
08.2.0.2	Mobile telephone equipment
08.2.0.3	Other equipment of telephone and telefax equipment
08.2.0.4	Repair of telephone or telefax equipment
08.3	Telephone and telefax services
08.3.0	Telephone and telefax services
08.3.0.1	Wired telephone services
08.3.0.2	Wireless telephone services
08.3.0.3	Internet access provision services
08.3.0.4	Bundled telecommunication services
08.3.0.5	Other information transmission services

09	RECREATION AND CULTURE
09.1	Audiovisual, photographic and information processing equipment
09.1.1	Equipment for the reception, recording and reproduction of sound and picture
09.1.1.1	Equipment for the reception, recording and reproduction of sound
09.1.1.2	Equipment for the reception, recording and reproduction of sound and vision
09.1.1.3	Portable sound and vision devices
09.1.1.9	Other equipment for the reception, recording and reproduction of sound and picture
09.1.2	Photographic and cinematographic equipment and optical instruments
09.1.2.1	Cameras
09.1.2.2	Accessories for photographic and cinematographic equipment
09.1.2.3	Optical instruments
09.1.3	Information processing equipment
09.1.3.1	Personal computers
09.1.3.2	Accessories for information processing equipment
09.1.3.3	Software
09.1.3.4	Calculators and other information processing equipment
09.1.4	Recording media
09.1.4.1	Pre-recorded recording media
09.1.4.2	Unrecorded recording media
09.1.4.9	Other recording media
09.1.5	Repair of audiovisual, photographic and information processing equipment
09.1.5.0	Repair of audiovisual, photographic and information processing equipment
09.2	Other major durables for recreation and culture
09.2.1	Major durables for outdoor recreation
09.2.1.1	Camper vans, caravans and trailers
09.2.1.2	Aeroplanes, microlight aircraft, gliders, hang-gliders and hot-air balloons
09.2.1.3	Boats, outboard motors and fitting out of boats
09.2.1.4	Horses, ponies and accessories
09.2.1.5	Major items for games and sport
09.2.2	Musical instruments and major durables for indoor recreation

09.2.2.1	Musical instruments
09.2.2.2	Major durables for indoor recreation
09.2.3	Maintenance and repair of other major durables for recreation and culture
09.2.3.0	Maintenance and repair of other major durables for recreation and culture
09.3	Other recreational items and equipment, gardens and pets
09.3.1	Games, toys and hobbies
09.3.1.1	Games and hobbies
09.3.1.2	Toys and celebration articles
09.3.2	Equipment for sport, camping and open-air recreation
09.3.2.1	Equipment for sport
09.3.2.2	Equipment for camping and open-air recreation
09.3.2.3	Repair of equipment for sport, camping and open-air recreation
09.3.3	Gardens, plants and flowers
09.3.3.1	Garden products
09.3.3.2	Plants and flowers
09.3.4	Pets and related products
09.3.4.1	Purchase of pets
09.3.4.2	Products for pets
09.3.5	Veterinary and other services for pets
09.3.5.0	Veterinary and other services for pets
09.4	Recreational and cultural services
09.4.1	Recreational and sporting services
09.4.1.1	Recreational and sporting services — Attendance
09.4.1.2	Recreational and sporting services — Participation
09.4.2	Cultural services
09.4.2.1	Cinemas, theatres, concerts
09.4.2.2	Museums, libraries, zoological gardens
09.4.2.3	Television and radio licence fees, subscriptions
09.4.2.4	Hire of equipment and accessories for culture
09.4.2.5	Photographic services
09.4.2.9	Other cultural services

09.4.3	Games of chance
09.4.3.0	Games of chance
09.5	Newspapers, books and stationery
09.5.1	Books
09.5.1.1	Fiction books
09.5.1.2	Educational text books
09.5.1.3	Other non-fiction books
09.5.1.4	Binding services and E-book downloads
09.5.2	Newspapers and periodicals
09.5.2.1	Newspapers
09.5.2.2	Magazines and periodicals
09.5.3	Miscellaneous printed matter
09.5.3.0	Miscellaneous printed matter
09.5.4	Stationery and drawing materials
09.5.4.1	Paper products
09.5.4.9	Other stationery and drawing materials
09.6	Package holidays
09.6.0	Package holidays
09.6.0.1	Package domestic holidays
09.6.0.2	Package international holidays
10	**EDUCATION**
10.1	Pre-primary and primary education
10.1.0	Pre-primary and primary education
10.1.0.1	Pre-primary education (ISCED-97 level 0)
10.1.0.2	Primary education (ISCED-97 level 1)
10.2	Secondary education
10.2.0	Secondary education
10.2.0.0	Secondary education
10.3	Post-secondary non-tertiary education
10.3.0	Post-secondary non-tertiary education
10.3.0.0	Post-secondary non-tertiary education (ISCED-97 level 4)

