

Euro area and European Union GDP flash estimates at 30 days

2016 edition

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Preface

Gross domestic product (GDP) is generally considered to be one of the most important economic indicators. Eurostat began publishing quarterly GDP flash estimates in 2003. Since then, these estimates have been released every quarter, 45 days after the quarter-end. The economic, financial and technological developments seen in recent years have made it increasingly important to have economic indicators available at the earliest possible stage. Policymakers and other users of economic indicators therefore wanted to see the quarterly GDP estimates published sooner after the quarter-end.

In view of this, in May 2013 the National Accounts Working Group set up the task force ‘GDP flash estimates at t+30 days’. The group’s mandate was to assess whether it would be possible to publish a sufficiently reliable flash estimate of GDP for the euro area and the EU based on the information available at t+30 days, including national estimates produced by the Member States.

The results of the task force’s work and the GDP t+30 flash estimates project is documented in two statistical working papers. This working paper focuses mainly on the methodology used to determine the GDP t+30 flash estimates for the euro area and the EU. It also includes the results of the test estimations that were performed for 16 quarters using this methodology, and explains the criteria that were used to assess these test results. In addition, this working paper gives some general information on the purpose of the GDP t+30 flash estimates project and discusses the need, from the users’ perspective, for earlier publication of the GDP flash estimates for the euro area and the EU.

The second statistical working paper, meanwhile, presents the methods and techniques used for producing early estimates of national GDP, focusing particularly on the techniques used for estimating the data for the third month of a quarter, which are not yet available at the point of preparing early estimates.

The objective of publishing the main results of the project is twofold. First, in publishing all the information related to its GDP t+30 flash estimates for the euro area and the EU, Eurostat is respecting its commitment to being fully transparent vis-à-vis its users. Second, the information provided in this working paper includes background information that might be important for users when interpreting the GDP t+30 flash estimates.

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Executive summary

The paper starts discussing the question why quarterly GDP should be estimated earlier. To answer this question user demands for early GDP estimates are analysed. The main users of GDP data, the European Commission and the European Central Bank, need early GDP data for policy making, monitoring the economic situation, and for forecasting purposes. Also other users (economic analysts and journalists, news agencies) will certainly be interested in timelier GDP data. Furthermore, it would be a welcome addition to the Principal European Economic Indicators, for which a GDP estimate at 30 days is currently missing.

Then the paper continues describing the development of the estimation method, the preparation of test estimates for a number of quarters, and the development of acceptance criteria that were used to assess the results of the estimates for the test quarters. Regarding the latter, four criteria were developed and quantified: i) GDP t+30 test estimates should be unbiased; ii) the average absolute revision should be limited; iii) the GDP-coverage of Member States' input should be sufficient; and iv) a communication plan regarding the introduction of GDP t+30 estimates should be available.

The elaboration of the estimation method and the assessment of the estimates for the test quarters against the predefined acceptance criteria is the core of this working paper. The method developed for producing preliminary flash estimates of quarterly GDP for the euro area and the EU 30 days after the end of the quarter is in many respects similar to the method currently used for the euro area and EU GDP t+45 flash estimates. The main differences are that the t+30 estimate has more limited country coverage and that greater use is made of preliminary country estimates (data for the third month often having to be estimated or partially estimated by the Member State at this earlier date). The methodology for producing GDP t+30 (test) flash estimates for the euro area and the EU is characterised by the following features:

- The flash estimates for the EU and the euro area are produced using the indirect approach, i.e. Member States flash estimates and/or indicators at t+29 ⁽¹⁾ are used as the main data source, rather than indicators at European level.
- All available information is used as far as possible:
 - All GDP t+30 flash estimates that are available from the Member States for the reference quarter will be used. This is the case irrespective of whether the country's GDP t+30 estimate has been published at t+30 days or whether it is unpublished and is provided confidentially to Eurostat exclusively for the purpose of producing the GDP t+30 flash estimate of the European aggregates.
 - Other relevant indicators may be used for a Member State if its GDP t+30 estimate is not available. These alternative indicators are mainly short-term economic statistics, such as the industrial production index, deflated real trade and the turnover of services, for which two months' data are available and the third month can be nowcast. The economic sentiment indicator (ESI) may also be used. Furthermore, the forecasts issued by private forecasters may be considered as secondary information when deciding on a growth estimate for countries for which data are missing country.

The decision to start publishing the GDP t+30 flash estimates for the euro area and the EU is based on the results of a testing phase carried out over the period 2012-2015. The GDP t+30 flash estimates for the euro area and the EU for the quarters from 2012Q1 to 2013Q4 were calculated retrospectively, and the Member States involved were asked to use only the data that would have been available within 30 days of the end of the reference quarter when supplying their national estimates.

- The estimates for the quarters from 2014Q1 to 2015Q4 were calculated in real time.
- Flash estimates are available earlier than traditional estimates. There is a trade-off between timeliness and accuracy. Based on the 16 test estimates, the expected revision of the GDP t+30

⁽¹⁾ Member States are requested to transmit their national estimates to Eurostat one working day before publication of euro area and EU GDP t+30 estimates.

- growth rates at t+45 would be ± 0.1 percentage points for the euro area at publication level (i.e. considering the published figures at the two points in time, which are given to one decimal place). For the EU, the revision was 0.0 percentage points in nine of the 16 quarters and ± 0.1 percentage points in the other seven. If there were to be a sudden dramatic change in economic trends, as was seen in 2008Q2 when the financial crisis broke, larger revisions than those mentioned above might be expected.
- The expected revisions have been tested against quality criteria set *a priori*. Over the 16 test quarters, the average revision made to the GDP t+30 flash estimates when publishing the t+45 estimates was 0.00 percentage points for the euro area and -0.01 percentage points for the EU (the quality criterion requires these values to be between -0.05 and 0.05 percentage points). The average absolute revision made to the GDP t+30 flash estimates when publishing the t+45 estimates was 0.06 percentage points for the euro area and 0.05 percentage points for the European Union (the quality criterion requires these values to be less than 0.10 percentage points). Comparing the GDP t+30 estimates with those produced at t+65, the average absolute revision would also have been 0.06 percentage points in the euro area and 0.05 percentage points in the European Union. The quality criterion requires these values to be less than or equal to 0.13 percentage points, a level set on the basis of the revision typically made between US t+30 and t+60 GDP estimates. The test results therefore fulfil the *a priori* determined quality criteria.
 - Flash estimates only concern the latest quarter. Data on the euro-area and the EU GDP for quarters up to and including the preceding quarter will not be revised with the GDP t+30 flash release (nor with the GDP t+45 flash release).

Contents

| | |
|---|----|
| Preface..... | 3 |
| Acknowledgements | 4 |
| Executive summary | 5 |
| Contents..... | 7 |
| 1. Introduction | 8 |
| 2. Why introduce GDP t+30 estimations? | 9 |
| 2.1 Introduction, user needs and developments in official statistics..... | 9 |
| 2.2 Background to the GDP t+45 days estimates | 11 |
| 2.3 Link with Principal European Economic Indicators (PEEIs) | 11 |
| 3. Eurostat’s estimation methods | 13 |
| 3.1 Flash estimate for a quarterly national accounts variable: terminology | 13 |
| 3.2. Compilation methodology..... | 14 |
| 4. Quality acceptance criteria | 18 |
| 4.1 Introduction | 18 |
| 4.2 Defining quality..... | 18 |
| 4.3 Considerations when setting the acceptance criteria | 19 |
| 4.4 Recommended acceptance criteria..... | 20 |
| 5. Results and assessment of the GDP t+30 test estimates | 23 |
| 5.1 Introduction | 23 |
| 5.2 Results of the GDP t+30 test estimates | 23 |
| 5.3 Assessment of GDP t+30 test estimates..... | 24 |
| Annexes | 29 |
| Annex A: Aggregation of the country growth rates | 29 |
| Annex B: Sample size for testing revisions for bias..... | 32 |
| Annex C: US t+30, t+60 and t+90 estimates of quarter-on-quarter GDP growth, and the associated revisions to the t+30 estimates | 36 |

1. Introduction

Eurostat began publishing quarterly GDP flash estimates in 2003. Since then, these estimates have been released every quarter, 45 days after the quarter-end. The introduction of the GDP t+45 flash estimates was described in the Eurostat flash project ⁽²⁾ as the project's 'first practical objective'. Reducing the time needed to produce a flash estimate of GDP to 30 days was mentioned as a 'next step' for the project. Ten years later, in May 2013, the National Accounts Working Group set up the task force 'GDP flash estimates at t+30 days'. The group's mandate was to assess whether it would be possible to publish a sufficiently reliable flash estimate of GDP for the euro area and the EU based on the information available at t+30 days, including national estimates produced by the Member States.

The task force was in operation between June 2013 and the end of 2015. It was made up of 18 members: Bulgaria, Czech Republic, Germany, Finland, France, Hungary, Italy, Lithuania, Latvia, the Netherlands, Poland, Portugal, Romania, Slovenia and the United Kingdom ⁽³⁾. Switzerland and the European Central Bank also joined the task force, and the contractor Cambridge Econometrics provided technical support.

The work of the task force covered the following areas:

- sharing information on and best practices for preparing early quarterly GDP estimates;
- producing a country-by-country overview of the sources available for GDP estimates between t+25 and t+60 days;
- developing a guidance document on methods and national estimation techniques;
- developing a method for producing GDP t+30 flash estimates for the euro area and the EU;
- developing quality acceptance criteria to be used for assessing the test results;
- preparing test estimates; and
- developing a communication plan.

At its final meeting on 7 October 2015, the task force discussed its achievements. The results of its work, and in particular the fact that the test estimates produced had met the quality acceptance criteria, meant that it was able to advise Eurostat to start releasing official quarterly GDP estimates at t+30 days for the euro area and the EU. This advice was discussed and endorsed by the National Accounts Working Group and the Directors of Macro-Economic Statistics at their respective meetings on 18 November 2015 and 10 December 2015. On the basis of this advice, Eurostat decided, at its Directors' meeting on 15 December 2015, to start releasing the GDP estimates for the euro area and the EU 30 days after the end of the reference quarter. This decision is to take effect as of the first quarter of 2016. A large number of Member States contribute to the GDP t+30 estimates for the euro area and the EU by providing their national estimates, and there has been broad support for introducing this new GDP flash estimate at t+30. Its launch is therefore considered to be an important achievement on the part of the whole European Statistical System (ESS).

This document presents some of the main results of the work carried out as part of the GDP t+30 project. Chapter 2 discusses the question of why the GDP t+30 flash estimates for the euro area and the EU are being introduced, and examines user needs. Chapter 3 presents the estimation methodology developed by Eurostat. This methodology was used for preparing the test estimates and will continue to be used for producing estimates from 2016Q1 onwards, when the GDP t+30 flash estimates are published as official releases.

One of the main tasks in the GDP t+30 project was to produce test estimates for eight quarters in real time and for eight quarters retrospectively using back data. Quality acceptance criteria were developed as a basis for assessing the results of the test estimates. Chapter 4 discusses how these criteria were developed. Chapter 5 presents the results of the 16 quarterly test estimates, and the assessment of these results against the quality acceptance criteria.

⁽²⁾ Eurostat, 2003, *Flash estimation of the quarterly Gross Domestic Product of the euro-zone and the European Union — Eurostat methodology*, Section 5.

⁽³⁾ Slovakia and Sweden joined the task force in 2013.

2. Why introduce GDP t+30 estimations?

2.1 Introduction, user needs and developments in official statistics

The question as to why GDP t+30 flash estimations are being introduced can be answered by considering three issues: user needs and developments in official statistics, the background to the GDP t+45 flash estimates, and the link between the GDP estimates and the Principal European Economic Indicators (PEEIs).

User needs, economic and financial developments and technological improvements inevitably trigger changes and further progress in the area of official statistics. In view of this, demand from users for more detailed information and for information to be available more quickly plays an important role.

