Commercial property price indicators: sources, methods and issues

2017 edition

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1.1. Introduction

The aim of this text is to outline source data and methodologies in relation to commercial property price indices (CPPIs), so as to better inform compilers and users of alternative data sources, measurement methods, and the issues at stake. The text covers the conceptual framework, the purposes and uses of CPPIs—as well as other indicators. It reviews the relative advantages and disadvantages of different data sources and methods of calculation and provides practical advice on compilation. It also summarises the methods and sources currently used to construct commercial property price indicators and provides background information, in the form of case studies, of relevant national practices.

The text is aimed, in particular, at government institutions, compiling or planning to compile CPPIs for official purposes, whilst not ignoring the wide-ranging uses of CPPIs outside of official statistics.

1.2. Background

An increased need over recent years to have better and more complete measures of changes in real estate prices led to the publication in 2013 of a *Handbook on Residential Property Price Indices* (*RPPIs*). At the same time, interest increased in commercial property price indicators from public institutions, policy makers, analysts, and market investors. However, more so than residential property prices indices (RPPIs), limited information is available on price changes of commercial buildings. Compared to house prices statistics, for commercial buildings additional problems typically arise such as a relatively small number of transactions and a greater variety of types of structures.

Against this background and in the context of the G20 Data Gaps Initiative, Eurostat took the lead, under the auspices of the Inter-secretariat Working Group on Price Statistics (IWGPS), in coordinating the drafting of this text by a team of authors composed of academics and statistical experts.

1.3. A Guide to Readers

Although not all of the chapters are self-contained, the text is not designed to be read from cover to cover. For example, some of the chapters can easily be skipped by compilers who are particularly interested in methodological issues. Further details on the contents of the text are given in Chapter 2.

The text is not prescriptive for three reasons. Firstly, it is not always possible to give practical guidance as some of the solutions to conceptual problems are not clear-cut and there are choices to be made about precisely how a practical solution is implemented. Secondly, what is applicable and what can be achieved will depend on the data and resources available to the institute compiling the CPPI. Thirdly, the concepts and methods for CPPIs are less well developed than for RPPIs and there has been less

practical experience. Recommended practices are likely to evolve and be supplemented by further advice with the accumulation of more practical experience on the compilation and use of CPPIs.

1.4. Acknowledgements

The writing of the text was the result of collaboration between several authors. David Geltner was the main editor.

The lead authors of the main chapters are as follows:

1. Preface Introduction – David Fenwick

2. Introduction – David Fenwick

3. Uses of Commercial Property Price Indicators - David Fenwick

4. Conceptual Framework for Commercial Property Price Indices - Chihiro Shimizu and David Geltner

5. Measuring Asset Price Changes over Time: Transaction Price-Based Indices - Marc Francke

6. Appraisal Based Indices - Marc Francke

7. Appraisal and Stock Market-Based Investment Return Indicators - Marc Francke

8. Additional Indicators for Commercial Property - Marc Francke

9. Data Sources - David Fenwick

10. Commercial Property Price Indicators Currently Available - David Fenwick

Glossary - David Baran

The drafting of the individual chapters involved participation by all the authors including those who acted as reviewers. The text also benefitted from the valuable contributions of many individuals and organisations, including input from both compilers and users of commercial property price indices in different parts of the world and experts from academia. Special mention must be made of the significant contribution made by Erwin Diewert who provided considerable advice, particularly on the conceptual issues underlying CPPIs and the methodological issues associated with their compilation especially in the context of official statistics.

Mick Silver and Nial O'Hanlon did an extensive editing of the original draft of the entire text.[1]

In addition, we acknowledge the contribution of participants at a Bank of International Settlements (BIS), European Central Bank (ECB), Eurostat, International Monetary Fund (IMF), Organisation for Economic Co-operation and Development (OECD) "International Conference on Commercial Property Price Indicators" concerned with the progress of this work held at the ECB in Frankfurt am Main, Germany on September 29–30, 2014, and acknowledge the ECB work in hosting the event.[2] The meeting was attended by 75 participants from 15 national statistical offices, 14 central banks, the aforementioned international organisations, several universities and private sector data providers. Particular note is due to the individual contributions at the conference and more generally by Ian Cullen, Martin Eiglsperger, Niall O'Hanlon, Jakob Holmgaard, Farley Ishaak, Tjeerd Jellema, Andrew Kanutin, Andreas Kunert, Bogdan Marola, Jens Mehrhoff, Paolo Passerini, Branko Pavlin, Gabriel Quirós, Joachim Recktenwald, Mick Silver and Oana Simene.

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(1)   Jens Mehrhoff drafted the part of chapter 4 setting out the definition of commercial property as agreed by the Inter-secretariat Working Group on Price Statistics

(2)   Details of the conference are at: https://www.ecb.europa.eu/pub/conferences/html/ws_comppi.en.html

2 | Introduction

In the context of official statistics, commercial property price indicators and more particularly commercial property price indices (CPPIs) are required by Governments for economic analysis and for formulating economic policy, and also by official agencies and institutions charged with overseeing and regulating the health of the financial system and the investment industry. In addition, investors themselves can find CPPIs useful for the monitoring of market performance relevant to individual investment decisions and portfolio management although their information requirements can differ from governments and official agencies and institutions. The uses of CPPIs are wide-ranging and impact on their conceptual basis and practical compilation.

CPPIs based on actual transaction prices are the ideal target measures for most uses. Price index numbers are traditionally compiled using the matched models method whereby the transaction price of an item in one period is compared with the transaction price of the same item in the next period. This is designed to minimize bias from changes in the quality of items whose prices are compared. However, the number of transactions of a type of commercial property may be relatively limited in a period with transactions in the next period being for a quite different mix of properties in terms of their quality characteristics. It is only the scarcity of direct transaction price data and the heterogeneity of the properties transacted that has led users to employ more indirect measures for the purpose of tracking CPPIs, such as appraisal-based indices.

The importance of measuring commercial property price inflation and the difficulties in properly doing so, particularly in the context of official statistics, were the main motivations behind the production of this text. The primary aim of the text is to outline the source data and methodologies so as to better inform both compilers and users. It provides background on alternative measures, their corresponding conceptual frameworks as well as practical advice on data sources and compilation. It also catalogues existing practices. These vary across countries and can depend on the availability of data.

Unlike the *Handbook on RPPIs* (Eurostat et al., 2013), this text does not provide recommendations on data and methodology. There are many issues regarding data sources and methods that are particular to the commercial property price index measurement and this text is designed to better ground our understanding of such issues. The intention is that a *CPPI Handbook* will be subsequently written and published that builds on this text.

Chapter 3 catalogues the main uses of CPPIs. It focuses on the use of CPPIs by governments and public institutions. In the realm of official statistics applications include: in national accounts; for financial stability and soundness analysis; to aid productivity measurement; to help measure risk exposure; as a macro-economic indicator of economic activity; for use in monetary policy and inflation targeting. Outside the realms relating to official government business, the use of CPPIs extend to an input into a company's or a citizen's decision making on whether and when to invest in commercial property and the returns they achieve or might expect to achieve. Chapters 4 and 7 outline how a CPPI differs from an investment returns index.

Chapter 4 outlines conceptual issues. It presents a basic framework for CPPIs from the perspective of, and for the purposes of, official agencies. The chapter describes the nature and role of CPPIs in the context of official statistics, including basic definitions and terminology. It also lists the types of data and indices and other related metrics for commercial property that are necessary or potentially useful

for different uses of CPPIs. It notes, in particular, that there are some basic conceptual considerations that are important from an investments and investors perspective which may be different from the viewpoint taken for national accounting and official statistics purposes.

Chapters 5 to 7 review the different concepts and methods for compiling CPPIs.

The focus of Chapter 5 is the construction of transaction-based CPPIs but it also includes an overview of the different phases in the compilation of a CPPI, including index design, development, and production. The methods of compiling transaction-based indices for commercial property, adjusted for variations in the mix of commercial property traded, are akin to the ones for residential property price indexes and are given by: simple averaging & mix-adjustment by stratification; hedonic methods; and the repeat sales method. Each method is reviewed in detail. The main difference compared with residential property is that commercial property is much more heterogeneous and there are usually significantly fewer transactions. This can limit the practical choices of index construction methodology.

Chapter 6 seeks to address a deficiency in transaction-based indices - that is with infrequent transactions. While there is an actual price in a reference period, there is no corresponding price for the same property in a subsequent period, as would be required for a matched model approach. However, assuming we have reliable and adequate matched appraisal prices in the subsequent period, we can attempt to make use of the cross-sectional ratio (or coefficient from a regression) of actual transaction price of properties to the corresponding appraisal price in a given period, in an attempt to "correct" for deficiencies in appraisal prices.

Chapter 7 discusses two alternative indicators. The first is based on appraisal values and produces appraisal-based indicators of investment returns. These appraisal-based 'indicators' (as distinct from 'indices' in contrast to the focus of Chapter 6) track and represent appraised values and returns, not transaction prices directly. The second, reviewed in Chapter 7, is based on stock market share prices of companies that are essentially purely invested in commercial property, thereby producing stock market-based indicators, that is, indicators of how the stock market values commercial property (indirectly, through the share prices of the traded firms). Empirical findings suggest that stock market price indices lead transaction-based indices; that stock markets are more efficient than the private asset market in identifying and reacting to market conditions. Similarly, empirical findings usually suggest that transaction-based indices lead appraisal-based indicators of investment return.

Chapter 8 reviews additional indicators for commercial property. It covers alternative indicators for the commercial property market not considered elsewhere in the text. As these are not the primary subject of this text they are not covered in depth or comprehensively. The alternative indicators covered include rent indices for commercial property, vacancy rates, construction starts and building permits.

Access to relevant and good quality data is critical to the compilation of CPPIs. In practice, the choice of methodologies, particularly for CPPIs, are constrained by the lack of data, especially on transaction prices. Chapter 9 reviews the advantages and disadvantages of different sources of information on commercial property prices. For most purposes, the target index is one that is based on transaction prices.

Chapter 10 catalogues the commercial property price indicators currently available in a number of countries. It summarises the methods and sources currently used to construct commercial property price indices and provides background information, in the form of case studies, of relevant national practices. Transaction-based indices and appraisal-based indices are published by a number of public and private sector suppliers of CPPIs but the supply and use of such indices is generally not so well developed compared with RPPIs — particularly for transaction-based indices which form the basis of indices needed for most official purposes.

3 | Uses of Commercial Property Price Indicators

3.1. Overview

Commercial Property Price Indices (CPPIs) are required by two broad constituencies of users and are associated with a number of applications. Firstly, in the realm of official statistics they are required for analysing economic trends for the purposes of understanding and tracking the economy and formulating economic policy. Secondly, CPPIs are required by agencies and institutions charged with overseeing and regulating the health of the financial system and the investments industry. Related to this second usage, investors themselves can find CPPIs useful for monitoring market performance relevant to individual investment decisions and portfolio management.

Key uses include: macroeconomic accounting and reporting and macroeconomic management; financial stability analysis; and informing investment decisions. Monitoring the evolution and movement in commercial property prices is considered of fundamental importance particularly in times of economic turbulence but also to facilitate market stability in the longer-term. This chapter describes the main uses to which CPPIs are put.

It is important to note that both of the above described constituencies and most if not all of the uses and applications for CPPIs, desire in principle the same fundamental type of index, namely, an index that tracks well the actual market price changes of commercial properties. Such an index directly serves the primary need of the financial oversight and investment constituency. But it also goes a long way towards serving the needs of the official economic statistics constituency.

All constituencies and uses would agree that the ideal is to have metrics that represent as directly and closely as possible changes in the actual transaction prices of traded commercial property. It is only the scarcity of transactions on heterogeneous properties that lead some users to develop and employ more indirect forms of commercial property value tracking such as appraisal-based indices.

Appraisal-based indices are aligned to the needs of investors in commercial property for making an assessment of current or future investments but do not always suit the needs of other users, especially in the context of official statistics. It is often the absence of relevant transaction information that has led to the use of appraisal-based data. Appraisal-based indices have a number of inherent problems that are listed elsewhere in this text. For example, they may only follow the actual transaction price with some time lag and do not always benefit from full transparency or consistency in their construction. Furthermore, the accuracy of appraisal-based indices depends on the quality of the appraised values and appraisal practices may vary substantially between countries.

The following applications are the main uses of CPPIs.

- In *the compilation of national accounts*: The System of National Accounts (SNA) provides a complete overview of flows and positions in an economy. Relevant flows in commercial property, among which production of and investments in newly produced property, sales and purchases of existing property, need to be adjusted for price changes to arrive at the volume changes. Stocks of commercial property feature on the SNA balance sheets. Here, current price estimates and holding gains/losses

(revaluations) of commercial property need to be estimated. For these and other purposes, CPPIs can provide very useful information to improve the quality of the national accounts estimates.

- *As a financial stability or soundness indicator to measure risk exposure.* The close monitoring of the Commercial Property Market has been promoted by the inclusion of Commercial Property Price Indicators, and their residential property counterparts, in the IMF's recommended list of Principle Global Indicators of financial stability (Recommendation 9 of the IMF's Financial Stability Board Report to the G20 entitled '*The Financial Crisis and Information Gaps*', 2009). The Statistics Department of the IMF disseminates data and metadata on selected Financial Stability Indicators (FSIs) provided by participating countries

- *As a macroeconomic indicator of economic activity.* Commercial Property Price Indices are just one of a number of economic indicators that enable analysts to keep a finger on the pulse of an economy, in particular when monitoring asset price movements.

- *For use in monetary policy and inflation targeting.* In several cases, rising prices of commercial property have been shown to be associated with periods of economic growth while falling commercial property prices often correspond with a slowing economy. In practice and when compared with the prices of residential property, commercial property prices are not as influential as a lead indicator of the performance of the economy, in part reflecting the relatively sparse availability of commercial property price indices compared to indices of residential property, but mostly because commercial property is usually a smaller sector than housing. Historically it has been residential property price indices that have been most influential in feeding into the formulation of monetary policy in modern times. This is partly due to governments and/or central banks adopting formal inflation targets based on the consumer price index and the fact that residential property prices can have a direct impact on the measurement of consumer price inflation when owner occupier housing (OOH) expenditures are included in the consumer price index.

- *As an input into a company's or a citizen's decision making on whether and when to invest in commercial property.* CPPIs (and other commercial property price indicators) are an essential input not only into the calculation of current and past investment returns but also in providing potential investors with indispensable knowledge on anticipated future returns based on historical relationships between commercial property prices and the performance of the economy and on working assumptions about the future economic outlook.

- *For use in making inter-area and international comparisons.* Regional and international indicators of commercial property prices and price trends are required: by Government and International Institutions for policy purposes, to analyse and take any necessary action regarding financial soundness, and by investors, such as managers of international property portfolios, in making decisions on their holdings of property to maximise return.

For all of the above uses, indices tracking market values and prices, and consistency with the SNA, are of paramount consideration ([3]). Just as importantly, the construction of CPPIs needs to be modular i.e. made up of separate building blocks that can be re-arranged or inter-changed to deliver the different requirements of different users as it is likely to be virtually impossible to have a single indicator that can fulfil all requirements.

The commercial property sector covers a broad and heterogeneous range of properties and business activities. Commercial property includes retail, office, apartments and industrial property. Price trends may well be different for these types of properties, as it may for each property in specific locations, say cities and/or locations within cities, and of properties of different size brackets, ages, and more. There is a very real sense in which each commercial property can be regarded as unique and the aggregation of their price changes into meaningful clusters of properties may vary by use. Given this heterogeneity of property it is for users to carefully examine their needs. For example, for financial stability analysis the interest may not be in the heterogeneity of the properties *per se*, but in the means by which the purchase is financed. There are also important differences between the owner-occupied residential and commercial property markets. While owner-occupied residential property is bought with the dual purpose of 'investment' and for 'shelter', a commercial property transaction is seen as an investment, sometimes with speculative motives. As a result, the dynamics of the commercial property market can be very different from the dynamics of the residential property market and, correspondingly, the risk profile will be a much more significant consideration to potential investors. Specific users and uses will have specific requirements. For instance, transaction-weighted indices are better suited to follow

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([3]) The SNA states very clearly that entries are to be 'at current value on the market or at its closest equivalent' (SNA 2008 3.16a).

pure price change than stock-weighted indices, which in turn are better suited to estimating the total value of the stock of commercial property etc. For some users such as national accountants and for productivity analysis, the division of a commercial property into the value of the building and the value of the land is also relevant (see Section 3.8).

3.2. In the national accounts: using the CPPI in the estimation of a component of wealth and as a deflator

CPPIs come into play in several ways in the national accounts. The SNA does not provide much specific reference or guidance regarding CPPIs, but the basic structure and principles elucidated in the SNA indicate the essential uses.

The SNA provides a complete overview of all economic flows during a certain period of time (quarter or year), and all positions at a certain moment in time (end of quarter or end of year). As such, the SNA also includes the production and purchase of new commercial property, transactions in existing commercial property, and the stocks of commercial property at the end of the period. These transactions and stocks are recorded for each sector or subsector, the main ones being non-financial corporations, financial corporations, general government, non-profit institutions serving households (NPISHs) and households.

Apart from the recording of newly produced property in the supply and use tables, the relevant flows are recorded on the so-called accumulation accounts: (de-)investments and depreciation costs in newly produced and existing commercial property on the capital account, holding gains and losses on the revaluation account, and catastrophic losses, uncompensated seizures, etc. on the other changes in the volume of assets account. The resulting positions or stocks feed into the balance sheets, which record all non-financial assets and financial assets as well as liabilities for each (sub) sector. When recording the above mentioned flows and positions in commercial (and residential) property, the SNA makes a distinction between produced assets, the structures, and non-produced assets, the land underlying the structures.

CPPI-data can support the compilation and subsequent analysis of national accounts in various ways. The main ones consist of the following:

- CPPIs can be used as a deflator for the production and investments in newly produced commercial property, thus allowing for the derivation of volume changes for the relevant variables. As stated before, it should be noted however that national accounts ask for a split of structures and underlying land.
- CPPIs can also be used for the estimation of (the developments in) the value of stocks of commercial property. Although national accounts report structures and underlying land separately on the balance sheets, having information on the total combined value can serve as an excellent benchmark for the quality of the estimates for the two components separately (see also below).
- Finally, CPPIs also allow for improved estimates of the changes in the stocks of commercial property due to revaluations, i.e. holding gains and losses arising from changes over time in the level and structure of prices.

The differentiation between the structures and the underlying land can be looked upon as the main difference in the statistical needs for CPPIs between the national accounts community and the financial oversight and investments community. The latter group of users generally has little need for the separation of the land and structure components of commercial property value.

It is important to note that national accountants typically construct stock level series for produced non-financial assets (e.g. buildings and other structures) by integrating flow data through the application of the so-called Perpetual Inventory Method (PIM). In line with this methodology, stocks of structures are estimated by summing up past investments, adjusted for price changes (to reflect the current replacement costs) and adjusted for depreciation. For the relevant price changes, national accountants

typically use the change in the Producer Price Index (PPI) for newly built structures, although a CPPI could facilitate a high level volume/price split of investments in new commercial property, if separate indices for new and existing commercial property are available. The value of land may be measured directly, by multiplying the quantity of land with an appropriate land price[4]. As stated before, CPPIs would in that case provide a benchmark for measuring the changes in the total value of the structures and underlying land. An alternative methodology for the measurement of land values is the residual approach, according to which the value of underlying land is set equal to the difference between the total property asset value (structures plus underlying land) minus the value of the structures based on PIM. The latter means that any divergence between the PPI and the CPPI will feed into the price change of land. The latter is also true for any others errors implicitly resulting from applying PIM (e.g. the assumptions used for the service lives, the age-price profiles, etc.)[5]. The general impact of structure depreciation on the property value, i.e. the relationship between the age of the structure and the property value could be estimated. It may also be possible to estimate typical structure lifetimes based on data on the ages of structures at the time of their demolition. All of this would be very helpful in improving the quality of the assumption on age-price profiles when applying PIM.

If a separate CPPI for newly built structures is compiled, or indeed if the CPPI can distinguish between land and structure components then it would be useful to compare it to a PPI for newly built structures.

3.3. A financial stability or soundness indicator to measure risk exposure

The IMF Report ([6]) on financial stability or soundness indicators, pointed to the fact that CPPIs are an essential input into 'macroprudential analysis', and in particular monitoring the vulnerability of domestic economies to shocks, because of the potentially large direct or indirect exposure of deposit takers to real estate asset values (both residential and commercial real estate) — asset values which are also a major element of the wealth of the private sector. The exposure arises from a number of perspectives. Direct exposure comes from: the ownership of commercial property; advancing loans to cover the purchase, construction or development of commercial property; the use of commercial property as collateral. Indirect exposure might arise from, for example: giving loans to other deposit takers who are directly exposed to commercial property prices or who have lending associated with the acquisition of real estate; exposure to corporations that can be adversely affected by changes in the servicing costs of real estate-related borrowing and/or price movements in commercial property.

Sharp falls in real estate prices have a detrimental impact on the health and soundness of the financial sector and on the financial situation of organizations, individuals and of individual households, by affecting credit ratings, the value of collateral, and the debt to equity ratio ([7]).

The relationship between real estate cycles and economic cycles has been well researched and documented, especially in those countries where real estate accounts for a significant proportion of national, corporate and household wealth. For instance, a number of non-governmental/commercial advisory services in the field of commercial property investment provide detailed reports on past investment performance and future potential returns based on modelling the relationship between

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([4]) A quite specific issue relating to the measurement of land is that quantities of land for a country as a whole generally do not vary but volumes can change substantially due to the changes in the economic use of land, e.g. changing from agricultural land to land for building housing or factories.

([5]) For more details, see the Eurostat-OECD (2015),

([6]) See footnote ([2])

([7]) An important related use that is not directly expressed here is as part of the Banks Capital adequacy requirements regime. Basle II and III, agreed upon by the members of the Basel Committee on Banking Supervision—a committee of banking supervisory authorities that was established by the central bank governors of the Group of Ten countries in 1974—stipulate particular approaches in terms of capital coverage for commercial property. Basel II primarily relates to the required level of bank loss reserves that must be held by banks for various classes of loans and other investments and assets that they have whilst Basel III primarily relates to controlling the risks for the banks of a run on the bank by requiring differing levels of reserves for different forms of bank deposits and other borrowings. In some situations / jurisdictions these capital adequacy requirements can be expressed in terms of 'marked to market', i.e. based on recording the price or value of a property or portfolio that reflects its current market value rather than its book value, the former being based on the most current market valuation updated using appropriate property price indices.

commercial property prices and the performance of the economy. The studies vary in detail and in their particular focus and cover. More detailed studies include reviews of the solvency risk relating to insurance company capital adequacy, focusing specifically upon real estate, and customised exercises investigating the risk profile of particular funds or property portfolios. These look at the historic relationship between commercial properties, and the performance of the economy as part of the input into risk analysis including the issues of capital values, rents, vacancy rates, returns on capital and segment volatility. For example, the Royal Bank of Scotland (RBS), in its more generalised report '*UK Commercial Real Estate Market Outlook*' undertakes a market analysis that considers alongside (transaction volumes, pricing and risk premium) capital and rental growth forecasts, derived from RBS Economics' macro-level outlook for the UK economy, which takes into account forecasts of the growth in GDP.

Other relevant research which undertakes forecasts of commercial property values based on the performance of the economy includes that undertaken by the Bank of England; see for example Benford and Burrows (2014). Their dividend discount model (DDM) breaks down changes in nominal property valuations into changes in rental values, expectations for rental value growth and interest rates. The growth in rental values — a key input to the model — was shown to be highly sensitive to economic conditions with rental values growth falling sharply in the aftermath of the 'dotcom' bust in the early 2000s, and sharper still during the 2008-09 recession. Their analysis shows that in a downturn, as companies go out of business and employment falls, the demand for commercial property space falls. More space 'available for let' becomes vacant and this spare capacity adds to downward pressure on rents and capital values. Some analysts, such as IPD (Investment Property Databank Ltd) not only produce assessments of the commercial property market but also compile indices.

The early identification of the build-up of bubbles in the asset prices of commercial property is paramount to facilitate pre-emptive action. It was the identification of the importance of commercial property prices in this regard that led to the writing, under the auspices of the Inter-Secretariat Working Group on Price Statistics (IWGPS), of this text on *Commercial Property Price Indices: Sources, Methods and Issues*. A similar impetus underlay the *Handbook on Residential Property Price Indices* (*RPPI*) [8], which was published in 2013.

3.4. A macroeconomic indicator of economic activity

Hiebert and Wredenborg (2012) illustrate the importance of the commercial property market to sustainable economic performance in the diagram below. The future value of commercial property assets will be influenced by the supply of such property (from the owners) and the demand (from the investors), including the demand and supply with respect to the rental sector [9].

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[9]   The overall real estate system consists of two types of markets, plus the development industry. The two markets are the space market (for the occupancy and usage of built space, with landlords on the supply side and tenants on the demand side), and the property asset market (with on the supply side investors — owners — looking to sell, and on the demand side investors looking to buy). The development industry adds to the physical supply of built assets. This system can generally respond more elastically to demand for additions in the stock of supplied space than to falling demand requiring less stock of built space. Either the space market or the asset market can be liable to endogenous speculative bubbles and cyclical tendencies, and lags inherent in the development process can trigger or exacerbate such phenomena.

Graph 3.1 The role of commercial property in the economy
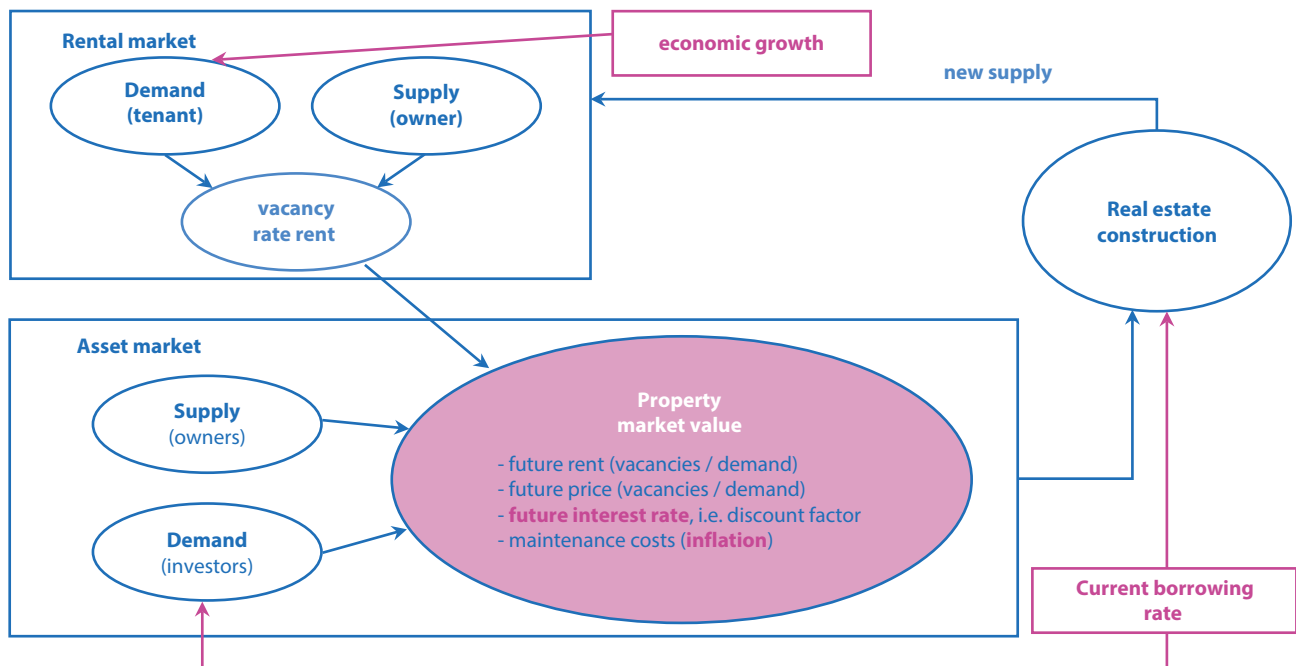
Source: ECB

Other factors include the view taken on future interest rates (the discount factor) and on maintenance costs including the rate of depreciation, and the opportunity cost of deploying the capital compared with other options. The dynamics of the commercial property market are also illustrated by the inclusion of future levels of real estate construction. Construction of commercial property will increase if the predicted returns increase, albeit with a time lag and dependent on the cost and availability of financial capital. The diagram also illustrates the effect on wealth creation from increased investment and economic activity.