10.4	Tertiary education
10.4.0	Tertiary education
10.4.0.0	Tertiary education
10.5	Education not definable by level
10.5.0	Education not definable by level
10.5.0.0	Education not definable by level
11	**RESTAURANTS AND HOTELS**
11.1	Catering services
11.1.1	Restaurants, cafés and the like
11.1.1.1	Restaurants, cafés and dancing establishments
11.1.1.2	Fast food and take away food services
11.1.2	Canteens
11.1.2.0	Canteens
11.2	Accommodation services
11.2.0	Accommodation services
11.2.0.1	Hotels, motels, inns and similar accommodation services
11.2.0.2	Holiday centres, camping sites, youth hostels and similar accommodation services
11.2.0.3	Accommodation services of other establishments
12	**MISCELLANEOUS GOODS AND SERVICES**
12.1	Personal care
12.1.1	Hairdressing salons and personal grooming establishments
12.1.1.1	Hairdressing for men and children
12.1.1.2	Hairdressing for women
12.1.1.3	Personal grooming treatments
12.1.2	Electric appliances for personal care
12.1.2.1	Electric appliances for personal care
12.1.2.2	Repair of electric appliances for personal care
12.1.3	Other appliances, articles and products for personal care
12.1.3.1	Non-electrical appliances
12.1.3.2	Articles for personal hygiene and wellness, esoteric products and beauty products

12.2	Prostitution
12.2.0	Prostitution
12.2.0.0	Prostitution
12.3	Personal effects n.e.c.
12.3.1	Jewellery, clocks and watches
12.3.1.1	Jewellery
12.3.1.2	Clocks and watches
12.3.1.3	Repair of jewellery, clocks and watches
12.3.2	Other personal effects
12.3.2.1	Travel goods
12.3.2.2	Articles for babies
12.3.2.3	Repair of other personal effects
12.3.2.9	Other personal effects n.e.c.
12.4	Social protection
12.4.0	Social protection
12.4.0.1	Child care services
12.4.0.2	Retirement homes for elderly persons and residences for disabled persons
12.4.0.3	Services to maintain people in their private homes
12.4.0.4	Counselling
12.5	Insurance
12.5.1	Life insurance
12.5.1.0	Life insurance
12.5.2	Insurance connected with the dwelling
12.5.2.0	Insurance connected with the dwelling
12.5.3	Insurance connected with health
12.5.3.1	Public insurance connected with health
12.5.3.2	Private insurance connected with health
12.5.4	Insurance connected with transport
12.5.4.1	Motor vehicle insurance
12.5.4.2	Travel insurance
12.5.5	Other insurance

12.5.5.0	Other insurance
12.6	Financial services n.e.c.
12.6.1	FISIM
12.6.1.0	FISIM
12.6.2	Other financial services n.e.c.
12.6.2.1	Charges by banks and post offices
12.6.2.2	Fees and service charges of brokers, investment counsellors
12.7	Other services n.e.c.
12.7.0	Other services n.e.c.
12.7.0.1	Administrative fees
12.7.0.2	Legal services and accountancy
12.7.0.3	Funeral services
12.7.0.4	Other fees and services

Annex II
Classification of individual consumption according to purpose (COICOP) – 2018

Annex II: Classification of individual consumption according to purpose (COICOP) – 2018

ND: Non-durable good

SD: Semi-durable good

D: Durable good

S: Service

01	FOOD AND NON-ALCOHOLIC BEVERAGES
01.1	**Food**
01.1.1	Cereals and cereal products (ND)
01.1.1.1	Cereals (ND)
01.1.1.2	Flour of cereals (ND)
01.1.1.3	Bread and bakery products (ND)
01.1.1.4	Breakfast cereals (ND)
01.1.1.5	Macaroni, noodles, couscous and similar pasta products (ND)
01.1.1.9	Other milled cereal and grain products (ND)

01.1.2	Live animals, and meat and other parts of slaughtered land animals (ND)
01.1.2.1	Live land animals (ND)
01.1.2.2	Meat, fresh, chilled or frozen (ND)
01.1.2.3	Meat, dried, salted, in brine or smoked (ND)
01.1.2.4	Offal, blood and other parts of slaughtered animals, fresh, chilled or frozen, dried, salted, in brine or smoked (ND)
01.1.2.5	Preparations of meat, offal, blood and other parts of slaughtered animals (ND)
01.1.3	Fish and other seafood (ND)
01.1.3.1	Fish, live, fresh, chilled or frozen (ND)
01.1.3.2	Fish, dried, salted, in brine or smoked (ND)
01.1.3.3	Fish preparations (ND)
01.1.3.4	Other seafood, live, fresh, chilled or frozen (ND)
01.1.3.5	Other seafood, dried, salted, in brine or smoked (ND)
01.1.3.6	Other seafood preparations (ND)
01.1.3.7	Livers, roes and other offal of fish and of other seafood in all forms (ND)
01.1.4	Milk, other dairy products and eggs (ND)
01.1.4.1	Raw and whole milk (ND)
01.1.4.2	Skimmed milk (ND)
01.1.4.3	Other milk and cream (ND)
01.1.4.4	Non-animal milk (ND)
01.1.4.5	Cheese (ND)
01.1.4.6	Yoghurt and similar products (ND)
01.1.4.7	Milk-based dessert and beverages (ND)
01.1.4.8	Eggs (ND)