At a strategic level, the ESS has committed to ‘respond to the need to provide policymakers with reliable, comparable and timely statistics to execute economic and financial policy’⁽⁴⁾. The work on the GDP t+30 flash estimates is one aspect of the action being taken by the ESS to fulfil this commitment.

Since May 2003, Eurostat has been publishing a flash estimate of quarterly seasonally and calendar-adjusted GDP growth 45 days after the end of the reference quarter (t+45). This has been greatly appreciated by the users of statistics and in particular by policymaking organisations such as the European Commission and the European Central Bank (ECB). The economic, financial and technological developments seen in recent years mean, however, that policymakers are increasingly needing to analyse economic activity more quickly, i.e. sooner after the end of a reference period. Having high quality, reliable published statistical data available quickly is therefore essential. As a result, policymakers and other main users of statistics were keen to see quarterly GDP estimates available earlier.

Main users: the European Commission and the European Central Bank

The European Commission’s Directorate-General for Economic and Financial Affairs (DG ECFIN) and the ECB rely heavily on the macroeconomic statistics produced and disseminated by Eurostat, and in particular on the quarterly national accounts. They therefore supported the ESS’s work on producing GDP t+30 flash estimates for the euro area and EU. Bringing the GDP release date forward is seen as a significant improvement in data availability, and it also meets users’ long-standing demand to have flash estimates available for the euro area and the EU at a similar date to that at which data is available for the other main economies, and in particular the euro area’s main trading partners, such as the United States.

Having GDP estimates available earlier will be useful for the following purposes:

A. For policy decision-making

Policy decision-making is a critical issue for the ECB, it being responsible for monetary policy in the euro area. The ECB’s Governing Council aims to keep inflation below, but close to, 2 % over the medium term. In order to achieve this objective, the Governing Council bases its decisions on a two-pillar monetary policy strategy, and implements them via its operational framework. The two pillars are economic analysis and monetary analysis — these form the basis of the Governing Council’s overall assessment of the risks to price stability, and thus of its decisions on monetary policy. The ECB’s economic analysis focuses on real economic activity, and therefore takes account of the fact that price developments over those horizons are largely determined by the interplay of supply and demand in the goods, services and factor markets. The GDP flash estimate is thus one of the important indicators used when setting monetary policy, in particular because policy decisions influence developments in economic variables such as output and prices. Bringing the quarterly GDP flash estimate forward by two weeks is therefore useful to the ECB for its monetary policy decision-making.

⁽⁴⁾ See *The ESS Vision 2020*, p. 5. Available at: <http://ec.europa.eu/eurostat/documents/10186/756730/ESS-Vision-2020.pdf/8d97506b-b802-439e-9ea4-303e905f4255>.

B. For monitoring the economic situation

- DG ECFIN provides a continuously updated assessment of the overall economic situation in the euro area and in the EU. This is used in discussions by all groups and committees working in areas covered by DG ECFIN, including in particular the Eurogroup. DG ECFIN and other Commission departments are also in close and frequent contact with other international organisations.
- The ECB (specifically the Directorate General Economics) produces updated assessments of the overall economic and monetary situation in the euro area and briefing notes that include the latest statistics on a regular basis. These are then used by the ECB's Executive Board and its Governing Council to inform their discussions, and by other EU bodies and international fora.

Having a sound understanding of the current developments in the economy, at an aggregate level, is critical in the contexts mentioned above. This understanding is informed by all the available statistics and indicators, and earlier availability of GDP estimates would therefore be of great benefit, GDP being the standard accepted aggregate measure of economic activity.

A reliable, objective and publicly available measure, such as GDP growth in the euro area and the EU, can help to establish a common understanding in international fora, and having this information available earlier would therefore be very valuable in this context also.

C. For forecasting/projection purposes

- The Commission's macroeconomic forecasts for the euro area and the EU are built bottom-up by aggregating data from individual country forecasts produced by country desk officers in DG ECFIN, but also include top-down elements, such as information provided by European aggregates. These forecasts are produced three times a year (winter, spring and autumn) and each forecast involves several iterations. Estimates of GDP for the euro area and the EU released 30 days after the end of the reference period could be of great value for forecasting. At least in the current forecast set-up, however, the flash estimate at t+30 days would still be released after the internal 'cut-off date' for information for each of the three forecasts, and could not therefore be taken into account when producing the forecasts. Nonetheless, in contrast to the t+45 releases, these estimates would be available prior to the *publication* of the forecast (the Q4 estimate would be available before the publication of the winter forecast in early February, the Q1 estimate before the publication of the spring forecast in early May, the Q3 estimate before the publication of the autumn forecast in early November). This would therefore allow the communication issued at the time of the forecast release to be adapted in view of the latest economic developments.

Whether the earlier availability of the European aggregates could help to ensure and improve the quality of the forecast in future depends on where a t+30 days release falls in future forecast calendars. If the GDP estimate were available at an early stage in the forecasting calendar, it could help to shape the central guidance issued to country desks at the beginning of the forecast exercise. This would thus ensure that national forecasts reflected the available aggregated figures (top-down approach) and that country forecasts were produced on the basis of a common interpretation of the current economic situation. If available at a later stage of a forecast exercise, the GDP t+30 flash estimates could be used for checking the plausibility of the aggregated national forecasts.

- The ECB carries out a number of forecasting and projection exercises as part of its monetary policy strategy. Two distinct types of projections can be identified.

The first are the forecasted 'early' estimates of quarterly GDP growth, which are produced twice a month. The forecasting model is a complex tool that combines backcasting and nowcasting techniques, focusing on quarterly developments. The earlier availability of a GDP flash estimate for the euro area will be quite significant for this type of forecasting. Having the GDP estimate available sooner would also reduce the time-gap between the release of this and other economic indicators used in the forecasting process.

The second type of forecasting is the macro-projection exercise, which is performed on a quarterly basis in two streams (one of which also involves all EU national central banks) and is similar to the

forecasting carried out by DG ECFIN. The results of the ECB's macro-projections are made publically available to users via the ECB's website and are also discussed in a dedicated publication. There is a 'cut-off' date for data to be included in these projections and it is important both for euro-area aggregates, such as GDP, and for the euro-area and EU Member States individually that all statistics are taken into account and that the most recent data are included. Bringing the flash estimate of GDP for the euro area and the EU forward is therefore also useful for this type of projection.

Other users

In addition to the main users discussed here, there are also many other users who will benefit from data on GDP growth being available sooner. These include other Commission departments, such as the Directorate-General for Employment, Social Affairs and Inclusion and the Directorate-General for Financial Stability, Financial Services and Capital Markets Union. In addition, having GDP data available earlier will be of relevance for institutional users such as the European Council and the European Parliament. Early information on the GDP growth rate in the euro area and in the EU will also be useful for national policymakers and governments. 'General users' may also be interested in the headline early estimates. Finally, the Eurostat communication unit has observed that economic journalists and news agencies in particular are always interested in earlier data on the main indicators.

2.2 Background to the GDP t+45 days estimates

The aim of the GDP t+45 estimates was (and still is) to provide quarter-on-quarter and year-on-year seasonally and calendar adjusted growth rates for quarterly GDP. Results for the euro area, the EU and for individual Member States that publish data at national level are published in Eurostat's news release at (or slightly before) 45 days after the end of the reference quarter.

Eurostat started producing and releasing the t+45 GDP estimates in 2003. At that time, the euro area and the EU comprised, respectively, 12 and 15 countries. At the start of the project, five countries (Germany, Greece, Italy, the Netherlands and the United Kingdom) provided their national estimates to Eurostat. These countries represented approximately 55 % of euro-area GDP and 60 % of EU GDP. For the large Member States that could not provide national estimates, related indicators were used. The national estimates (for the countries listed) and related indicators (for other large countries) provided the input for a regression model that estimated the GDP for the euro area and the EU.

Gradually, more Member States started producing estimates of national GDP at t+45 days. By 2006Q1, for example, the countries contributing to the GDP flash project represented 74 % and 72 % respectively of euro-area and EU GDP. By 2015Q2, this had risen to 97 % for the euro area and 95 % for the EU. The revisions made to the GDP t+45 estimates at the first regular release at t+60 days are very small. The estimates of the European aggregates are now almost entirely based on Member States' input. Estimation techniques and modelling are no longer used. Chapter 3.2 discusses the methodology used to produce the GDP t+45 estimates for the euro area and the EU in more detail.

The launch of the GDP t+45 releases in 2003 was viewed as an intermediate stage that would eventually lead to estimates of quarterly GDP being released 30 days after the end of the reference quarter. The good results of the GDP t+30 project (with test estimates showing that only limited revisions have been necessary, and coverage of all test estimates already at a higher level than was achieved for the GDP t+45 estimates when they were first released) indicate that the release of GDP estimates for the euro area and the EU can be brought forward to 30 days after the end of the reference period.

2.3 Link with Principal European Economic Indicators (PEEIs)

Users of EU economic statistics have, for a long time, been looking forward to see releases of European national accounts data set to a calendar of 30, 60 and 90 days after the end of the reference period. This would match the established practices for data releases for other critical monthly and quarterly macroeconomic indicators and those of the EU's main economic partners such as the United States. The largest euro area and EU Member States are also already following this schedule for data releases.

A first attempt at assessing the feasibility of compiling a GDP t+30 flash estimate for the euro area and the EU was made in 2008, as part of work on the Principal European Economic Indicators (PEEIs), of which the GDP flash estimate is one. In a workshop organised by the ECB Directorate General Statistics the practices of a number of national statistical institutes, the needs of users of the ECB's statistics, and the Eurostat plan to develop GDP t+30 flash estimates for the euro area and the EU were discussed. The schedule for data releases proposed as a result of this initiative was as follows:

- 30 days: advanced estimates ('flash estimates') of GDP, possibly employment, and ideally some expenditure/output components;
- 60 days: preliminary estimates of GDP and the main expenditure and output components; a flash estimate of the balance of payments;
- 90 days: final estimates of the indicators released at 60 days, plus quarterly financial and non-financial accounts for institutional sectors and balance of payments statistics.

Although this proposal was not put into practice at the time, the users' and policymakers' need for earlier estimates remained the same.

The main advantage of the proposed schedule, with data releases at 30, 60 and 90 days was (and still is) that it allows a comprehensive and consistent approach to be taken to data releases across the different areas within national accounts. The proposed GDP t+30 flash estimates are an important part of this schedule of releases.

3. Eurostat's estimation methods

This chapter discusses the method used by Eurostat for compiling the GDP t+30 flash estimates for the euro area and the EU. This method was developed by Eurostat and used to produce the test estimates. As of 2016Q1, it will be used to compile the regular GDP t+30 estimates that are going to be released as of this quarter.

Section 3.1 introduces the terminology related to flash estimates. Section 3.2 then presents the overall methods used for preparing the annual and quarterly national accounts. As the method for preparing the GDP t+30 flash estimate was designed to be as close as possible to that used for the GDP t+45 flash estimate, Section 3.2 also goes on to discuss the method used to compile this latter estimate. The section concludes by presenting the method developed for the GDP t+30 estimates.

3.1 Flash estimate for a quarterly national accounts variable: terminology

The users of national accounts data have been calling for reliable, early quarterly European national accounts figures for some time. The short-term indicators currently available (e.g. production indices, statistics on prices and foreign trade, and business surveys) can help users to form a picture of economic developments in that particular variable and/or industrial activity. To have a more complete picture of developments at macroeconomic level, however, there needs to be a system in which each partial variable can be assessed with respect to other variables, and which shows the breakdown of a variable as proportions of an aggregate figure.

Quarterly national accounts form such a system. Users would ideally like to have preliminary flash estimates available for all the main quarterly national accounts variables. In an ideal situation, all the variables would be published soon after the end of the quarter and would be reliable. Experience has, however, shown that it may be easier to produce a reasonably reliable early estimate of aggregate GDP than of its components. In addition, quarterly GDP growth is the most followed variable in the quarterly national accounts.