Conversely, such business-related activity as demonstrated above, can, of course, result in banks having dangerously large lending exposures and, correspondingly, in institutional investors, such as insurance companies and pension funds being at the mercy of fluctuations in commercial property prices. Thus, plummeting demand can have dire consequences through over-exposure — a situation that the monitoring of commercial property prices, in the context of financial stability indicators, is designed to help financial system overseers to either avoid through pre-emptive action or to mitigate and protect against through resiliency and robustness measures such as macroprudential policy. There is potential inherent volatility in the commercial property market without appropriate checks. Commercial property asset prices have significant linkages with financial systems and can have the potential to amplify or prolong business cycles.

3.5. Monetary policy and inflation targeting

Many central banks have *inflation targets,* which can directly involve indices of property prices. For instance Ericsson et al. (1998) note that central banks in some countries, such as the central banks of Canada, New Zealand, Norway, and Sweden, utilize a Monetary Conditions Index (MCI) [10] as a day-to-day operating target for the conduct of monetary policy. In an expanded version of this index, as that

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[10] An index number calculated from a linear combination of a small number of economy-wide financial variables deemed relevant for monetary policy.

suggested by Jarociński and Smets (2008) and Goodhart and Hofmann (2007), the MCI would include some measure of residential property prices because of the important role this variable plays in the inflationary process and for economic performance. Other central banks have an inflation target based on a consumer price index (CPI), which incorporates the movement in residential property prices via the owner-occupied housing costs treatment ([11]). The status of commercial property prices in monetary policy is less formal and less mechanistic. Nevertheless pertinent issues are raised relating to how monetary policy affects the commercial property market and the implications of developments in commercial property prices on monetary policy and decisions on interest rates.

3.6. A commercial property index as an input to a company's or citizen's decision making on whether to invest in commercial property

Potential individual investors and corporate or institutional investors in commercial property (including pension funds, insurance companies, etc.), whether by purchasing properties or buying into portfolios managed by a third party, are dependent on commercial property price indicators, either directly or indirectly, to assess anticipated future returns on potential investments based on modelling the historical relationships between commercial property prices and the performance of the economy and on working assumptions made about the future economic outlook.

3.7. Uses made of other indicators relating to the commercial property sector

In addition to the role of CPPIs (asset price indices) in the national accounts as noted earlier, indices of total investment returns, which include both the capital and income components of the investment return, can be useful to help quantify the user costs of commercial property. User costs are essentially the annual service flow that commercial property provides in the production (and possibly consumption, in the case of rental housing) in the economy. User costs must reflect the total cost of capital, which reflects investors' opportunity cost of capital and the total investment returns, including both the current net cash flow provided by the investment as well as the price change of the capital asset. The asset price change component of a commercial property investment total return index should typically be essentially the same thing as a CPPI price index. But the total return including income will be more relevant for estimating the magnitude of commercial property user costs and hence the flow of commercial property services. Individual period-by-period total investment returns as tracked by investment performance indices may be very volatile, reflecting the periodic price movements in the property asset market. However, the long-term average real returns, or risk premium over riskless interest rates, revealed by such investment return indexes, can be useful for estimating property user costs.

Other non-CPPI type indicators are relevant for economic and macroprudential analysis of the commercial property market. The range of other indicators, relating to the commercial real estate market, reflects both the complex relationships between commercial property prices and the functioning of the economy and the key concerns of those monitoring the commercial property market, as reflected in the main uses of a CPPI referred to earlier in this Chapter. The dynamics of commercial property prices can influence future investment and economic activity and result, in the

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([11]) The issue of house prices and inflation targeting is discussed further in Chapter 3, section 2.2.7 of the *Handbook on Residential Property Prices Indices*.

longer-term, in unsustainable levels of indebtedness. The precise relationships and timescales have been subject to a great deal of scrutiny and subsequent debate. By way of example, the IMF (2006) notes that 'deposit takers may have large exposures (both direct and indirect) to real estate and because of this they may be affected by the potential volatility of price movements. Moreover, real estate assets are a major element of the wealth of the private sector'. It also notes that 'the direct exposure to risks arising from real estate-related lending of deposit takers can be monitored through the FSIs related to real estate loans'. The latter include: return on equity (net income to average capital [equity]); regulatory capital to risk-weighted assets ([12]); liquid assets to short-term liabilities; commercial real estate loans to total loans.

By way of illustration, providers of statistics on commercial property publish a range of additional indicators ([13]). These include property fund indices and a number of other statistics or 'markers' relating to financial stability such as:

- Net Debt as a percentage of NAV

$$\left(\frac{GrossDebt_t - Cash_t}{NAV_t}\right) \times 100$$

- Gross debt as a percentage of NAV

$$\left(\frac{GrossDebt_t}{NAV_t}\right) \times 100$$

- Gross debt as a percentage of GAV

$$\left(\frac{GrossDebt_t}{GAV_t}\right) \times 100$$

- 12 month Distribution Yield or Gross Yield

$$\left(\frac{\left(\sum_{t=1}^{12} Distribution_t\right)}{NAV_t}\right) \times 100$$

Where NAV = Net asset value, GAV = Gross asset value.

Appendix 3.1 provides further elaboration.

3.8. Land Prices

Land is unique in that it is neither produced, nor is it consumed in the sense that the stock of land is in general terms finite and it is not generally subject to physical wear and tear. As such, although land is discussed in the SNA, land price indices are not specifically included in the methodology of the national accounts or consumer price indices. Nonetheless, land represents a valuable asset, the price movements of which may be useful, for example, in analysing the wider economy or perhaps for helping to identify asset price bubbles or as a lead indicator of property prices. We have already noted the need in the national accounts to decompose property price indices into land and structure components. However, direct evidence on vacant land prices is relatively scarce, and what data does exist varies substantially from one country to another. But it may also be noted that the land component of a CPPI can be estimated, under certain assumptions, as a residual from such an overall property price index minus a construction cost producer price index (with adjustment for structure depreciation as appropriate).

([12]) This Financial Stability Indicator provides an indication of the financial leverage—that is, the extent to which assets are funded by other than own funds—and another measure of capital adequacy of the deposit-taking sector. For more details see Chapter 6, page 77 of the IMF's Financial Soundness Indicator: Compilation Guide.

([13]) The illustrative list comes from the commercial provider IPD. IPD's property fund indices follow the same basic index methodology used in their annual appraisal-based indices. See Chapter 9.

There are several potential uses of land price indices (LPI), including:

- In the national accounts to help update balance sheets and to separate out user costs between produced (structures) and non-produced (land) components;
- As a lead indicator in the monitoring of property price indices where land often represents a significant, if not the most significant, component of the total price;
- As an economic indicator which can be used to identify potential asset price bubbles;
- As a potential deflator to remove the price of land from turnkey dwellings ([14]);
- As an indicator of the value of the stock of land; and
- As a tool for economic analyses of the relative performance of investments and assets.

The above uses should, at least in theory, determine the conceptual target of LPIs, although in practice data availability or the lack of it can also contribute significantly to the development and availability of relevant statistics. As noted, the more effective approach will often be to take advantage of the residual nature of land value.

Having reviewed in detail the use of commercial property indicators the next chapter presents a basic framework for commercial property price indices from the perspective of, and for the purposes of, official agencies. It includes a description of the nature and role of CPPIs in relation to the SNA.

3.9. References

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([14]) A turnkey house or apartment describes a home built on the developer's land, with the developer's financing ready for the customer to move in. If a contractor builds a 'turnkey home' they frame the structure and finish the interior so that everything is completed down to build in cupboards and cabinets and carpet.

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3.10. Appendix 3.1: Examples of uses of other commercial property indicators for economic and macroprudential analysis

The following Graph 3.2 shows how lending, by Euro area Monetary Financial Institutions (MFIs) to non-financial corporations, varies by sector and how the real estate sector has had an increasing and by far the greatest share of these loans. Thus, it can be seen that lending for 'real estate activities' accounts for the largest share in total euro area MFI non-financial corporate lending and it grew from 28 per cent in 2003 to 34 per cent in 2011.

Graph 3.2 Lending by Euro area MFIs to nonfinancial corporations by sector (per cent of total non-financial corporate lending)
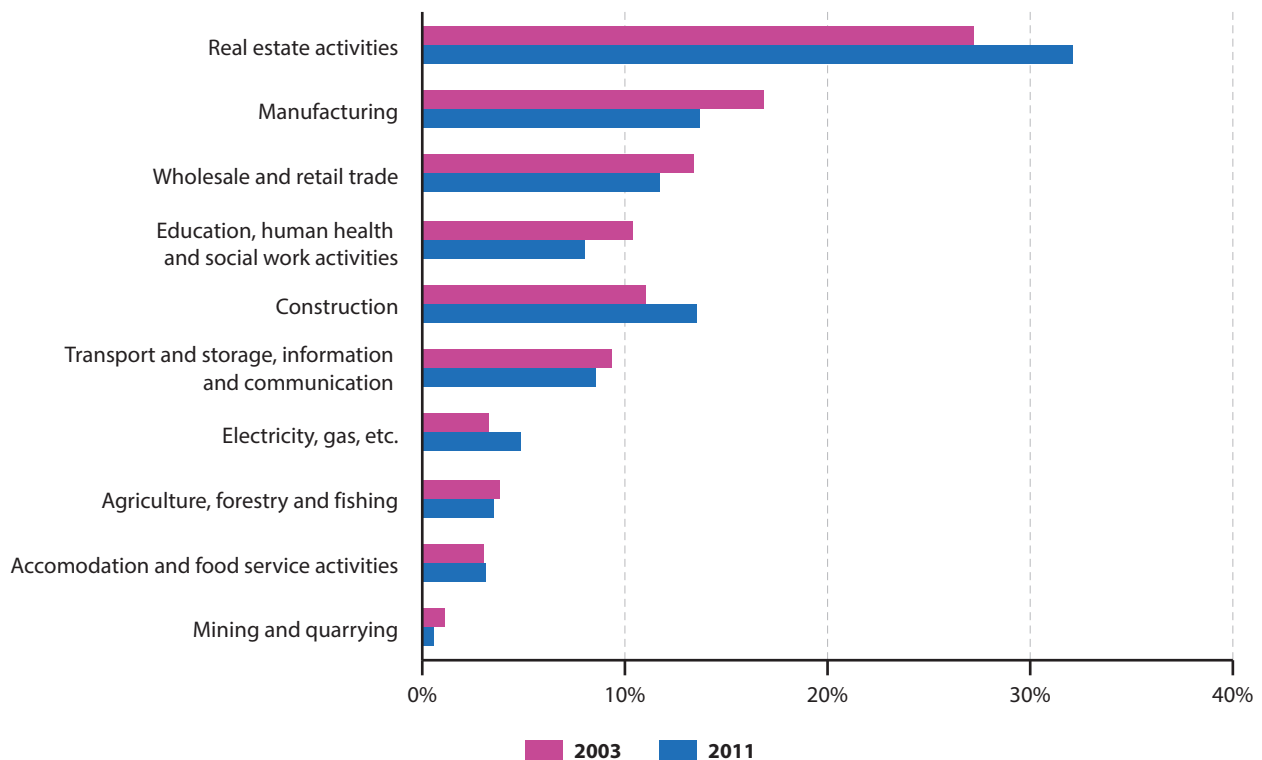
Source: ECB

Further analysis shows how the totality of bank lending exposures varies across Euro area countries and also how for individual countries the distribution of exposures between lending in the domestic market,

lending to other European Union countries and lending to the rest of the world can vary. The latter point is illustrated by Graph 3.3 below.

Graph 3.3 Geographical breakdown of commercial property loans issued by surveyed Euro area banks (2007; per cent of total)
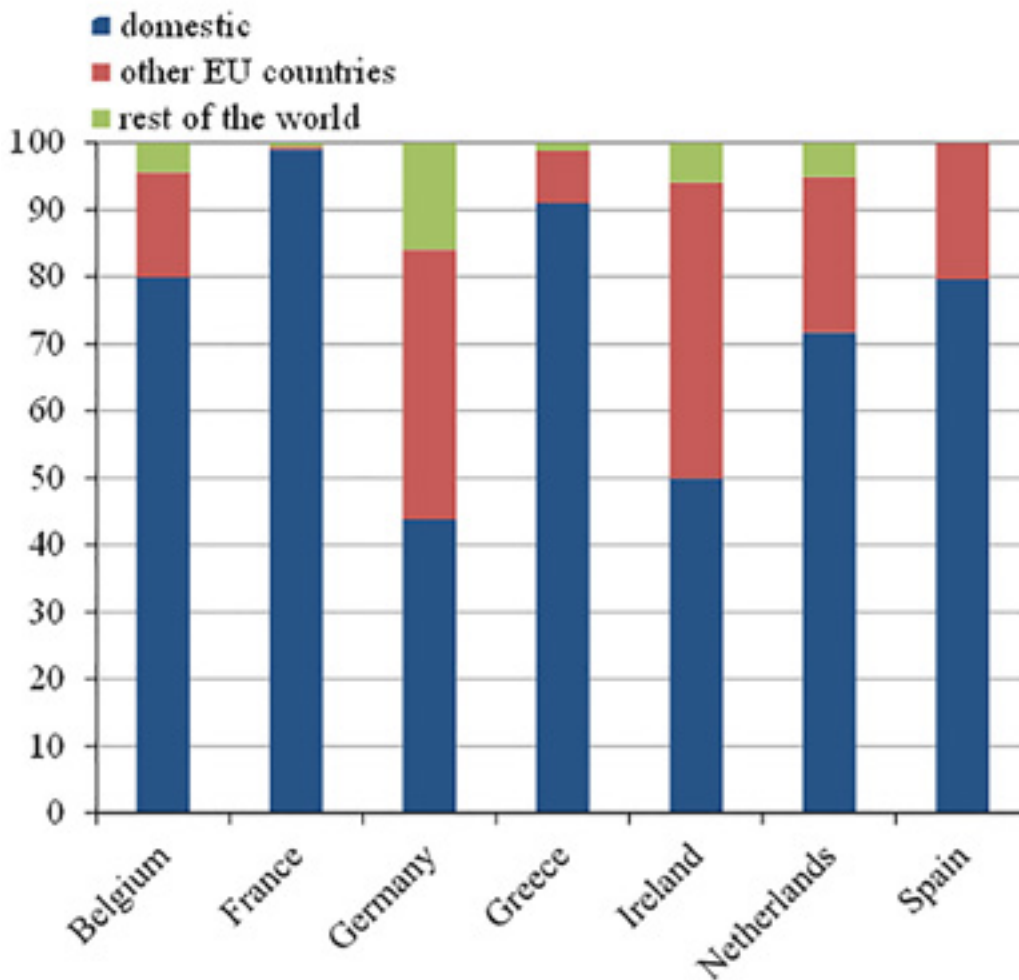
Source: ECB

The exposure of institutional investors is also of relevance both in the context of potential issues relating to longer-term financial stability and of the impact of this exposure on economic growth. Also the relationship between supply and demand and the sustainability of prices, as illustrated by the role of commercial property markets in the macro-economy, as shown in Graph 3.1. The following graph, Graph 3.4, shows that the largest share of direct investment ([15]) in commercial property by institutions is by pension funds, which held about two-thirds of the assets owned by institutions.

([15]) In other words, through the direct ownership of property rather than through buying into property portfolios managed by trusts or Real Estate Investment Trusts (REITs).

Graph 3.4 Direct investment in commercial property by occupational pension funds and insurance companies in the European Union
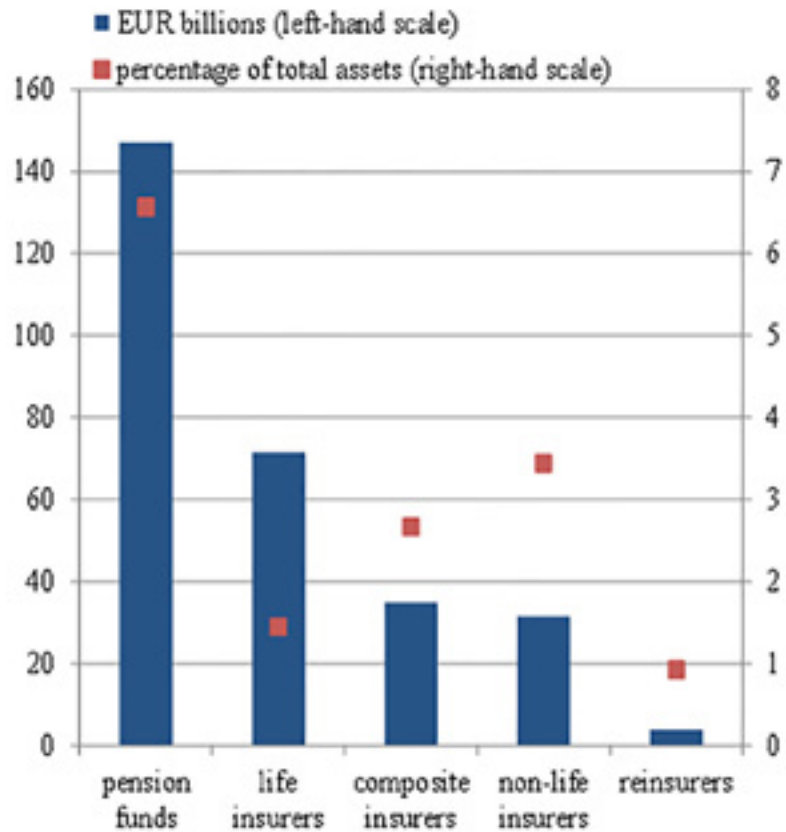
Source: EIOPA = European Insurance and Occupational Pensions Authority

To put things in a broader perspective, Graph 3.5 illustrates the relationships between the commercial and residential property markets, and real GDP growth. It is interesting to note that in recent years the prices of prime commercial property values have been relatively more volatile than residential property prices, emphasising the importance of commercial property values in the context of financial stability indicators.

Graph 3.5 Real GDP growth, prime commercial property values and residential property prices in the euro area (per cent change per annum)
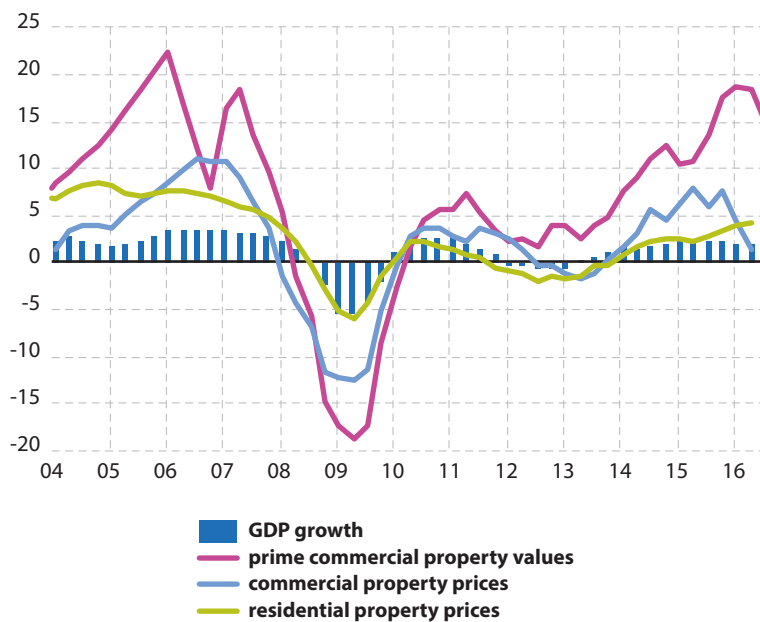
Sources: ECB, Jones Lang LaSalle and ECB calculations

The uses of CPPIs, as described above, illustrate the need users have for a broad range of indicators relating to the property market. In addition to commercial property price indices for the commercial market as a whole and for different sub-sectors, (retail, office, industrial) and the need for a residential property price index, per se, data requirements extend to loans, rents, vacancy rates, broken down by sector, and also to a number of derived variables. The latter include the ratios of debt to capital and capital values to GDP, plus other derivatives such as gross yields. Deviations of these variables from the long-term position can be a first indication of problems ahead. The focus of much of the analysis of the commercial property market is on trends and turning points. In this context users need regular and timely data and a back-series that is long enough to facilitate econometric modelling for the detection and identification of economic relationships.

The graph below shows the deviations from the long-term position of a number of derived variables and is illustrative of the type of analyses that are carried out. In 2007, at the time of the global financial crisis, the ratios of capital value-to-private consumption and of capital value-to-employment were above their 1997 levels for the EU as a whole and significantly above for a number of individual countries. In contrast the capital value-to-GDP ratio and the gross yields were below the 1997 levels for the EU as a whole and, again, the position varied between countries.

Graph 3.6 Value misalignment indicators for prime commercial property in selected Euro area countries (per cent deviation from average values from 1997)
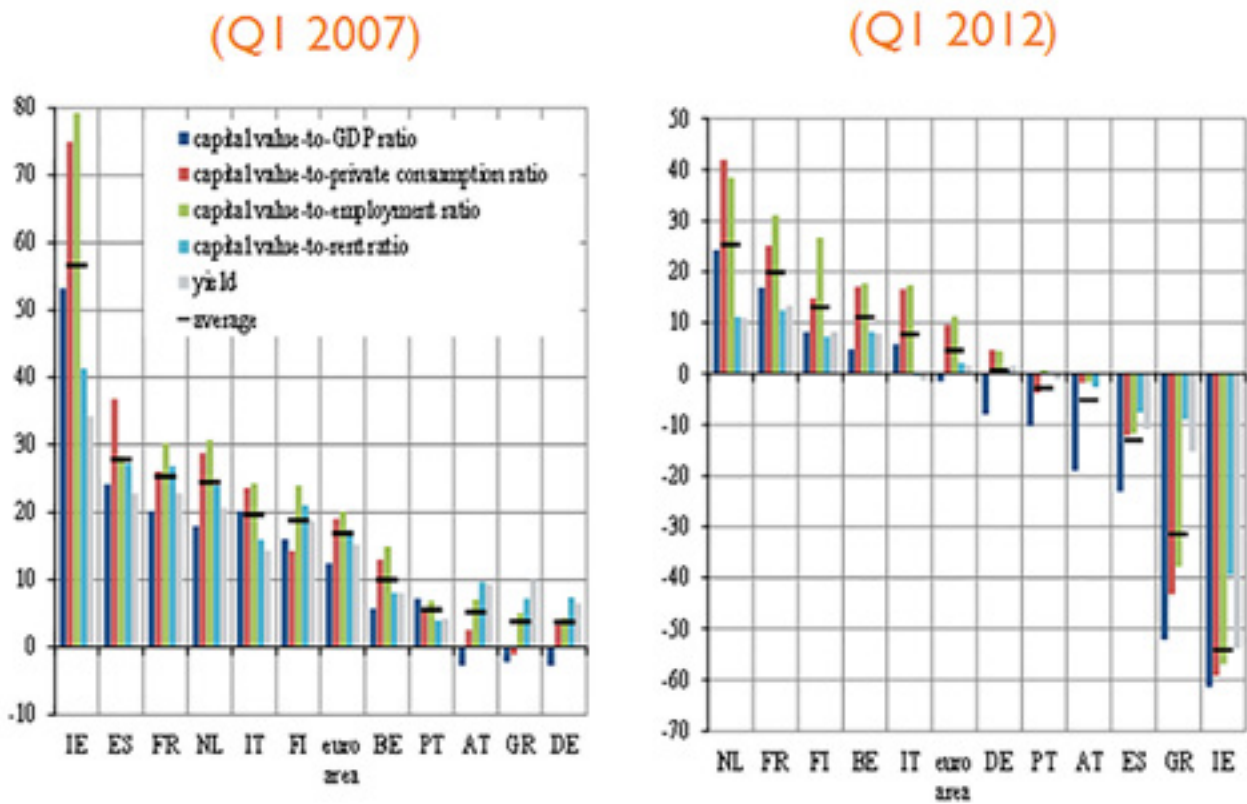
Sources: Jones Lange LaSalle, ECB and ECB calculations.

4 Conceptual Framework for Commercial Property Price Indices

4.1. Introduction

The purpose of Chapter 4 is to present a basic framework for commercial property price indices (CPPIs) from the perspective of, and for the purposes of, official agencies. The chapter will describe the nature and role of CPPIs in their relationship to Official Statistics, including basic definitions and terminology. We will also suggest the main ways in which CPPIs may be used, including some implications for the types of data and indices and other related metrics for commercial property that are necessary, or potentially useful, for all users of CPPIs.

It should be noted that the types of official agencies that require CPPIs fall into two groups; those that are responsible for macroeconomic and monetary policy-making, and those that are responsible for overseeing and regulating the financial system ([16]). We will note how both of these constituencies share major and fundamental commonalities in the types of CPPIs that can be most useful for them. This concurrence is fortunate and important, for the obvious reason that it potentially enables economies to promote, develop, produce and use CPPIs.

In constructing price index measurements, it is necessary to compare transaction prices of constant-quality representative goods and services in successive periods. However, this is particularly challenging in the case of CPPIs. It is very difficult to continuously monitor the prices of properties of the same quality in the market. This is because each property can be considered to be unique, especially with regard to location. The transaction prices available from one period to the next will reflect not only the underlying property price inflation, but changes in the mix of quality of those properties transacted in each period. If in one quarter, for example, more retail properties in prime locations are transacted than in the previous period, average prices will increase as a result of this quality-mix change. Thus there is a need to measure constant-quality price indices.

Throughout this text we will use the term 'constant-quality' property price indexes. The term is used as being synonymous with quality 'mix-adjusted' property price indices. In both regards, the extent to which a property index is of constant quality and the related efficacy of the mix-adjustment will depend on the methods used in this regard, as outlined later in this chapter. Although these terms reflect the conceptual purity of what is required, they will however also be used in subsequent chapters to denote an index that has benefited from a more limited quality-mix adjustment. This is because a conceptually perfect valuation of, and correction for, average price change due to the quality mix change of transaction bundles from one period to the next is always going to be an approximation.

A change in the mix in the quality of properties transacted may not only arise from differing properties being transacted in different periods, but also from changes made to the same property if transacted in the two periods compared. For example, a commercial building may be refurbished to meet new energy efficiency standards or have an extension added to house more apartments, offices, and so forth. The requirements of a measure of constant-quality property price change are

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([16]) See Mehrhoff, J. (2015), 'How should we measure residential property prices to inform policy makers?', *IFC Bulletin*, 40. While Mehrhoff discusses residential property his arguments are equally valid for commercial property as well.

that it is not contaminated by changes in the values of price-determining characteristics of the properties compared. Any change in the mix of the values of characteristics being compared requires a quality adjustment. Indeed, as outlined in Section 4.5.3, the hedonic approach considers the nature of properties to be bundles of characteristics tied together, and any change to the values of the components of any characteristic is a change in the very definition of the property: the price of like must be compared with like.