01.1.4.9	Other dairy products (ND)
01.1.5	Oils and fats (ND)
01.1.5.1	Vegetable oils (ND)
01.1.5.2	Butter and other oils and fats derived from milk (ND)
01.1.5.3	Margarine and similar preparations (ND)
01.1.5.9	Other animal oils and fats (ND)
01.1.6	Fruits and nuts (ND)
01.1.6.1	Dates, figs and tropical fruits, fresh (ND)
01.1.6.2	Citrus fruits, fresh (ND)
01.1.6.3	Stone fruits and pome fruits, fresh (ND)
01.1.6.4	Berries, fresh (ND)
01.1.6.5	Other fruits, fresh (ND)
01.1.6.6	Fruits, frozen (ND)
01.1.6.7	Fruits, dried and dehydrated (ND)
01.1.6.8	Nuts, in shell or shelled (ND)
01.1.6.9	Fruits and nuts, ground, and in other preparations (ND)
01.1.7	Vegetables, tubers, plantains, cooking bananas and pulses (ND)
01.1.7.1	Leafy or stem vegetables, fresh or chilled (ND)
01.1.7.2	Fruit-bearing vegetables, fresh or chilled (ND)
01.1.7.3	Green leguminous vegetables, fresh or chilled (ND)
01.1.7.4	Other vegetables, fresh or chilled (ND)
01.1.7.5	Tubers, plantains and cooking bananas (ND)
01.1.7.6	Pulses (ND)
01.1.7.7	Other vegetables, tubers, plantains and cooking bananas, dried and dehydrated

	(ND)
01.1.7.8	Vegetables, tubers, plantains and cooking bananas, frozen (ND)
01.1.7.9	Vegetables, tubers, plantains, cooking bananas and pulses, ground, and in other preparations (ND)
01.1.8	Sugar, confectionery and desserts (ND)
01.1.8.1	Cane sugar and beet sugar (ND)
01.1.8.2	Other sugars and sugar substitutes (ND)
01.1.8.3	Jams, marmalades, fruit jellies, purées and pastes, and honey (ND)
01.1.8.4	Nut purées, nut butters and nut pastes (ND)
01.1.8.5	Chocolate, cocoa and cocoa-based food products (ND)
01.1.8.6	Ice, ice cream and sorbets (ND)
01.1.8.9	Other sugar confectionery and desserts n.e.c. (ND)
01.1.9	Ready-made food and other food products (ND)
01.1.9.1	Ready-made food (ND)
01.1.9.2	Baby food (ND)
01.1.9.3	Salt, condiments and sauces (ND)
01.1.9.4	Spices, culinary herbs and seeds (ND)
01.1.9.9	Other food products n.e.c. (ND)
01.2	**Non-alcoholic beverages**
01.2.1	Fruit and vegetable juices (ND)
01.2.1.0	Fruit and vegetable juices (ND)
01.2.2	Coffee and coffee substitutes (ND)
01.2.2.0	Coffee and coffee substitutes (ND)
01.2.3	Tea, maté and other plant-derived products for infusion (ND)

01.2.3.0	Tea, maté and other plant-derived products for infusion (ND)
01.2.4	Cocoa drinks (ND)
01.2.4.0	Cocoa drinks (ND)
01.2.5	Water (ND)
01.2.5.0	Water (ND)
01.2.6	Soft drinks (ND)
01.2.6.0	Soft drinks (ND)
01.2.9	Other non-alcoholic beverages (ND)
01.2.9.0	Other non-alcoholic beverages (ND)
01.3	**Services for processing primary goods for food and non-alcoholic beverages**
01.3.0	Services for processing primary goods for food and non-alcoholic beverages (S)
01.3.0.0	Services for processing primary goods for food and non-alcoholic beverages (S)
02	**ALCOHOLIC BEVERAGES, TOBACCO AND NARCOTICS**
02.1	**Alcoholic beverages**
02.1.1	Spirits and liquors (ND)
02.1.1.0	Spirits and liquors (ND)
02.1.2	Wine (ND)
02.1.2.1	Wine from grapes (ND)
02.1.2.2	Wine from other sources (ND)
02.1.3	Beer (ND)
02.1.3.0	Beer (ND)
02.1.9	Other alcoholic beverages (ND)
02.1.9.0	Other alcoholic beverages (ND)