The flash estimate of quarterly GDP:

- gives an early picture of economic developments;
- can be used in conjunction with other national accounts variables;
- is produced and published as soon as possible after the end of the quarter; and
- is based on a less complete set of information than is the GDP estimate given in the traditional quarterly national accounts.

Flash estimates therefore differ both from forecasts and leading indicators. The aim of producing GDP flash estimates at EU level is to estimate GDP growth in a way that is, as far as possible, similar to that in which later regular estimates are produced, but using less complete data sources.

Flash estimates and traditional estimates of quarterly accounts differ in a number of their characteristics.

- Release date: flash estimates are available earlier than traditional estimates (typically within 30-45 days).
- Accuracy: there is a trade-off between timeliness and accuracy. Flash estimates are in general less accurate than traditional estimates. The loss of accuracy is, however, kept as small as possible.
- Reference period: flash estimates are typically only produced for the latest quarter. The data for the preceding and earlier quarters is not usually revised.
- Coverage: the number of breakdowns of variables included in flash estimates is usually more limited.
- Information available: flash estimates are based on a more limited set of information. Information from surveys covering the whole quarter, for example, is often not available.
- Use of estimates: due to the lack of direct information, flash estimates may include components that are estimated using statistical methods. For example, there may be two months of short-term statistics available, and other available indicators (such as the economic sentiment indicator) would then be used

for the third month. The flash estimate would typically be produced from these different components using autoregressive distributed lag (ADL) models, autoregressive integrated moving average with exogenous variables (ARIMAX) models and time series regression techniques.

3.2. Compilation methodology

The European Statistical System (ESS) is a network made up of the national statistical institutes in the Member States, plus Eurostat, the European Commission's statistical office. The national accounts figures for the euro area and the EU are compiled by Eurostat using the national accounts figures submitted by the Member States' national statistical institutes. The European aggregates, while being calculated by Eurostat, therefore also depend on input from the whole ESS.

For the national accounts main aggregates, the same approach is used for data on all variables, irrespective of the timing — from the supply and use tables, sent 36 months after the end of the reference period, and which include the most detailed breakdowns, right through to the quarterly GDP flash estimates, sent 45 days after the quarter-end. The national accounts data sent by Member States are based on primary statistical data gathered by each of the national statistical institutes. The European aggregates are therefore produced using an indirect approach, i.e. on the basis of data gathered at Member State level, rather than by surveying the variables directly at EU level.

Compilation of annual and quarterly European national accounts

The European System of Accounts 2010 (ESA2010) provides guidance with the aim of achieving consistency across Member States' national accounts data. Country data need to be comparable in order to be suitable for being used in compiling European national accounts. The ESA2010 transmission programme is included as an Annex to the ESA2010 Regulation⁽⁵⁾. The programme sets out the deadlines for submitting national data to Eurostat. Eurostat thus receives the required data from most Member States on these dates. Its first step in producing the European annual national accounts is to aggregate the national data to give the totals for the euro area and the EU. This first aggregation is done in current prices, and is therefore a simple addition, as data in current prices are additive. The national figures for chain-linked volumes with moving base years are not, however, additive. In these cases, therefore, the country data have to be totalled in the previous year's prices to obtain the aggregate variables for the euro area and the EU. Calculating the chain-linked volume figures for the European aggregate variables in year t requires both of the following to be available: figures for the European aggregate variables for year t in the previous year's prices, and figures for year $t-1$ in current prices. Furthermore, after having carried out the first aggregation of the figures, the European-level national accounts data in current and previous year's prices have to be balanced, so that, e.g. the components of supply and use will add up to the same figure.

For the quarterly national accounts data transmissions, for example at 60 days after the quarter-end, some Member States have derogations allowing them to send data later than specified in the requirements. Data for the vast majority of, but not all, Member States are therefore available for compiling the European quarterly national accounts. As a result, the quarterly European level figures cannot be directly aggregated due to data for certain countries being missing. To solve this problem, a different indirect approach is applied using the time dimension: the annual European national accounts level figures are temporally distributed to the quarters based on the quarterly national accounts figures of those Member States that sent quarterly data to Eurostat. The temporal disaggregation of the annual figures is performed using the Chow-Lin regression-based method. A linear model is specified so as to describe the relationship of the quarterly GDP indicator with the annual GDP. This model can also be used for estimating quarterly changes in GDP for the most recent quarter(s) for which annual GDP is not available. The process of disaggregating the annual total over time also ensures that the quarterly figures add up to the annual ones: the non-adjusted quarterly figures add up to the non-adjusted annual figure, and the seasonally and calendar-adjusted quarterly figures add up to the calendar-adjusted annual figures.

⁽⁵⁾ Regulation (EU) No. 549/2013. Available at: <http://ec.europa.eu/eurostat/web/esa-2010>.

Method for producing the GDP t+45 flash estimate

The ESA2010 transmission programme requires Member States to send the first set of quarterly national accounts data two months after the end of the quarter. In view of users' need to have data on GDP available earlier than this, the majority of Member States have also agreed to provide a flash estimate of quarterly GDP to be used for compiling the GDP t+45 flash estimates for the euro area and the EU. In most cases, Member States and Eurostat currently publish their GDP t+45 estimates on the same day.

Given that 45 days after the quarter-end is a relatively short deadline for producing macroeconomic statistics, it was agreed when Member States first started providing the GDP t+45 estimates that they would only be expected to send the seasonally and calendar-adjusted GDP growth rates. The figures they send are: i) the reference quarter compared with the previous quarter (quarter-on-quarter growth); and ii) the reference quarter compared with the same quarter of the previous year (year-on-year growth). Providing information on the seasonally adjusted quarter-on-quarter growth (including calendar adjustment where relevant) was seen as the main target of the GDP t+45 flash estimates. Whenever this data is available for a Member State, Eurostat therefore uses the quarter-on-quarter national GDP growth as its primary information.

The GDP t+45 flash estimates for the euro area and the EU have been published since 2003Q1. Eurostat developed the method for producing the flash estimate and tested its performance before the first data release. The GDP t+30 flash estimate has been developed following a similar procedure, and the aim was to make the methodology for producing this estimate as similar as possible to that already being used for the GDP t+45 flash estimate. It is therefore useful to consider briefly the methodological decisions that were taken during the development of the GDP t+45 flash estimates.

The first regular GDP t+45 flash estimate for the euro area and the EU was already being prepared at that time using the Chow-Lin regression-based temporal disaggregation technique, in a manner similar to that described above. To calculate an estimate of GDP for the most recent quarter(s), the specified Chow-Lin regression model relation between quarterly GDP indicator (deviating from the annual level) and annual GDP was applied for obtaining a European quarterly GDP that is in line with the evolution at annual level.

During the testing phase of the GDP t+45 estimates for the euro area and the EU, there were five Member States producing GDP estimates before or at t+45 days: Germany (t+45), Greece (t+45), Italy (t+45), the Netherlands (t+45) and the United Kingdom (t+25). These countries together accounted for more than 50 % of EU GDP. For two other large economies (France and Spain) for which GDP t+45 estimates were not yet available, the industrial production index of the reference quarter was available before t+45. For these two countries, GDP growth was therefore estimated using a regular regression model for which the inputs were one or more available indicators (mainly the industrial production index).

Next, the temporal disaggregation was prepared for quarters up to the quarter preceding the reference quarter ($Q-1$):

1. by aggregating the annual GDP of all countries up to the most recent year available; and
2. by aggregating the quarterly GDP of all countries for which it was available for quarters up to $Q-1$ (GDP data for Ireland and Luxembourg were missing at that time).

In order to complete the quarterly GDP indicator time series, i.e. to have a figure for the GDP indicator for the reference quarter (Q), the weighted average of the quarterly growth rates of the countries providing flash estimates was considered as the growth estimate for the EU (for which there were seven such countries) and for the euro area (for which there were six countries producing estimates) for the reference quarter Q . The quarterly GDP indicator series (as described in point 2 above) was then extended to include the reference quarter Q by applying the calculated estimates of the euro area and EU growth rates to the series.

It should be remembered that the quarterly indicator series (referred to in point 2 above) was not at the same level as the annual series due to quarterly GDP data being missing for two countries. As a last step, temporal disaggregation was therefore applied using the Chow-Lin regression model, to align the annual and quarterly GDP series.

The method for producing the GDP t+45 flash estimates described in this section was mainly used until 2013, at which time the methodology was simplified. Since 2013, the quarterly GDP levels for the euro area and the EU have been directly derived by applying the respective quarter-on-quarter growth rates for quarter Q to the GDP levels for quarter $Q-1$. These growth rates are obtained by aggregating the countries' GDP t+45 flash growth rates using the weights of their GDP in current prices for year $y-1$. The main factors that made this simplification possible were, first, that countries that had not been providing quarterly GDP data in 2003 had started to do so, and second, that by 2013, the number of Member States producing GDP t+45 flash estimates had grown such that they then accounted for over 90 % of euro-area and EU GDP ⁽⁶⁾. The GDP t+45 flash estimates for the euro area and the EU are therefore now almost entirely based on the input from Member States, with estimation techniques and modelling no longer being used.

Method for producing the GDP t+30 flash estimate

When the task force started work in May 2013, three Member States — Belgium, Lithuania and the United Kingdom — were already publishing a GDP flash estimate at t+30 days or earlier (the UK publishes at t+25 days). The task force's aim was to document the experience and best practices learnt by Member States that already publish a flash estimate at t+30 days, those that are testing or have tested its feasibility and those who would be willing to start testing the possibility. Another, more specific objective mentioned in the task force's mandate was to assess whether it would be possible to publish a sufficiently reliable flash estimate of GDP for the euro area and the EU, based on the information available at t+30 days, including national estimates produced by the Member States. It was, however, emphasised in the mandate that the task force was in no way aiming to push Member States to publish national quarterly GDP data at t+30. The decision as to whether or when to publish data is left entirely to the national statistical institutes.

The description of the task force's work given in the mandate indicates that the choice to use an indirect approach had already been made at the beginning of the project, and before starting to produce the GDP t+30 test estimates for the euro area and the EU. The flash estimates produced by Member States, whether published or for internal use only, and/or the indicators available at t+29, are therefore used as the main data sources, rather than indicators at euro area or EU level. The exact definition of the statistics to be provided for the GDP t+30 estimates is the same as that for the GDP t+45 estimates: seasonally and calendar-adjusted quarter-on-quarter and year-on-year growth estimates for the euro area and for the EU. When developing the method by which to produce the GDP t+30 flash estimate, the approach taken was therefore to follow the method already being used for the GDP t+45 flash estimates as closely as possible.

The process for producing the GDP t+30 flash estimates for the euro area and the EU can be presented as five steps:

- A group of Member States send their t+30 quarter-on-quarter and year-on-year seasonally and calendar-adjusted GDP growth estimates 29 days after the end of the reference quarter. This group includes Member States that already publish their t+30 estimates ⁽⁷⁾ and Member States that send confidential estimates to Eurostat.
- Eurostat aggregates the countries' quarter-on-quarter growth rates using the weights of their respective annual GDP in current prices for year $y-1$, to produce aggregate growth rates for the euro area and the EU. (See equation A.5 in Annex A for further details. Annex A also provides a more extensive discussion of the method used for aggregating the volume growth rates of the components of GDP.)
- Optional step: estimating the growth rate for a major EU country for which data are missing. If the GDP estimate for a major Member State is not available, its GDP growth is estimated using other available data. The other available data would typically consist of indicators such as the industrial production index, deflated retail trade and the turnover of services, for which two months' data would be available

⁽⁶⁾ For the t+45 flash estimates for 2013Q1, for example, these Member States accounted for 97 % of euro-area GDP and 95 % of EU GDP. In September 2015, five Member States did not provide GDP t+45 estimates: Croatia, Denmark, Malta, Slovenia and Sweden. Sweden only provides a GDP t+30 estimate for the second quarter.