There are price index number issues as to the choice of period in which the characteristics are held constant: a hedonic constant (Laspeyres-type) reference period price index or a hedonic (Paasche-type) constant current period price index, or some symmetric (for example Fisher-type) average of the two. But these are well considered index number issues as outlined in the *Handbook on RPPIs*. Issues in compiling CPPIs are considered in, among others, Fisher, J., D. Geltner, and H Pollakowski (2007), Devaney, S. and M.R. Diaz (2011), Shimizu, C., W.E. Diewert, K.G. Nishimura and T. Watanabe (2013), Kanutin (2013), Silver (2013), Diewert, W.E. and C. Shimizu (2014), and Geltner, D.M., N.G. Miller, J. Clayton and P. Eichholtz (2014), Mehrhoff (2015).

The following issues must be considered in preparing commercial property price indices:

- Economic indices, as typified by price indices, generally track the transaction prices of the same kind of items over time. This requires that the previously noted heterogeneity be controlled in some way when comparing prices of property assets throughout time.
- The product heterogeneity is particularly problematic due to the sparse number of commercial property transactions relative to those for say residential property. The quality-mix of properties transacted is likely to vary considerably from one period to the next.
- Additionally, what is sweepingly referred to as 'commercial property' covers a broad range of property types: offices, retail facilities, investment housing, factories, distribution facilities, hotels, hospitals, care facilities, etc.
- Property is a durable good; therefore it is necessary to take into account the depreciation that occurs with the passage of time in an appropriate way. More so, since the useful life of commercial property is relatively long, maintenance is therefore carried out, and investments are made in renovation. Thus, when controlling for quality-mix, to compare 'like with like' both depreciation and capital improvements must, in principle, be quantified.
- The data sources are generally secondary sources that are not tailor-made by the NSIs. This may adversely affect the coverage of the index timeliness, reliability, availability of price determining characteristics, and type of price available—for example, asking instead of transaction price, as well as related indicators including appraisals of properties.
- Last but not least, property prices have to be compiled from infrequent transactions on heterogeneous properties. While these are well-known problems in residential property, they are elevated with commercial property.

Chapter 4 is organized as follows. Section 4.2 presents some basic definitions and terminology. Section 4.3 shortly addresses the role of CPPIs in the System of National Accounts. Section 4.4 focuses on the classification of commercial properties. Section 4.5 gives an overview of the methods for the construction of CPPIs. Section 4.6 presents aggregation and weighting issues for CPPIs. The decomposition of CPPIs into land and structure components is covered in the annexes at the end of the document.

4.2. Some basic definitions & terminology of commercial property

4.2.1. What is 'commercial property'?

Before considering CPPIs, it is necessary to define 'what is commercial property?' Property represents one of the most significant, non-financial assets owned by households, firms, and governments. However, the use of property and its economic role changes depending on the entity that owns and uses it.

The term 'commercial property' is not defined or used in the System of National Accounts (SNA). The 2008 SNA categorizes real property within the non-financial asset classification simply as (1) dwellings (para. 10.68), (2) other buildings and structures (para. 10.73), and (3) land (para. 10.175), independently of whether or not buildings and structures are situated on it.

While 'property' might be considered a more general term than 'real estate', the two are used interchangeably in the remainder. Both their meaning is 'land … and things that have been attached to the land (e.g. buildings)' [17]. In what follows, and independently of which of the two terms is used, they refer to developed land; i.e., buildings together with land.

The Basel Committee on Banking Supervision defines commercial property as all non-residential property [18]. More precisely, residential property has the nature of a dwelling and satisfies all applicable laws and regulations enabling the property to be occupied for housing purposes (para. 53). Commercial property, on the other hand, is property that is not a residential property as defined before (para. 57) [19].

Both definitions are not sufficiently precise for most purposes, including but not limited to macroeconomic and macroprudential policy-making. In view of the limitations of the definitions set out above, we provide building blocks for definitions of commercial property [20]. The building blocks are thought to be flexible enough to accommodate different definitions according to the varying uses of indicators.

The delineation is inspired by SNA terminology and contrasts

- the type of property concerned: residential or non-residential; with
- the economic activity involved: selling/renting, construction, own use or non-market.

The following table presents the building blocks and the background to each of them is elucidated below.

Table 4.1 Delineation of residential and commercial property

Assets Activities	Residential properties		Non-residential properties
Selling and renting of real estate	Rental housing	*of which* *Owned by households*	Investment properties
Construction of buildings	Residential buildings under construction	*of which* *For use by owner-occupiers*	Non-residential buildings under construction
Own use	Owner-occupied housing		Corporate properties
Non-market	Social housing		Other non-residential properties

As such, the delineation includes all types of properties, independently of whether or not they are eventually considered as being commercial in the particular use of this definition. Notably, it also considers the construction of buildings since the experience of a number of countries during the recent financial crisis has demonstrated how important it is to monitor investments in this economic activity. Furthermore, properties are the buildings together with the land on which they are situated.

The express aim of the building blocks is two-fold:

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[17] See Royal Institution of Chartered Surveyors (RICS) (2017), *RICS Valuation – Global Standards (RICS Red Book)*; definition of 'real estate'.

[18] Basel Committee on Banking Supervision, *Revisions to the Standardised Approach for credit risk – Second consultative document*, December 2015. Technically, the definition is indirect through the exposure secured by an immovable property rather than the property directly.

[19] There are currently three competing definitions of commercial property in the European Union. The Capital Requirements Regulation (CRR) does not provide a precise definition other than describing it as 'offices or other commercial premises'. The analytical credit database (AnaCredit) regulation defines commercial property as 'property other than residential property' (as defined in the CRR). The European Systemic Risk Board (ESRB) recommendation 'on closing real estate data gaps' defines commercial property as 'any income-producing immovable property, excluding social housing, property held by end-users and buy-to-let housing'.

[20] See Mehrhoff, J. (2017), 'What is "commercial property"?', *IFC Bulletin*, 46.

1. Every property goes into one and only one building block; i.e., every property appears exactly once somewhere (technically speaking, it is a partition).
2. Since it is appropriate to use different measurement approaches depending on the specific analytical objective, the building blocks can be flexibly grouped.

At the broadest level, we could define 'commercial property' as including all property other than owner-occupied housing and property used in non-market activities (social housing and, for example, most types of non-residential property owned by government). This definition corresponds to the highlighted building blocks.

The above definition includes non-residential properties that are largely used and occupied by their owners (referred to as 'corporate properties') and properties under construction. These properties are very seldom traded and in the absence of a market for such properties, generally speaking, CPPIs will not be able to represent the pricing directly.

Typically, corporate properties are not treated as real estate investments by their owners, but they are rather used as capital stock in production processes other than real estate activity. In value terms, such properties may account for a large proportion of the stock of commercial property in some countries. Thus, the need to designate the actual coverage of a CPPI and the nature and relative values of excluded properties.

That would leave us with rental housing and investment properties being considered as 'commercial property' at a narrower level. While both blocks are the classical real estate investment from the owner point of view to earn rentals or for capital appreciation, residential properties that are rented out (rental housing) might be excluded from this designation taking a user point of view. This is because in terms of their actual use, they belong – together with owner-occupied residential property – to the housing market stock.

For residential property owned by households primarily for the purpose of letting to tenants ('buy-to-let housing'), the distinction is not always clear-cut. This type of activity is only significant in certain countries. One position is that, since the buy-to-let activity is typically undertaken by part-time, non-professional landlords with a small property portfolio, it belongs more to the residential than the commercial sector [21]. However, others argue that, although a comparatively large percentage of residential property may be owned by private individuals, it is quite similar to commercial property insofar as it forms part of sole proprietors' private assets and is used as loan collateral [22].

Depending on the perspective, apartments and houses which are rented out are commercial or residential property. They cannot be classified generally, but only in relation to the concrete objective of the study. This nicely shows that a building-block approach allows the creation of tailor-made definitions according to specific user needs.

4.2.2. Target index and quality adjustment

The target index for a CPPI is a *'transaction-based constant-quality price index',* in the sense outlined in the introduction to this chapter. Transaction prices are ideal as they represent observable market valuations. Constant-quality price indices are essential to proper CPPI measurement so that CPPIs only reflect price changes, rather than changes in the mix of properties (property types, characteristics, locations and so forth) that are sold in the periods compared. Thus, when attempting to measure pure price change over time it is necessary to keep the quality constant.

Bearing in mind the nature of the target index described above, there are three key questions that need to be addressed by compilers of CPPIs. Firstly, what are the prices required? Secondly, how can the quality of the assets whose prices are being compared be kept constant; i.e., how can 'like with like'

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(21) See Dierick, F., and Point, E. (2017), 'Closing real estate data gaps for financial stability monitoring and macroprudential policy in the EU', *IFC Bulletin*, 46.

(22) See Deutsche Bundesbank (2013), 'Commercial property prices in Germany: conceptual considerations and statistical status quo', *Monthly Report*, May, pp. 53-55.

comparisons be maintained? Thirdly, how should the various types of property (offices, industrial, retail etc.) be aggregated together.

These issues are complex, interlinked and are dependent on both the primary *use* of the index and the availability of data (which for CPPIs can be either scarce and/or incomplete).

What prices to use in a CPPI?

In constructing CPPIs, the nature of price data available is for the large part specific to each country's institutional arrangements for purchasing and selling commercial property, and recording the price, as well as the institutional arrangements for financing the purchase. Suitable data on prices may only be available for asking prices, say from realtors/agents; a price somewhat near completion may be available from lenders; or transaction prices available from notaries or a land registry. As outlined in Section 4.2.3 and subsequent chapters, appraisal-based indices may, as a consequence, also have a role to play.

How to keep quality constant in a CPPI?

Quality adjustment, in the sense outlined in the introduction to this chapter, refers to adjusting for the differing characteristics of properties sold in the periods being compared, so that 'like with like' comparisons are being made through time; i.e., the quality of the assets (property characteristics) being measured by the index remains 'constant'. This is particularly pertinent for commercial properties, which are very heterogeneous in terms of their size, functionality and physical quality, compared to residential property, for example, which is generally less heterogeneous. It is therefore difficult to accurately represent pure transaction price change with statistics such as simple averages and median values by using transaction prices where the mix of properties transacted changes.

The principle methods for estimating constant-quality price indices are regression-based methods; the hedonic and repeat sales methods as described in the *Handbook on Residential Property Price Indices (RPPIs)* and applied by many countries. Hedonic regression-based methods require in each period adequate samples of prices and price-determining characteristics of each property transacted and for the commercial property market, for which the number of transactions may be extremely limited, the collection of data that can accommodate this type of analysis may be strongly restricted to only certain regions and uses in each country.

For the repeat sales method, estimation of a constant-quality price index is only possible with re-bought and re-sold properties for which there are at least two transactions in the period under study, although this may extend to say 25 years. Nonetheless, such transactions may be extremely limited for some types of buildings, especially retail, factory, and warehouse properties in specific locations.

Given the above, even though a *pure* transactions-based index is conceptually ideal, it may not be possible for it to be reliably estimated in many circumstances, due to the fact that the required quality adjustments, based on applying either the hedonic method or the repeat sales method, may not be possible in practice. That being the case, quality adjustment based on property market prices in combination with appraisals, will in some circumstances, emerge as a more practical and pragmatic alternative, in particular, where transaction data are sparse and there is reliable and consistently measured appraisal data for commercial properties.

How to aggregate the various types of properties?

The various motivations for the analysis of commercial property prices, from the monetary policy assessment of price signals to the use for financial stability purposes or as a soundness indicator, call for alternative measures to be applied. However, these indicators can give different results, which could undermine their credibility for many users. Yet, there should be no unique indicator. In order to determine whether threats to the economy or financial stability emanate from the commercial property market, the analyses should be based on a broad set of indicators. In this respect, Section 4.6 deals with aggregation and weighting issues in some more detail.

4.2.3. Appraisal prices

The term 'appraisal prices' as used here, refers to market values of property assets (also referred to as 'valuations'), where the estimates are made by professional appraisers or assessors ('valuers'). Such valuations are '[t]he estimated amount for which [a property] should exchange on the valuation date between a willing buyer and a willing seller in an arm's length transaction, after proper marketing and where the parties had each acted knowledgeably, prudently and without compulsion' [23]. In real estate terminology, such valuations are not referred to as 'prices', as the latter term is reserved for actual transactions. However, in the present context we shall use the terms 'appraisal price' and 'appraisal' interchangeably.

In some countries, the private sector provides what are described as appraisal-based CPPIs. By this, in the present context, we are referring to pure appraisal-based indices (as described in Chapter 7, not the *Sale Price Appraisal Ratio* (SPAR) or transaction-based appraisal-regressor indices as described in Chapter 6). These private sector indices work well for benchmarking for investors. That is to say, investors use appraisal-based indices to compare the investment performance of their own properties with that of other properties, held either by other investors or by competing investment managers. Such appraisal-based indices have come to form a type of industry 'standard' measure of such commercial property investment performance in some countries. As investment performance includes the change in the capital value of the property assets over time, such indices explicitly track the appraisal-estimated asset value changes over time for commercial investment properties. However, as Mehrhoff (2015) shows, capital values are influenced by quality change in addition to pure price change. Using capital values, therefore, introduces quality aspects in the form of (net) depreciation that, in turn, may lead to a biased measure of pure price change. The picture drawn from price indices and performance indicators can be fundamentally different. Eventually, this may lead to the wrong conclusion being drawn in analyses and for policy making. It should be noted that some indices may also include rental income earned. Although this information is not the type of price change information that is required in a pure property price index, it does provide some related information. Such income return indices will be of direct interest to financial system regulators and overseers where, for example, the 'search for yield' can be well-tracked by such indices.

Thus, appraisals, where reliable and adequate, might be used where transaction data are sparse to help estimate CPPIs. Such estimates require the use of appraisal prices in conjunction with the sparse transaction prices. These SPAR and transaction-based appraisal-regressor indices methods, as noted above, are outlined in Chapter 6. However, a major restriction on their use is that the appraisal data have to be reliable and adequate and while the extent of this will vary between, and possibly within, countries, it remains a major caveat on its use. Appraisal data have an attraction in that for the market of properties covered by appraisals, successive matched price estimates for individual properties are available. We elaborate here on the potential disadvantages of appraisal values and refer back to this section when outlining the use of this data in Chapters 6 and 7. The extent to which these potential disadvantages are problematic for property price indices will vary between countries. The listing here of these potential problems are to serve compilers of CPPIs as something of a checklist of issues to be applied to their consideration of the use of appraisal data in their country CPPI compilation.

4.2.4. Potential problems with appraisal-based indices

The concepts and measures of appraisal indices differ from those of transaction-based price indices, the former having an (albeit informed) subjective basis that does not accord with the (transaction-based) valuation principle of price statistics.

1. The independence of appraisers has been questioned. Gallimmore and Wolverton (1997), Kinnard, Lenk and Worzala (1997) and Wolverton (2000), for example, suggested a possible bias caused by clients and the determination of the appraisal fee, as it relates to appraised value.
2. Guidelines to professional appraisers are that they base their appraisal on the transactions of similar properties currently in the market, introducing circularity in the argument that appraisals

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[23] See Royal Institution of Chartered Surveyors (RICS) (2017), *RICS Valuation – Global Standards (RICS Red Book)*; definition of 'market value'.

solve the problem of sparse data. Appraisal data are often heralded as a panacea to the problem of sparse data.

3. Valuations made by an appraisal firm are largely conducted irregularly, say annually, and quarterly data may in part be (stale) estimates by the manager/owner of the property largely based on the last formal appraisal. It may be, for example, that a quarterly index compiled from annual appraisal data would include, on average and depending on reporting requirements, three-quarters of its price observations each quarter based on interpolations and all of its price change measures, based on interpolations.

4. Depending on the institutional arrangements for the country, the timeliness of an appraisal index, especially if it relates to a requirement for an adequate sample size for interpolations, may be problematic.

5. Information on capital expenditures and depreciation are used, in appraisal-based indices, as a means for quality adjustment between appraisals. There is much in the definition of these variables that render them inadequate as currently constructed for the needs of CPPIs ([24]).

6. Guideline for appraisals and definitions vary between and within countries, and substantially so.

7. The sample of values is for larger professionally-managed properties—there may be a sample selectivity bias.

8. The population from which the data used to create appraisal indices changes over time. Since the purpose of these indexes, as currently used in the private sector, is to capture changes in investment returns of properties, they are estimated either by taking investment properties which are owned by clients or by sampling the population. As a result, if a given property is sold off and is no longer an investment target, it is removed from the index; if a property becomes a new investment target, it becomes part of the index. In other words, the properties, which are the target of the index, change over time. Average prices of a bundle of properties are no longer compared with average prices of 'like' bundle. In this sense, these indices are not completely free from bias stemming from quality changes over time.

9. There is evidence that appraisal-based indexes unduly smooth and lag prices ([25]).

10. Users for macroeconomic analysis have an established preference for transaction-based indexes. The European Central Bank (ECB), as part of a stocktaking exercise on CPPIs, asked end-users their views as to their needs: the relatively uniform response was for commercial property price index based on transaction prices; valuation indexes were, as noted by Kanutin (2013), only 'a second best option'.

Considering some of these issues in more detail, a number of studies have indicated problems in appraisal prices, especially smoothing the gap between appraisal prices and transaction prices. Looking at past studies, one can see that the following issues occur with respect to real estate appraisal prices: the valuation error problem, lagging/smoothing problem, and client influence problem.

Firstly, they tend to diverge from transaction prices in periods of wild market fluctuation (valuation error problem); see for example, Shimizu and Nishimura (2006) ([26]). Secondly, they may not be able to capture turning points in prices with precision (lagging problem). In addition to lagging, appraisal

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[24] Same-property prices over time reflect the effect of depreciation in the structure, and appraisal-based indices, like other types of CPPIs, do not automatically control for or separate out the structure depreciation effect in the asset price change. Capital improvement expenditures on the property are also a consideration, however, most investment return indicator appraisal-based indices (the subject of Chapter 7) do eliminate capital expenditures from the capital return (price change) index, and explicitly report capital expenditures on the properties each period. Capital expenditures are sometimes reported only to the extent that such expenditure brings the property back to its previous period's quality. A change in capital expenditure quality may be over and above this sum, say an extension to the building. The index number treatment to maintain a constant-quality price index is considered in Section 4.5.

[25] A summary of these issues is in Geltner, Miller, Clayton & Eichholtz (2014, Chapter 25). Earlier literature goes back to, among others, Cole, Guilkey and Miles (1986), Geltner (1991), Fisher, Geltner, and Webb (1994), Jeffries (1997), Geltner *et al.* (2003), Shimizu and Nishimura (2006), Geltner and Fisher (2007), and Devaney and Diaz (2011). Crosby (2000) provides an international comparison of the impact on valuation accuracy caused by different social structure in each country. Geltner, Graff and Young (1994), Geltner (1997, 1998), Bowles, McAllister, and Tarbert (2001) consider the impact of appraisal error on a property index and pointed out time-lag structure in appraisal-based index.

[26] This research found that appraisal-based index had certain problems in Japanese bubble period in 1980's and 1990's. The appraisal price indices were highly 'smoothed' and hence shows different peak periods and growth rates across several periods in comparison with transaction-based index. This research investigated the ratio of appraisal land index to transaction price index to show the magnitude of 'valuation error'. The ratio for commercial land in three core Tokyo wards was 80.84 % in 1975 and dropped to 46.40 % by 1981. Then the ratio rose in 1982 and 1983 reaching 69.55 % in initial bubble period. However, it increased again after the burst of the bubble to 104.24 % in 1993. In 1999, the appraisal price was bigger than the transaction price index by approximately 20 % after collapse of bubbles.

price-based indexes tend to smooth out true price changes (smoothing problem), so that they tend to underestimate price volatility [27]. Thirdly, the question of independence of appraisers was already addressed above.

However, the existing appraisal-based indices for the large part represent same-property (matched-good) tracking, and the evolution in index property sample composition over time tends to be slow and gradual, usually with considerable ability to control such evolution, at least in principle, by the constructing composite indices that are aggregated from composition-pure sub-indices that are (or that can be) reported by the index compiler.

In using appraisal prices for CPPIs, how exactly are appraised prices (or assessed property values for taxation purposes) formed for CPPIs? A mixture of methods is used, including the following [28]:

• Ratio methods;
• Estimation of expected discounted cash flows;
• Comparable property comparisons [29]; and
• Formal or informal hedonic regression methods.

Are appraised or assessed values reliable enough to be used for the purpose of official statistics (if the target index is a transaction-based constant-quality price index)? Appraisers do have an incentive to 'get things right' since, when an appraised property is actually sold, the sale price can be compared with the assessed value and if the discrepancy is too great, the appraiser's reputation will be adversely affected, which, in turn may lead to reduced work for the appraiser in the future. Furthermore, in the case of the private sector investment-oriented indices, investment managers are usually required to officially report the appraisal-based asset values (the so-called 'marked-to-market values') to their investor clients, and in many cases clients can buy into or sell out of the manager's investment fund based on the appraised values. This could be argued to make the appraised values a type of semi-liquid valuation.

However, as previously mentioned, the number of transactions in commercial property is scarce and hence the number of appraisal data may also be either scarce, or else based on judgements that do not have a very strong basis in current market transactions.

The practice of regular and mark-to-market valuation of the invested property at present is also limited mainly to the matured economies, in terms of property investment (although there are appraisal-based indices in a few emerging market countries, such as South Africa).

It should be noted that property assessed valuations in land and for property tax purposes are much more widespread than the private sector appraisal-based indices that are used in the investments industry described above. However, it is not clear if the assessed values for tax purposes are accurate or consistent enough to construct reliable price indices in many countries. Parties with an interest in CPPIs should consider further investigation of this approach in the future.

Finally, it is important to note that, whether we are referring to property tax assessments carried out by the public sector, or investment-oriented valuations carried out by the private sector, there is a major problem of lack of consistency in appraisal norms and practices both across and within countries. The extent to which such inconsistency would pose problems for cross-country comparisons needs to be studied. (However, this same point could be raised to some extent about transaction prices, as well as appraisals. Property asset markets function very differently across countries, and trading and pricing is carried out under different norms and traditions, as well as different procedures in the transaction marketplace, which can cause the exact meaning of reported transaction prices to differ across countries, for example, in the extent to which they represent free-market arm's length exchanges.)

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[27] See the chart and surrounding discussion in Geltner, Miller, Clayton and Eichholtz (2014; p. 655) for an illustration of these points.

[28] See Geltner, Miller, Clayton and Eichholtz (2014; pp. 634-656) for an excellent summary of how appraisals are made in practice.

[29] Appraisers frequently base their estimates for the asset value of a commercial property on sales of similar properties during the same time period. See Baum and Crosby (2008).

4.3. Commercial Property Price Indices and the System of National Accounts

The System of National Accounts (SNA) ([30]) provides a comprehensive accounting framework for an economy. The SNA partitions the value flows in the economy into various meaningful categories and provides a reconciliation of the flow accounts with the corresponding stock accounts. The SNA also recommends the decomposition of the values in the cells of these accounts, into price and volume components.

There are at least four cases in which commercial property price indices *could be used* to convert nominal values into volumes or real values in the SNA:

• the value of the stocks of commercial property (see also below);
• the value of the production of and investments in newly produced commercial property;
• the sales and purchases of existing commercial property; and
• the value of the structures part in the above mentioned flows.

A property price index is required in order to form user costs of commercial properties that are used in the commercial property sector, if users would like to decompose Gross Operating Surplus (GOS) of the commercial property index ([31]).

Furthermore, commercial property is a component of the wealth of a sector and the national economy. As such, it is recorded on the national accounts balance sheets. A price index, preferably a stock-weighted one, is therefore required, so that balance sheet estimates of wealth by component can be estimated ([32]). It should be noted however that SNA balance sheet estimates of wealth distinguish between the structures component of commercial property and the land component ([33]). Thus, in order to construct the relevant estimates according to the SNA, it is necessary to decompose commercial property values into the two components, structures and underlying land, and to construct price indices for each of these components. However, having a CPPI for the combined value would also be very helpful as a benchmark for the estimations of the two components. When it comes to changes in balance sheet items, CPPIs can also be useful for the decomposition of the changes in stocks of commercial property, more in particular to estimate the revaluations of stocks held, due to price changes.

Finally, a transactions-based price index is also needed to estimate the real output of the commercial property real estate services; i.e., the industry that provides services that facilitate commercial properties transactions. The situation is similar to the need for a residential property price index, so that the real output of the residential property real estate services industry can be estimated, the algebra of which is explained in the *Handbook on Residential Property Price Indices* (RPPIs) and need not be repeated here ([34]).

([30]) See Eurostat, IMF, OECD, UN and the World Bank (2009).

([31]) Recall that SNA 2008 permits this decomposition of GOS into price and quantity components but does not require it. However, every country that attempts to measure the Multifactor Productivity (MFP) of its industries will require commercial property price indices in order to accomplish this task. Moreover, to measure MFP by industry, a decomposition of commercial property values by industry into land and structure components will also be required.

([32]) A price index for the stock of commercial properties is also of some use to central bankers and mortgage lenders who are interested in monitoring property prices for the possibility of bubbles in their countries; see Chapter 6.

([33]) Compared to having a CPPI at all, this is of course a second-tier problem in practice.

([34]) See Section 3.10 of Eurostat (2013).

4.4. Classification of commercial properties

4.4.1. The segmentation and stratification dimensions in commercial property asset markets

Commercial properties are very heterogeneous. Heterogeneity exists not only at the individual asset level, but at an aggregate level in populations of properties that effectively trade in distinct asset market segments. To construct useful CPPIs it is crucial to recognise this type of aggregate level heterogeneity and market segmentation, because different price dynamics can prevail across different market segments. Prices in one market segment might be rising at the same time that those in another segment are falling. If one mixes the two segments (or 'populations') together without care and attention, then one may think nothing is happening to prices in either market.

In general, statistical techniques for estimating price indices will assume that all the empirical price observations are drawn from a single 'population' in terms of pricing characteristics or the valuation model. It is therefore important that stratification is used in the construction of a CPPI, not only to ensure that the index properly represents what is happening in the property market, but also for analytical purposes, where it is desirable to develop fundamental breakdowns, based on groups of properties that are as homogeneous as possible in terms of pricing behaviour and price evolution. This facilitates the most effective statistical estimation possible. It also allows more flexibility and scope for the analysis of what is going on in commercial real estate markets.

In the next section we will consider only the property classifications that are prominent in official statistics, which are primarily focused on building types. In Section 4.4.3, we discuss market segmentation and sample stratification viewed primarily from the investment industry perspective.

4.4.2. Classifications in official statistics that could be used for commercial properties

The classification of commercial property has had little attention in official statistics. The only internationally recognised detailed classification of commercial properties in official statistics is the *Classification of types of construction* (CC, 1998), a nomenclature for the classification of constructions according to their type. It was developed on the basis of the provisional *Central product classification* (CPC) published in 1991 by the United Nations [35].

The CC is designed to serve different purposes such as statistics on construction activities, construction reports, building and housing censuses and price statistics on construction work and national accounts. In addition, the CC is used for defining constructions which will be needed to provide information on specific variables (e.g. building permits, production) concerning short-term statistics.

The CC principles are based mainly on the technical design resulting from the special use of a structure (e.g. commercial buildings, road structures, waterworks, pipelines) and, particularly for buildings, on its main use (e.g. residential, non-residential). The site of a construction, its ownership and the institution to which it belongs are normally irrelevant criteria. Civil engineering works are classified mainly according to the engineering design which is determined by the purpose of the structure.

The classification is structured for buildings as follows.