02.2	**Alcohol production services**
02.2.0	Alcohol production services (S)
02.2.0.0	Alcohol production services (S)
02.3	**Tobacco**
02.3.0	Tobacco (ND)
02.3.0.1	Cigarettes (ND)
02.3.0.2	Cigars (ND)
02.3.0.9	Other tobacco products (ND)
02.4	**Narcotics**
02.4.0	Narcotics (ND)
02.4.0.0	Narcotics (ND)
03	**CLOTHING AND FOOTWEAR**
03.1	**Clothing**
03.1.1	Clothing materials (SD)
03.1.1.0	Clothing materials (SD)
03.1.2	Garments (SD)
03.1.2.1	Garments for men or boys (SD)
03.1.2.2	Garments for women or girls (SD)
03.1.2.3	Garments for infants (under 2 years of age) (SD)
03.1.2.4	School uniforms (SD)
03.1.3	Other articles of clothing and clothing accessories (SD)
03.1.3.1	Other articles of clothing (SD)
03.1.3.2	Clothing accessories (SD)
03.1.4	Cleaning, repair, tailoring and hire of clothing (S)

03.1.4.1	Cleaning of clothing (S)
03.1.4.2	Repair, tailoring and hire of clothing (S)
03.2	**Footwear**
03.2.1	Shoes and other footwear (SD)
03.2.1.1	Footwear for men (SD)
03.2.1.2	Footwear for women (SD)
03.2.1.3	Footwear for infants and children (SD)
03.2.2	Cleaning, repair and hire of footwear (S)
03.2.2.0	Cleaning, repair and hire of footwear (S)
04	**HOUSING, WATER, ELECTRICITY, GAS AND OTHER FUELS**
04.1	**Actual rental payments made for housing**
04.1.1	Actual rental payments made by tenants for main residence (S)
04.1.1.0	Actual rental payments made by tenants for main residence (S)
04.1.2	Other actual rental payments (S)
04.1.2.1	Actual rental payments made by tenants for secondary residences (S)
04.1.2.2	Garage rental payments and other rental payments made by tenants (S)
04.2	**Imputed rental payments for housing**
04.2.1	Imputed rental payments of owner-occupiers for their main residence (S)
04.2.1.0	Imputed rental payments of owner-occupiers for their main residence (S)
04.2.2	Other imputed rentals (S)
04.2.2.0	Other imputed rentals (S)
04.3	**Maintenance, repair and security of the dwelling**
04.3.1	Security equipment and materials for dwelling maintenance and repair
04.3.1.1	Materials for the maintenance and repair of the dwelling (ND)

04.3.1.2	Security equipment (SD)
04.3.2	Services for the maintenance, repair and security of the dwelling (S)
04.3.2.0	Services for the maintenance, repair and security of the dwelling (S)
04.4	**Water supply and miscellaneous services relating to the dwelling**
04.4.1	Water supply (ND)
04.4.1.1	Water supply delivered through network systems (ND)
04.4.1.2	Water supply delivered through other systems (ND)
04.4.2	Refuse collection (S)
04.4.2.0	Refuse collection (S)
04.4.3	Sewage collection (S)
04.4.3.1	Sewage collection through sewer systems (S)
04.4.3.2	Sewage collection through on-site sanitation systems (S)
04.4.4	Other services related to the dwelling (S)
04.4.4.1	Charges for maintenance of multi-occupied buildings (S)
04.4.4.9	Other services related to the dwelling n.e.c. (S)
04.5	**Electricity, gas and other fuels**
04.5.1	Electricity (ND)
04.5.1.0	Electricity (ND)
04.5.2	Gas (ND)
04.5.2.1	Natural gas through networks (ND)
04.5.2.2	Liquefied hydrocarbons (ND)
04.5.3	Liquid fuels (ND)
04.5.3.0	Liquid fuels (ND)
04.5.4	Solid fuels (ND)

04.5.4.1	Coal, coal briquettes, peat and peat briquettes (ND)
04.5.4.2	Wood fuel, including pellets and briquettes (ND)
04.5.4.3	Charcoal (ND)
04.5.4.9	Other solid fuels (ND)
04.5.5	Other energy for heating and cooling (ND)
04.5.5.0	Other energy for heating and cooling (ND)
05	**FURNISHINGS, HOUSEHOLD EQUIPMENT AND ROUTINE HOUSEHOLD MAINTENANCE**
05.1	**Furniture, furnishings, and loose carpets**
05.1.1	Furniture, furnishings and loose carpets (D)
05.1.1.1	Household furniture (D)
05.1.1.2	Garden and camping furniture (D)
05.1.1.3	Lighting equipment (D)
05.1.1.4	Furnishings, loose carpets and rugs (D)
05.1.2	Repair, installation and hire of furniture, furnishings and loose carpets (S)
05.1.2.0	Repair, installation and hire of furniture, furnishings and loose carpets (S)
05.2	**Household textiles**
05.2.1	Household textiles (SD)
05.2.1.1	Furnishing fabrics and curtains (SD)
05.2.1.2	Bed linen and bedding (SD)
05.2.1.3	Table linen and bathroom linen (SD)
05.2.1.9	Other household textiles (SD)
05.2.2	Repair, hire and sewing services of household textiles (S)
05.2.2.0	Repair, hire and sewing services of household textiles (S)