⁽⁷⁾ By the end of 2015, six Member States were publishing quarterly GDP estimates before or at t+30: Austria, Belgium, Latvia, Lithuania, Spain and the United Kingdom.

and the third month could be nowcast. Rather than relying only on a one-point estimate, the aim is to have a number of nowcast estimates, in order to be able to compare them. Nowcast estimates of national data would typically be produced in the following ways:

1. using the national accounts weights of the country to weight the growth rates of the industrial production index, deflated retail trade and turnover of services;
2. using all or some of the indicators mentioned above in an ADL or ARIMAX model, together with the GDP;
3. using the economic sentiment indicator (ESI) in one of the models mentioned in point 2.

The above estimates can then be compared against forecasts issued by official and/or commercial forecasters. Once an estimate has been determined for a country for which data were missing, it can then be included in the aggregation of the country growth rates, along with the other GDP estimates provided directly by the Member States.

- Optional step: using the ESI for rounding. If there is a situation where rounding poses a potential problem, i.e. if the second decimal of the GDP $t+30$ estimate for either the euro area or the EU is close to 5 (i.e. a growth rate of $\sim x.x5$ %), this estimate can be topped up by using the ESI for the part of the European aggregate for which country estimates are missing. A weighted aggregate of the ESIs of the countries for which GDP estimates are missing would be calculated. This would then be entered into an ARIMAX model, together with the aggregated GDP growth rate for previous quarters for the same set of countries, in order to nowcast the development of the reference quarter. In the most recent test estimates, Member States that were not providing GDP flash estimates accounted for approximately 10 % of EU GDP and 6 % of euro-area GDP. The contribution of these countries to the developments seen at euro-area and EU level is therefore typically minor.
- Once a final quarter-on-quarter GDP growth estimate has been obtained for the euro area and the EU, the GDP level estimates for both areas for the reference quarter (Q) are then derived by applying the quarter-on-quarter GDP growth rate to the seasonally and calendar-adjusted GDP figures for quarter $Q-1$. The seasonally and calendar-adjusted estimate of GDP in the reference quarter (Q) is used to calculate an estimate of the year-on-year GDP growth for both the euro area and the EU.

4. Quality acceptance criteria

4.1 Introduction

An important part of the GDP t+30 project was to assess the feasibility of producing a flash estimate of GDP growth at 30 days after the end of the reference quarter for both the euro area and the EU ⁽⁸⁾. The EU Member States that participated in the task force ‘GDP flash at t+30 days’ were therefore asked to provide test data in real time from 2014Q1 to 2015Q4 (with delivery of the data no later than 29 days after the end of the quarter). In addition, data were to be ‘reconstructed’ for all quarters going back to 2012Q1. Member States that were already producing GDP flash estimates at t+30 were able to simply supply Eurostat with these estimates. Those countries that were not already producing GDP flash estimates at t+30 days were asked to calculate their national estimate retrospectively (i.e. using the data that would have been available to them 29 days after the end of the quarter).

National data were therefore available for 16 quarters (eight quarters in real time and eight quarters as a mixture of retrospective and real time results) for testing the quality of the GDP t+30 flash estimates produced for the euro area and the EU.

In order to assess the feasibility of producing a flash estimate of GDP growth in the euro area and the EU at 30 days after the end of the reference quarter, it was necessary to set criteria that the results of the test estimates would need to fulfil. These ‘quality acceptance criteria’ and how they were arrived at is the subject of this chapter.

Section 4.2 examines the definition of quality. Section 4.3 discusses some of the considerations that were taken into account when setting the quality criteria. Section 4.4 presents the criteria to be used for assessing the quality of the test estimates.

4.2 Defining quality

Quality is a term frequently used in statistics, but the definition of quality can vary. It can be defined in a narrow or in a broad way. In the former case, the focus is purely on statistical accuracy. In the latter, the definition may also include accessibility and timeliness, i.e. how soon after a reference period statistics are released. It is clear that quality is important to users of official statistics and that it should be a main consideration when developing statistics for publication.

The ESS recommends that assessment of the quality of statistics should comment on nine areas:

- relevance, assessment of user needs and perceptions;
- accuracy and reliability;
- timeliness and punctuality;
- coherence and comparability;
- accessibility and clarity;
- cost and burden;
- confidentiality;
- statistical processing.

These different aspects of quality should all be considered when developing statistics for publication. For the GDP t+30 flash estimate, however, at least in the early stages of development, the main considerations were accuracy and timeliness. These two dimensions are discussed in more detail below.

⁽⁸⁾ In 2016, the EU is made up of 28 Member States, of which 19 are in the euro area. The test estimates for the period 2012-2015 were carried out using the ‘changing composition’ of the euro area and the EU, i.e. on the basis of the countries actually in the euro area and the EU at any particular point in time. The test estimates for the EU produced between 2012Q1 and 2013Q2 are therefore for 27 Member States, and those for later quarters are based on 28 Member States. The number of euro area countries was 17 in 2012/2013, 18 in 2014 and 19 in 2015.

The accuracy of the GDP t+30 flash estimate is probably the most important quality indicator. The aim is to produce an estimate that gives a good indication of GDP growth but at an earlier point in time than the current GDP t+45 estimate. The quality of later estimates is assessed regularly. A ‘good’ GDP t+30 flash estimate is therefore one that consistently produces an estimate of growth ‘similar’ to the ones released later (at t+45, t+65 and t+100 ⁽⁹⁾). The revisions needed to the GDP t+30 flash estimates will therefore form the basis of one of the acceptance criteria.

It may also be of interest to examine the revisions needed to individual Member States’ GDP flash estimates. Assessing the quality of the Member States’ estimates goes beyond the scope of the project, however. Therefore, only the revisions needed to the GDP t+30 flash estimates for the euro area and the EU will be considered when developing the quality acceptance criteria.

The timeliness – the time between the end of the reference period and publication – is set by definition in the case of the GDP t+30 flash estimates. It is important to ensure that the EU Member States involved consistently send their data by the t+29 deadline ⁽¹⁰⁾ to avoid any risk of the publication of the European aggregates being delayed.

4.3 Considerations when setting the acceptance criteria

A number of issues had to be considered before setting the quality acceptance criteria. One critical consideration was whether enough observations would be available to determine whether the aggregate is of sufficient quality. Using retrospective back data from Member States meant that the time series could be extended, but there were still only 16 quarters of data. The short time span will obviously increase the risk of the results giving a misleading picture of the accuracy of the statistics and thus an incorrect assessment.

The data for quarters from 2012Q1 to 2013Q4 were, for the majority of Member States, produced on a retrospective basis. During initial discussions about the possible methods for producing flash estimates, a number of Member States indicated that their normal methods were not entirely theoretical, and that expert judgement also played a role. Retrospective data can, however, only be produced using a purely theoretical approach, which may potentially lead to inferior results compared to those that would have been produced had there been an element of expert judgment (although there is no way to prove this). Consideration should also be given to the fact that Member States are at the start of a developmental process. It would be expected that Member States will refine their methods during the next two years, leading to a gradual improvement in results. Accordingly, later quarters may provide a better barometer for accuracy than the earlier estimates. This, however, is very much dependent on Member States’ approach to developing their methodology for flash estimates.

As stated in the previous section, the preferred measure of accuracy is the revision made to the GDP t+30 flash estimate. A useful starting point for determining what is an acceptable level of revision is to consider the revisions made to the current GDP t+45 flash estimate. Eurostat publishes data on the revisions of the euro area 12 (EA-12) on its website ⁽¹¹⁾. At the time of preparing this paper, data were available from 2003Q1 to 2013Q4 for the flash (t+45), second (t+65) and third (t+100) estimates. Table 1 below shows the average and absolute average revision made to the t+45 estimates compared with the t+65 and t+100 estimates.

⁽⁹⁾ Eurostat published the European aggregates at t+100 for quarters up to 2014Q3.

⁽¹⁰⁾ In order to allow publication at t+30 days in 2016, national GDP flash data will need to be provided before 16.00 on day t+29.

⁽¹¹⁾ Revisions for the euro-area 12 Member States (EA-12) are available at: <http://ec.europa.eu/eurostat/web/national-accounts/data/other>

Table 1: Revisions to quarter-on-quarter GDP t+45 growth of euro area 12 at 65 and 100 days
(percentage points of GDP growth)

| | Average revision | Average absolute revision |
|----------------------|------------------|---------------------------|
| t+45 to t+65 | 0.00 | 0.02 |
| t+45 to t+100 | 0.00 | 0.03 |

Source: Eurostat calculations

Over this 11-year period, the revision performance of the GDP t+45 flash estimate for the EA-12 was very good. The revision performance of the t+45 estimates for the EU was similar to that for the EA-12, as shown above.

To put this data into context, and also as a starting point for fixing the criteria to be met by the GDP t+30 flash estimate, it is worth considering the revisions made to the US GDP flash estimate, which is published at t+30. These were as follows, over the period from 2003Q1 to 2014Q3:

Table 2: Revisions to quarter-on-quarter GDP t+30 growth of the United States at 60 and 90 days
(percentage points of GDP growth)

| | Average revision | Average absolute revision |
|---------------------|------------------|---------------------------|
| t+30 to t+60 | 0.02 | 0.13 |
| t+30 to t+90 | 0.02 | 0.16 |

Source: Eurostat calculations

As can be seen from the tables above, the US appears to revise its estimate more than has been necessary for the EA-12 estimate, with the absolute revision in particular being significantly larger. There is of course a variety of reasons why this might be the case, including the fact that the US flash estimate is produced 15 days earlier. The revisions made to the US estimates will be taken into consideration when setting the acceptance criteria for accuracy for the GDP t+30 flash estimates for the euro area and the EU.

As a minimum, the GDP t+30 flash estimate needs to be an unbiased estimate of the GDP t+45 figure. In other words, the frequency of upwards and downwards revisions should be broadly equal, and the average revision should be not statistically significantly different from 0. Performing a statistical test on such a short run of observations would, unfortunately, be difficult. Using a student's t-test on a sample of this size would result in a high probability of a 'type II error', leading to the null hypothesis being accepted on false grounds, i.e. concluding that there is no bias when there is. See Annex B for more details.

In addition, as mentioned in Section 4.2 of this chapter, it is necessary to set deadlines by which Member States are required to submit their data. This will ensure that Eurostat always receives the data with enough time to produce the GDP estimates for the euro area and the EU by the t+30 deadline. As the first publication is scheduled for April 2016, it should be sufficient to test whether the four quarters of 2015 are transmitted to Eurostat in time (i.e. at t+29 days).

4.4 Recommended acceptance criteria

The previous sections have looked at the meaning of the quality of statistics and the factors that need to be taken into consideration when setting the acceptance criteria. Given the options available as criteria and the limitations of the data, the following four acceptance criteria were recommended.

1. Unbiased GDP t+30 flash estimate

The GDP t+30 flash estimate should be an unbiased estimate of the t+45 estimate of GDP growth, with an average revision of between -0.05 and +0.05 percentage points, and no more than 66.7 % of revisions in the same direction.

This criterion has been set to test for bias. The ideal way of testing for bias would be to perform a statistical test. As the sample is too small to perform this type of test, the recommendation is therefore to use the boundaries -0.05 and +0.05. To avoid a scenario where a small number of large revisions in one direction (plus or minus) offset a large number of smaller revisions in the other direction, the criterion also includes a test on the percentage of revisions in each direction (tested at publication level, i.e. to one decimal place).

This criterion should be tested on all the available test data (from the first flash estimate in 2012Q1 onwards) and kept under review once the estimates start to be published.

2. Limited average absolute revision

The average absolute revision made to the t+30 estimate of GDP growth should be: i) less than or equal to 0.10 percentage points when the t+45 estimate is published; and ii) less than or equal to 0.13 percentage points when the t+65 estimate is published.