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[35] See http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Classification_of_types_of_construction_(CC)

11 Residential buildings

- 111 One-dwelling buildings
- 112 Two- and more dwelling buildings
- 113 Residences for communities

12 Non-residential buildings

- 121 Hotels and similar buildings
- 122 Office buildings
- 123 Wholesale and retail trade buildings
- 124 Traffic and communication buildings
- 125 Industrial buildings and warehouses
- 126 Public entertainment, education, hospital or institutional care buildings
- 127 Other non-residential buildings

This lack of a fully satisfactory internationally recognised nomenclature for commercial property, in the context of official statistics, has led to producers and users adopting their own classifications. For example, a working group of German government institutions and actors in the real industry came together to develop a classification of commercial real estate which should be a (national) standard, suitable for analysis, accepted by all market participants, compatible with the data pool, and take account of existing norms (SNA and CC) ([36]).

For the purposes of analysis and valuation, developed land is first categorised according to four main groups:

- Residential property;
- Commercial property;
- Agriculture, forestry and fishing property; and
- Other property.

The category 'commercial property' contains properties with very heterogeneous uses and yield targets; it is further broken down according to nine segments:

- Wholesale and retail trade buildings;
- Office buildings;
- Industrial buildings;
- Hotels and hospitality buildings;
- Hospital or institutional care buildings;
- Leisure, culture and education buildings;
- Technical infrastructure buildings;
- Other non-residential buildings; and
- Other structures.

This classification of commercial property is largely similar to the CC. The first report of the German working group also further stratifies wholesale and retail trade buildings as well as office buildings. For the trade buildings, characteristics such as floor area and technical design were taken into consideration. Examples include shopping centers, department stores and specialist retailers. Office buildings are identified mainly through the range of functions of the buildings. Thus, it distinguishes between single-use buildings including office parks, and business premises which are mainly used as offices.

([36]) See German Property Federation (ZIA) (2016), *Strukturierung des sachlichen Teilmarktes wirtschaftlich genutzter Immobilien für die Zwecke der Marktbeobachtung und Wertermittlung*. Further members of the working group were the association of surveyor committees (AK-OGA), the Federal Statistical Office (Destatis), the Deutsche Bundesbank, Immobilien Scout GmbH, the Association of German Public Banks (VÖB), the Association of German Cities, the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR), and the Association of German Pfandbrief Banks (vdp).

4.4.3. Classification of commercial property based on market segments

An important conceptual issue to consider when developing a system of CPPIs is the nature of commercial property asset market segmentation. This segmentation can help determine the strategy for data sample stratification and the design of a hierarchical system of asset price indices, starting with basic breakdowns that are directly estimated on the sample strata, and continuing through to various higher levels of aggregate indices that are constructed as value-weighted composites of the lower-level indices.

A final point that should be made about commercial property market segmentation is that it tends to be dynamic. While some basic segments will tend to be quite permanent, others may change over time. Thus, statistical agencies should plan to periodically revisit the CPPI segmentation and stratification structure and modify it as and when necessary, whilst bearing in mind that those users want continuity in addition to representativity.

There are three major dimensions of commercial property market segmentation or stratification: building usage type 'sector', geographic region or location 'market', and building physical quality 'class'. We will discuss each of these in turn below.

1) Commercial Property by type of use

Traditionally the four most widely recognized types of use in commercial real estate are trade buildings, office buildings, industrial buildings and possibly rental housing. Each of these will be introduced in order below.

- Trade buildings

Various types of facility are covered by the term 'trade buildings', ranging from urban-type retail facilities located in the central business district, to large-scale shopping malls located in suburban areas or small-scale individual shops. The diversity of these trade buildings is even greater than that of office buildings, and when measuring their market value and performing quality adjustment it is necessary to consider characteristics such as store structure, in addition to factors such as building structure, size, and location.

- Office buildings

In the office building transaction market, buildings intended for property investment are transacted frequently (for example in the United States, typically within 5 to 10 year horizons), but there are fewer transactions involving 'own use'; i.e. corporate properties. Since transactions are also fewer in non-urban areas, it can often be the case that when attempting to estimate a transaction-based price index, there are insufficient transactions in such instances.

- Industrial buildings

Industrial buildings include various sub-types including most prominently industrial production facilities and warehouses or distribution and logistics facilities. Another specialized category of property, sometimes referred to as 'flex space' or 'R&D space', is a sort of hybrid between office and industrial space tailored particularly for the high-tech industry. Flex space often includes laboratories and light, industrial production or research and testing facilities, but also is designed to accommodate some warehousing and headquarters, or front-office facilities, all within the same building or complex. Sometimes flex space is presented as a separate category but more commonly it is combined within the industrial as a special sub-type.

- Rental housing

'Rental housing' can also be considered commercial property from the owner's perspective. Investors (albeit individuals in many cases; i.e. 'buy-to-let' housing) determine the value based on the revenue generated. Much of the official information from transaction records will not separately identify such purchases [37].

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[37] Shimizu et al. (2012) point out that measurement of imputed rent for owner-occupied housing in Tokyo using the equivalent rent method and different user cost methods found a several-fold discrepancy between the two particularly during periods of large fluctuations in housing prices.

The distinction between residential property purchased for 'rental housing' and residential property purchased for 'owner-occupied housing' demands ongoing attention. In national accounting, if the private household has an incorporated business that lists the second house as an asset in the business, then this property will appear in the corporate business sector. The same applies if the second house is part of a partnership. If the business is not incorporated, then the return from this investment will probably be regarded as self-employment income. This is not entirely satisfactory: in principle the household sector should really be split into two separate parts: the consuming part and a possible business part, where regular production accounts could be constructed.

2) Geographic Regions & Markets

The second dimension of commercial property market segmentation is geographic region or market. As noted, users of commercial space generally need such space to be in a particular location or geographic region. As buildings cannot move, this creates market segmentation by geography. Thus, differences in rental markets can directly cause differences in property asset market price dynamics. In addition, investors may have differential preferences for properties in different locations and this can further cause differential price dynamics in the asset markets. A particular example is where establishing a commercial property acts as a growth pole that attracts related commercial properties, such as high-technology industries and apartment blocks with an expanding local concomitant services sector including bars and retail premises. There is a sense in which a building with such a growth pole changes its locational attributes over time.

There are several different ways to identify and define geographic location-based market segments for commercial property, such as proximity to the city center or availability of parking space for trade buildings, location in the central business district for office buildings, access to motorways, etc. for industrial buildings, distance from amenities for rental housing.

In many countries, such broad and contiguous/bordering regions are not very homogeneous in terms of commercial property market segments. Such broad regions therefore may not be the most effective way to define geographic market segments. However, they have the advantage of being large and therefore avoid data scarcity problems.

3) Property Physical Quality & Size Classes

The third dimension of market segmentation is defined by the perceived physical quality and/or the 'size', of the building.

There are cases where office buildings are presented as prime or secondary, class A to C, etc., but the way they are defined varies, depending on the country, the company, association or foundation determining the definition, etc. ([38]) Nevertheless, this definition is arguably a moving target that changes with the times and varies depending on the country.

As with the other two dimensions of commercial property, segmentation and stratification, insufficient data availability can limit the ability of a set of CPPIs to fully differentiate between quality classes. In particular, the quantity and reliability of data on the smaller, lower quality class buildings is often more of a challenge than for the larger, more expensive properties. In some cases, this may make it impossible to compile CPPIs that include lower class buildings. However, it should be kept in mind that the impact, or role, of larger more expensive properties in the national economy and in the financial system may be greater than that of the smaller properties, even though there may be many smaller properties.

4.4.4. Treatment of types of estates: freeholds and leaseholds

The ownership of real property can be defined in various ways, that is, different sorts of 'claims' on real property can exist. It is these claims that are actually traded on the property market. In many English speaking countries (which are typically governed by so-called 'common law'), the ownership claims on real property are referred to as 'estates'. For example, an estate may be 'fee simple', typically referred

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([38]) Such as those independently set by the United States Building Owners and Managers Association (BOMA), Australia's Property Council of Australia, or private firms.

to as a 'freehold', or an estate may be 'leasehold'. A leasehold, evidenced by a 'lease' issued by the freeholder, provides full or limited rights on the property for a finite period of time, often conditional on the payment of an annual lump sum, whereas a freehold has no time limit or expiration.

Thus, there are two markets: the sale of freehold and the sale of leases ('leasehold' in the United Kingdom). The latter can be variable in length, which will be influenced by market conditions e.g. in some countries, many relatively short-term leases are given on retail property during economic downturns.

While freehold is absolute ownership, leasehold is where the freeholder further leases those rights to a third party for a limited period of time, which may be land only, in some cases, or building and land in other cases. Lease periods are mixed in duration where some countries have lease periods like 999 years or 99 years, while others may be just 10 years or so. Therefore, when attempting to measure the economic value of leasehold, the longer the remaining period of the lease, the closer the present value will be to the value of the freehold. This is because the present value with a longer remaining lease period will be less influenced by discounting the cash flow in the future, than the present value with a shorter remaining lease. As with property appraisal approaches, while it varies depending on the country, in the case of freeholds prices are determined using three approaches: the comparable approach of analogizing from similar transaction prices, the cost approach of accumulating from costs, and the income approach of determining based on income. With leasehold, on the other hand, for buildings with land leasehold rights (in the case of personal use), if it is the building only, then it will be based on the right to lease the building, and prices are thus determined by taking into consideration the gap between market rent and actual paid rent, etc. In determining prices in that case, how long the contract period will continue, or whether transactions like that exist in practice, etc. will be important in determining prices ([39]).

The leasehold market needs to be covered in commercial property price indicators where it is of a significant size. In such an event, leasehold and freehold transactions need to be treated separately for the purposes of compilation.

At one extreme, short to medium term leases that lack full control of the property characterize the space market or rental market for the usage of real property. Such leases, and any trading of them, (such as sub-leasing) would be considered part of the 'space market', rather than the 'asset market'. At the other extreme, very long-term 'ground leases' provide virtually full control over the property for a long period of time. Leases in the space market are rarely for more than 10 or 20 years, they often cover only a part of a building or property, and typically do not include major reconstruction or redevelopment rights. Leaseholds in the asset market, when initially created, are often as long as 99 years, or longer. They typically cover the entire property or building and normally include development or redevelopment rights. Leases in the space market are typically paid for by periodic rental payments with little, or no, up-front lump-sum payment (in fact in some cases the landlord actually pays the tenant at the beginning of the lease by means of tenant improvement allowances). Leaseholds in the asset market are often paid for with a single lump-sum payment up front, similar to buying a fee simple estate, although it is not uncommon for ground leases to include periodic rent payments as well. Options and rent revisions are common in many leases.

The subject of CPPIs is property assets, hence, the asset market, not the space market. However, the two markets are clearly linked and some metrics of the space market will be considered in Chapter 8. Leases in the space market are essentially a component, or a consideration, in the tracking of space market indicators such as rent, occupancy and absorption. But long-term ground leaseholds would normally be treated in CPPIs tracking asset market values (the main subject of this text) - including the CPPI methodologies described in Chapters 5 to 7.

In the latter case the nature and terms of the ground lease become part of the 'hedonic' or quality characteristics of the property. Comparing leaseholds with freeholds or comparing two leaseholds with different characteristics and remaining terms or rental payments involves 'apples-versus-oranges' comparisons, that need to be monitored as much as possible. The issue of monitoring heterogeneity across properties that transact in different periods of time when constructing a property price index, will be discussed further later in this chapter, and in more depth in Chapters 5 to 7.

([39]) See details, Fisher and Martin (1994), Keating, D.M. (1998).

4.5. Main methods for the construction of a commercial property price index

In this section the four main methods for constructing a transaction-based property price index that were suggested in the *Handbook on Residential Property Price Indices* will be adapted to the construction of CPPIs. The first three methods assume that information on the sales of commercial properties in a particular stratum is available, along with some information on the characteristics of the properties. The fourth method that was suggested in the *Handbook on Residential Property Price Indices* is the SPAR method which requires property assessment information, in addition to property sales information.

4.5.1. The stratification approach

To measure pure price change, commercial property prices must be adjusted for quality change. In other words, to compile a constant-quality price index it is necessary to control for/monitor/look out for any variations in the price determining characteristics of the properties. The most important characteristics include:

- The area of the structure;
- The area of the land that the structure sits on;
- The location of the property;
- The age of the structure;
- The type of structure; i.e., whether the building is a commercial office building, a retail store, a parking lot, a hospital, a warehouse, a factory, and so on;
- The materials used in the construction of the house (primarily wood, brick, concrete or other material); and
- Other price determining characteristics, such as landscaping, distance from amenities, the number of floors, and the degree to which new environmental standards are met.

It should be noted that while all the above contribute to the price of a property, not all the characteristics will necessarily be recorded or are often used to produce a stratified index. What is of concern is that say a stratified index is compiled as a weighted average of price changes of individual stratum where the strata are only defined on a limited basis, say by capital city and broad-brush 'type' of property. There would be no quality-mix adjustment within strata and while the resulting measure may be described as one that used the stratified approach, it would do so in an ineffectual manner. The *Handbook on RPPIs* recommends quality-mix adjustment by hedonics within strata to better account for the myriad price-determining characteristics other than capital city and 'type' of property.

Stratification of transactions according to some of the price determining characteristics is a straightforward and computationally simple procedure. By defining a number of reasonably homogeneous strata or cells, the average selling price within each cell can only be used as an approximation to a constant-quality price for that type of property. Regular index number theory can then be applied to aggregate up the average prices by cell into an overall index. Such stratification methods are also known as *mix-adjustment methods*.

Thus, when an adequate classification system is designed to capture the heterogeneity of commercial properties, it may be found that cells are empty, due to the lack of transactions in commercial properties for those cells. This would of course be problematic for all of the following transaction-based measures.

4.5.2. The repeat sales method

The repeat sales method [40] addresses the quality mix problem by comparing properties that have been sold more than once in the sample period. Restricting the comparison to units that have been sold repeatedly ensures that the price relatives compare like with like, to the extent that the quality of

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[40] The repeat sales method was initially proposed by Bailey, Muth and Nourse (1963). For a more in depth discussion of the repeat sales method in the commercial property context; see Geltner, Miller, Clayton and Eichholtz (2014; 657-662) and Chapter 5 below.

the properties remains unchanged within each property over time. The standard repeat sales method is based on a regression model where the repeat sales data pertaining to all periods are pooled. (Such pooling is necessary for the repeat sales regression, as the dependent variable observations span multiple periods of time since they are sale pairs that occur at different points in time.) There are two potential drawbacks to the repeat sales approach. Firstly, is the issue of 'revisions': when new periods are added to the sample and the model is re-estimated, the previously estimated price indices will change. However, the method is widely used and accepted in the United States for residential and commercial property price indices. Secondly, the method does not make use of all the information on property sales; for example, properties selling only once, especially sales of new buildings, in the period under study are necessarily excluded from playing a role in the index.

Another drawback of the repeat sales method is that it does not account for quality changes in the structure of a commercial property; i.e., over time, depreciation of the structure occurs, which can be offset by capital expenditures, to a certain extent. The repeat sales method does not take these changes in the quality of the structure into account [41].

A positive feature of the repeat sales method is that it provides a useful index of actual capital gains on individual properties and as such, is a useful index for investors in commercial properties [42]. Finally, a major advantage of the repeat sales method is that it does not require information on the *characteristics* of the structure or its location.

4.5.3. Hedonic regression methods

A hedonic regression model postulates that the selling price of a property is a function of the characteristics of the structure on the property on the one hand, and the characteristics of the location of the property on the other [43]. A sample of property sales in a given stratum over a number of time periods is collected along with the relevant property characteristics, and a regression of the property prices (or the logarithms of the property prices) on the property characteristics is then implemented. There are several versions of a hedonic regression model that have been suggested in the literature:

- *The time dummy variable approach*. Data on property transactions are pooled over a number of periods. The logarithm of the property price is taken as the dependent variable and parameters of time dummy variables, along with those of the property characteristic variables are estimated. The parameters (exponentiated for log-linear functional forms) of the time dummy variables are then estimated to give a time series of quality-adjusted property prices. In this approach, the hedonic surfaces are constant from period to period, except for the time dummy variable which shifts the entire hedonic surface in a proportional manner for each period in the sample.
- *The characteristics prices approach*. In this approach, separate hedonic regressions are run for each period in the sample. Then typically, a suitable average characteristics vector is chosen for making a comparison between two periods and the hedonic regression for the current period is evaluated at the chosen average vector of characteristics, giving a current period predicted average price (say p^t) and the hedonic regression for the prior period is evaluated at the same average vector of characteristics, giving a prior period predicted average price (say p^{t-1}) and the chain link index going from period $t-1$ to t is defined as p^t/p^{t-1}.

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[41] Since net depreciation of the structure on a property is generally positive, it is likely that the repeat sales index will have a slight downward bias. However, repeat sales indices frequently suffer from *sample selectivity bias* which may reduce this downward bias. The purchaser of such a property may make some modest capital expenditures and resell the property at its 'true' market price. The inclusion of these 'flipped' properties may impart a substantial upward bias in the repeat sales index. Thus, most repeat sales indices exclude rapidly transacted properties from the index. Limited empirical comparisons suggest that repeat sales indices may often not differ greatly from corresponding hedonic price indices that explicitly control for building age. Possibly the two sources of bias may tend to cancel each other out in some cases. It should also be noted that repeat sales indices can in principle serve as a starting point for the construction of a constant-quality price index that does account for depreciation, provided there is sufficient quantity and quality of information about the nature and magnitude of depreciation.

[42] Repeat sales indices and other asset value indices have been the main focus of the commercial property literature since this type of index is helpful in determining the total investment return of a commercial property project; see for example Fisher, Geltner and Pollakowski (2007). Bokhari and Geltner (2012) and Geltner, Miller, Clayton and Eichholtz (2014; 635-644).

[43] For comparisons of the hedonic regression and the repeat sales methodologies; see Diewert, Nakamura and Nakamura (2009), Diewert (2010) (2011), Shimizu, Nishimura and Watanabe (2010) and Deng, McMillen and Sing (2013). See Devaney and Diaz (2011) and Bokhari and Geltner (2014) for applications of the hedonic regression methodology in the commercial property context.

- *The hedonic imputation approach*. This approach is similar to the previous approach in that a separate hedonic regression is run for each period in the sample. However, predicted prices based on the actual characteristics for *each property* with some constant period, say period t−1, characteristics are computed and averaged in each period. The average price in period t of period t-1 properties is then compared with the average price in period t-1 of the self-same period t-1 properties to form the constant-quality price index.
- In both the *characteristics prices* approach and the *hedonic imputation approach* it is useful to consider two possible formulations. The first index (a Laspeyres-type index) uses either the actual sum of the period t−1 prices — or the predicted period t−1 prices ([44]) — (using the period t−1 hedonic regression) in the denominator of the index and the sum of the predicted prices of the period t−1 properties (using the period t hedonic regression, but using the characteristics of the period t−1 properties) in the numerator of the index. The second index (a Paasche-type index) uses the sum of predicted period t−1 prices in the denominator, using the period t−1 hedonic regression and the characteristics of the period t properties and either the l period t sum of the actual property prices — or the sum of the predicted prices of the period t properties, using the period t hedonic regression ([45]) — in the numerator of the index. A final (Fisher) index is the geometric mean of the Laspeyres and Paasche indices.

These alternative indices will be described in more detail in Chapter 5 ([46]).

Hedonic methods require data on prices and characteristics. They also require sufficient number of transactions each period. Sales of commercial properties may be so sparse and the number of price determining characteristics so large that there will not be a sufficient number of sales in each period to allow implementation of these hedonic regression methods. In using data on price-determining characteristics evidence is available to judge the heterogeneity of properties and to identify possible property types and locations for which sample sizes might be adequate ([47]).

4.5.4. The SPAR method

Many countries tax real estate property and therefore are likely to have an official property valuation office that provides periodic appraisals of all taxable real estate properties. Assessment based methods combine selling prices with appraisals to compute price relatives (sale price appraisal ratios) and some control for quality mix changes. The *Sale Price Appraisal Ratio* (SPAR) method is based on the matched model methodology. In contrast to the repeat sales method, it utilises all (single and repeat) sales data and there is no revision of previously estimated indices. Of course the method can only be applied in countries where accurate assessed values of the properties are available. The underlying assessed value index is simply an asset value index of the type studied in Section 4.5.2 above. But the SPAR method makes an adjustment to this asset value index. The (reference period) sum of the values of the actually sold properties is divided by the corresponding sum of assessed values for those properties and this ratio is used to adjust the underlying asset value index. The method will be more fully explained in Chapter 6.

The SPAR method has been used by a number of countries to form residential property price indicators. However, applications to the commercial property market are fewer; see Eurostat and OECD (2014) for a description of the Danish experience with a SPAR index for commercial property. Sparseness of data and variations in the reference period ratio of assessed to transaction prices would be of concern. Another issue with the SPAR method is that any given property will not enter the index until it is appraised, thus new properties will not enter the index until after their first appraisal, which may be some time after being sold.

([44]) If the period t−1 hedonic regression has a constant term in it, then the actual sum of the period t−1 prices will be equal to the period t−1 predicted prices using the period t−1 hedonic regression.

([45]) If the period t hedonic regression has a constant term in it, then the actual sum of the period t prices will be equal to the period t predicted prices using the period t hedonic regression.

([46]) One can also refer to the *RPPI Handbook* for descriptions of these methods; see Eurostat (2013) Sections 5.11-5.18 for the time dummy method, Sections 5.20-5.24 for the characteristics prices approach and Sections 5.25-5.29 for the hedonic imputation approach.

([47]) However, the hedonic imputation method can be applied in the commercial property context if sales data are replaced by appraisal or tax assessment data. Diewert and Shimizu (2014) showed how this can be done for their sample of Tokyo office building appraisals. They used the framework explained in the Annex but instead of assuming a quarterly geometric structure depreciation rate, they estimated it and found that in their sample of properties, the rate was very close to 0.5 % per quarter.

4.6. Aggregation and weighting issues

The choice of transactions or valuations for the weights of a CPPI will depend on the statistical target and principal use of the CPPI.

If the statistical target/use is, like for most purposes including macroeconomic analysis and financial stability, to measure the price development of actual commercial property sales in, for example, a pure price index, then both the prices and weights in the index should be transaction based (although, as discussed above, the lack of transactions that generally occur may require the use of valuations as a proxy). Property transactions are often subject to transfer and property taxes etc., thus administrative sources, such as land registries, may be useful in compiling transaction-based weights and indices. However, as the European Commission / European Central Bank Joint Expert Group (JEG) concluded ([48]):

'It is common practice in many Member States for tax reasons to hive off special purpose entities (SPEs), whose only operation is the ownership of the (commercial) property in question. In case of a transaction – of the SPE –, no property taxes are due and no property transaction is recorded in either of the administrative sources since the owner of the property itself has not changed. To date it has not been possible to make even a rough estimate of the potential impact of this effect; this is in part also due to the fact that estimates of the market sizes in general, calculated by large real estate firms, show significant divergence.'

It should be noted that the usefulness of transactions data will be dependent on the metadata recorded against each sale, which can vary from one data source to another, as well as varying by country. Again, the JEG writes:

'In general, no meta information is available from such sources as regards the quality characteristics of the properties transacted. Yet, these are *sine qua non* for the derivation of (pure) price indices. This shortcoming is even more evident in some of the indices disseminated by private data providers. This caveat needs to be underlined for the reason that property prices are much harder to measure than consumer prices, where transaction prices of like-with-like representative goods and services can be compared. Property prices, on the other hand, have to be compiled from infrequent transactions on heterogeneous properties. Furthermore, there might be a considerable time lag between the transaction and the administrative recording, negatively affecting the timeliness of the thus derived indicators. While these are well-known problems in residential property, they are elevated with commercial property.'

If the statistical target or primary use of the CPPI is the change in the value of the stock of commercial properties — such as estimating total wealth held in commercial property — then the use of stock weights is more appropriate. For a stock-weighted index, the key point is to which extent the flow information (from sales) is representative for the stocks to estimate the total value of the stock of commercial property; see Section 4.6.2. Stock-weighted price indices clearly require some information on the value (or quantity) of the stock of commercial properties.

4.6.1. The construction of aggregate price indices for sales of commercial properties

Sections 4.13-4.18 of the *Handbook on Residential Property Prices (RPPIs)* present an analysis of aggregation and weighting issues for constructing property price indices in the residential housing context. The discussions on the stratification approach can be carried over to the present commercial property context, provided that sales of commercial properties are sufficient to provide a sufficient number of property sales in each cell in the classification system for each sample period.

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[48] See Joint Expert Group (JEG) (2017), *Report of the European Commission / European Central Bank Joint Expert Group on Commercial Property Price Indicators*; available at CIRCABC (https://circabc.europa.eu/). The problem with SPEs is elevated for the fact that these share deals, compared to asset deals, are only insufficiently statistically covered and taking place even at an international level.

Suppose that the national commercial property market has been divided up into M strata, such as by type of use, and a *repeat sales model,* or *hedonic regression model,* has been run for each of these groupings for say, T periods. Denote the resulting price index (or indicator ([49])) for stratum *m* in period *t* by P_m^t for *m* = 1, … ,M and *t* = 1, … ,T. Typically, *repeat sales indices* are constructed by looking at all property sales in the stratum in each period and thus typically, information on the total value of property sales in stratum *m* in period *t*, V_m^t , will be available for *m* = 1, … ,M and *t* = 1, … ,T. Thus, the quantity, or volume, of property sales in stratum *m* in period *t*, Q_m^t, can be defined by dividing the value of sales V_m^t during period *t* by the corresponding repeat sales price index for that period, P_m^t ; i.e., define Q_m^t as follows:

(4.1) $\qquad\qquad Q_m^t = V_m^t / P_m^t$; $\qquad\qquad\qquad\qquad$ *m* = 1, … ,M; $\qquad$ *t* = 1, … ,T.

Now form price and quantity vectors, P^t and Q^t, over the M strata for each time period:

(4.2) $\qquad\qquad P^t = \left[P_1^t, … , P_M^t \right]$; $Q^t = \left[Q_1^t, … , Q_M^t \right]$; $\qquad$ *t* = 1, … ,T.

At this point, normal index number theory can be applied to the period t price and quantity vectors, P^t and Q^t, in order to form economy wide commercial property price and quantity indicators for the T periods ([50]).

Again, suppose that the national commercial property market has been divided up into M strata and a *time dummy hedonic regression model* has been run on the sales of commercial properties for each stratum for T periods. Denote the resulting time dummy price index for stratum *m* in period *t* by P_m^t for *m* = 1, … ,M and *t* = 1, … ,T. Of course, in this situation, information on the total sales of properties in each period t, V_m^t , will be available. Now use definitions (4.1) and (4.2) in order to form strata price and quantity (volume) vectors for each period and then use normal index number theory to form economy wide commercial property price and quantity indices for the T periods.

Finally, suppose that the national commercial property market has been divided up into M strata and a separate *hedonic regression model* has been run on the sales of commercial properties for each time period and for each stratum. This situation is unlikely to occur in practice in the commercial property context, due to the scarcity of sales of commercial properties in each time period. However, if this method for constructing stratum prices is used, then the algebra to construct stratum indices is carefully explained in Sections 5.25-5.34 of the *Handbook on Residential Property Prices (RPPIs).* The methods explained there will lead to commercial property price indices for each stratum *m* in each period *t*; denote these stratum price indices by P_m^t for *m* = 1, … ,M and *t* = 1, … ,T. In this situation, information on the value of total sales of properties in each period t, V_m^t , will be available. Now use definitions (4.1) and (4.2) in order to form strata price and quantity (volume) vectors for each period and then use normal index number theory to form economy wide commercial property price and quantity indices for the T periods.