05.3	**Household appliances**
05.3.1	Major electric and other household appliances (D)
05.3.1.1	Major kitchen appliances (D)
05.3.1.2	Major laundry appliances (D)
05.3.1.3	Heaters and air conditioners (D)
05.3.1.4	Cleaning equipment (D)
05.3.1.9	Other major household appliances (D)
05.3.2	Small household appliances (SD)
05.3.2.1	Small appliances for the cooking and processing of food (SD)
05.3.2.2	Small appliances for the preparation of beverages (SD)
05.3.2.9	Other small household appliances (SD)
05.3.3	Repair, installation and hire of household appliances (S)
05.3.3.0	Repair, installation and hire of household appliances (S)
05.4	**Glassware, tableware and household utensils**
05.4.0	Glassware, tableware and household utensils (SD)
05.4.0.1	Glassware, crystal ware, ceramic ware and china ware (SD)
05.4.0.2	Cutlery, flatware and silverware (SD)
05.4.0.3	Kitchen utensils and articles (SD)
05.4.0.4	Repair and hire of glassware, tableware and household utensils (S)
05.5	**Tools and equipment for house and garden**
05.5.1	Motorized tools and equipment (D)
05.5.1.0	Motorized tools and equipment (D)
05.5.2	Non-motorized tools and miscellaneous accessories (SD)
05.5.2.1	Non-motorized tools (SD)

05.5.2.2	Miscellaneous accessories (SD)
05.5.3	Repair and hire of motorized and non-motorized tools and equipment (S)
05.5.3.0	Repair and hire of motorized and non-motorized tools and equipment (S)
05.6	**Goods and services for routine household maintenance**
05.6.1	Non-durable household goods (ND)
05.6.1.1	Household cleaning and maintenance products (ND)
05.6.1.9	Other non-durable household goods (ND)
05.6.2	Domestic services and household services (S)
05.6.2.1	Domestic services provided by paid staff (S)
05.6.2.9	Other household services (S)
06	**HEALTH**
06.1	**Medicines and health products**
06.1.1	Medicines (ND)
06.1.1.1	Medicines, vaccines and other pharmaceutical preparations (ND)
06.1.1.2	Herbal medicines and homeopathic products (ND)
06.1.2	Medical products (ND)
06.1.2.1	Medical diagnostic products (ND)
06.1.2.2	Preventive and protective devices (ND)
06.1.2.3	Treatment devices for personal use (ND)
06.1.3	Assistive products (D)
06.1.3.1	Assistive products for vision (D)
06.1.3.2	Assistive products for hearing and communication (D)
06.1.3.3	Assistive products for mobility and daily living (D)
06.1.4	Repair, rental and maintenance of medical and assistive products (S)

06.1.4.0	Repair, rental and maintenance of medical and assistive products (S)
06.2	**Outpatient care services**
06.2.1	Preventive care services (S)
06.2.1.1	Immunization services (S)
06.2.1.9	Other preventive care services (S)
06.2.2	Outpatient dental services (S)
06.2.2.1	Dental preventive services (S)
06.2.2.9	Other outpatient dental services (S)
06.2.3	Other outpatient care services (S)
06.2.3.1	Outpatient curative and rehabilitative services (S)
06.2.3.2	Outpatient long-term care services (S)
06.3	**Inpatient care services**
06.3.1	Inpatient curative and rehabilitative services (S)
06.3.1.0	Inpatient curative and rehabilitative services (S)
06.3.2	Inpatient long-term care services (S)
06.3.2.0	Inpatient long-term care services (S)
06.4	**Other health services**
06.4.1	Diagnostic imaging services and medical laboratory services (S)
06.4.1.0	Diagnostic imaging services and medical laboratory services (S)
06.4.2	Patient emergency transportation and emergency rescue services (S)
06.4.2.0	Patient emergency transportation and emergency rescue services (S)