This criterion has been set to ensure that the level of revisions made to the GDP t+30 flash estimate is acceptable. In theory, the first part of criterion 1 (that the average revision must be between -0.05 and +0.05 percentage points) could be met if there were large offsetting revisions in both directions, which would be undesirable. Criterion 2 will guard against this. When setting these boundaries, particular consideration was given to the revisions made to the US early estimates of GDP over the period 2012Q1 to 2014Q3. An overview of the revisions to early estimates of US GDP growth is attached as Annex C ⁽¹²⁾. Although it could be argued that the revisions made to GDP estimates for the euro area and the EU could be expected to be smaller than those for the US statistics, it should also be kept in mind that the GDP t+30 flash estimates for the euro area and the EU are developing statistics. As mentioned in Section 4.3, a substantial number of Member States produced the data for the quarters between 2012Q1 and 2013Q4 on a purely theoretical basis, without having the opportunity to make use of expert judgement. It can be assumed that expert judgement would improve these early estimates, and therefore that the revisions needed should decrease over time. On the basis of these considerations, limits have been set that are quite similar to the revisions made to US statistics.

This criterion should be tested on data from all test quarters.

3. Sufficient coverage

For the final two quarters of 2015, Eurostat needs to receive estimates from Member States whose combined GDP in the previous year accounted for 70 % of total GDP for the euro area and the EU respectively by the t+29 deadline.

This criterion will ensure sufficient coverage. It has also been set to safeguard against the publication of a GDP t+30 flash estimate before it has been proven that it will be possible to deliver the estimate consistently by this date. This criterion will reduce the likelihood of insufficient data being available to produce good quality GDP t+30 flash estimates for the euro area and the EU once data releases begin. In addition to meeting this criterion, there should also be no known reasons why the criteria would not be met for every quarter in 2016. This should be ensured by obtaining commitments from the representatives of the Member States involved.

4. Availability communication plan

The main milestones set out in the communication plan should be met, or there should be plans in place to ensure that they will be met, before publication of the GDP t+30 flash estimate begins.

The communication of the GDP t+30 flash estimate will be vitally important to the success of the statistic. Section 4.3 highlights the good revision performances of the current GDP t+45 flash estimate. Given that there

⁽¹²⁾ Annex C provides data on revisions to US estimates over a slightly longer period: 2012Q1-2025Q2.

is always a trade-off between timeliness and accuracy, the introduction of a GDP t+30 flash estimate will almost certainly lead to larger revisions to subsequent estimates (compared to those required for the GDP t+45 estimate). It is important that users are aware of this. Having a good communication plan in place should help users to understand and interpret the new statistic, and make them aware of the consequence of improved timeliness in terms of the subsequent revisions required.

The four acceptance criteria described above have been applied to the GDP t+30 test estimates for the euro area and the EU. If these acceptance criteria are met, then publication of the GDP t+30 flash estimate could start in 2016. The next chapter assesses the GDP t+30 test estimates against the three technical quality acceptance criteria. (The fourth quality acceptance criterion, the availability of a communication plan, is deemed to have been met on the basis of the draft of a communication strategy for managing the introduction of the GDP t+30 flash estimates for the euro area and the EU.)

5. Results and assessment of the GDP t+30 test estimates

5.1 Introduction

The previous sections discussed the method used to prepare the GDP t+30 test estimates for the euro area and the EU, and explained the quality acceptance criteria to be used for assessing these test estimates. This chapter will now present the results for the 16 test quarters and compare these results with the GDP estimates released at t+45 days, t+65 days and t+100 days (the flash, second and third estimates). It analyses the revisions made to the GDP t+30 estimates at each of these dates (i.e. the difference between the GDP t+30 estimate and each of the above-mentioned later estimates) and assesses the GDP t+30 test estimates against the quality acceptance criteria.

Section 5.2 briefly presents the test estimates and Section 5.3 assesses these results against the quality acceptance criteria, as set out in Chapter 4.

5.2 Results of the GDP t+30 test estimates

To assess the feasibility of estimating the quarter-on-quarter and year-on-year GDP growth in the euro area and the EU at 30 days after the quarter-end, Eurostat, in cooperation with the participating Member States, compiled 16 GDP t+30 test flash estimates. Eight of the test estimates were produced retrospectively for past quarters from 2012 and 2013 and eight estimates were compiled in real-time during 2014 and 2015.

As already explained in Chapter 4.3, for the quarters where estimates were produced retrospectively, Member States were asked to provide estimates calculated using only primary source data that would have been available 29 days after the end of the reference quarter. Real-time t+30 estimates could be used for Belgium, Spain, the UK and Lithuania as these countries were already publishing GDP t+30 estimates at that time.

The estimates for the quarters from 2014Q1 to 2015Q4 were calculated in real-time. The participating Member States were asked to provide their estimates to Eurostat 29 days after the end of the reference quarter. The data provided by the various Member States included published estimates (as mentioned above) for Belgium, Spain, the UK and Lithuania, and, from 2014Q3 onwards, also for Austria and Latvia. Using the estimates provided by all participating Member States, Eurostat then compiled the real-time GDP t+30 flash estimates for the euro area and the EU.

Table 3 below compares the test t+30 and the t+45 flash estimates for quarter-on-quarter GDP growth in the euro area. Table 4 shows the corresponding data for the EU.

Table 3: Euro area, test t+30 and t+45 flash estimates of GDP growth
(quarter-on-quarter GDP growth rates, %; revisions to growth rates, percentage points)

| Quarter | Composition euro area | Compilation level | | | Publication level | | | Coverage | |
|---------|-----------------------|-------------------|-------|----------------------|-------------------|------|----------------------|----------|-------------------------|
| | | t+30 test | t+45 | Revision t+45 - t+30 | t+30 test | t+45 | Revision t+45 - t+30 | % of GDP | Number of Member States |
| 2012Q1 | EA-17 | -0.06 | 0.02 | 0.08 | -0.1 | 0.0 | 0.1 | 70 | 7 |
| 2012Q2 | EA-17 | -0.07 | -0.18 | -0.11 | -0.1 | -0.2 | -0.1 | 70 | 7 |
| 2012Q3 | EA-17 | 0.07 | -0.05 | -0.13 | 0.1 | -0.1 | -0.2 | 91 | 8 |
| 2012Q4 | EA-17 | -0.51 | -0.59 | -0.08 | -0.5 | -0.6 | -0.1 | 91 | 8 |
| 2013Q1 | EA-17 | -0.21 | -0.22 | -0.01 | -0.2 | -0.2 | 0.0 | 70 | 7 |
| 2013Q2 | EA-17 | 0.31 | 0.27 | -0.04 | 0.3 | 0.3 | 0.0 | 91 | 8 |
| 2013Q3 | EA-17 | 0.11 | 0.09 | -0.02 | 0.1 | 0.1 | 0.0 | 91 | 8 |
| 2013Q4 | EA-17 | 0.26 | 0.28 | 0.02 | 0.3 | 0.3 | 0.0 | 91 | 8 |
| 2014Q1 | EA-18 | 0.28 | 0.19 | -0.10 | 0.3 | 0.2 | -0.1 | 70 | 8 |
| 2014Q2 | EA-18 | 0.07 | 0.05 | -0.03 | 0.1 | 0.0 | -0.1 | 63 | 8 |
| 2014Q3 | EA-18 | 0.13 | 0.16 | 0.03 | 0.1 | 0.2 | 0.1 | 88 | 9 |
| 2014Q4 | EA-18 | 0.22 | 0.34 | 0.12 | 0.2 | 0.3 | 0.1 | 94 | 10 |
| 2015Q1 | EA-19 | 0.29 | 0.40 | 0.11 | 0.3 | 0.4 | 0.1 | 73 | 10 |
| 2015Q2 | EA-19 | 0.27 | 0.31 | 0.04 | 0.3 | 0.3 | 0.0 | 94 | 11 |
| 2015Q3 | EA-19 | 0.26 | 0.30 | 0.04 | 0.3 | 0.3 | 0.0 | 94 | 11 |
| 2015Q4 | EA-19 | 0.24 | 0.27 | 0.03 | 0.2 | 0.3 | 0.1 | 94 | 11 |

Source: Eurostat calculations

Table 4: EU, test t+30 and t+45 flash estimates of GDP growth
(quarter-on-quarter GDP growth rates, %; revisions to growth rates, percentage points)

| Quarter | Composition EU | Compilation level | | | Publication level | | | Coverage | |
|---------|----------------|-------------------|-------|----------------------|-------------------|------|----------------------|----------|-------------------------|
| | | t+30 test | t+45 | Revision t+45 - t+30 | t+30 test | t+45 | Revision t+45 - t+30 | % of GDP | Number of Member States |
| 2012Q1 | EU-27 | -0.03 | -0.05 | -0.01 | 0.0 | 0.0 | 0.0 | 70 | 12 |
| 2012Q2 | EU-27 | -0.10 | -0.16 | -0.06 | -0.1 | -0.2 | -0.1 | 73 | 13 |
| 2012Q3 | EU-27 | 0.25 | 0.13 | -0.12 | 0.2 | 0.1 | -0.1 | 86 | 13 |
| 2012Q4 | EU-27 | -0.48 | -0.51 | -0.04 | -0.5 | -0.5 | 0.0 | 86 | 13 |
| 2013Q1 | EU-27 | -0.08 | -0.11 | -0.03 | -0.1 | -0.1 | 0.0 | 70 | 12 |
| 2013Q2 | EU-27 | 0.35 | 0.32 | -0.03 | 0.3 | 0.3 | 0.0 | 89 | 14 |
| 2013Q3 | EU-28 | 0.26 | 0.24 | -0.02 | 0.3 | 0.2 | -0.1 | 86 | 13 |
| 2013Q4 | EU-28 | 0.37 | 0.39 | 0.03 | 0.4 | 0.4 | 0.0 | 86 | 13 |
| 2014Q1 | EU-28 | 0.42 | 0.32 | -0.09 | 0.4 | 0.3 | -0.1 | 71 | 14 |
| 2014Q2 | EU-28 | 0.22 | 0.18 | -0.04 | 0.2 | 0.2 | 0.0 | 65 | 13 |
| 2014Q3 | EU-28 | 0.27 | 0.30 | 0.03 | 0.3 | 0.3 | 0.0 | 85 | 15 |
| 2014Q4 | EU-28 | 0.30 | 0.38 | 0.08 | 0.3 | 0.4 | 0.1 | 90 | 17 |
| 2015Q1 | EU-28 | 0.34 | 0.42 | 0.08 | 0.3 | 0.4 | 0.1 | 75 | 16 |
| 2015Q2 | EU-28 | 0.38 | 0.41 | 0.03 | 0.4 | 0.4 | 0.0 | 92 | 17 |
| 2015Q3 | EU-28 | 0.31 | 0.37 | 0.06 | 0.3 | 0.4 | 0.1 | 90 | 16 |
| 2015Q4 | EU-28 | 0.31 | 0.35 | 0.03 | 0.3 | 0.3 | 0.0 | 91 | 17 |

Source: Eurostat calculations

5.3 Assessment of GDP t+30 test estimates

Table 3 shows that the revisions to the published data (growth rate given to one decimal place) for the GDP t+30 estimates for the euro area would have been 0.0 six times (38 %), +0.1 five times (31 %), -0.1 four times (25 %) and -0.2 on one occasion (6 %), meaning there would have been five downwards revisions (31 %), and also five upwards revisions (31 %). Table 4 shows that revisions to the published data for the EU would have been 0.0 nine times (56 %), -0.1 four times (25 %) and +0.1 three times (19 %), meaning there would have been four downwards revisions (25 %) and three upwards revisions (19 %). The average revisions, when comparing figures at t+30 and t+45 given to two decimal places, are 0.00 for the euro area and -0.01 for the EU. Both the numbers of revisions in each direction and the average revision to be made between the t+30 and the t+45 estimate are therefore within the limits allowed by the first quality criterion as specified in Chapter 4.4 (an unbiased GDP t+30 flash estimate for the euro area and the EU).