4.6.2. The construction of aggregate price indices for stocks of commercial properties

Some countries will estimate the value of commercial property in periodic censuses of buildings. Using the stratified measurement framework outlined in Section 4.5.1, assume that such a census of buildings took place in period 1. Denote the census aggregate value of commercial properties in stratum *m* in time period 1 by V_m^C for *m* = 1, … ,M. Assume that the repeat sales method, or a hedonic regression method, has been used to obtain a price index P_m^t for each stratum *m* for time periods 1, … ,T. Define the *implicit stock quantity or volume for stratum m in period 1,* Q_m^C , as follows:

(4.3) $\qquad\qquad Q_m^C = V_m^C / P_m^1$; $\qquad\qquad\qquad$ *m* = 1, … ,M.

([49]) Recall that repeat sales indices do not make allowances for net depreciation of the structures on commercial properties.

([50]) The choice of index number formula or whether to form chained or fixed base indices is left up to the national statistical office.

A reasonable approximation to an economy wide commercial property price index for the stock of properties for period t is the following *Lowe* (1823) *index*:

$$(4.4) \qquad P_{Lo}^t = \sum_{m-1}^{M} P_m^t Q_m^C \Big/ \sum_{m-1}^{M} P_m^1 Q_m^C \qquad t = 1, \dots ,T$$

$$= \sum_{m-1}^{M} \left(P_m^t / P_m^1 \right) V_m^C \Big/ \sum_{m-1}^{M} V_m^C$$

where the second equation follows using definitions (4.3). This index assumes that the stratum volumes (the Q_m^C) are fixed over the sample period, which of course will not be true (due to new structures, depreciation, capital expenditures and demolitions of structures).

4.6.3. Frequency and revision policies

Requirements with regard to publication frequency depend on the purpose of use. When one considers use as an early warning signal in economic policy, high frequency, timely information is needed. When it comes to providing actual public statistics however, preparing them on a quarterly or even annual basis may be more realistic.

Certain types of statistically based methodologies that are useful for constructing commercial property price indices involve 'backward adjustments' (that is revisions to historical series) and will therefore require a formal revisions policy. In particular, some regression-based index models that are based on pooled data samples will, in principle, have revisions to historical series every time the index is updated with new data. This occurs, for example, with hedonic indices that are estimated on the full historical transaction database and rely on time dummy variables to construct the index. However, in such indices (which will be described in depth in Chapter 5), backward revisions are not normally significant beyond very recent periods and, in any event, moving window/adjacent pairs hedonic regression methods, as outlined in the *Handbook on Residential Property Prices (RPPIs)*, do not require revision to historical series.

On the other hand, repeat sales indices potentially present a more serious backward revision issue. Repeat sales indices are estimated from pairs of repeated sales of the same property. The dependent variable in the regression is a price change ratio (or log price difference) which inherently spans multiple periods of time and can go back across the entire index history. Furthermore, indirectly *every* repeat sale observation affects the estimated return for *every* period in the entire index history. However, (i) by construction, repeat sales index have a heteroscedasdicity adjustment that gives less weight to price pair observations further apart in time, so revisions to the more distant past series are less pronounced; (ii) the revision process is an improvement on the previous estimates in that it takes into account in the current period more up to date data; and (iii) repeat sales indices are accepted in the United States for use in residential and commercial markets—it is not the case that revisions necessarily damage credibility (see discussion in Chapter 5).

4.7. References

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5 Measuring asset price change over time: transaction price-based indices

5.1. Introduction

This chapter concerns the construction of transaction-based Commercial Property Price Indices (CPPIs). The subsequent chapters will provide alternative methods to construct CPPIs or commercial property price indicators. Chapter 6 will treat appraisal-based CPPIs, which use appraisal values in a base period to correct for differences in characteristics between traded properties. Chapter 7 will discuss two other methods; the first based on appraisal values, produces appraisal-based indicators of investment returns while the second method is based on stock market share prices and produces stock-market based indicators.

Before we drill down into the specifics about different types of CPPIs and commercial property price indicators, it will be useful to step back and consider the big picture. Exhibit 5.1 provides an overview of the different phases in the production of a commercial property price index or indicator, including design, development, and production.

Exhibit 5.1
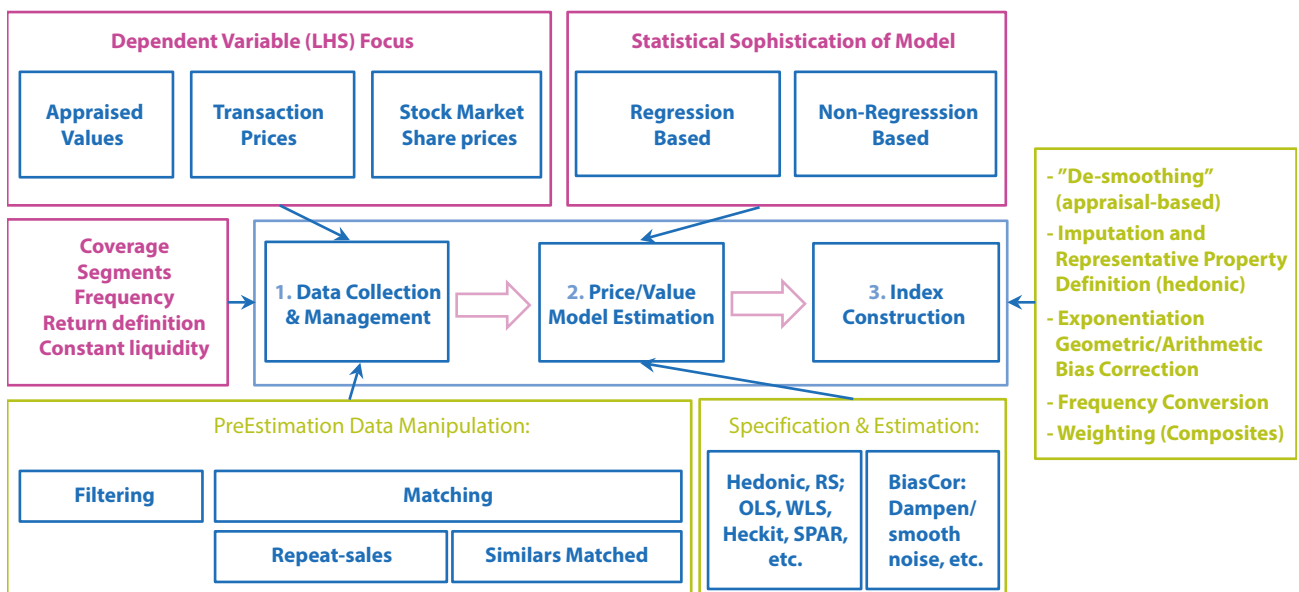
Three Major "phases of index" production: 1. Data Collection & Management; 2. Model Estimation; 3. Index Contruction. **Boxes above and left represent threshold considerations** Boxes below & to right represent methodology processes & choices

Exhibit 5.1 points out that production of a price index or indicator consists of three phases:

- Data collection and preparation prior to price index or indicator computation;
- Computation or estimation of a basic price or value model on which the price index or indicator will be based; and
- Construction of the final reported price index or indicator based on the value model.

It is important to note that in this chapter (and in general unless it is clear otherwise from the context), our concern is with transaction prices as the dependent variable. In the top-left box in Exhibit 5.1 'Value' refers to the most likely or expected market price at which the subject properties would exchange between a willing buyer and seller in an arm's length transaction, after proper marketing and where the parties had each acted knowledgeably, prudently and without compulsion. It is an appraisal value not a transaction price.

The three phases of the production process are depicted in the flow across the three numbered boxes grouped in the blue rectangle in the centre of Exhibit 5.1. The exhibit suggests that there are threshold considerations that relate particularly to the first two of those production phases. There are also choices that must be made about specific methodologies and procedures relating to all three of the production phases, including the post-modelling index construction phase.

Among the threshold issues that must be considered and decided are the coverage, segmentation and frequency of the index. Another important threshold issue is the type and source of property price data that the index will use. This data will serve as the dependent variable in regression models, and will more broadly be the fundamental basis on which the index price indications and asset price change measurements will be based. As noted above, our concern here is with transaction prices, although appraisals, and indirect measurements by stock market share prices, will be considered in later chapters.

Another major threshold consideration is the degree of mathematical or statistical sophistication the index will employ. In general, regression-based methods are most powerful. However, some index producers may prefer simpler or more transparent methods for practical reasons, and in some contexts the simple methods can be quite effective.

Exhibit 5.1 highlights three groups of specific methodology and procedural choices relating to the three phases of index production, as indicated in the green rectangles. First, there are a number of data manipulation procedures that can potentially be applied before the data is actually used to compute value inferences or aggregates. For example, it will usually be necessary to employ basic filtering procedures to eliminate erroneous or unreliable observations. There are also various matching procedures which can pair sale transactions with each other in ways that can sometimes be useful. Most prominent among these is repeat sales matching, in which different transactions of the same property across time are matched together revealing percentage changes in prices between when the property was bought and when it was sold. Repeat sales price indices are based on such matched data pairs. Other matching procedures also exist which do not require the exact same property to be matched in sale pairs over time. In some circumstances matched samples may allow more effective use of a transaction database.

Major methodological and procedural choices must be made in the next phase of index production, the computation or estimation of the price or valuation model used to aggregate the input data to produce a value metric or inference for the index. In the case of regression-based transaction price indices, this is where the choice is made between repeat sales versus hedonic indices (or hybrids of the two), and among the hedonic indices, what type and specification of model. There are also a variety of econometric techniques that can be deployed or not, including multi-stage models and various bias-correction or noise-filtering (smoothing) techniques, some of which can help substantially in dealing with small sample sizes. Even among simpler, non-regression-based computations there are methodological choices to be made, such as how individual property price-change indications are weighted to form an index.

The final index production phase, the construction of the index from the underlying valuation model, also involves numerous specific index design and policy choices. The bullet points in the green rectangle at the right of Exhibit 5.1 list several of these, though the list is not comprehensive. We focus on transaction-based price indices. The methods for constructing transaction-based CPPIs are identical to the ones for residential property price indices and are given by:

11. Simple Averaging
12. Mix-Adjustment methods;
13. Hedonic price methods;
    a. Pooled regression: time dummy variable method;
    b. Chained regression: separate regression per period (characteristics prices and imputation methods);
14. Repeat sales method.

However, commercial property is much more heterogeneous and has less transaction prices than residential property, and there are consequences for the choice of the index construction method. For example, simple averaging is less viable for commercial property transaction prices. Applications of (chained) hedonic price models for commercial property are rare, and for specific property types effectively non-existent.

In the simple averaging the basis for the price index is the evolution of some measure of the central tendency of property prices (per square meter) over time. For mix-adjustment methods the price change observations are stratified into price-determining categories, usually by location and type, and average prices tracked for each stratum. The national overall index is a weighted average of these changes. The effectiveness of the method is determined by the effectiveness of the stratification.

In the hedonic price method transaction prices are modelled by a function of price on property characteristics, including location and time of sale. If it is assumed that the characteristics' coefficients are constant over time, a price index can be derived from the estimated time dummy variable coefficients (pooled regression). If the coefficients are allowed to vary over time, a price index can be derived from the estimation results from the separate regressions per period (chained regression).

Appraisal valuations may be used with transaction prices. The appraisal-based model for transaction prices together with the Sales Price Appraisal Ratio (SPAR) method will be covered separately in Chapter 6.

Finally the repeat sales method uses transaction prices from properties which have been sold more than once. Relative price changes between different sales of individual properties are regressed on time dummy variables representing the periods between the buying and selling date. A price index is constructed from the time dummy variable coefficients.

The setup of this chapter is as follows. Section 5.2 discusses some threshold considerations. Section 5.3 deals with the data source for the transaction price indices. Sections 5.4 to 5.7 discuss the different methods. Sections 5.4 and 5.5 deal with the simple averaging and mix-adjustment methods. Section 5.6 introduces hedonic price and repeat sales models, both being examples of regression based methods. Sections 5.7 and 5.8 cover in more technical detail the hedonic price and repeat sales methods. Section 5.9 deals with index construction issues. Finally, Section 5.10 discusses some measures for index evaluation that do not apply exclusively to transaction-based indices.

5.2. Selected threshold considerations

Threshold considerations are issues that the index developer must address at the very outset, that set the basic characteristics and constraints or framework within which more specific index product design decisions will be made. Of course, like any new product design and development, index development is inevitably a somewhat iterative process, as all the aspects depicted in Exhibit 5.1 are interconnected and affect each other. For example, the decision about index methodology depends on the decision on the type of data to be used, and vice versa the decision on the type of data depends in part on the desired type of index model, and so forth. In the remainder of this section, we single out two particular threshold questions for further mention.

5.2.1. Equal and value weighted indices

The first question is whether at the elementary level price indices should be equal or value weighted. This choice has consequences for the choice of the specific statistical model. Some statistical models are more suitable to produce value weighted price indices, like the arithmetic repeat sales model (Shiller, 1991) or the value weighted SPAR model. Standard repeat sales and hedonic price models use the natural logarithm of the transaction price and therefore produce equally weighted log price indices. However, value-weighted indices for individual properties are implicit in measures of ratios of averages, quality-adjusted or otherwise, and have more general validity.

The second question is what the weighting scheme should be to aggregate the lower level market segment indices to composite indices.

5.2.2. Constant and varying liquidity indices

For liquid markets, like the stock market, transaction prices are informative for market dynamics. In less liquid and heterogeneous markets, like the real estate asset market, the transaction prices alone are less informative (Fisher et al., 2003, Goetzmann and Peng, 2006). Caplin and Leahy (1996) conclude that in markets with frictions — the real estate market being a typical example — there is no reason to view the transaction price as a sufficient statistic for the state of the market. Moreover, they conclude that the volume of sales will provide important supplementary information. For this reason in Chapter 8 the transaction volume is added as one of the additional market indicators. A complementary option is to adjust a price index for varying liquidity.

5.3. The data on which transaction price indices are based

Transaction-based price indices require the availability of transaction prices and dates. The transaction date can either be the date of the legal transfer or the date of signing the sales contract. Indices based on the date of the sales contract are more up to date, because the date of legal transfer lags the date of the sales contract.

Transaction data need to be filtered such that the remaining transactions are 'arms-length' (open market) transactions and reflect the market value. The filter may require additional information on the terms of the transaction and/or the parties to the transaction as it should exclude transactions between related parties or foreclosure transfers in which the lender takes title.

For the repeat sales model special attention has to be paid to the identification of the property included in the sale: the property at the buying date must be identical — apart from the effect of depreciation — to the property at the selling date. Major renovation construction projects and part sales violate this assumption.

These violations might not be identified from the variables describing the property characteristics, because they are either missing or incomplete. Changes in the property characteristics may be identified by extreme price changes between the buying and selling date. Repeat sales where the average relative annual price change is extreme may be filtered out.

An additional filter for repeat sales is based on the time between sales. Repeat sales may be excluded where the time between buying and selling of the property is short, say 12 months. Those sales will most probably violate the assumption of an 'arms-length' (open market) transaction. For example, the transaction could be between related parties or major renovations may have taken place between the two sales.

Note that the two filters — extreme price changes and short time between sales — can also be applied to the repeat sales in a hedonic model in those cases where the hedonic characteristics do not substantially change between the date of buying and selling.

5.4. Simple averaging

In this and the following three sections we cover the major methods for producing transaction-based CPPIs.

The simplest measure of property price change, 'simple averaging', is based on some measure of central tendency from the distribution of property prices (perhaps normalized to a 'per square meter' metric if data on property size is available) sold in a period, in particular the mean or the median. A major shortcoming of this approach is that no account is taken of changes in the quality-mix of properties transacted between different periods. For example, if a higher proportion of "prime site" properties are sold in the current period compared with the reference period the simple average index will overstate the price increase, possibly substantively and misleadingly so.

However, the use of simple averaging approaches is more effective in cases where properties are relatively homogeneous and there are a large number of transactions ([51]). That being the case, this type of index will be less viable for the commercial property market, where there is considerable heterogeneity and few transactions, compared to owner-occupied housing markets (as covered in the RPPI).

5.5. Mix-adjustment by stratification

If the mean or median price is sufficiently representative of the market (preferably normalized to a 'per square meter' metric), then constructing a price index by stratifying data according to market characteristics and aggregating the mean or median values should be considered next.

If one can identify market segments or 'strata' that are relatively homogeneous in terms of asset pricing and price dynamics, then a relatively simple approach to building a price index is to compile the mean or median transaction price within each segment during each period of time that the index is to be reported (such as annually, quarterly, or monthly). Of course, this ignores (or treats only very simplistically) the heterogeneity at the individual property level and therefore the changes in the quality-mix transacted within strata.

For mix-adjustment methods the price change observations are stratified into price-determining categories, usually by location and type, and average prices tracked for each stratum. The national overall index is a weighted average of these stratum price changes. The effectiveness of the method is determined by the effectiveness of the stratification. This related process of mix adjustment, based on the stratification approach to address the issue of market segmentation and sample selection bias, may typically be necessary to more carefully implement the Simple Averaging price index method. This mix-adjustment does not obviate the need for more detailed mix-adjustment within strata.

([51]) In part, the need for large sample sizes is because in the absence of regression based methodology it is not possible to make use of some of the econometric techniques that have been developed to improve efficiency in the use of data for making inferences.

5.6. An introduction to hedonic & repeat sales methods

Although the simple averaging and mix-adjustment by stratification index construction techniques described in the preceding sections may be useful starting points in some circumstances, we noted that they do not control for the heterogeneity that exists at the individual property level, which can be more important in commercial property than in owner-occupied residential property. For example, during the 2008-09 crash some indicators of average or median price per square meter of commercial property at first went up. But this was not because prices were rising, but rather because there was a 'flight to quality': the only transactions that were being completed were on very high quality assets. Thus, a key challenge in constructing good commercial property transaction-based indices is to control for **property heterogeneity**, the variation in the 'quality' (broadly speaking, including the size) of the properties that are transacting between different periods of time. Additionally, regression-based techniques can be optimized for statistical efficiency, which can be important when data sample sizes are small, as they often are with commercial property.

How the manner in which controlling for property-level heterogeneity is addressed defines the two major statistically rigorous approaches for constructing commercial property price indices: **hedonic** and **repeat sales** regression. Both approaches are based on an underlying regression model from which the index is produced.

Hedonic indices use all available transaction price observations for which good and sufficient hedonic data is available. (Hedonic data refers to measures of property attributes and characteristics that can affect value in the asset market, such as property type, size, age, location, various measures of quality including amenities and functionality.) In contrast, repeat sales indices use only properties that have transacted at least twice in the historical dataset on which the index is based. Hedonic indices attempt to control for property heterogeneity by building a hedonic value model, that is, a model that explicitly estimates the values of the various attributes of commercial property quality, what causes one property to be worth more than another as of the same point in time. In contrast, repeat sales indices control for quality by basing the price index only on the price *changes* over time within the *same* properties between when they are bought and sold. It is presumed that the same property represents the same 'quality' over time. The basic difference between the hedonic and the repeat sales approaches is depicted in Exhibit 5.2.

Exhibit 5.2
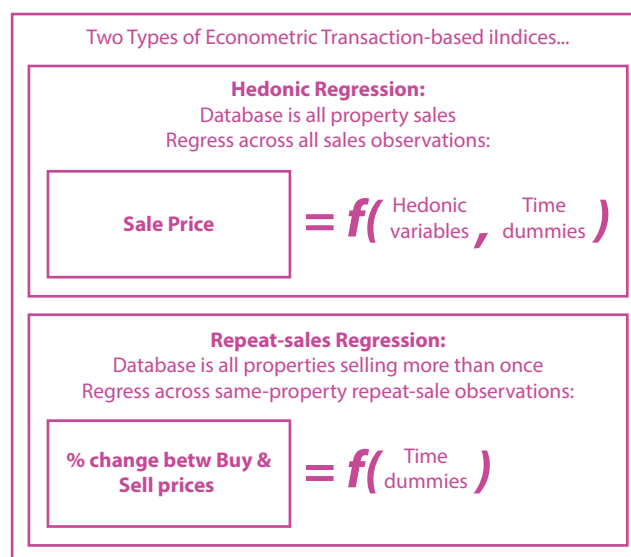
The key advantage of repeat sales indices is the parsimony of the model and the resulting minimal data requirements (they don't need hedonic data, only the date and price of the property transactions),

as well as their transparency and relevance for financial system and investment analysis (they directly track actual 'round-trip' price change experiences realized by investors). One of the key advantages of hedonic indices is that they can use sales of properties that have only sold once, and they can allow explicit control for, and analysis of, the property attributes affecting pricing. This can facilitate more rigorous or in-depth causal analyses and broader or more flexible applications of the price indexing. Hedonic indices also can be less subject to 'backward adjustment', the revision of the entire historical index as updated price data becomes available each period. Repeat sales indices are particularly susceptible to this phenomenon as each observation spans multiple historical periods of time between the 'buy' and 'sell' dates in the repeat sale observation, so new data directly brings new evidence about the history.

5.6.1. Hedonic indices

There are two broadly different approaches to specify hedonic price indices, making different assumptions on the coefficients of the characteristics in the hedonic price model. In the **chained** approach a separate, purely cross-sectional hedonic regression model is estimated each period, on only the transactions occurring in that period. This allows the implicit prices of the hedonic attributes to vary over time. The index is then constructed based on the characteristics prices approach or the imputation approach. In the **pooled** approach a single regression model is estimated on the entire historical transactions database. The sale prices (actually, more typically the natural log of sale price) are regressed onto the properties' hedonic attributes plus a set of time dummy variables corresponding to the historical periods in the price index. The regression's estimated coefficients on the time dummy variables capture the relative changes in the 'average' cumulative price level over time, and the index is constructed by exponentiating these coefficients (assuming log-valued dependent variable) ([52]).

5.6.2. Repeat sales indices

The other major approach to building a transaction-based price index is the repeat sales method ([53]). As noted, in the repeat sales approach quality differences are controlled for by the fact that the regression is run only on price **changes** between consecutive sales of **same** properties. (The observations are generally screened insofar as possible to filter out properties that underwent major rehabilitation or renovation and improvement between the consecutive sales.) The repeat sales model regresses the percentage changes in price between the 'buy' and the 'sell' of each property onto time-dummy variables representing the periods of historical time tracked by the price index. The time dummies equal one if they correspond to a time period between the buy and the sell dates in the given observation, and zero otherwise.

The following two sections discuss in more technical depth the hedonic and repeat sales approaches respectively.

5.7. The hedonic price method

The hedonic price model requires characteristics of the transacted properties at the time of sale. Due to the heterogeneity of commercial properties, the list of explanatory variables is extensive and differs by market segment. Actually, only a few studies are available in which hedonic price models are applied on commercial real estate transaction prices. Most of them concern office buildings. Eichholtz et al. (2010) and Fuerst and McAllister (2011) apply a hedonic price model to measure the impact of

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([52]) The pooled approach will also require a definition of a 'representative property' in order to construct an index if time-varying regressors (such as property age, or time parameterizations, or time-dummy variables) are interacted with property characteristics such as location, type, and size. It should also be noted that the literature has included hybrid approaches to hedonic transaction-based price indexing that are midway between the pure chained and the pure pooled index constructions. See Section 5.8.2 for more details.

([53]) And of course, it is possible to construct hybrid indices that combine the hedonic and repeat sales specifications. (See Case et al., 1991, and Case and Quigley, 1991.)

green certificates on transaction prices for office buildings. Downs and Slade (1999), Fisher et al. (2003), Munneke and Slade (2000, 2001), Nappi-Choulet and Maury (2009), and Tu et al. (2004) apply a hedonic price model to construct price indices for offices. The explanatory variables in these studies include:

1. Office size;
2. Building size;
3. Lot size;
4. Building class (A, B);
5. Building materials;
6. Number of stories;
7. Age of the property;
8. Renovated (yes or no) or renovation year;
9. Amenities;
10. Use (such as single-tenant, mixed use, multi-tenant);
11. Green rating;
12. Financing type;
13. Leasehold or otherwise;
14. Date of sale; and
15. Location, measured by regional dummy variables and/or distance to the central business district.

Fehribach and Rutherford (1993), Jackson (2002), and Lockwood and Rutherford (1996) apply a hedonic price model on industrial properties. The variables in these studies include:

1. Building size;
2. Size of office space;
3. Number of dock doors;
4. Rail siding (yes/no);
5. Ceiling height;
6. Age;
7. Use (single-tenant or multitenant building);
8. Date of sale; and
9. Location, measured by regional dummy variables and/or distance to the airport.

Hedonic transaction price models for retail property are rare if at all existent.

Transaction prices can be filtered by using the hedonic characteristics.

The hedonic approach is focused on properties as assets and views properties as tied 'bundles' of physical and locational attributes desired by users and which therefore impart value to the property assets as evidenced by their transaction prices. This is known as the **hedonic** model of property value, and it will be helpful to represent this model mathematically. The natural log of the transaction price n sold in period t is represented as the linear combination of a set of hedonic (or 'quality') attributes of the property:

$$(5.1) \quad p_{n,t} \equiv \ln P_{n,t} = \sum_{k=1}^{K} Z_{k,n,t} \gamma_{k,t} + \sum_{t=1}^{T} D_{n,t} \beta_t + \varepsilon_{n,t}.$$

Equation (1) contains K hedonic variables $Z_{k,n,t}$ (property physical and locational attributes) which can assume different values not only for different property transactions, $n = 1,2,\ldots$, Nt, but also some attributes can vary for the same property as of different points in time ($t = 1,\ldots,T$ are the periods of the price index). For example, the age of the property (time since building construction) would be an element of the hedonic attribute vector. And the $\gamma_{k,t}$ implicit prices of the attributes also can vary across time (hence the t subscript). The $D_{n,t}$ are time dummy variables (1 if sale in period t, 0 otherwise), and the β_t coefficients reflect the general level of the market pricing in period t [54].

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[54] If the regression is estimated on only a single period's worth of transaction data, as with chained hedonic indices, then there is only one value of t in any given regression and β_t is like the intercept or constant in the purely cross-sectional price model. It thus captures any systematic price determinants not related to the cross-sectional variation in the hedonic variables that have been included in the model (i.e., effect of omitted hedonic variables and the overall price level in the market).

Viewed from this hedonic perspective, property price changes over time in principle may reflect any one or combination of three sources:

i.   Changes in the values of the hedonic **attributes** of the property (the $Z_{k,n,t}$ in Equation (1), such as, size, age, distance to the nearest subway station, etc.);

ii. Changes in the hedonic coefficients (the $\gamma_{k,t}$ in the equation, changes in the **implicit prices** of the hedonic attributes, e.g., how much the market is paying for a given distance to the nearest subway station, etc.); or

iii. Movement in the current **intercept** in the cross-sectional hedonic specification (the $D_{n,t}$ in the equation), reflecting value changes not otherwise captured in the hedonic model (the β_t in the equation, which presumably largely reflect changes in general **market conditions**, the relative balance between supply and demand in the asset market, though the β_t will also capture the longitudinal effect of **omitted hedonic variables**, for example, if there is no data on whether buildings have fiber-optic as opposed copper cable but fiber-wired buildings are more valuable and proportionately more of them are being sold over time).

From this perspective the specifications and approaches for regression-based property transaction price indexing can be viewed as ways of either controlling, or not controlling, for each of these sources of price change.