07	TRANSPORT
07.1	**Purchase of vehicles**
07.1.1	Motor cars (D)
07.1.1.1	New motor cars (D)
07.1.1.2	Second-hand motor cars (D)
07.1.2	Motorcycles (D)
07.1.2.0	Motorcycles (D)
07.1.3	Bicycles (D)
07.1.3.0	Bicycles (D)
07.1.4	Animal-drawn vehicles (D)
07.1.4.0	Animal-drawn vehicles (D)
07.2	**Operation of personal transport equipment**
07.2.1	Parts and accessories for personal transport equipment (SD)
07.2.1.1	Tyres (SD)
07.2.1.2	Parts for personal transport equipment (SD)
07.2.1.3	Accessories for personal transport equipment (SD)
07.2.2	Fuels and lubricants for personal transport equipment (ND)
07.2.2.1	Diesel (ND)
07.2.2.2	Petrol (ND)
07.2.2.3	Other fuels for personal transport equipment (ND)
07.2.2.4	Lubricants (ND)
07.2.3	Maintenance and repair of personal transport equipment (S)
07.2.3.0	Maintenance and repair of personal transport equipment (S)
07.2.4	Other services related to personal transport equipment (S)

07.2.4.1	Parking services (S)
07.2.4.2	Toll facilities (S)
07.2.4.3	Driving lessons, tests, licences and roadworthiness tests (S)
07.2.4.4	Hire of personal transport equipment without driver (S)
07.3	**Passenger transport services**
07.3.1	Passenger transport by railway (S)
07.3.1.1	Passenger transport by train (S)
07.3.1.2	Passenger transport by rapid transit and tram (S)
07.3.2	Passenger transport by road (S)
07.3.2.1	Passenger transport by bus and coach (S)
07.3.2.2	Passenger transport by taxi and hired vehicle with driver (S)
07.3.2.3	Passenger transport for students to and from school (S)
07.3.2.9	Other passenger transport by road (S)
07.3.3	Passenger transport by air (S)
07.3.3.1	Passenger transport by air, domestic (S)
07.3.3.2	Passenger transport by air, international (S)
07.3.4	Passenger transport by sea and inland waterway (S)
07.3.4.0	Passenger transport by sea and inland waterway (S)
07.3.5	Combined passenger transport (S)
07.3.5.0	Combined passenger transport (S)
07.3.6	Other passenger transport services (S)
07.3.6.0	Other passenger transport services (S)

07.4	**Transport services for goods**
07.4.1	Postal and courier services (S)
07.4.1.1	Letter handling services (S)
07.4.1.2	Courier and parcel delivery services (S)
07.4.9	Other transport of goods (S)
07.4.9.1	Removal and storage services (S)
07.4.9.2	Delivery of goods (S)
08	**INFORMATION AND COMMUNICATION**
08.1	**Information and communication equipment**
08.1.1	Fixed telephone equipment (D)
08.1.1.0	Fixed telephone equipment (D)
08.1.2	Mobile telephone equipment (D)
08.1.2.0	Mobile telephone equipment (D)
08.1.3	Information processing equipment (D)
08.1.3.1	Computers, laptops and tablets (D)
08.1.3.2	Peripheral equipment and its consumable components (D)
08.1.4	Equipment for the reception, recording and reproduction of sound and vision (D)
08.1.4.0	Equipment for the reception, recording and reproduction of sound and vision (D)
08.1.5	Unrecorded recording media (SD)
08.1.5.0	Unrecorded recording media (SD)
08.1.9	Other information and communication equipment and accessories (D)
08.1.9.1	Other information and communication equipment (D)
08.1.9.2	Other information and communication accessories (SD)
08.2	**Software, excluding games**

08.2.0	Software, excluding games (S)
08.2.0.0	Software, excluding games (S)
08.3	**Information and communication services**
08.3.1	Fixed communication services (S)
08.3.1.0	Fixed communication services (S)
08.3.2	Mobile communication services (S)
08.3.2.0	Mobile communication services (S)
08.3.3	Internet access provision services and online storage services (S)
08.3.3.0	Internet access provision services and online storage services (S)
08.3.4	Bundled telecommunication services (S)
08.3.4.0	Bundled telecommunication services (S)
08.3.5	Repair and rental of information and communication equipment (S)
08.3.5.0	Repair and rental of information and communication equipment (S)
08.3.9	Other information and communication services (S)
08.3.9.1	Television and radio licences and fees (S)
08.3.9.2	Subscriptions to audiovisual streaming services and rental of audiovisual content (S)
08.3.9.9	Other information and communication services n.e.c. (S)
09	**RECREATION, SPORT AND CULTURE**
09.1	**Recreational durables**
09.1.1	Photographic and cinematographic equipment and optical instruments (D)
09.1.1.1	Cameras (D)
09.1.1.2	Accessories for photographic and cinematographic equipment (D)
09.1.1.3	Optical instruments (D)