As can be seen from Tables 3 and 4 above, the coverage of the GDP t+30 estimates varied between 63 % and 94 % of total GDP for the euro area, and between 65 % and 92 % of total GDP for the EU. During the final two quarters of 2015, the coverage has been at an average of 94 % of GDP for the euro area and 91 % for the EU. The test estimates therefore clearly meet the coverage criterion as specified in Chapter 4.4 (coverage should be more than 70 % of total GDP for the euro area and the EU respectively).

The performance of the t+30 quarter-on-quarter GDP growth estimates is further analysed in Tables 5 (for the euro area) and 6 (for the EU). A similar analysis for the t+30 estimates of year-on-year GDP growth is given in Tables 7 (for the euro area) and 8 (for the EU).

Table 5: GDP t+30 test estimates and revisions for the euro area
(quarter-on-quarter GDP growth rates, %; revisions to growth rates, percentage points)

| | GDP growth rates | | | | | Revisions to t+30 estimate at | | | |
|--|------------------|-------|-------|-------|--------------|-------------------------------|-------|-------|----------|
| | t+30 | t+45 | t+65 | t+100 | t+3m+65 d | t+45 | t+65 | t+100 | t+3m+65d |
| 2012Q1 | -0.06 | 0.02 | -0.01 | 0.01 | -0.02 | 0.08 | 0.05 | 0.07 | 0.04 |
| 2012Q2 | -0.07 | -0.18 | -0.17 | -0.18 | -0.17 | -0.11 | -0.09 | -0.10 | -0.10 |
| 2012Q3 | 0.07 | -0.05 | -0.05 | -0.07 | -0.07 | -0.13 | -0.12 | -0.14 | -0.14 |
| 2012Q4 | -0.51 | -0.59 | -0.59 | -0.59 | -0.59 | -0.08 | -0.09 | -0.08 | -0.08 |
| 2013Q1 | -0.21 | -0.22 | -0.21 | -0.27 | -0.16 | -0.01 | 0.00 | -0.06 | 0.05 |
| 2013Q2 | 0.31 | 0.27 | 0.29 | 0.26 | 0.30 | -0.04 | -0.01 | -0.04 | -0.01 |
| 2013Q3 | 0.11 | 0.09 | 0.08 | 0.13 | 0.15 | -0.02 | -0.03 | 0.02 | 0.04 |
| 2013Q4 | 0.26 | 0.28 | 0.28 | 0.23 | 0.26 | 0.02 | 0.02 | -0.03 | 0.00 |
| 2014Q1 | 0.28 | 0.19 | 0.18 | 0.21 | 0.22 | -0.10 | -0.10 | -0.08 | -0.06 |
| 2014Q2 | 0.07 | 0.05 | 0.03 | : | 0.07 | -0.03 | -0.04 | : | 0.00 |
| 2014Q3 | 0.13 | 0.16 | 0.16 | : | 0.18 | 0.03 | 0.03 | : | 0.06 |
| 2014Q4 | 0.22 | 0.34 | 0.33 | : | 0.36 | 0.12 | 0.11 | : | 0.14 |
| 2015Q1 | 0.29 | 0.40 | 0.37 | : | 0.52 | 0.11 | 0.08 | : | 0.23 |
| 2015Q2 | 0.27 | 0.31 | 0.36 | : | 0.39 | 0.04 | 0.09 | : | 0.12 |
| 2015Q3 | 0.26 | 0.30 | 0.29 | : | : | 0.04 | 0.03 | : | : |
| 2015Q4 | 0.24 | 0.27 | : | : | : | 0.03 | | : | : |
| Average revision | | | | | | 0.00 | 0.00 | -0.05 | 0.02 |
| Average absolute revision | | | | | | 0.06 | 0.06 | 0.07 | 0.08 |
| Root of the mean squared errors (RMSQE) | | | | | | 0.07 | 0.07 | 0.08 | 0.10 |

Source: Eurostat calculations

Table 6: GDP t+30 test estimates and revisions for the EU
(quarter-on-quarter GDP growth rates, %; revisions to growth rates, percentage points)

| | GDP growth rates | | | | | Revisions to t+30 estimate at | | | |
|--|------------------|-------|-------|-------|----------|-------------------------------|-------|-------|----------|
| | t+30 | t+45 | t+65 | t+100 | t+3m+65d | t+45 | t+65 | t+100 | t+3m+65d |
| 2012Q1 | -0.03 | -0.05 | -0.02 | 0.00 | -0.02 | -0.01 | 0.01 | 0.03 | 0.01 |
| 2012Q2 | -0.10 | -0.16 | -0.14 | -0.15 | -0.15 | -0.06 | -0.04 | -0.05 | -0.05 |
| 2012Q3 | 0.25 | 0.13 | 0.12 | 0.11 | 0.11 | -0.12 | -0.13 | -0.14 | -0.14 |
| 2012Q4 | -0.48 | -0.51 | -0.49 | -0.49 | -0.50 | -0.04 | -0.01 | -0.01 | -0.02 |
| 2013Q1 | -0.08 | -0.11 | -0.06 | -0.13 | -0.05 | -0.03 | 0.02 | -0.04 | 0.03 |
| 2013Q2 | 0.35 | 0.32 | 0.36 | 0.32 | 0.36 | -0.03 | 0.01 | -0.03 | 0.01 |
| 2013Q3 | 0.26 | 0.24 | 0.23 | 0.26 | 0.31 | -0.02 | -0.03 | 0.00 | 0.05 |
| 2013Q4 | 0.37 | 0.39 | 0.42 | 0.39 | 0.39 | 0.03 | 0.05 | 0.02 | 0.03 |
| 2014Q1 | 0.42 | 0.32 | 0.30 | 0.33 | 0.33 | -0.09 | -0.11 | -0.09 | -0.08 |
| 2014Q2 | 0.22 | 0.18 | 0.16 | : | 0.23 | -0.04 | -0.06 | : | 0.01 |
| 2014Q3 | 0.27 | 0.30 | 0.30 | : | 0.32 | 0.03 | 0.02 | : | 0.05 |
| 2014Q4 | 0.30 | 0.38 | 0.41 | : | 0.43 | 0.08 | 0.11 | : | 0.14 |
| 2015Q1 | 0.34 | 0.42 | 0.44 | : | 0.54 | 0.08 | 0.10 | : | 0.20 |
| 2015Q2 | 0.38 | 0.41 | 0.45 | : | 0.46 | 0.03 | 0.06 | : | 0.08 |
| 2015Q3 | 0.31 | 0.37 | 0.37 | : | : | 0.06 | 0.06 | : | : |
| 2015Q4 | 0.31 | 0.35 | : | : | : | 0.03 | : | : | : |
| Average revision | | | | | | -0.01 | 0.00 | -0.04 | 0.02 |
| Average absolute revision | | | | | | 0.05 | 0.05 | 0.05 | 0.06 |
| Root of the mean squared errors (RMSQE) | | | | | | 0.06 | 0.07 | 0.06 | 0.08 |

Source: Eurostat calculations

Table 7: GDP t+30 test estimates and revisions for the euro area
(year-on-year GDP growth rates, %; and revisions to growth rates, percentage points)

| | GDP growth rates | | | | | Revisions to t+30 estimate at | | | |
|--|------------------|-------|-------|-------|----------|-------------------------------|-------|-------|----------|
| | t+30 | t+45 | t+65 | t+100 | t+3m+65d | t+45 | t+65 | t+100 | t+3m+65d |
| 2012Q1 | -0.07 | 0.01 | -0.05 | -0.04 | -0.05 | 0.08 | 0.02 | 0.03 | 0.02 |
| 2012Q2 | -0.28 | -0.39 | -0.46 | -0.45 | -0.46 | -0.11 | -0.18 | -0.17 | -0.19 |
| 2012Q3 | -0.46 | -0.58 | -0.61 | -0.62 | -0.61 | -0.12 | -0.15 | -0.16 | -0.15 |
| 2012Q4 | -0.78 | -0.86 | -0.89 | -0.91 | -0.96 | -0.08 | -0.11 | -0.13 | -0.18 |
| 2013Q1 | -1.04 | -1.05 | -1.11 | -1.15 | -1.02 | -0.01 | -0.07 | -0.11 | 0.01 |
| 2013Q2 | -0.66 | -0.70 | -0.45 | -0.59 | -0.57 | -0.04 | 0.21 | 0.08 | 0.09 |
| 2013Q3 | -0.35 | -0.37 | -0.36 | -0.30 | -0.29 | -0.02 | 0.00 | 0.05 | 0.07 |
| 2013Q4 | 0.48 | 0.50 | 0.52 | 0.47 | 0.50 | 0.02 | 0.04 | -0.01 | 0.02 |
| 2014Q1 | 0.97 | 0.88 | 0.90 | 0.92 | 0.95 | -0.09 | -0.08 | -0.05 | -0.02 |
| 2014Q2 | 0.68 | 0.66 | 0.67 | : | 0.80 | -0.02 | 0.00 | : | 0.12 |
| 2014Q3 | 0.75 | 0.78 | 0.79 | : | 0.80 | 0.03 | 0.04 | : | 0.05 |
| 2014Q4 | 0.76 | 0.88 | 0.86 | : | 0.87 | 0.12 | 0.10 | : | 0.11 |
| 2015Q1 | 0.88 | 0.99 | 1.01 | : | 1.24 | 0.11 | 0.14 | : | 0.37 |
| 2015Q2 | 1.18 | 1.22 | 1.53 | : | 1.59 | 0.04 | 0.35 | : | 0.41 |
| 2015Q3 | 1.53 | 1.57 | 1.59 | : | : | 0.04 | 0.06 | : | : |
| 2015Q4 | 1.47 | 1.49 | : | : | : | 0.03 | : | : | : |
| Average revision | | | | | | 0.00 | 0.02 | -0.05 | 0.05 |
| Average absolute revision | | | | | | 0.06 | 0.10 | 0.09 | 0.13 |
| Root of the mean squared errors (RMSQE) | | | | | | 0.07 | 0.14 | 0.10 | 0.18 |

Source: Eurostat calculations

Table 8: GDP t+30 test estimates and revisions for the EU
(year-on-year GDP growth rates, %; revisions to growth rates, percentage points)

| | GDP growth rates | | | | | Revisions to t+30 estimate at | | | |
|--|------------------|-------|-------|-------|----------|-------------------------------|-------|-------|----------|
| | t+30 | t+45 | t+65 | t+100 | t+3m+65d | t+45 | t+65 | t+100 | t+3m+65d |
| 2012Q1 | 0.15 | 0.14 | 0.11 | 0.12 | 0.10 | -0.01 | -0.04 | -0.04 | -0.05 |
| 2012Q2 | -0.18 | -0.24 | -0.29 | -0.30 | -0.32 | -0.06 | -0.11 | -0.11 | -0.13 |
| 2012Q3 | -0.23 | -0.35 | -0.41 | -0.40 | -0.36 | -0.13 | -0.18 | -0.17 | -0.14 |
| 2012Q4 | -0.58 | -0.61 | -0.59 | -0.63 | -0.66 | -0.03 | -0.01 | -0.05 | -0.08 |
| 2013Q1 | -0.64 | -0.67 | -0.68 | -0.75 | -0.65 | -0.03 | -0.04 | -0.10 | -0.01 |
| 2013Q2 | -0.21 | -0.24 | -0.03 | -0.16 | -0.14 | -0.03 | 0.17 | 0.04 | 0.06 |
| 2013Q3 | 0.08 | 0.06 | 0.08 | 0.19 | 0.21 | -0.02 | 0.00 | 0.11 | 0.14 |
| 2013Q4 | 0.97 | 0.99 | 1.06 | 1.04 | 1.05 | 0.02 | 0.09 | 0.07 | 0.08 |
| 2014Q1 | 1.51 | 1.41 | 1.40 | 1.43 | 1.43 | -0.10 | -0.11 | -0.08 | -0.08 |
| 2014Q2 | 1.25 | 1.21 | 1.20 | : | 1.34 | -0.04 | -0.05 | : | 0.10 |
| 2014Q3 | 1.26 | 1.29 | 1.30 | : | 1.25 | 0.03 | 0.04 | : | -0.02 |
| 2014Q4 | 1.23 | 1.32 | 1.30 | : | 1.30 | 0.08 | 0.07 | : | 0.07 |
| 2015Q1 | 1.28 | 1.36 | 1.45 | : | 1.68 | 0.08 | 0.17 | : | 0.39 |
| 2015Q2 | 1.58 | 1.61 | 1.87 | : | 1.69 | 0.03 | 0.29 | : | 0.11 |
| 2015Q3 | 1.80 | 1.86 | 1.89 | : | : | 0.06 | 0.09 | : | : |
| 2015Q4 | 1.72 | 1.76 | : | : | : | 0.03 | : | : | : |
| Average revision | | | | | | -0.01 | 0.03 | -0.04 | 0.03 |
| Average absolute revision | | | | | | 0.05 | 0.10 | 0.09 | 0.10 |
| Root of the mean squared errors (RMSQE) | | | | | | 0.06 | 0.12 | 0.10 | 0.14 |