The (**chained) imputed/characteristics hedonic** index, which is based directly on Equation (5.1), controls for changes in the hedonic attribute 'quantities' (the $Z_{k,n,t}$) by specifying a 'representative property'. This allows the indexing process to explicitly relate property price change either to changes in the property characteristics' implicit prices (the $\gamma_{k,t}$) or to general market conditions and omitted longitudinal variables (the β_t). The representative property can be defined so as to establish a Laspeyres or Paasche index. Or indeed, in principle the representative property can be specified however the index developer wishes (reasonably within the bounds of the sample characteristics), and this makes the chained hedonic the most powerful approach for exploring causality or correlates in the asset price dynamics. The chained hedonic index effectively requires separate, purely cross-sectional regression models to be run on each single index period (t), which makes this approach require sufficiently large transaction data samples to have enough transactions within each period of time the index must cover. This along with the need for accurate and complete hedonic price model specification and good and consistent data collection for all the hedonic variables can make the chained hedonic index difficult to produce in practice although they have very desirable properties theoretically ([55]).

The **pooled (or time dummy) hedonic** approach attempts to control for changes in property quality defined as changes in the property attributes 'quantities' (the $Z_{k,n,t}$), but does not attempt to control for changes in the implicit prices of the property characteristics (it is assumed that the $\gamma_{k,t}$ are constant over time, so $\gamma_{k,t} = \gamma_k$). The effects of implicit price changes are therefore captured in the time dummy coefficients (the β_t) and rolled undifferentiated into the price index. In the nomenclature of Equation (5.1), the pooled hedonic method would drop the time subscript from the implicit prices, replacing $\gamma_{k,t}$ by γ_k. The pooled hedonic model is constructed from a single regression run on the entire historical database of transactions, which may make it practical even when there are not many transactions within some periods of time.

The hedonic price method is perhaps the most rigorous approach to building a transaction-based price index, and as noted in Section 5.6 it offers the most general and flexible model, directly reflecting the physical property perspective of price indexing described in that section. As noted, there are two major methods of constructing a hedonic price index, the time-dummy and the imputed/characteristics hedonic methods. These will be discussed in more depth in the present section, before concluding with a summary of the strengths and weaknesses of hedonic indices for commercial property price indexing in general.

([55]) A particular specification of the model suggested by Diewert in Chapter 8 of the RPPI handbook would allow direct estimation of structure and land price indices separately, which could be particularly convenient for national accounts applications.

5.7.1. Time dummy variable method

The time dummy variable method assumes the coefficients (the implicit prices) of the characteristics attributes to be constant over time, simplifying Equation (5.1) to

$$(5.2) \quad p_{n,t} = \beta_1 + \sum_{k=1}^{K} Z_{k,n,t} \gamma_k + \sum_{t=2}^{T} D_{n,t} \beta_t + \varepsilon_{n,t}$$

The coefficients β_t, along with the regression constant, represents the average level of the product's quality-constant log price level for each period, where the quality is controlled for by the $Z_{k,n,t}$ terms that reflect the properties characteristic attributes. The logarithmic price change between periods *1* and *t* is provided by $\beta_t - \beta_1$.

Equation (5.2) can be estimated as a single regression on a pooled database of the entire history. The estimated log price levels are denoted by $\hat{\beta}_t$. This hedonic regression is the so-called **pooled** or **time dummy** variable specification of the hedonic price index [56].

The time dummy price index for *t=1,…,T* is given by

$$(5.3) \quad I_{TD}^{t} = \exp\left(\hat{\beta}_t - \hat{\beta}_1\right).$$

5.7.2. Hedonic imputation method

Instead of performing estimation one time for multiple periods by pooling data, it is also possible to estimate the characteristic price parameter for each period. Recasting Equation (5.1) in vector notation we have:

$$(5.4) \quad p_t = \mathbf{1}\beta_t + Z_t\gamma_t + \varepsilon_t ,$$

where p_t is the (N_t x 1) dimensional vector for the time *t* logarithmic transaction prices, **1** is a (N_t x 1) vector of ones γ_t is the (*K* x 1) dimensional coefficient vector for the *K* different property attributes' prices as of period *t*, Z_t includes the (N_t x *K*) explanatory variable matrix for the values of the *K* different attributes across the N_t different property transactions as of time *t*, and ε_t is the (N_t x 1) dimensional error vector for time *t*.

The model is estimated separately on N_t observations in each period *t* by ordinary least squares. The estimated coefficients are denoted by $\hat{\beta}_t$ and $\hat{\gamma}_t$.

Price indices can either be constructed by the characteristics prices approach or the hedonic imputation approach. Let *Z** denote the row vector of characteristics of a standardized property. Examples of *Z** are the sample or population average in the base period or in period *t*, or a rolling window average. The characteristics prices approach geometric index is given by

$$(5.5) \quad I_{CPG}^{t} = \exp\left(\hat{\beta}_t - \hat{\beta}_1 + Z^*\left(\hat{\gamma}_t - \hat{\gamma}_1\right)\right).$$

The hedonic imputation approach indices can be derived from the characteristics prices approach index. In case *Z** is defined as the sample average of the base period, denoted by the row vector $\overline{Z}_{.1}$, then the resulting index is a hedonic double imputation geometric Laspeyeres price index, given by

$$(5.6) \quad I_{HDIGL}^{t} = \exp\left(\hat{\beta}_t - \hat{\beta}_1 + \overline{Z}_{.1}\left(\hat{\gamma}_t - \hat{\gamma}_1\right)\right).$$

In case *Z** is defined as the sample average of period *t*, denoted by $\overline{Z}_{.t}$, then the resulting index is a hedonic double imputation geometric Paasche price index, given by

$$(5.7) \quad I_{HDIGP}^{t} = \exp\left(\hat{\beta}_t - \hat{\beta}_1 + \overline{Z}_{.t}\left(\hat{\gamma}_t - \hat{\gamma}_1\right)\right).$$

The Fisher index can be derived from the geometric mean of Equation (5.6) and (5.7). For details on the computation of characteristics prices and imputation indices we refer to Chapter 5 of the RPPI handbook.

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[56] See details, RPPI handbook, Chapter 5.

5.7.3. Characteristics, advantages, and disadvantages of the hedonic method

One can see that price indices with what is broadly called the 'hedonic method' vary considerably depending on the approach employed in estimation.

The advantages and disadvantages of the hedonic method in the estimation of property price indices are outlined below. The following may be considered as advantages:

- They have sound basis in economic and index number theory, the theoretical biases of the hedonic method are well considered;
- Compared to some other approaches such as repeat sales, it is possible to use all transaction price data, so it may be considered the most efficient approach;
- As hedonics makes it possible to control for the many characteristics of property, it enables the sorting of data into specialized indices by purpose/region.

Disadvantages include:

- As it is necessary to collect many property-related characteristics, information-gathering costs may be high;
- In cases where it is not possible to collect important characteristics for determining property prices, one faces the problem of omitted variable bias;
- Calculated indices vary depending on the functional form and model specification used. In other words, there is a low level of reproducibility;
- In cases of strong heterogeneity, it may not be possible to control for quality—which can be a problem in the commercial property market.
- Since the underlying economic theory and statistical procedures are complicated, the organizations creating the indices require specialized skills, and explaining the indices to users is difficult;
- For the period-by-period regressions: the coefficients of the characteristics may become very volatile over time, in specific when the numbers of observations per period are relatively low (as is common in commercial real estate). There are in between methods, where the coefficients are allowed to change over time.

5.8. Repeat sales method

The **repeat sales** index does not attempt to explicitly control for change in either the implicit prices (the $\gamma_{k,t}$) or the attribute 'quantities' (the $Z_{k,n,t}$), thereby rolling all price change undifferentiated into the time dummy coefficients (the β_t). However, the repeat sales index adopts a completely different approach to controlling for property quality variation. By estimating the regression only on price *changes* within repeat sale pairs of the *same properties*, there is a presumption that the attribute quantities (the $Z_{k,n,t}$) are essentially constant and therefore controlled for in the context of an index aimed purely at measuring longitudinal price movements regardless of their source or cause. By replacing $\gamma_{k,t}Z_{k,n,t}$ with $\gamma_k Z_{k,n}$ in Equation (5.1), and subtracting a prior sale price of the same property at time s from the subsequent sale price at time t (prices in natural logarithms: $\ln P_{n,t} - \ln P_{n,s}$), the hedonic terms on the right-hand side of Equation (5.1) cancel out and we are left with only the time-dummy variables on the right-hand side: $\beta_t - \beta_s$. Thus, the repeat sales regression is also estimated on a pooled historical database, but only of properties that have sold more than once. The need for properties that have sold more than once can make it difficult to produce repeat sale indices in some circumstances.

To the extent that a major focus or motivation of the property perspective on asset price indexing is to be able to analyse the causal determinants or at least correlates of price movements, only the chained hedonic index provides a complete ability to do this within the price index model, in theory. And in practice even the chained hedonic is limited by omitted variables or model misspecification. Of course, any indexing method can analyse price movement causality or correlation exogenously to the index construction model, by comparing indices based on artfully defined differentiated databases of sales, for example, comparing an index of properties within walking distance of subway stations to an

index of properties otherwise similar not within walking distance of subways, or an index of fiber-wired buildings with an otherwise similar index of copper-wired buildings.

The repeat sales method is of considerable interest for commercial property price indexing. To date, it is probably the most widely used and cited method of transaction-based commercial property price indices to be regularly produced and published commercially to serve the investments industry. The major reason is probably its relatively light data requirements, and its feasibility in markets that are very actively traded. Another reason is that it measures seller's/purchaser's experiences directly. In this section we will introduce the model formally, and then we will discuss several specific considerations and enhancements in the repeat sales method, before summarizing the major strengths and weaknesses.

5.8.1. Repeat sales index

5.8.1.1. STANDARD REPEAT SALES

The standard derivation of the repeat sales method based on the property perspective of price indexing described in Section 5.7.1 starts with the assumption that the commercial property characteristics do not change over time and that the parameters associated with the characteristics do not change either [57]. The underlying price determination model is not different from Equation (5.1). However, the repeat- sales method focuses on properties that appear multiple times in the data set, that is, properties transacted repeatedly. Suppose that property n is transacted twice, in period s and period $t>s$, $Z_{n,s} = Z_{n,t}$ and $\gamma_s = \gamma_t$, then the change in the house price is given by

$$(5.8) \quad \Delta_{s,t} \ln P_n = P_{n,t} - P_{n,s} = (\beta_t - \beta_s) + (\varepsilon_{n,t} - \varepsilon_{n,s}),$$

indicating that the price change is solely determined by the difference between the two transaction times, irrespective of commercial property characteristics. Note that for identification reasons it assumed that the log price level in the initial period $t=1$ is equal to 0, so $\beta_1 = 0$. The model can be reformulated as

$$(5.9) \quad \Delta_{s,t} \ln P_n = (0, \ldots 0, -1, 0, \ldots, 0, 1, 0 \cdots 0) \beta + \varepsilon_n,$$

where β is the vector of log price levels. If it is assumed that the error terms are independent and identically distributed random variables, then the model can be estimated by ordinary least squares.

The repeat sales model can alternatively and equivalently be specified as

$$(5.10) \quad \Delta_{s,t} \ln P_n = \mu_{s+1} + \cdots + \mu_t + \varepsilon_n = (0, \ldots 0, 1, \ldots, 1, 0 \cdots 0) \mu + \varepsilon_n = D_n \mu + \varepsilon_n.$$

where μ_t denotes the log price for period t, and D_n is a time dummy variable vector, which takes a value of 1 for all periods starting from period $s + 1$ up to period t, and 0 in the other periods. For identification reasons it is assumed that $\mu_1 = 0$. This model is equivalent to Equation (5.9). It holds that $\beta_t = \sum_{s=1}^{t} \mu_s$, so β_t is the cumulative log price.

In order to reduce temporal aggregation and the resulting temporal lag and smoothing bias in the index, the first and last dummy variables can be replaced by time weighted terms f_s and f_t, measuring the proportion of the period that is included in the price. For example, in a calendar year based annual-frequency repeat sales model, a sale in September of year t would be given a value of $f_t = 9/12$ instead of 1 if it were a second-sale, or a value of $f_s = 3/12$ instead of zero if it were a first sale, in the time dummy variable for year t, see Byron and Colwell (1982) and Geltner (1997). This leads to the following repeat sales specification

$$(5.11) \quad \Delta_{s,t} \ln P_n = (0, \ldots, 0, f_s, 1, \ldots, 1, f_t, 0, \ldots, 0) \mu + \varepsilon_n = D_n \mu + \varepsilon_n.$$

The repeat sales index follows from the estimation results from Equations (5.9), (5.10) or (5.11), and is given by

$$(5.12) \quad I_{RS}^t = \exp\left(\hat{\beta}_t\right) = \exp\left(\sum_{s=1}^{t} \hat{\mu}_s\right).$$

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[57] We noted in 5.3 that this is not the only basis on which to derive the repeat sales index method.

5.8.1.2. CASE-SHILLER ADJUSTMENT TO REPEAT SALES INDEX

There are two commonly treated problems in the standard repeat sales method just described. One is heteroskedasticity: error terms are likely to become larger when two transaction dates are further apart. The second is the age effect: a property is not qualitatively the same as time goes by. The heteroskedasticity in the error term is taken into consideration by Case and Shiller (1987, 1989). They assume that the variance of the error term has a fixed component σ_ξ^2 and a component depending on the distance between the first sale and resale dates $(t-s)\sigma_\eta^2$:

(5.13) $\quad \mathrm{Var}\left(\varepsilon_n\right)^2 = \sigma_\xi^2 + (t-s)\sigma_\eta^2.$

The estimation procedure consists of three steps:

i.   Estimate Equation (5.9), (5.10) or (5.11) by ordinary least squares. The residuals from this regression are denoted by e_n.
ii.   The squares of the residuals e_n are regressed on a constant and the holding period, the time between the two consecutive sales

(5.14) $\quad e_n^2 = \sigma_\xi^2 + (t-s)\sigma_\eta^2 + \varepsilon_n.$

   The ordinary least squares estimates are denoted by $\widehat{\sigma}_\xi^{\,2}$ and $\widehat{\sigma}_\eta^{\,2}$.

iii. Estimate Equation (5.9), (5.10) or (5.11) by weighted least squares, where the weights are provided by $\left(\widehat{\sigma}_\xi^{\,2} + (t-s)\widehat{\sigma}_\eta^{\,2}\right)^{1/2}$. The weighted least squares estimates for β and μ are denoted by b and m respectively.

The Case-Shiller-adjusted weighted repeat sales index is given by

(5.15) $\quad I_{\mathrm{WRS}}^t = \exp\left(b_t\right) = \exp\left(\sum_{s=1}^{t} m_s\right).$

The repeat sales age effect problem is a type or aspect of aggregation bias. Aggregation bias is a problem relating to the two assumptions in repeat sales regression model (8) (assumption 1: all characteristics are constant over time; assumption 2: all characteristic parameters are constant over time). For example, if there are changes in characteristic values due to deterioration/obsolescence of property capital, renovations and maintenance, changes in the surrounding geographic environment, etc., such assumptions are not valid. Additionally, Knight, Dombrow, and Sirmans (1997) tested whether or not characteristic parameters change with the observation period (assumption 2). In order to estimate a stable price index, an observation period of sufficient length is necessary, but the longer the observation period, the more liable these kinds of structural changes are to occur. The biggest problem is the downward effect on property prices due to deterioration pointed out by Bailey et al. (1963), Palmquist (1979), and others ([58]).

5.8.2. Matched sample estimation

The restriction on the sample selection for the repeat sales method may be responsible for a bias in the property price index. The extent of the bias will depend on both the extent to which properties with a single sale are omitted and the difference in the price change of included properties compared with the price change of these single sale properties, had they been resold during the period. The latter is of course counterfactual, but some insight can be gained by examining the descriptive characteristics of the excluded properties and comparing these with the characteristics of properties that have been resold and included in the repeat sales index. If there are both a large number of excluded single sale properties and their characteristic are very different from included properties, the repeat sales method can be argued to be open to a potential substantial bias. One method of ameliorating such bias, proposed by McMillen (2012), is to identify properties within the repeat sales sample that have similar

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([58]) See, for example, Chau et al. (2005), or Wong et al. (2013).

properties to the excluded ones and impute matched prices for the excluded ones to bring them into the sample. The efficacy of the procedure depends on being able to effectively identify a sufficiently large sample size of similar properties.

5.8.3. Sample selection and data issues in repeat sales versus hedonic indices

Data quantity is not merely a matter of the number of observations in the regression estimation database. Each repeat sale observation spans multiple index periods and encompasses evidence from two sales. As a result, more than in a hedonic index, all repeat sale observations are used in the regression to estimate each and every periodic return in the index history. This makes repeat sales observations statistically more powerful 'pound for pound' than the individual transaction observations used in hedonic indices. (But the flip side is that this feature of repeat sales indices also makes them more susceptible to backward adjustments, historical revisions that reach back through the entire index history, and this can pose a practical disadvantage for some uses of the index.)

Another practical consideration is that, to be usable in a hedonic index, a transaction observation must have good and complete hedonic data, measured consistently with that of the other observations in the dataset. This is challenging with commercial property and can cause many observations to be unusable.

Even with the above in mind, it is generally true that a hedonic index can use many more transaction observations than can a repeat sales index. But in reality a major data advantage of hedonic indices over repeat sales indices has more to do with bias than with sample size per se.

This is because there tends to be a systematic difference between the performance of properties that are sold more frequently compared to those that are sold less frequently, and repeat sales databases are naturally more dominated by the former [59].

The fact that repeat sales indices are more dominated by the shorter-held properties may be fine from the perspective of representing average investor experiences, but it can cause bias from the perspective of representing more general price change. From this perspective hedonic indices can portray a more complete picture of the price performance of the broader population of properties.

DISCUSSION OF SAMPLE SELECTION BIAS CORRECTION

There exists a widely accepted econometric technique for correcting for **sample selection bias**, known as the Heckman two-step procedure, which can be applied to econometrically rigorous transaction-based real estate price indices. This technique is difficult to employ in the production versions of the repeat sales indices, but it can be used in research and academic studies to shed light on the nature and magnitude of sample selection bias in real estate price indices.

There have been several such studies, some of the more well known of which will be briefly reviewed here. Gatzlaff and Haurin (1997) applied the Heckman correction to a repeat sales index of housing prices in Miami, Florida from 1971-1995. They found very little sample selection effect, well under 0.5 per cent per year (primarily in the expected direction: the uncorrected repeat sales index was biased upwards). Gatzlaff and Haurin were able to correct for both single sale bias and repeat sale bias because they had good hedonic data on the entire standing stock of homes, not just those that were sold during the sample period. This suggests that their correction was probably greater than what would exist purely between repeat sales and single sales. In other words, the sample selection bias of their repeat sales index relative only to a corresponding hedonic index (which they did not examine) would probably have been even less than the correction they found. Gatzlaff and Haurin also found that sample selection upward bias effect in the price index is less strong (or even opposite) when the asset market is very weak.

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[59] Shimizu et al. (2010) provide an example for the residential sector in Tokyo.

Munneke and Slade (2000, 2001) applied the Heckman correction to hedonic price indices based on a sample of 890 office property sales in Phoenix, Arizona during 1988-1996, a period that included a substantial downturn followed by a strong recovery in that market. They were also able to obtain data on unsold properties, so the sample selection correction was between properties selling once and properties not selling at all during the sample history, not exactly the same thing as a comparison between properties selling more than once and properties selling once. Their studies also found very minor sample selection effects, generally also less than 0.5 per cent per year on average, with the selection upward bias present in the downturn as well as the upturn.

The Heckman procedure was applied to correct for sample selection bias in the NCREIF-based transaction-based index in the United States (so-called TBI) when that index was produced at MIT from a regression model. This was essentially a hedonic type index covering all NCREIF properties sold (once) during 1985-2011. The correction was for sold versus unsold properties, but the Heckman correction never had a significant effect in the TBI (and it is not applied in the SPAR method NCREIF is currently using to produce the index).

The difficulty with applying the Heckman correction in actual production commercial property repeat sales price indices is that it requires estimation of a binary-choice model of the probability of selection based on the full population. In the price index context the binary-choice model is a probit model of the probability that any given property sells. In the case of a repeat sales index compared only to a corresponding hedonic index the probit model would represent the conditional probability that a property sells again after it has already sold once, estimated on the full sample (serving as the population) consisting of all sales not just repeat sales. This type of modeling requires good hedonic data. Yet in a production context repeat sales indices make most sense precisely in the situation in which good hedonic data is relatively lacking or unreliable.

5.8.4. Characteristics, advantages, and disadvantages of repeat sales indices

The repeat sales method is broadly adopted in estimating property price indices.

For markets with a high level of heterogeneity in particular, such as the commercial property market, quality adjustment is extremely difficult, so if sufficient transactions exist, using the repeat sales method is advantageous. This was proposed by Geltner and Goetzmann (2000), and there have been subsequent cases where it has been put into practice.

To summarize the above points, the advantages include:

- Since the index is created by comparing prices of repeatedly transacted properties at different points in time, there is no need for information relating to the property characteristics;
- The problem of omitted variable bias that occurs with the hedonic method is largely avoided;
- The estimation method is simple and there is a high level of reproducibility;
- Even in the case of strong heterogeneous property, it is feasible to estimate a price index.
- Due to its simple concept, it is easy to explain to users; and
- It directly tracks actual transaction prices.

The disadvantages include:

- Since the price index is estimated using only information for properties transacted at least twice (information for properties transacted only once is discarded), this method is inefficient. As a result, its use is difficult in countries or regions where liquidity is low, and it often becomes difficult to estimate indices for smaller market segments or strata;
- Since the depreciation that accompanies the aging of the building between the two transaction times is ignored, there is a potential downward bias if depreciation is not controlled for;
- If investment in renovations is made between the two transaction times, there is an upward bias if this is not controlled for;
- Depending on the database composition, it may be cost-intensive to identify transactions involving the same property (there are quite a few countries where it is difficult to identify transactions involving the same property); and

- When new transaction price information is generated, the data — including even past series — changes, so it is not possible to produce definite values. (This is also a problem, though less so in practice, with time-dummy hedonic indices.)

5.9. Index construction

In this section of Chapter 5 we will discuss some considerations that are applicable at the index construction phase of the CPPI production process:

1. Geometric/arithmetic bias correction;
2. Noise reduction and frequency conversion;

5.9.1. Geometric/arithmetic bias correction

Repeat sales and hedonic price models typically use the natural logarithm of transaction prices as dependent variable, and therefore produce ratios of geometric means of prices per period. The geometric means of prices have a natural interpretation for a time series; their comparison across periods represents growth rates. In a cross section however, the geometric mean does not have a natural interpretation. So we may want to adjust the estimated geometric mean of the prices to an arithmetic mean.

Consider the repeat sales model formulated as in Equation (5.10) or (5.11). The elements of vector μ are the periodical log returns. Under the assumption that the log returns are normally distributed, the arithmetic mean μ_t^a can be approximated by

$$(5.16) \quad \mu_t^a \approx \exp\left(\mu_t + \frac{1}{2}\sigma_{\mu_t}^2\right) - 1,$$

Goetzmann (1992) provides an estimation method for the variance term $\sigma_{\mu_t}^2$. The residuals of the repeat sales model are denoted by e and calculated from Equation (5.10) or (5.11) by $e_n = \Delta_{s,t}\ln P_n - D_n\hat{\mu}$. The vector e^2 denotes the element by element squared residuals. The variance term estimators are given by the elements of $\hat{\sigma}_\mu^2$ (apart from the first element)

$$(5.17) \quad \hat{\sigma}_\mu^2 = \left(\begin{pmatrix}1 & D\end{pmatrix}'\begin{pmatrix}1 & D\end{pmatrix}\right)^{-1}\begin{pmatrix}1 & D\end{pmatrix}' e^2,$$

where **1** denotes a vector of ones, and D is the matrix with rows D_n.

Subsequently, the arithmetic means μ_t^a can be used to construct an arithmetic mean price index.

An alternative to this procedure is provided by Shiller (1991), who proposes an adjusted repeat sales model specification, which directly gives arithmetic means of periodical returns.

In the hedonic price model which directly gives arithmetic means of periodical returns $\sigma_{\mu_t}^2$ can simply be estimated from the variances of the residuals per time period.

5.9.2. Noise reduction and frequency conversion

Due to the relatively low number of transactions and great heterogeneity of commercial properties, transaction-based CPPIs will often exhibit considerable noise without some sort of noise filtering or smoothing treatment.

The most general specification of the hedonic price model has been given in Equation (5.1). Both the constant and the characteristics' coefficients (β_t and γ_t) are allowed to vary over time. Moreover, the coefficients are independent over time (fixed effects); *a priori* no structure is assumed on the evolution of the coefficients over time. The consequence is that the estimated coefficients in a specific period

solely depend on transaction prices and characteristics in that period. The main advantage is that the evolution of the estimated coefficients is quite flexible; there is no functional form restriction. However, the main drawback of this fixed effects approach is that the estimated coefficients can have very large standard errors. In specific cases it might be even impossible to estimate some of the coefficients, due to lack of specific information. This will be the case when the number of observations per period is low. The consequence of large estimation errors is that the hedonic price (and repeat sales) index will become very volatile and will have a saw-toothed appearance (negative first-order autocorrelation).

In order to reduce the impact of the large estimation errors on the price index different methods have been proposed. A first group of methods consists of a two-step procedure (see Section 10.3.2 for specific examples.) In the first step price indices are derived from a version of a hedonic price or repeat sales model. In the second step these price indices are inputted into a smoothing algorithm like a locally weighted regression, moving average, Hodrick-Prescott filter (Hodrick and Prescott, 1997) and exponential smoothing. An important drawback is that these methods tend to induce a delay or temporal lag bias into the indices. Such identification of turning points can be important for monitoring the financial system and investment industry.

Another solution to noise reduction is to impose some (flexible stochastic) structure on the time evolution of the coefficients. The consequence is that the estimated coefficients in a specific period do not only depend on transaction prices and characteristics in that period, but also on this information in preceding (and subsequent) periods, where the weights depend on the specification of the structure on the time evolution. The standard errors of the estimated coefficients will typically be smaller compared to the fixed effects approach, so the resulting price index will be less noisy. In general this method does not introduce much temporal lag bias, the main problem with many more common smoothing methods. Adding a new period of transaction prices will lead to revision of the estimated coefficients in preceding periods. However, this revision tend be small in practice, see Francke (2010). Moreover, in hedonic price models the revision can completely be avoided at the cost of less efficient coefficient estimates in preceding periods ([60]).

An extreme version of a structure on the time evolution of the characteristics of coefficients is the time dummy variable hedonic price model where it is assumed that the characteristics estimates in preceding periods are constant over time, $\gamma_{k,t} = \gamma_k$ in Equation (5.1).

The fixed time effects specification in the time dummy variable hedonic model and in the repeat sales model can still result in very high standard errors of the estimated coefficients in case of a low number of observations per period and/or large outliers. In these models these coefficients represent the log price index, so the price index will become very volatile.

A solution is to replace the fixed time effects by a flexible stochastic trend model, in which current log price levels or returns depend on preceding and subsequent levels or returns ([61]). An example for the repeat sales model is the model proposed by Goetzmann (1992), where the log price level follows a random walk with drift. The Goetzmann approach was used both in the original version of the CPPI and in the MIT regression-based version of the TBI, see Gatzlaff and Geltner (1998), and Fisher et al. (2007). The Goetzmann model has been extended by Francke (2010). He assumes that the log price level follows a random walk with time varying drift (a local linear trend model). This model has been demonstrated to work quite well on sparse residential transaction data in the Netherlands. An example of a flexible stochastic trend for the hedonic price model is the model proposed by Schwann (1998), where the log price level follows a random walk. Francke and De Vos (2000) and Francke and Vos (2004) provide a far more general approach to model log price levels for different market segments simultaneously by a hierarchical trend model and provide efficient estimation procedures by a combination of ordinary least squares and the Kalman filter and smoother.