09.1.2	Major recreational durables (D)
09.1.2.1	Camper vans, caravans and trailers (D)
09.1.2.2	Aeroplanes, microlight aircraft, gliders, hang gliders and hot-air balloons (D)
09.1.2.3	Boats, yachts, outboard motors and other water-sport equipment (D)
09.1.2.4	Horses, ponies, camels and dromedaries and accessories (D)
09.1.2.9	Other major recreational durables (D)
09.2	**Other recreational goods**
09.2.1	Games, toys and hobby-related articles (SD)
09.2.1.1	Video game computers, consoles, game applications and software (SD)
09.2.1.2	Other games, toys and hobby-related articles (SD)
09.2.1.3	Celebration articles (ND)
09.2.2	Sporting, camping and open-air recreation equipment (SD)
09.2.2.1	Sporting equipment (SD)
09.2.2.2	Camping and open-air recreation equipment (SD)
09.3	**Garden products and pets**
09.3.1	Garden products, plants and flowers (ND)
09.3.1.1	Garden products (ND)
09.3.1.2	Plants, seeds and flowers (ND)
09.3.2	Pets and pet products (D)
09.3.2.1	Pets (D)
09.3.2.2	Products for pets and other household animals (ND)
09.4	**Recreational services**
09.4.1	Hire and repair of photographic and cinematographic equipment and optical instruments (S)

09.4.1.0	Hire and repair of photographic and cinematographic equipment and optical instruments (S)
09.4.2	Hire, maintenance and repair of major recreational durables (S)
09.4.2.1	Hire, maintenance and repair of camper vans and caravans (S)
09.4.2.2	Hire, maintenance and repair of other major recreational durables (S)
09.4.3	Hire and repair of games, toys and hobby-related articles (S)
09.4.3.1	Hire of game software and subscription to online games (S)
09.4.3.2	Hire and repair of games, toys and hobby-related articles (S)
09.4.4	Hire and repair of sporting, camping and open-air recreational equipment (S)
09.4.4.0	Hire and repair of sporting, camping and open-air recreational equipment (S)
09.4.5	Veterinary and other services for pets (S)
09.4.5.0	Veterinary and other services for pets (S)
09.4.6	Recreational and sporting services (S)
09.4.6.1	Recreational and leisure services (S)
09.4.6.2	Services associated with the practice of sports (S)
09.4.6.3	Services associated with attendance at sporting events (S)
09.4.7	Games of chance (S)
09.4.7.0	Games of chance (S)
09.5	**Cultural goods**
09.5.1	Musical instruments (D)
09.5.1.0	Musical instruments (D)
09.5.2	Audiovisual media (SD)
09.5.2.0	Audiovisual media (SD)
09.6	**Cultural services**

09.6.1	Services provided by cinemas, theatres and concert venues (S)
09.6.1.0	Services provided by cinemas, theatres and concert venues (S)
09.6.2	Services provided by museums, libraries and cultural sites (S)
09.6.2.0	Services provided by museums, libraries and cultural sites (S)
09.6.3	Photographic services (S)
09.6.3.0	Photographic services (S)
09.6.9	Other cultural services (S)
09.6.9.0	Other cultural services (S)
09.7	**Newspapers, books and stationery**
09.7.1	Books (SD)
09.7.1.1	Educational books and textbooks (SD)
09.7.1.9	Other books (SD)
09.7.2	Newspapers and periodicals (ND)
09.7.2.1	Newspapers (ND)
09.7.2.2	Magazines and periodicals (ND)
09.7.3	Miscellaneous printed matter (ND)
09.7.3.0	Miscellaneous printed matter (ND)
09.7.4	Stationery and drawing materials (ND)
09.7.4.0	Stationery and drawing materials (ND)
09.8	Package holidays
09.8.0	**Package holidays (S)**
09.8.0.0	Package holidays (S)
10	**EDUCATION SERVICES**
10.1	**Early childhood and primary education**

10.1.0	Early childhood and primary education (S)
10.1.0.1	Early childhood education (S)
10.1.0.2	Primary education (S)
10.2	**Secondary education**
10.2.0	Secondary education (S)
10.2.0.0	Secondary education (S)
10.3	**Post-secondary non-tertiary education**
10.3.0	Post-secondary non-tertiary education (S)
10.3.0.0	Post-secondary non-tertiary education (S)
10.4	**Tertiary education**
10.4.0	Tertiary education (S)
10.4.0.0	Tertiary education (S)
10.5	**Education not defined by level**
10.5.0	Education not defined by level (S)
10.5.0.1	Tutoring (S)
10.5.0.9	Other education not defined by level (S)
11	**RESTAURANTS AND ACCOMMODATION SERVICES**
11.1	**Food and beverage serving services**
11.1.1	Restaurants, cafés and the like (S)
11.1.1.1	Restaurants, cafés and the like – with full service (S)
11.1.1.2	Restaurants, cafés and the like – with limited service (S)
11.1.2	Canteens, cafeterias and refectories (S)
11.1.2.1	Canteens and cafeterias of universities, schools and kindergartens (S)
11.1.2.9	Other canteens, cafeterias and refectories (S)