Source: Eurostat calculations

The four tables above compare the GDP growth rate at t+30 days with the estimates published at t+45 days (first estimate), at t+65 days (second estimate), at t+100 days (third estimate) and after three months plus 65 days. The last growth vintage allows us to assess how the GDP t+30 estimate for the reference quarter has changed by the time of publication of the second (65 days) estimate for the next quarter. The revisions are calculated as the later estimate minus the t+30 estimate, e.g. the estimate produced at t+45 minus the estimate at t+30. The average revisions, average absolute revisions and the root of the mean squared errors (RMSQE) are given in each table.

As can be seen in Tables 5 and 6, the average absolute revisions made to the t+30 estimate of the quarter-on-quarter GDP growth rates at t+45 and t+65 were 0.06 percentage points for the euro area and 0.05 percentage points for the EU (each at both points in time). The second quality criterion given in Section 4.4 requires that the average absolute revision between the t+45 and t+30 estimates should be less than or equal to 0.10 percentage points and the average absolute revision between the t+65 and t+30 estimates should be less than or equal to 0.13 percentage points. The GDP t+30 test estimates for the euro area and the EU therefore also fulfil the second quality criterion.

It should be noted that the average absolute revisions made to the t+30 estimates of quarter-on-quarter GDP growth for the euro area only slightly increased when the second (65 days) estimate for the subsequent quarter was available (the absolute average revision at this point being 0.08 percentage points, where it was 0.06 percentage points at 45 and 65 days after the end of the reference quarter). The average absolute revision for the EU was 0.06 percentage points on releasing the second (65 days) estimate for the following quarter, which was only 0.01 percentage points higher than it had been at t+45 and t+65.

As can be seen in Tables 7 and 8, the average absolute revisions to the GDP t+30 year-on-year growth are only slightly larger, for both the euro area and the EU. The same pattern has been seen for the t+45 flash.

Overall, the GDP t+30 test estimates for the euro area and the EU met all the predefined quality acceptance criteria, and the statistics can thus be considered to be of good quality.

Annexes

Annex A: Aggregation of the country growth rates

This Annex explains how the Member States' chain-linked volume growth rates are aggregated to compile the EU and euro-area growth rates.

The following notation will be used (reflecting the notation used in the Handbook on quarterly national accounts (Eurostat 2013, pp. 190-191)):

- The aggregate variable X at quarter c of year y in current prices is denoted by $X_{CP}^{c,y}$, in prices of the previous year by $X_{PPY}^{c,y}$, and for chain-linked volumes by $X_{CV}^{c,y}$.
- The implicit price deflator of the chain-linked volume indices is denoted by $P_X^{c,y} = \frac{X_{CP}^{c,y}}{X_{CV}^{c,y}}$.
- Measures indexed by a year only denote annual data, e.g. X_{CP}^y (the current price value of the aggregate X in year y) and $P_X^y = \frac{X_{CP}^y}{X_{CV}^y}$ is the implicit price deflator of X in the same year.
- Chain-linked volume indices have to be referenced to a value in a particular period, usually at 100 or the current price value in the reference year, thus $X_{CV}^0 = 100$ or $X_{CV}^0 = X_{CP}^0$.
- The annual chain-linked volume growth between y and $y-1$ can be calculated as $\frac{X_{CV}^y}{X_{CV}^{y-1}} = \frac{X_{PPY}^y}{X_{CP}^{y-1}}$
(where the latter is the Laspeyres type volume index $L_Q^y = \frac{X_{PPY}^y}{X_{CP}^{y-1}}$).

An annual chain Laspeyres volume index referenced to the current price value in year 0 can therefore be expressed as

$$X_{CV}^y = \prod_{m=1}^y \frac{X_{PPY}^m}{X_{CP}^{m-1}} X_{CP}^0.$$

In the case of annual overlap quarterly chain-linking method (used by Eurostat and the common practice in most EU countries) the quarterly previous year price figures refer to average prices of the previous year. This means that the quotient of a variable given in the previous year's prices and the corresponding chain-linked volume estimate is equal to the annual implicit price deflator of the previous year

$$\frac{X_{PPY}^{c,y}}{X_{CV}^{c,y}} = \frac{X_{PPY}^y}{X_{CV}^y} = \frac{X_{CP}^{y-1}}{X_{CV}^{y-1}} = P_X^{y-1}.$$

The following section first explains the background to the aggregation of annual country (or component) growth rates to give the annual growth rate of the aggregate. It then discusses the use of the annual current price weights for the year $y-1$ in aggregating Member States' chained quarter-on-quarter GDP growth rates to produce aggregates for the euro area and the EU.

Annual case

The relative growth rate of the chain-linked volumes (CV) for an individual country i is calculated by

$$A.1 \quad \frac{x_{CV,i}^y - x_{CV,i}^{y-1}}{x_{CV,i}^{y-1}} = \frac{x_{PPY,i}^y - x_{CP,i}^{y-1}}{x_{CP,i}^{y-1}}. \text{ Multiplying both sides of the equation by } x_{CP,i}^{y-1} \text{ gives}$$

$$A.2 \quad \Leftrightarrow x_{CP,i}^{y-1} \cdot \left(\frac{x_{CV,i}^y}{x_{CV,i}^{y-1}} - 1 \right) = x_{PPY,i}^y - x_{CP,i}^{y-1}. \text{ This equation shows that, when multiplying the}$$

annual chain-linked volume relative growth by the current price figure at $y-1$, the result is the absolute volume growth between year y in the previous year's prices and year $y-1$ in current prices. Dividing both sides of formula A.2 above for country i by the same formula expressed for the European aggregate gives

$$A.3 \quad \frac{x_{CP,i}^{y-1} \cdot \left(\frac{x_{CV,i}^y}{x_{CV,i}^{y-1}} - 1 \right)}{X_{CP}^{y-1} \cdot \left(\frac{X_{CV}^y}{X_{CV}^{y-1}} - 1 \right)} = \frac{x_{PPY,i}^y - x_{CP,i}^{y-1}}{X_{PPY}^y - X_{CP}^{y-1}}.$$

Now, multiplying both sides of the above by the chain-linked volume growth rate of the aggregate, i.e. by

$$\left(\frac{X_{CV}^y}{X_{CV}^{y-1}} - 1 \right), \text{ gives:}$$

$$A.4 \quad \left(\frac{x_{CP,i}^{y-1}}{X_{CP}^{y-1}} \right) \cdot \left(\frac{x_{CV,i}^y}{x_{CV,i}^{y-1}} - 1 \right) = \left(\frac{x_{PPY,i}^y - x_{CP,i}^{y-1}}{X_{PPY}^y - X_{CP}^{y-1}} \right) \cdot \left(\frac{X_{CV}^y}{X_{CV}^{y-1}} - 1 \right).$$

The right-hand side of equation A.4 shows that the chain-linked relative volume growth rate of the aggregate is multiplied by a term in which the absolute volume growth of component x_i is expressed as a proportion of the absolute volume growth of the aggregate X . The result is thus the contribution made by the volume growth of component x_i to the relative volume growth of the aggregate X .

The left-hand side of the equation A.4 shows that the contribution made by the same component x_i to the relative volume growth of the aggregate X can also be calculated by multiplying the relative growth rate of the component x_i by the current price level of the component x_i over the current price level of the aggregate X in year $y-1$.

Quarterly case

The Handbook on quarterly national accounts (Eurostat 2013, pp. 200-204) discusses different methods for calculating the growth contributions of the components to the quarter-on-quarter chain-linked volume growth of the aggregate variable, such as GDP. The method discussed above, applied to the quarter-on-quarter growth rate of the component x_i of the aggregate X , is called the weighted growth rates (*WGR*) method. In our example, using annual current prices as the weights, the formula is:

$$A.5 \quad \text{Contrib.}WGR^A(x_i, X)^{c,y} = \left(\frac{x_{CP,i}^{y-1}}{X_{CP}^{y-1}} \right) \cdot \left(\frac{x_{CV,i}^{c,y} - x_{CV,i}^{c-1,y}}{x_{CV,i}^{c-1,y}} \right) = \left(\frac{x_{CP,i}^{y-1}}{X_{CP}^{y-1}} \right) \cdot \left(\frac{x_{CV,i}^{c,y}}{x_{CV,i}^{c-1,y}} - 1 \right)$$

In the case of European aggregates, when the Laspeyres chained- volume index is used, together with the annual overlap quarterly chain-linking methodology, the current price figure for year $y-1$ forms the moving base period for the volume calculation. A natural choice is therefore to use the weighted growth rates method described above with annual weights. It is worth noting that, as mentioned in the Handbook

on quarterly national accounts (Eurostat 2013, p. 204), the attractions of the WGR method are that it is simple to use and easy to understand and it is independent of the quarterly linking method. The Handbook on quarterly national accounts (Eurostat 2013, pp. 203-204) suggests it as one method for calculating the contribution made by the component x_i to the quarter-on-quarter volume growth of the aggregate X .

This method is used in calculating the t+30 and t+45 flash estimates of the quarterly GDP for the euro area and the EU. The quarter-on-quarter growth estimates provided by the Member States are aggregated using the equation A.5 above.

It is worth noting, though, that the contributions calculated using this method are not *exactly* additive in the quarterly case. This is most visible in the case of the quarter-on-quarter growth rate between Q1 and Q4, as the former has year $y-1$ as a base year and the latter year $y-2$. The Handbook on quarterly national accounts (Eurostat 2013, pp. 200-204) discusses another additive volume data method, which includes a correction for the first quarter, the effect of which is that the quarterly contributions will add up exactly to the same contribution of the component in the annual data. Finally, the Handbook discusses how a correction factor can be introduced into the WGR method (using annual or quarterly weights), in order to obtain results for the contributions of the components that are exactly additive:

$$A.6 \quad \text{Contrib.WGR}^A(x_i, X)^{c,y} \cdot \left(\frac{x_{CV,i}^{c-1,y} / X_{CV}^{c-1,y}}{x_{CV,i}^{y-1} / X_{CV}^{y-1}} \right) = \text{Contrib.AVD}(x_i, X)^{c,y} .$$

In practice, when aggregating the country growth rates to give the euro-area and EU totals, the size of the correction that would need to be made to the aggregate relative growth rate is quite small, e.g. between 2010Q1 and 2015Q2, the average absolute value of the correction was 0.0004 %. The proportions of the Member States' GDPs in the aggregate GDP are rather stable, both between quarters and between years.