Rambaldi and Fletcher (2014) propose a more general hedonic price model in which in Equation (5.1) both the coefficient of the constant (β_t) and the characteristics (γ_t) are allowed to vary over time according to a flexible stochastic trend model (in their case a random walk). This model can be

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[60] This holds for the rolling window hedonic regressions. It is also applicable to hedonic price models where the coefficients follow a stochastic trend specification and where this model is estimated by the Kalman filter (and not the Kalman smoother).

[61] Note that there also specifications where the fixed effects are replaced by a deterministic function, for example cubic splines and Fourier form approach, see for example McMillen and Dombrow (2001) and McMillen and McDonald (2004).

estimated by the Kalman filter and smoother. This approach can be seen as a midway between chained and pooled regressions; the coefficients are allowed to change over time, however according to a flexible stochastic structure.

A simpler alternative for a midway between chained and pooled regressions is the so-called *Rolling Window Hedonic Regression* method, see for example Munneke and Slade (2001) and Shimizu et al. (2010). Initially the time dummy variable hedonic price model is estimated on transaction prices in the periods *(1,..., M)*. In period *M+1* the time dummy variable hedonic price model is estimated on the periods *(2,..., M+1)*, and so on. Appropriate price indices can be calculated from the sequence of estimation results. More details can be found in the paragraphs 8.43 to 8.48 of the *Handbook on Residential Property Price Indices (RPPIs)*. Compared to hedonic price model in which the coefficients are allowed to vary over time according to a stochastic trend model, the rolling window hedonic regression method is much easier to estimate. However, the main drawback is that an arbitrary *M*-periods selection will not perform an optimal weighting of past information.

Recently Bokhari and Geltner (2012) provided an alternative noise reduction technique which can be applied to either the repeat sales or hedonic price methods, which is computationally simpler and does not require an adaptation of the repeat sales model specification.

The first step of their so called two-stage frequency conversion (2SFC) methodology is to perform low frequency (say annual) repeat sales estimation with higher frequency (say quarterly) staggered starting dates. This produces four different annual price series. The second step is to combine the four staggered annual indexes to derive an up-to-date quarterly-frequency index—a frequency conversion. Bokhari and Geltner (2012, pages 526–529) propose the use of a "Moore-Penrose pseudoinverse" matrix of the data to derive an up-to-date quarterly-frequency index. They refer to this frequency-conversion method as the "Generalized Inverse Estimator", or GIE for short. This procedure converts staggered annual returns to quarterly returns, from which a quarterly price index can be derived. This two-stage procedure can improve the accuracy of high-frequency indices in scarce data environments. An important advantage is that the 2SFC technique does not introduce much temporal lag bias, the main problem with many more common smoothing methods.

5.10. Index evaluation

The last section in this chapter highlights four different criteria to evaluate estimated property price indices:

1. Standard errors;
2. Volatility and first order autocorrelation;
3. Revision; and
4. Temporal bias: lead and lag relations.

The effects should be analysed at the stratum segment as well as at higher levels.

5.10.1. Standard errors of price indices

For statistically estimated CPPIs it is possible to calculate the standard error of the estimated price index. In the repeat sales model and time dummy variable hedonic price model the standard errors of the coefficients on the dummy variables for time will be provided by the statistical package [62]. In the characteristics prices approach (Equation 5.5) the standard errors (*se*) of the log price index can be calculated as:

$$(5.18) \quad se\left(\ln I_{CPG}^{t}\right) = \sqrt{\left(1\ Z^{*}\right)\left[Var\left(\hat{\delta}_{1}\right) + Var(\hat{\delta}_{t})\right]\left(1\ Z^{*}\right)'},$$

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[62] These are given by the standard errors of the estimated values of β_i for *t=1,....T*, in Equation (5.2) and (5.9).

where the vector Z* denotes characteristics of a standardized property, $\hat{\delta}_t = \left(\hat{\beta}_t \; \hat{\gamma}_t \right)'$, and $\text{Var}(\hat{\delta}_t)$ is the variance-covariance matrix of the estimated coefficients, provided by the statistical package [63].

When comparing different estimated price indices, the index series with the lowest average standard error is to be preferred [64]. This standard error depends on the number of observations, the heterogeneity of the properties, and the explanatory power of the applied model.

An important advantage of the hedonic price model is that it uses all transactions for which all relevant hedonic characteristics are available. The corresponding drawback is that it requires characteristics of the properties, which in practice are difficult to obtain: missing hedonic characteristics may even result in a lower number of observations compared to the repeat sales. It is inevitable that the model is misspecified due to missing (important) explanatory variables and/or improper functional form. Misspecification has the undesired consequence that estimates of the coefficients of the included variables are biased, having consequences for the price index.

Compared to the hedonic model the repeat sales model has the advantage that it suffers far less from misspecification and omitted variable problems, however at the cost of omitting all single sales, so substantially reducing of the sample size unless/until the database becomes quite mature [65]. Reducing the sample size has the consequence that the standard error of the log price levels will increase.

The conclusion is that the positive effect of the larger sample size in the hedonic model — compared to the repeat sales model, comes at the cost of omitted variable bias[66].

5.10.2. Volatility and first-order autocorrelation

The effect of transaction noise (cross-sectional price dispersion) and specification error in a repeat sales or hedonic price model based CPPIs is that such phenomena introduce estimation error in the estimated price indices. Guo et al. (2014) describe two metrics to quantify a comparison of the relative amount of noise between two or more indices: the volatility and the first-order autocorrelation of the index return series, where index return for period *t* is the relative price index change from period *t*-1 to *t*, defined by the price index value in period *t* divided by price index value in period *t-1* minus 1.

The volatility is measured by the standard deviation of the index return and the first order autocorrelation is the correlation between the index return series and the one period lagged index return series.

Guo et al. (2014) show that noise introduces excess volatility and as a consequence decreases the first order autocorrelation [67]. Assuming other things to be equal, the index returns series (for the same market segment) that has lowest volatility and highest autocorrelation is to be preferred.

5.10.3. Revision effects

Indices based on pooled hedonic price models and repeat sales models have revision effects [68]. Each time new information is added to the observation sample, the estimated log price levels in preceding periods will be updated. In a pooled hedonic price model the revisions are due to updates of the time-invariant coefficients of the explanatory variables. Repeat sales indices are even more susceptible to revision as each observation spans multiple historical periods of time between the buy and sell dates in the repeat sale observation, so new data directly brings new evidence about the history. The revisions

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[63] The standard errors of the hedonic double imputation geometric Laspeyres, Paasche and Fisher log price index levels can be derived in a similar way.

[64] Standard formulas apply for the mean and standard error when exponentiating the log price index levels.

[65] That is, by which time most of the properties in the covered population have indeed sold at least twice.

[66] Some comparisons of repeat sales and hedonic models estimated on the same set of transactions (all of them repeat sales) have found that the repeat sales index has less noise than the corresponding hedonic index even though the repeat sales index has half the number of observations in its estimation sample. (See D. Geltner, ltner, ugh the repeat sales index has hort', Section 3.1.2.2, Exhibit 8.)

[67] It reduces the first order autocorrelation with at most -0,5.

[68] The imputed (chained) hedonic price model is not subject to revision effects.

of past returns may be ignored — statistical generally agencies do not like revisions — however, from a statistical point of view it means that not all available information has been used.

The magnitude of the revisions can be analysed empirically by performing recursive model estimation, starting with an initial sample from *t=1,...,T*, and adding new information (transactions) period-by-period.

When *T* is sufficiently large, the estimate of the time invariant coefficients of the explanatory variables do not tend to change substantially as new information arrives. The result is that the revision effects are relatively small or not present at all. In the repeat sales model the arrival of new information will in practice mainly affect the most recent return estimates [69]; the estimates of recent returns are based on a relatively small sample of observations, and one additional period of observations adds substantially to this information set. Adding new information will reduce the impact of noise on the estimated recent returns.

There is empirical evidence that there is a systematic component to the backward revisions in the repeat sales indices, namely, they tend to be negative. That is revisions bring the overall long-run trend growth rate of the index down, slightly and gradually over time as more data extends to the index history. This is because of loss-aversion, that investors tend to hold onto relative `losers' and sell `winners' more readily and quickly, relatively speaking. Thus, as the repeat sales database matures, it includes more long-held properties, which tend to be those that on average haven't done as well per period. This effect won't exist in markets where investors don't exhibit loss-aversion behaviour, and/or it may effectively disappear as the repeat sales database becomes sufficiently mature.

In case noise-reduction techniques have been applied (such as described in Section 5.9.2) the impact of noise on the estimated returns is lower. From that perspective the revision effect will be smaller than the case without applying noise reduction techniques. However, additional revision effects may occur for the most recent periods due to the applied noise-reduction model. Francke (2010) shows for a repeat sales model that the impact of revision is small in case the log price level is assumed to follow a local linear trend model, even when the numbers of observations per period are low. The impact of revision is found to be substantially smaller compared to a model without noise-reduction techniques.

5.10.4. Temporal bias: lead and lag relations

Empirical findings suggest that stock market-based indicators (see Chapter 7) lead transaction-based indices; stock markets are more efficient than the private asset price market. Empirical findings usually suggest that transaction-based indices lead appraisal-based indicators of investment return, most likely due to the lagging behaviour of real estate appraisers, see Chapter 7.

As a result a stock market-based indicator is an early indicator of turning points in the market cycle. A turning point can be defined as a change from a positive (negative) to a negative (positive) return, eventually measured over more than one period to reduce the potential impact of noise on the estimated return. When different measures are available for the same market segment, the turning points can be compared empirically.

Note that noise reduction techniques may lead to some temporal lag bias, because the estimate of the current return depends on preceding returns. Empirical findings show that this effect is small in practice (Francke, 2010; Bokhari and Geltner, 2012).

5.11. References

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[69] Sometimes the backward adjustments extend quite far back into the index history. This is possible because sometimes a new repeat sales observation, although having its second sale only recently, had its prior sale back near the beginning of the index history.

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6 Appraisal based indices

6.1. Introduction

This chapter covers appraisal-based indices. We are not speaking here of an appraisal-based indicator of investment return that will be addressed in Chapter 7, because here in Chapter 6 the dependent variable in the regression, the fundamental type of value indication data the index is measuring, is still actual commercial property transaction prices. Rather, here we are referring to the use of appraisal values on the right-hand-side of the regression model, as the main regressor. Such indices have been produced in the United States at MIT and by NCREIF (Fisher et al., 2007), and in the United Kingdom and other countries based on data by IPD (Devaney and Diaz, 2011). A simplified variant of this type of index produced without employing statistical estimation methods is known as a SPAR (Sale Price Appraisal Ratio) index (Bourassa et al., 2006; de Vries et al., 2009).

We noted in Section 5.7 that the most difficult challenges for hedonic indices are their vulnerability to omitted variables bias and functional misspecification. This holds in particular for commercial properties where the list of regressors is extensive and data on property characteristics are hard to obtain. But when there exists a good, professional appraisal of each of the transacting properties' values not long before each transaction has occurred, this problem may be substantially mitigated. Then this appraisal can serve as a sort of catch-all regressor variable. The appraisal valuation reflects the value implication of all of the properties characteristics and attributes in the professional judgment of the appraiser. It thus attempts to control for cross-sectional differences in property 'quality'.

Appraisal-based indices can only be computed for property populations that are regularly and consistently appraised, as is the case for some populations of commercial investment property. To the extent that commercial properties are appraised in the reported 'assessed values' by property tax authorities as recorded in land registries, this may be a larger potential data source, however, one that may contain more serious issues regarding the quality and consistency (and frequency) of the appraisals (or assessments). Appraisal-based indices obviously depend on the quality of the appraisal values, and there will be some concerns. Appraisal values are likely to be smoothed and lag the true price level, because of noisy prices and infrequent and irregular trading of individual commercial properties [70]. Moreover, expensive (cheap) properties may be more likely to be undervalued (overvalued).

Another issue with appraisal-based indices is that they do not correct for changes in quality — depreciation and major repairs and renovations — between the appraisal and transaction date. This is less of an issue for frequently appraised properties, because the time between the appraisal and transaction date will be short. More generally, there is a lack of control for building age (depreciation) in either the appraisal regressor or the transaction price dependent variable. This is also typical of repeat sales indices and the investment performance oriented indicators that are the subject of Chapter 8. Such lack of control is not a problem for use of CPPIs by financial system overseers or the investments industry. It is a problem that may be addressed with the use of supplementary information about the nature and magnitude of depreciation in commercial property [71].

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[70] A comprehensive discussion on appraisal smoothing can be found in Geltner et al. (2003).

[71] The same can be said about the need to account for capital improvement expenditures.

6.2. Appraisal value as regressor

The basic regression equation including appraisal values is given by

(6.1) $p_{n,t} = \beta_t + a_{n,t}\gamma_t + \varepsilon_{n,t}, t = 1,\dots,T, \ n \in S(t)$

where p denotes the transaction price and a is the appraisal value, both in natural logarithm. The subscripts n and t denote an individual property and time. $S(t)$ denotes the sample of properties transacted in period t with size N_t.

When $\gamma_t = 1$ prices are proportional to assessed values, so expensive (cheaper) properties are not undervalued (overvalued). When $\gamma_t < (>)1$ expensive properties are undervalued (overvalued). When $\gamma_t = 1$ and β_t is unequal to 0, properties are systematically undervalued ($\beta_t > 0$) or overvalued ($\beta_t < 0$). By estimating β_t and γ_t one can correct for these valuation biases.

Note that in this specification the appraisal value and transaction price relate to the same period. To avoid sales chasing (where a property sale triggers an appraisal at close to the selling price for that property), the valuations must be done prior to the transaction date. This implies that a lagged appraisal value should be used in the regression model. On the other hand the valuations should be recent to avoid that property characteristics have changed between valuation and transaction date, so the lag should be as short as possible.

The regression model for the sample of transaction prices in base period t with lagged appraisal values at time $s < t$ as regressor can be written as

(6.2) $p_{n,t} = \beta_t + a_{n,s}\gamma_t + z_{n,t}\delta_t + \varepsilon_{n,t}, n \in S(t)$.

where the row vector $z_{n,t}$ includes some control variables, and δ_t is the corresponding coefficient vector. This type of model has been proposed by for example Clapp (1990) and Clapp and Giaccotto (1992).

Equation (6.2) can be estimated by ordinary least squares, giving the parameter estimates $\hat{\beta}_t$, $\hat{\gamma}_t$, and $\hat{\delta}_t$. The fitted log values are denoted by $\hat{p}_{n,t}$, and the fitted monetary values by $\hat{P}_{n,t}$. The latter can be obtained by taking the exponent of $\hat{p}_{n,t}$, possibly corrected by the factor $\exp(\hat{\sigma}_t^2 / 2)$, where $\hat{\sigma}_t^2$ is the square of the standard error of regression [72].

A complication might be that for some transactions in period t no appraisal value is available in s, but in an earlier period ().

Price indices can be derived from the regression output for the traded properties.

In case information over the total population of properties Ω is available [73], the appraisal-based percentage price change can be computed as

(6.3) $\Delta_{AP}(t,t+1) = (\sum_{n \in \Omega} \hat{P}_{n,t+1} / \sum_{n \in \Omega} \hat{P}_{n,t}) - 1$.

The resulting price appraisal-based index for the total population is equal to

(6.4) $I_{AP}^t = (1 + \Delta_{AP}(1,2)) \times \cdots \times (1 + \Delta_{AP}(t-1,t))$.

This index method is currently used by the European Central Bank (Kanutin, 2013) [74].

In case only information on the sample of traded properties is available, the appraisal-based percentage price change is given by

(6.5) $\Delta_{AS}(t,t+1) = (\sum_{n \in S(t+1)} P_{n,t+1} / \sum_{n \in S(t+1)} \hat{P}_{n,t}) - 1$.

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[72] This correction is only relevant for index construction in case the standard error of regression varies over time.

[73] Note that the total population of properties can change over time due to acquisitions and sales of properties. To avoid composition effects in the price index one can select those properties that are in the population for at least some period, say a year.

[74] The European Central Bank uses a slightly modified version of Equation (6.2). To reduce the impact of noise, Equation (6.2) is not only applied on transaction prices in period t, but also on transaction prices in t-1, so $n \in \{S(t-1), S(t)\}$

The imputed Paasche index is provided by

$$(6.6) \quad I^t_{AS} = \left(1 + \Delta_{AS}(1,2)\right) \times \cdots \times \left(1 + \Delta_{AS}(t-1,t)\right).$$

6.3. The SPAR method

The sales price appraisal ratio (SPAR) method does not require estimation of a regression model. The percentage price change between period t and $t+1$ is given by

$$(6.7) \quad \Delta_{SPAR}(t,t+1) = \frac{\sum_{n \in S(t+1)} P_{n,t+1} / N_{t+1}}{\sum_{n \in S(t)} P_{n,t} / N_t} \times \frac{\sum_{n \in S(t)} A_{n,s} / N_t}{\sum_{n \in S(t+1)} A_{n,s} / N_{t+1}} - 1,$$

where N_t is the number of transactions in period t, and the valuation date s is prior to the transaction date t, $s < t$. The first term is the ratio of the average transaction price in period $t+1$ and the average transaction price in period t. The second term is the ratio of the average of appraisal values for transactions in period t and the average of appraisal values for transactions in period $t+1$. The SPAR index is subsequently calculated from the compounded price changes,

$$(6.8) \quad I^t_{SPAR} = \left(1 + \Delta_{SPAR}(1,2)\right) \times \cdots \times \left(1 + \Delta_{SPAR}(t-1,t)\right).$$

6.4. Characteristics, advantages, and disadvantages of appraisal-based indices

As with any transaction-based index, appraisal-based indices can be subject to substantial noise if the sample sizes of transaction properties within each period are small, and/or in case of severe outliers. In order to reduce the impact of noise, data need to be cleaned. Individual ratios of sales price to appraisal value might be found implausible, and need to be deleted from the data set.

The appraisal-based method has the following advantages:

- Appraisal-based indices are easy to compute. This holds in specific for the SPAR index that does not require regression or sophisticated econometrics, making it easy for some agencies to implement;
- Like the repeat sales method, the appraisal-based method does not need characteristics of the properties, so avoiding omitted variable bias and misspecification errors. For commercial property the set of characteristics is large and characteristics are hard to obtain;
- Since it is a method based on traditional index theory, SPAR is easy to understand, and the estimation method is simple, it has a high level of reproducibility; and
- Where there is systematic bias between appraisal values and contemporaneous transaction prices the appraisal-based method can, to some extent, correct for it;
- Appraisal-based indices do not require revisions of the past index series.

Its disadvantages include:

- The appraisal-based method cannot directly deal with depreciation and major repairs and renovations between appraisal and transaction date, supplemental data is required;
- Appraisal-based indices require a population of properties that is frequently reappraised in a consistent manner. This limits it pretty much to the same types of populations for which appraisal-based indicators of investment return can be constructed (see Chapter 7);
- Appraisal values may not be available for all properties at a high frequency, say quarterly basis. The population that is quarterly appraised is only a subset of the total population, say 25 per cent, such that each year all properties in a portfolio are appraised;
- Appraisal-based indices depend on the quality of the appraisal values. Appraisal practices will differ across countries; and
- The SPAR method assumes proportionality between appraisal values and transaction prices. This point opens up the critical question of the reliability of appraisal values.

6.5. References

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7 | **Appraisal and Stock Market based Investment Return Indicators**

7.1. Introduction

All of the CPPI methods in the two preceding chapters have relied wholly or substantially on the direct use of transaction price data from the property asset market. Chapter 5 covered transaction-based indices and Chapter 6 appraisal-based indices. In this chapter we depart from the dependence on transaction price data, and focus on appraisal and stock market based investment return indicators (IRIs).

Stock market-based indicators measure the values at which investors can obtain the economic benefits of commercial property ownership by means of investment through securities traded on the public stock exchange. As such, these indicators provide indirect, however relevant, information about commercial property asset market values.

In other words, while a direct transaction-based price index is clearly the preferred method of CPPI construction where feasible, the reality is that transaction price data will not always enable transaction-based price indices to be produced with sufficient precision and granularity without excess noise or lack of representativeness. It is in such circumstances that appraisal and stock market based IRIs can be useful indicators.

It is also important to note that appraisal and stock market based IRIs have other appealing features. Previously we noted that there are two other important constituencies for CPPIs, besides the National Statistical Institutes (NSIs). It was noted that Central Banks and other official agencies responsible for the regulation and oversight of the financial system require CPPIs to track the status of the real estate investment industry and of financial institutions that lend money on commercial property assets. And it was noted that in many countries a large private sector investment industry focuses on income-producing commercial property. Both of these two constituencies have a direct need for IRIs — indices designed to track the investment performance of commercial property assets. The appraisal and stock market based IRIs described in the present chapter are the major types of IRIs. They report not only periodic asset value changes but also property net income each period as a fraction of beginning of period asset value.

The fact that IRIs are valuable information products in the private sector investments industry means that private organizations in that industry have taken the initiative to develop commercial IRI information products. In some countries these products are quite extensive, of high quality with long histories, and are widely respected and used within the investments industry. This development, which is continuing and extending in more and more countries, may be beneficial for official agencies including NSIs and Central Banks in their quest to develop practical sources of necessary data for tracking commercial properties for various purposes.

Chapter 7 is organized as follows. We treat appraisal-based IRIs in Section 7.2 and stock market-based IRIs in Section 7.3.

7.2. Appraisal-based Investment Return Indicators

7.2.1. Property Appraisals

The property market has few transactions (i.e., it is thin) and is heterogeneous. Commercial property transactions in particular are extremely few in number compared to other asset/service or housing transactions, and collecting sufficient data is difficult. Heterogeneity is especially pronounced for commercial property. As a result of this, advanced quality adjustment must be performed when aggregating such data. In terms of the problem of insufficient data, it is not just a problem of there not being enough data to perform aggregation; since the liquidity is extremely low, it also involves the problem of there being the possibility of observing only one specific transaction.

In light of this, efforts have been made to compile property price indicators using property appraisal values ([75]). In particular, when attempting to capture the movements of markets that are strongly heterogeneous with few transactions, using property appraisals may be a valuable method of providing an indicator of price changes.

In the commercial property market, valuation surveys are conducted by property appraisal experts ([76]). In recent years, with the dramatic growth in the property investment market, it has become possible to obtain property appraisals that are periodically surveyed for the purpose of measuring the performance of investment properties. In addition, many countries use property assessment values for the purpose of tax assessment.

For the purpose of this text the term appraisal-based IRI refers to an investment return (or performance) indicator of commercial property that is based on professional appraisals of individual property values within a defined population of properties constituting the index universe. Within that universe the appraisals are conducted on all of the constituent properties with a certain degree of regularity and frequency. An indicator, in index form, is then produced by aggregating the appraisal values across the properties. Within each reporting period of the index (e.g., calendar years or quarters), the *capital return* or *appreciation return* is based on the change in the reported valuations of the *same* set of properties between the beginning and end of the period as best as is possible in the prevailing circumstances and reflecting the norms of practice of the local appraisal profession. A broader measure of investment *total return* also reflects the net cash flow generated by the properties during the period.

Investment return indexes are the oldest and most traditional form of commercial property price indicator in regular production. Indices produced by NCREIF in the United States and by IPD in Britain date back to the 1970s.

Investment return indicators have some limitations, some of them already mentioned in Chapter 6. Appraisals may be subject to valuation errors, lagging and smoothing, and client influence problems. Moreover, it is less easy or straightforward to adjust IRI capital returns to hold the 'quantity' of structure constant (as though not depreciating). These issues will be discussed in the remainder of this section.

([75]) The terms 'appraisal values', 'appraisal', and 'valuation' are often used interchangeably in practice, and will be so used in this chapter. The term 'appraisal price' is sometimes used, but can be misleading. In real estate terminology, normally the term 'price' refers to an actual transaction. (See the Glossary.) Appraisal valuations are, of course, not transactions and not prices in this sense. Rather, appraisals are *estimates* of the most likely or expected price at which a property will or would transact. (Other types of appraisals are also possible, such as appraisals of 'investment value' or of conditional value conditioned on hypothetical conditions. But appraisals used to produce IRIs are estimates of 'market value' as defined above.)

([76]) The term 'survey' is often used in the appraisal context to mean the same thing as the term 'estimate' or 'estimation'. To some extent the terminology is a British/American language difference, with British tending to use the terms 'survey' and 'valuation' while American English uses the terms 'estimate' and 'appraisal'.

7.2.2. Specific considerations in appraisal-based IRIs

Because appraisal-based IRIs have been around for a relatively long time with a particular industry target as their constituency, a number of conventions and procedures have come to be widely practiced, though with some variation across countries. The conventions typically reflect the nature of data availability as well as the particular interests of the investment industry that is the target constituency for IRIs. In this section we will briefly describe two such considerations that result from these conventions and which are important for users of appraisal-based indicators to be aware of.

7.2.2.1. THE APPRAISAL VALUATION PROCESS

The real estate appraisal profession has a long tradition in many countries, and as a result professional appraisals are generally made according to well elaborated guidelines and procedures. Traditionally, in many countries, some variant of the 'three approaches to valuation' characterizes the market value estimation process at the overall level. The three approaches are: market comparison, cost, and income. But in practice, in many circumstances, the 'three approaches' boil down primarily to one approach, namely, the market comparison approach, at least if the objective of the appraisal is to estimate the most likely transaction price (in other words the 'Market Value') of the subject property, which is typically the case for appraisals used in IRIs (and assuming that there is a well-functioning market for the type of property asset in question).

In the market comparison approach to property appraisal, the appraiser estimates the price at which the subject property would sell by comparison to the known transaction prices of other similar properties which sold recently in the same or similar market, suitably (but subjectively) adjusted to reflect (the appraiser's expert judgment about) the differences between the subject property and the comparable transacted properties (differences in size, age, quality of structure and location, etc.), known as 'comparables' (or 'comps' for short). It can be characterized as a form of informal hedonic modelling approach.

Now consider the income approach, in which the value of the property asset is estimated as the present discounted value of a projected future stream of net cash flows the property is expected to generate. Because properties are so long-lived, this present value is extremely sensitive to the discount rate applied to the projected future net cash flows. Where should the appraiser get this discount rate from? If the objective is to estimate the property's Market Value, then the discount rate should be the opportunity cost of capital (OCC) faced by investors (potential purchasers of the property). This OCC is most directly and accurately reflected in the expected returns implied by the prices at which similar properties are currently trading. In other words, the discount rate should be such as to give a present value of the property indicated by the transaction prices of similar properties trading in the property market (adjusted of course for differences in the income earning projections for the different properties). Thus, we are actually back to the 'market comparison' approach, in practice, even though we are going through the motions of the 'income approach'.

Alternatively, consider the cost approach, in which the value of the subject property is estimated as its 'replacement cost', considering both the cost of the land and the cost of the structure, with the latter suitably adjusted to reflect the age and accumulated depreciation within the current structure (as improved). In the cost approach it is straightforward enough to estimate the replacement cost of how much it would cost to construct a similar building new today. But how to value the effect of the actual accumulated depreciation on that structure cost? And furthermore, how to estimate the current value of the land? Again, if the objective is to estimate the current Market Value of the subject property asset, then the method for accounting for structure depreciation and for land value must be guided by what price similar properties (land + buildings) are selling for today in the property market. Thus, once again, we are effectively back to the 'market comparison' approach even though we are going through the motions of the 'cost approach'.

For these reasons, even though appraisers often formally report that they are using all 'three approaches to valuation', in actual reality and practice, they are relying directly or indirectly most heavily on the market comparison approach, at least if they are charged with estimating the Market Value of the subject property, and given that the subject property is not so unique, is of a type and location for which there does exist a reasonably well functioning market for the trading of such properties. This

is one reason why it generally makes sense to view the capital returns within appraisal-based IRIs as aiming fundamentally at the same type of property asset price change information that transaction price based CPPIs are also aimed at. Appraisals are just another method of getting at that value estimate, different from statistical estimation procedures based directly and purely on transaction price data itself.