11.2	**Accommodation services**
11.2.0	Accommodation services (S)
11.2.0.1	Hotels, motels, inns and similar accommodation services (S)
11.2.0.2	Holiday centres, camping sites, youth hostels and similar accommodation services (S)
11.2.0.3	Accommodation services of boarding schools, universities and other educational establishments (S)
11.2.0.9	Other accommodation services (S)
12	**INSURANCE AND FINANCIAL SERVICES**
12.1	**Insurance**
12.1.1	Life and accident insurance (S)
12.1.1.0	Life and accident insurance (S)
12.1.2	Insurance connected with health (S)
12.1.2.0	Insurance connected with health (S)
12.1.3	Insurance connected with dwellings (S)
12.1.3.0	Insurance connected with dwellings (S)
12.1.4	Insurance connected with transport (S)
12.1.4.1	Personal transport insurance (S)
12.1.4.2	Travel insurance (S)
12.1.9	Other insurance (S)
12.1.9.0	Other insurance (S)
12.2	**Financial services**

12.2.1	Financial intermediation services indirectly measured (S)
12.2.1.0	Financial intermediation services indirectly measured (S)
12.2.2	Explicit charges by deposit-taking corporations (S)
12.2.2.0	Explicit charges by deposit-taking corporations (S)
12.2.9	Other financial services (S)
12.2.9.1	Remittances fees (S)
12.2.9.9	Other financial services n.e.c. (S)
13	**PERSONAL CARE, SOCIAL PROTECTION AND MISCELLANEOUS GOODS AND SERVICES**
13.1	**Personal care**
13.1.1	Electric appliances for personal care (SD)
13.1.1.1	Electric appliances for personal care (SD)
13.1.1.2	Repair of electric appliances for personal care (S)
13.1.2	Other appliances, articles and products for personal care (ND)
13.1.2.0	Other appliances, articles and products for personal care (ND)
13.1.3	Hairdressing salons and personal grooming establishments (S)
13.1.3.1	Hairdressing (S)
13.1.3.2	Personal grooming treatments (S)
13.2	**Other personal effects**
13.2.1	Jewellery and watches (D)
13.2.1.1	Jewellery and watches (D)
13.2.1.2	Repair and hire of jewellery, clocks and watches (S)
13.2.2	Devotional articles and articles for religious and ritual celebrations (SD)

13.2.2.0	Devotional articles and articles for religious and ritual celebrations (SD)
13.2.9	Other personal effects n.e.c. (SD)
13.2.9.1	Travel goods, baby articles and other personal effects n.e.c. (SD)
13.2.9.2	Repair and hire of other personal effects (S)
13.3	**Social protection**
13.3.0	Social protection (S)
13.3.0.1	Childcare services (S)
13.3.0.2	Retirement homes for elderly persons and residences for disabled persons, not providing medical care (S)
13.3.0.3	Home care services for elderly and disabled (S)
13.3.0.9	Other social protection services (S)
13.9	**Other services**
13.9.0	Other services (S)
13.9.0.1	Prostitution (S)
13.9.0.2	Religious services (S)
13.9.0.9	Other services n.e.c. (S)

GETTING IN TOUCH WITH THE EU

In person
All over the European Union there are hundreds of Europe Direct information centres. You can find the address of the centre nearest you at: https://europa.eu/european-union/contact_en

On the phone or by email
Europe Direct is a service that answers your questions about the European Union. You can contact this service:
– by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
– at the following standard number: +32 22999696 or
– by email via: https://europa.eu/european-union/contact_en

FINDING INFORMATION ABOUT THE EU

Online
Information about the European Union in all the official languages of the EU is available on the Europa website at: https://europa.eu/european-union/index_en

EU publications
You can download or order free and priced EU publications at: https://op.europa.eu/en/publications. Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see https://europa.eu/european-union/contact_en).

EU law and related documents
For access to legal information from the EU, including all EU law since 1952 in all the official language versions, go to EUR-Lex at: http://eur-lex.europa.eu

Open data from the EU
The EU Open Data Portal (http://data.europa.eu/euodp/en) provides access to datasets from the EU. Data can be downloaded and reused for free, for both commercial and non-commercial purposes.

KS-GQ-24-003-EN-N

Harmonised Index of Consumer Prices (HICP)

the HICP Methodological Manual represents a comprehensive overview of methods that are used in the compilation process for the harmonised index of consumer prices (HICP). The manual intends to be a practical guide to all steps necessary to produce an HICP and is thus useful for statisticians who are new to the field of price statistics and statistical offices aiming to set up a similar inflation measure. Users of the HICP, such as businesses, policy-makers and researchers may also find this manual useful to help them understand and interpret HICP data.

For more information

https://ec.europa.eu/eurostat/

Publications Office
of the European Union

ISBN 978-92-68-12009-5