Annex B: Sample size for testing revisions for bias

Introduction

This Annex discusses the effect on the results of a student's t-test of having a small number of observations. It examines the method used by the UK to test whether the revisions to economic indicators would be biased. Finally, the Annex considers whether the limited number of observations available from the testing phase of the GDP t+30 flash estimate rules out the use of a statistical test in assessing the possible bias in revisions.

Terminology

- Type 1 error: rejecting the null hypothesis when it is true (i.e. saying there is bias when there is not).
- Significance level: the probability of a type 1 error (i.e. the probability of saying there is bias when there is not).
- Type 2 error: accepting the null hypothesis when the alternative hypothesis is true (i.e. saying there is no bias when there is).
- Power: 1 minus the probability of a type 2 error (i.e. the probability of correctly identifying bias).

Method

The current method for testing for bias in the revisions to early estimates of economic indicators in the UK is to use t-tests to test for bias. This method was recommended in the paper "An examination of the way CSO [the Chief Scientist Office] tests for bias in the initial estimates of major economic indicators; some suggested improvements". (Dr C. Chatfield, CSO Research Project, University of Bath).

For the annual series, the t-test assumes that revisions are independent.

The test statistic is calculated as $t = \frac{\bar{x}}{s_{\bar{x}}}$, where:

\bar{x} is the average revision

$s_{\bar{x}}^2 = \frac{s^2}{n}$, where:

s^2 is the population variance in the revisions (estimated using the sample)

n is the sample size.

The test statistic is compared to a t-distribution with n degrees of freedom. The significance level used is 0.05, meaning that the probability of a type 1 error is 0.05 or 5 %.

For the quarterly series, an adjusted t-test is used, which assumes that revisions follow an AR(1) process (meaning that the revision at one time point depends on the revision made at the previous time point).

The test statistic is calculated as $t = \frac{\bar{x}}{s_{\bar{x}}^{*2}}$, where:

\bar{x} is the average revision.

$s_{\bar{x}}^{*2} = \frac{s^2(1+\alpha)}{n(1-\alpha)}$, where:

s^2 is the population variance in the revisions (estimated using the sample)

n is the sample size

α is an estimate of the correlation between revisions at time t and time $t-1$.

The test statistic is compared to a t-distribution with $n \frac{(1-\alpha^2)}{(1+\alpha^2)}$ degrees of freedom. The significance level used is 0.05, meaning that the probability of a type 1 error is 0.05 or 5 %.

Impact of reducing the sample size on type 1 errors

If the sample size were to be reduced then the critical value used to compare the test statistic should be changed to reflect the change in the degrees of freedom. If the significance level remained unchanged, then the probability of a type 1 error would also remain unchanged.

The critical value for a two-sided t-test with a significance level of 0.05 and a sample size of 14 is 2.145.

Impact of reducing the sample size on the power of the test

The problem created by a smaller sample size is that it reduces the power of the test. The power of the test depends on the sample size, the effect size and the significance level.

The effect size puts into context how large the average revision is in relation to the spread of the revisions. It is calculated as the mean of the revisions divided by the standard deviation of the revisions (i.e. the t-test statistic divided by the square root of the number of observations).

$$d = \frac{\bar{x}}{s}, \text{ where:}$$

\bar{x} is the average revision

s^2 is the population variance in the revisions (estimated using the sample).

Figure 1 below shows the power of the test and the probability of type 2 errors for different effect sizes when using a t-test at significance level 0.05 for sample sizes of 14 (the number of quarters likely to be available for testing) and 20 (i.e. five complete years of test quarters) and 8. The sample size of 8 has been chosen because it would be the degrees of freedom used in the modified t-test if alpha was 0.5 and the sample size was 14. If alpha is close to 0, then the power will be close to that of a test with sample size 14. If alpha is between 0 and 0.5, then the power will be between the power of the tests carried out with sample sizes 8 and 14. If alpha is greater than 0.5, then the power will be lower than the power of the test carried out using a sample size of 8.

To get an idea of the effect size in the current revisions hypothesis test, effect sizes based on the current revisions analysis are:

Annual comparisons:

- Preliminary GDP estimate (at t+25d) compared with the third GDP estimate (at t+89d): -0.7 (same as 0.7)
- Second GDP estimate (t+58 d) compared with the third GDP estimate (t+89 d): -0.3 (same as 0.3)
- Third GDP estimate (t+89 d) compared with the estimate after 3 years: 0.4

Quarterly comparisons:

- Preliminary GDP estimate (at t+25d) compared with the third GDP estimate (at t+89d): 0.3
- Second GDP estimate (t+58 d) compared with the third GDP estimate (t+89 d): 0.1
- Third GDP estimate (t+89 d) compared with the estimate after 3 years: (same as 0.1)

To get an idea of alpha in the current revisions hypothesis test, alpha based on the current revisions analysis are:

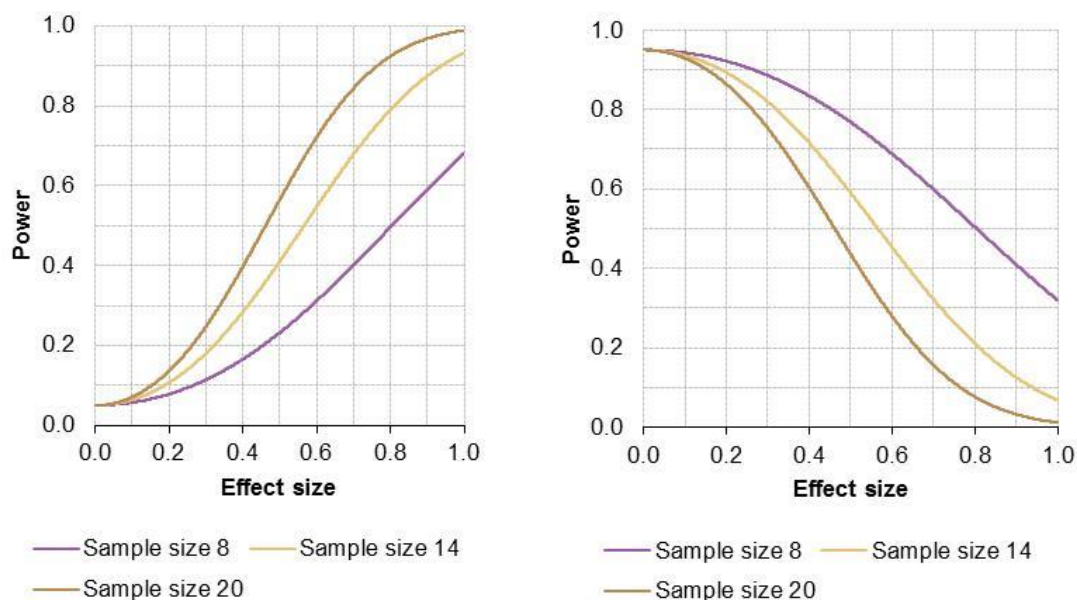
Annual comparisons:

- Preliminary GDP estimate (at t+25d) compared with the third GDP estimate (at t+89d): -0.1 (same as 0.1)
- Second GDP estimate (t+58 d) compared with the third GDP estimate (t+89 d): -0.2 (same as 0.2)
- Month 3 estimate (t+89 d?) compared with the estimate after 3 years: 0.0

Quarterly comparisons:

- Preliminary GDP estimate (at t+25d) compared with the third GDP estimate (at t+89d): 0.0
- Second GDP estimate (t+58 d) compared with the third GDP estimate (t+89 d): -0.5 (same as 0.5)
- Third GDP estimate (t+89 d) compared with the estimate after 3 years: (same as 0.1) 0.4

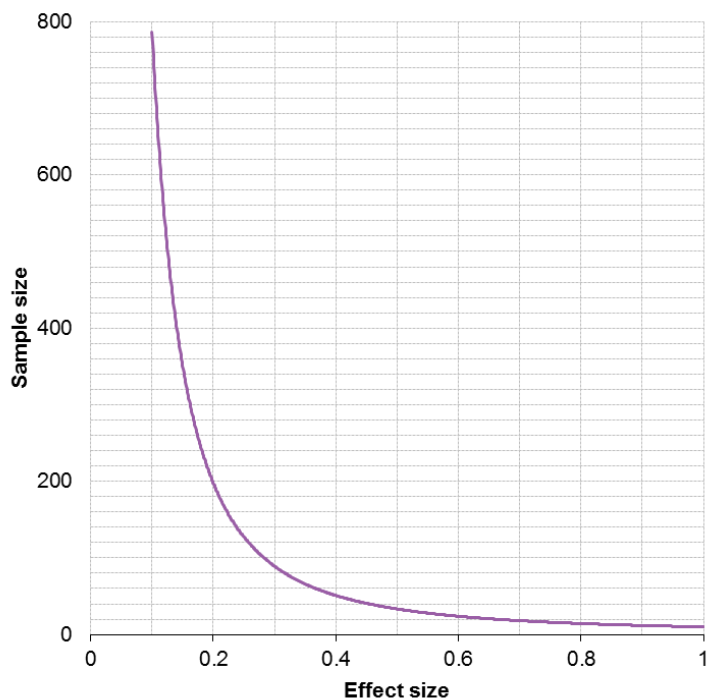
Figure 1: Power of the t-test for given sample sizes and effect sizes and a significance level of 0.05.



Source: UK Office for National Statistics

A common threshold for acceptable power is 80 %. Figure 2 shows the sample size that would be required to achieve a power of 80 % for given effect sizes and a significance level of 0.05.

Figure 2: Sample size required to achieve 80 % power for different effect sizes and a significance level of 0.05.



Source: UK Office for National Statistics

Recommendation

The initial results suggest that the GDP t+30 flash estimate has a low effect size. The recommendation is therefore that a student's t-test would not be used as a quality acceptance criterion, due to the risk of a type II error. Instead, it is recommended that appropriate boundaries for the size of the revision should be set.

Annex C: US t+30, t+60 and t+90 estimates of quarter-on-quarter GDP growth, and the associated revisions to the t+30 estimates

Table 9: GDP t+30 estimates and revisions for the US

(quarter-on-quarter GDP growth rates, %; revisions to growth rates, percentage points)

| | GDP growth rates | | | Revisions to t+30 estimate at | |
|--|------------------|-------|-------|-------------------------------|-------|
| | t+30 | t+60 | t+90 | t+60 | t+90 |
| 2012Q1 | 0.55 | 0.46 | 0.46 | -0.08 | -0.08 |
| 2012Q2 | 0.38 | 0.43 | 0.42 | 0.05 | 0.04 |
| 2012Q3 | 0.50 | 0.66 | 0.77 | 0.16 | 0.27 |
| 2012Q4 | -0.04 | 0.03 | 0.09 | 0.07 | 0.13 |
| 2013Q1 | 0.62 | 0.59 | 0.44 | -0.03 | -0.18 |
| 2013Q2 | 0.71 | 0.92 | 0.91 | 0.21 | 0.20 |
| 2013Q3 | 0.71 | 0.89 | 1.02 | 0.18 | 0.31 |
| 2013Q4 | 0.80 | 0.59 | 0.65 | -0.21 | -0.15 |
| 2014Q1 | 0.03 | -0.25 | -0.74 | -0.27 | -0.77 |
| 2014Q2 | 0.97 | 1.03 | 1.13 | 0.05 | 0.16 |
| 2014Q3 | 0.88 | 0.96 | 1.22 | 0.08 | 0.34 |
| 2014Q4 | 0.65 | 0.54 | 0.55 | -0.11 | -0.10 |
| 2015Q1 | 0.06 | -0.19 | -0.04 | -0.25 | -0.10 |
| 2015Q2 | 0.58 | 0.91 | 0.97 | 0.33 | 0.39 |
| Average revision | | | | 0.01 | 0.03 |
| Average absolute revision | | | | 0.15 | 0.23 |
| Root of the mean squared errors (RMSQE) | | | | 0.18 | 0.29 |

Source: US Bureau of Economic Analysis

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