7.2.2.2. RETURN DEFINITIONS

The return each period to each property in an IRI reflects the classical definition of investment holding period returns (HPRs). Note that in the remainder of this chapter the terms net operating income and capital expenditures will be used in a business accounting sense, and not as national accounts terms. The investment **total return** for period t is defined as follows:

$$(7.1) \quad r_t = (\Delta V_t + CF_t)/V_{t-1}$$
$$= (AV_t - AV_{t-1} + PS_t - CE_t + NOI_t)/AV_{t-1}$$

where: ΔV_t is the change in asset value during period t; CF_t is the net cash flow from the asset to the investor during period t (positive for net flow *to* the investors, negative for net flow *from* the investors); V_{t-1} is the asset value as of the end of period t-1; AV_t is the appraised (reported) valuation of the property for period t; PS_t is the net proceeds from any partial sale of the property asset during period t (e.g., if the property consisted of two buildings and one was sold); CE_t is the capital expenditures (cash outflow) spent on the property during period t; and NOI_t is the Net Operating Income generated by the property during period t (comparable to corporate 'earnings' in stock market metrics, that is, prior to subtracting out capital improvement expenditures). A more extensive description of the different components will be given in Section 7.2.3.

In Equation (7.1), the top line is the generic definition applicable to any type of asset, and the bottom line elaborates that same definition more specifically for commercial property. Implicitly, then it is assumed that $V_{t-1} = AV_{t-1}$, $V_t = AV_t + PS_t$, and $CF_t = NOI_t - CE_t$.

The calculations of the returns can be modified to take into account that the cash flows may not occur at the ends of the period, but somewhere between the starts and ends of the periods. Let w_i denote the remaining fraction of time for cash flow (CF) i, for $i=1,…,n$. The time-weighted return can be expressed as

$$(7.2) \quad r_t = \left(\Delta AV_t + \sum_{i=1}^{n} CF_{i,t} \right) / \left(AV_{t-1} - \sum_{i=1}^{n} w_i CF_{i,t} \right).$$

The adjustments to the denominator (referred to as a 'modified Dietz' formulation) cause the computed return to more closely approximate the exact internal rate of return (IRR) produced by the investment during the period. The amounts subtracted would include some portion of the net capital cash flow during the period ($PS_t - CE_t$) and of the net operating income during the period (NOI_t). This reflects the fact that cash flow to (or from) the investor from these sources (partial asset sales, capital improvement expenditures, and net operating income) usually actually occur at intermediate points in time within the index return period t, rather than entirely at the end of the period.

For example, if the denominator in the bottom line of Equation (7.1) is reduced by the amount $(1/2)(PS_t - CE_t + NOI_t)$ then the computed return will very closely approximate the IRR if all of those intermediate cash flows occurred evenly (ratably) throughout the period, or if they all occurred exactly halfway through the period. Generally the effect of this adjustment is very minor (a few basis points per annum), as partial sales rarely occur, NOI_t is typically less than 10 per cent of the asset value per year, and CE_t is typically on the order of only 1 per cent to 3 per cent of asset value per year.

In an appraisal-based IRI the asset valuations (AV_t and AV_{t-1}) are generally based on professional appraisals or officially reported valuations of the properties as reported by the property-owning institutions that are members of the appraisal-based IRI pool. While the composition of properties in the index may change during the period, the investment return is based only on all the properties that were in the pool as of the beginning of the period. Any properties sold out of the pool during the period are generally included, with their transaction sale price substituting for AV_t. As properties are typically held many years, in any given return period only a small fraction of the ending property valuations (AV_t) reflect actual transaction prices instead of appraisals.

More technically, in terms of treatment in the enhanced denominator as described in Equation (7.2), a property sale price may be treated like the PS_t amount rather than like the AV_t amount in the return computation. In other words, some portion of the sale price P_t may be subtracted from the AV_{t-1} value in the denominator of the return. The return can be expressed as:

$$(7.3) \quad r_t = \left(P_t - AV_{t-1} + \sum_{i=1}^{n} CF_{i,t} \right) / \left(AV_{t-1} - wP_t - \sum_{i=1}^{n} w_i CF_{i,t} \right),$$

where w is the remaining fraction of time for the transaction price, see Chapter 9 from Geltner et al. (2014). This procedure of time-weighting sales in the denominator can cause distortion in the index when a large property is sold at a transaction price significantly different from its prior appraisal valuation in the index as of the previous quarter before the quarter when it was sold [77].

7.2.2.3. A FEATURE OF APPRAISAL-BASED IRIS: APPRECIATION IS NET OF CAPITAL EXPENDITURES

Another general point about appraisal-based IRIs computation procedures is worth special attention. In the typical appraisal-based IRI the previous formula for total return is broken out into two mutually exclusive and additive components: **income return** (y_t) often also referred to as current return or cash yield, and **appreciation return** (g_t) often also referred to as capital return. Thus:

$$(7.4) \quad y_t = (CF_t + CE_t)/V_{t-1} = NOI_t/AV_{t-1}$$

$$g_t = (\Delta V_t - CE_t)/V_{t-1} = (AV_t - AV_{t-1} + PS_t - CE_t)/AV_{t-1}$$

$$r_t = y_t + g_t$$

Note in Equation (7.4) that the appreciation return (or capital return) does not represent all and only the change in asset value between the beginning and end of the return period. Rather, it reflects that change in value *minus* the capital expenditures [78] made on the asset during the period. This convention causes the return component breakout to be inconsistent with typical stock market metrics, in which the capital return simply reflects the change in the share price of the stock during the period. Corporate earnings retained by the firm and ploughed back into capital expenditures are simply part of why or how the stock price might increase, and are therefore not subtracted from the capital gain.

Interestingly, this convention for treating CE_t resembles the treatment in the national accounts. In general, the SNA suggests that capital improvement expenditures should be recorded in a separate account of Gross Fixed Capital Formation (GFCF) distinct from that which records the property's building structure. This facilitates the application of different depreciation rates to the building and the capital improvement, which enables a more accurate tracking of capital consumption in the economy.

In the case of commercial properties, many capital expenditures are routine internally financed by the operating income of the property. Properties undergoing major renovation or rehabilitation construction projects are generally excluded from appraisal based IRIs. In the United States, among larger prime properties of the type tracked by appraisal-based IRI, the CE_t/AV_{t-1} fraction is typically 2 per cent to 3 per cent per year, and same-property values still tend to grow less than inflation even after that.

From the perspective of CPPIs, this brings an important implication about the typical appraisal-based appreciation indicator. If one 'chains together' appraisal-based appreciation returns (compound growth) as in (starting from an index base value of 1.00 in Period 0):

$$(7.5) \quad \text{Index Value at end of Period t} = V_t = (1+g_1)(1+g_2)(1+g_3)\ldots(1+g_t),$$

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[77] For example, as of 2014 NCREIF is considering changing its recording procedures to address this distortion effect. One approach is to simply treat the sale as if it occurred at the end of the index reporting period, by convention either the period of, or the period before, when the sale was actually closed. (The date of sale closings are normally several weeks or more after the date when the transaction price was actually agreed by the parties.)

[78] The basic definition for capital expenditures is usually essentially similar to the NA definition, although it may vary somewhat from country to country. The basic definition is if an expenditure is for something that lasts for more than a year then at least that part of it that lasts more than a year is capital improvement expenditures (CE).

then the resulting index levels will not trace out the asset price evolution over time. Rather, such an 'appreciation' index will fall below the track of property price evolution by the fraction CE_t/AV_{t-1} each period, cumulatively. Similarly, the appraisal- based income return will over-state the actual net cash flow yield (comparable to the dividend yield for a stock) by that same fraction each period. (These two deviations obviously cancel each other out in the total return formula and hence in the cumulative total return index level.)

While this procedure is consistent with SNA convention, it may be inconsistent with the way Central Banks or other agencies need to track commercial property asset market values relevant for financial industry oversight. However, appraisal-based IRIs are normally able to, and often do, provide the underlying components of the return computation each period, including the CE_t values. This makes it easy and straightforward for index users wanting an alternative asset price tracking definition to adjust the reported appraisal-based IRIs to add back in the CE_t values to the capital return (asset value change) and subtract it from the income return (asset operating yield).

On the other hand, appraisal-based IRIs do not generally have or report information about property structure depreciation. As a result, it is less easy or straightforward to adjust IRI capital returns to hold the 'quantity' of structure constant (as though not depreciating), as is required in the SNA. The result is that appraisal-based IRIs, like some types of transaction-based price indices (such as repeat sales, appraisal-based price indices and also some specifications of hedonic indices), must depend on exogenous sources of information about structure depreciation rates and land value fractions, in order to be adjusted to reflect pure price-changes for purposes of structure and land value deflation in the SNA.

7.2.3. Data collection

For the construction of appraisal-based indicators one needs detailed information with respect to the asset valuations and cash flows of all individual properties at each period t:

- valuations of asset value at the beginning and end of each period: AV_{t-1} and AV_t;
- net proceeds of partial sales PS_t;
- capital expenditures CE_t; and
- net operating income NOI_t.

Moreover, in order to compute time-weighted returns the precise timing of the cash flows must be known [79].

The assessment of all these components is performed by professional surveyors [80] and requires a detailed valuation standard. Ideally, all property returns that are used within one index must be assessed by the same standards. In practice this assumption is violated for indices covering several countries, because valuation conventions and standards differ from country to country. A commonly used standard is the Royal Institution of Chartered Surveyors valuation professional standard (RICS, 2012). However, its exact implementation differs across countries.

In the remainder of this section we will give a more detailed description of capital expenditures and net operating income.

Capital expenditures CEt typically include leasing costs (tenant build-outs or improvement expenditures, leasing commissions to brokers) and property improvements (major repairs, replacement of major equipment, major remodeling of building, grounds and fixtures and expansion of rentable area). Capital expenditures do not generally imply any expansion or enhancement of property size and quality beyond its starting size and quality. At most they forestall or slow down the rate of real depreciation the property experiences due to physical and functional obsolescence.

NOI_t is the net operating income during period t. It is defined as the potential gross income (PGI) minus the vacancy allowance (VA) plus other income (OI) minus operating expenses (OE),

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[79] For indices of quarterly frequency or more frequent, there is very little difference between time-weighted and simple returns.

[80] 'Appraisers' in United States terminology.

(7.6) $NOI_t = PGI_t - VA_t + OI_t - OE_t = EGI_t - OE_t,$

where *EGI* is effective gross income. We will briefly discuss the different components of the net operating income [81]:

- The potential gross (*PGI*) income is the amount of rent the property will produce if it is 100 percent occupied for the entire year and all occupants pay their rent. Note that PGI does reflect the effect of depreciation in the property structure, by virtue of the fact that the PGI the property can charge declines (in real terms) with depreciation as the structure ages (and must compete with more and more newer structures in the rental market);
- Vacancy allowance (*VA*) consist of missing rental income because of vacancy and delinquent non-paying tenants;
- Other income (*OI*) is income not coming from renting space, like income from parking stalls/spaces and laundry machines;
- The effective gross income (*EGI*) is the potential gross income minus the vacancy allowance plus other income. Note that quoted rents may differ from the actual rent, because new renters are offered free rent periods and generous moving allowances, and so on. For the calculation of the income return we need the actual rent payments;
- The operating expenses (*OE*) relate to the operation of the property, and include:
  - Fixed expenses, predictable, not dependent of the occupancy level, like property tax, insurance premiums;
  - Variable expenses, unpredictable, dependent of the occupancy level, like management fees and utilities (electricity, water, sewer and heating fuel);
  - Maintenance and repair; and could include
  - Reserve for replacements that need to be done periodically. We will not include these reserves in the operating expenses. These major replacements are included in the capital improvement expenditures (*CE*).

7.2.4. Computation of appraisal-based IRIs

In this section we will highlight several issues that can be important in the computation of appraisal-based indicators of investment return.

7.2.4.1. VALUE AND EQUAL WEIGHTED INDICES WITHIN A MARKET SEGMENT

An appraisal-based IRI is based on the returns of a defined set of properties in a specific market segment. These properties are owned by the index member firms [82]. This subsection discusses the weighting of returns (capital gain, income return, and total return) within a specific market segment. The weighting of market segment returns to produce a composite index has been covered in a previous chapter. Here we discuss the issue particularly from the perspective of appraisal-based IRIs.

The returns according to Equation (7.1) or its modifications in Equations (7.2) — (7.4) are computed for each property, each period. These returns are then aggregated across all the properties to arrive at the index return for the period. Normally in the published IRIs the aggregation is by value-weighting the individual property returns. Thus, each property's return is multiplied by the fraction of its property's starting value (AV_{t-1}) in the overall aggregate index starting value at the beginning of the period, and the resulting value-weighted returns are summed across all the properties in the index as of the beginning of the period.

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[81] For an extensive discussion, see for example Chapter 13 from Lusht (2012).

[82] Alternatively, appraisal-based IRIs could in principle be based on assessed values that are used for property taxation. For example, in the Netherlands all properties are assessed on a yearly basis for property tax purposes. However, such indices generally would have to be limited to capital return, excluding the income component, as property tax authorities do not generally gather operating income data. Thus, a land registry based index would probably not be an IRI. Furthermore, property taxation authorities generally have not displayed much interest in producing or publishing such indices, though some NSIs have produced types of commercial property value indices based on property tax data in countries such as Japan, Hong Kong, and Denmark (see Chapter 10).

The value-weighted returns for the capital gain, income and total return are given by

$$(7.7) \quad \overline{g}_{.t}^V = \frac{\sum_{i=1}^{n_t} \left(AV_{i,t} - AV_{i,t-1} + PS_{i,t} - CE_{i,t} \right)}{\sum_{i=1}^{n_t} AV_{i,t-1}},$$

$$\overline{y}_{.t}^V = \sum_{i=1}^{n_t} NOI_{i,t} \Big/ \sum_{i=1}^{n_t} AV_{i,t-1},$$

$$\overline{r}_{.t}^V = \frac{\sum_{i=1}^{n_t} \left(AV_{i,t} - AV_{i,t-1} + PS_{i,t} - CE_{i,t} + NOI_{i,t} \right)}{\sum_{i=1}^{n_t} AV_{i,t-1}}.$$

where n_t is the total number of properties included in the index at time t. The denominator can be replaced by the time-weighted variants as given by Equations (7.2) and (7.3).

This type of value-weighting of the returns produces an index return that is equivalent to the return that would have been achieved by a single portfolio consisting of all of the properties in the index as of the beginning of the period. The process is therefore sometimes referred to as 'pooling' of the property performance data. Such value-weighting makes particular sense if the index is viewed as representing an entire 'population' or 'universe' of subject properties of interest. This perspective is most appropriate for investors or analysts wanting to use the index for 'benchmarking' purposes, to compare the performance of a particular portfolio or investment manager with the 'universe' of all (or most) such investment managers or portfolios that are competing and representative of the same type of investments.

An alternative method of aggregating the individual property returns to produce the index is equal-weighting. With equal-weighting each property's return each period has an equal weight in the index return for that period, which is a simple cross-sectional arithmetic average across the returns of all the properties in the index as of the beginning of the period.

The equal weighted averages for the capital gain, income and total return are given by respectively

$$(7.8) \quad \overline{g}_{.t}^E = \frac{1}{n_t} \sum_{i=1}^{n_t} g_{i,t},$$

$$\overline{y}_{.t}^E = \frac{1}{n_t} \sum_{i=1}^{n_t} y_{i,t},$$

$$\overline{r}_{.t}^E = \frac{1}{n_t} \sum_{i=1}^{n_t} r_{i,t}.$$

Usually there is little difference between the equal and value weighted versions of an appraisal-based IRI. Equal-weighting makes the index less influenced by a few very large properties, which may make the index a little bit smoother (less volatile).

The value and equal weighted IRIs are constructed by compounding the average returns, where the index level in the base period is set to 100.

7.2.4.2. SET OF PROPERTIES IN THE INDEX IS NOT CONSTANT OVER TIME

The set of properties can evolve over time by the buying (selling) of properties and the entering (leaving) of new index member firms, so it is important to monitor the evolution of the market segments over time. Moreover, properties undergoing major renovation or rehabilitation construction projects are generally excluded from appraisal-based IRIs. The composition of properties in the index will always reflect the aggregate composition of the constituent members and portfolios in the index pool [83].

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[83] Market segment IRIs are more 'pure' and constant by sector or type of property and region of location. A composite index is constructed from the market segment IRIs based on stock value or transaction value weighting metrics.

Another issue is that not all properties may be re-assessed in each period. For example, for a quarterly index each quarter 25 per cent of the total properties may be re-assessed, such that all properties are re-assessed on a yearly frequency. In such case if all property-level valuations as carried on the member firms' books are used for the calculation of the aggregate return, the aggregate return will be lagging. This is called the stale appraisal effect. If on the other hand only the returns of re-assessed properties are used for the calculation of the aggregate return, the aggregate return may not be totally representative for the total population and a statistical process such as that in the repeat sales regression described in Chapter 5 would have to be used to derive the index (Geltner and Goetzmann, 2000). In another approach, Section 5.9.2 describes a method to create a high frequency (say quarterly) index from staggered low frequency (say yearly) indices (Bokhari and Geltner, 2012).

7.2.4.3. 'SAME-PROPERTY'

The type of appraisal-based IRI described here is an example of a 'same-property' index. Such an index reflects the change over time in asset values or prices of a specified fixed set of properties (apart from the properties entering and leaving the set as described in the previous subsection). In other words, the index return within each period derives from the ratio of the end-of-period to beginning-of-period values of the same properties (all those in the index as of the beginning of the period). This is directly representative of the type of value change or price change that investors in properties experience, because investors buy specified properties and they can only sell (or refinance) those *same* properties over time. The properties in a same-property index age one period for each calendar period in the index. Same-property indices are more directly relevant for investors and lenders and those concerned about the financial condition of the real estate investment industry. But as noted previously, the inclusion of depreciation in the value change tracked by IRIs requires adjustment before the capital return can be directly applied within the SNA framework.

While the typical appraisal-based IRI is 'same-property' in the previously described sense, it is also true that the set of properties in the index does evolve over time. As noted, the property composition evolves with the sale of properties or departure of member firms from the index, and the purchase of new properties and arrival of new member firms. Generally, the evolution of the composition of a large and mature appraisal based index is quite gradual. For example, Exhibit 7.1 shows the evolution of the value based proportion of the five major commercial property usage type sectors (Apt: apartments; Ind: industrial properties; Off: offices; Ret: retail; Hot: hotels) within the NECREIF Property Index (NPI) in the U.S., starting from March 1978 up to November 2012.

Exhibit 7.1

Apt   Ind   Off   Ret   Hot
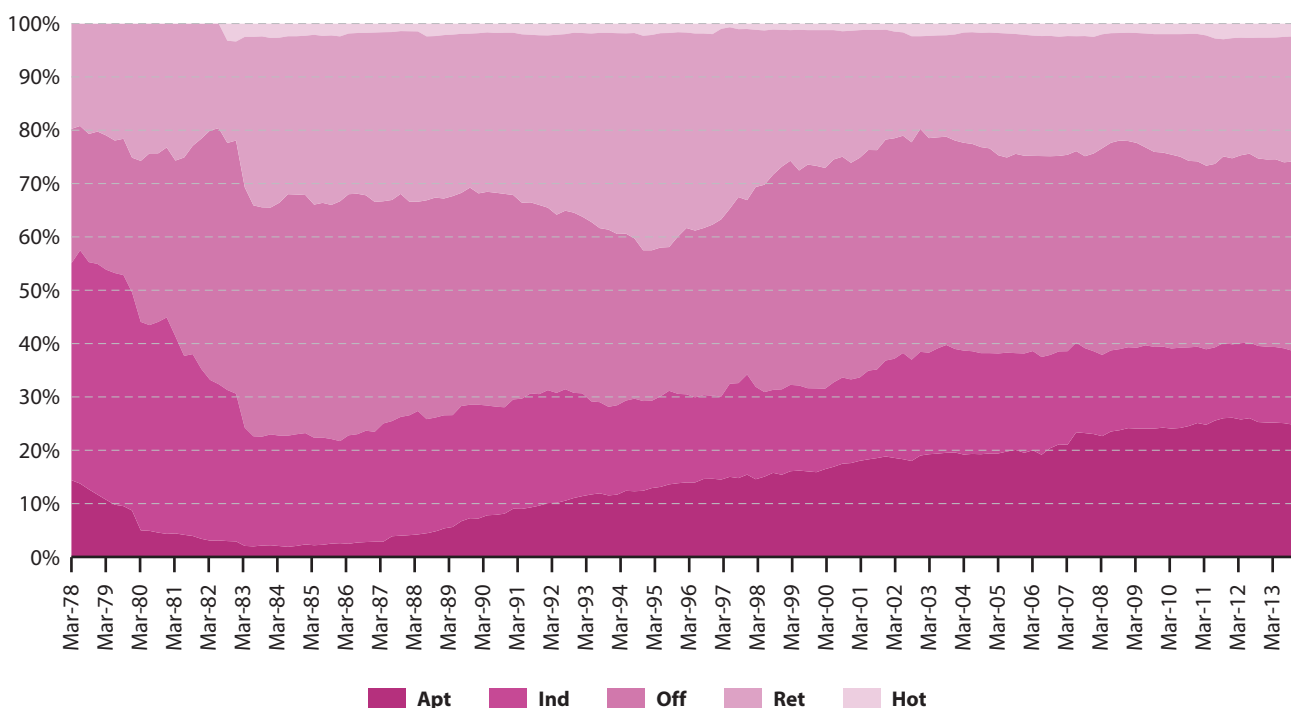
7.2.5. De-smoothing of appraisal-based IRIs

Appraisal values are likely to be smoothed and lag the true price level, because of noisy prices and infrequent and irregular trading of real estate at the level of individual properties. These characteristics of individual property price observations make it rational for real estate appraisers to, in effect, base the appraisal value partly on contemporaneous market prices (established from transactions prices) and partly on a previous appraisal [84],

$$(7.9) \quad AV_t = \alpha P_t + (1-\alpha)AV_{t-1}$$

where AV is the appraised value and P the market price (Quan and Quigley, 1991), and α a smoothing parameter between 0 and 1. When $\alpha = 1$ appraisal are only based on current market prices. The higher the size of α, the less is the degree of smoothing and lagging. The implications of smoothed appraisal-based property returns are (McAllister et al., 2003):

i.   relatively high and persistent levels of serial correlation positively linked to frequency of measurement;
ii. relatively low levels of standard deviation; and
iii. appraisal-based series fail to accurately record the timing of market movement.

In case the appraisal series are expressed in logarithms, continuously compounded returns can be expressed as (Geltner et al., 2003)

$$(7.10) \quad r_t^T = \left(r_t^a + (1-\alpha)r_{t-1}^a\right)/\alpha$$

where r_t^a indicates the appraisal based return and r_t^T the market price based return [85]. Given an estimate of α the `true' market return can be computed from the appraisal based returns by the above formula. Geltner et al. (2003) provide a summary of different methods to estimate α. Empirical studies find monthly smoothing parameters in the range 0.50 to 0.62.

The de-smoothing procedure will reduce the serial correlation, increase the standard deviations, and advance (de-lag) the timing of the market movements.

7.2.6. Characteristics, advantages, and disadvantages of appraisal-based IRIs

Property appraisal information can be a very important source of information in the estimation of property price indices. In particular, in regions where there are few transactions and markets which are strongly heterogeneous, such as the logistics facility, hotel, or hospital markets, there are quite a few cases where one has to rely on property appraisal information.

There are cases where it is possible to periodically observe property appraisal amounts. For example, many countries have property assessment data for property taxes. And on the property investment market, property appraisals are periodically conducted for investment properties. There are also countries and organizations that regularly conduct property appraisals with the objective of constructing indices. Given this, when property transaction prices cannot be observed, property appraisals or property price indicators and return estimates using those appraisals may capture trends in the commercial property market, and they may be an extremely valuable source of information when attempting to measure the economic value of commercial property.

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[84] Even if the appraisers do not explicitly base the current appraisal partly on a previous appraisal, it can amount to the same thing if in fact the 'contemporaneous' market prices they are using as 'comparable sales' are not all extremely recent. Basing the current appraisal on an average of past transaction prices produces a moving average type appraisal process, while basing it on a previous appraisal produces an autoregressive process. But either way it has a temporal lag bias, and in fact, by the invertibility of the autoregressive process it can be expressed as an infinite-order weighted moving average process. What appraisers do is no doubt not perfectly or exactly described by any simple time series model, but the model provided here is a good working illustration, see Quan and Quigley (1991).

[85] Note that it is possible to introduce additional lags in this formula.

Not only are there transaction-based price indices that make direct use of property appraisals, but many inventive approaches have also been developed, such as methods like the SPAR method that correct problems of sample selection biases in the repeat sales method by using property appraisals and methods that perform estimation by combining property appraisals and transaction prices in the hedonic method estimation, see Chapter 5.

On the other hand, appraisal-based indicators have several disadvantages. It has been pointed out in a number of studies that there are several drawbacks with using appraisals; these include valuation errors, lagging and smoothing, and client influence problems in the resultant indices, as well as possible non-representativeness [86].

Valuation errors occur because property appraisals are determined based on the judgment of property appraisal experts, so there is a certain degree of error in the price determination of absolute value [87]. In specific, appraisals tend to diverge from transaction prices in periods of wild market fluctuation (valuation error problem) [88].

Lagging occurs because the information appraisers are able to use in price determination is historic information, so there is a certain lag in price determination, see for example Geltner et al. (1994), Geltner (1997, 1998), Bowles et al. (2001).

Smoothing, which is related to the valuation errors and lagging, occurs because not only is there a strong possibility of misjudging market turning points, but changes also undergo smoothing, so price changes occur only gradually, so that they tend to underestimate price volatility [89].

The independence of appraisers is another question. Gallimmore and Wolverton (1997) and Kinnard et al. (1997) suggested the possible bias caused by clients and appraisal fees related to appraised value. As highlighted by Crosby et al. (2004) and Crosby et al. (2010), clients may seek to persuade property appraisers to raise the price in an attempt to maintain the property's investment performance. In other words, with respect to appraisal value, there is a problem of the price being distorted due to the client influencing the property appraisal. This is known as the client influence problem.

Valuation practices and terminology vary considerable by country, for commercial property valuations often include an estimate of the potential future income or return the property could deliver [90]. A lack of harmonization in terminology and valuation practices between countries makes international comparison of commercial property prices indices difficult. Furthermore, assessed values for the purpose of tax assessment may differ from investment property appraisal values, and since they are assessed values, there is an even stronger possibility that they do not properly capture market changes as they may reflect political or administrative constraints on the property valuation for taxation purpose.

Another issue regarding appraisal-based IRIs is that they do not take quality differences across properties into account. Specifically, appraisal-based IRIs collect values each time for a fixed set of properties, so that they do not conduct any quality adjustment. However, the quality of buildings

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[86] See Geltner et al. (2003) for a survey on this issue. See also Chapter 25 in Geltner et al. (2014).

[87] This is fundamentally not different from statistical estimation error that occurs in regression-based (or other types of) direct transaction price based indices, in that the fundamental source of the 'error' is the cross-sectional dispersion in individual asset transaction prices due to asset heterogeneity and idiosyncratic components in individual tranactions, the ultimate source of empirical data about commercial property market values.

[88] For example, Nishimura and Shimizu (2003), Shimizu and Nishimura (2006, 2007), construct two indices for the Japanese bubble period in the late 1980s and early 1990s, one based on transaction prices and the other based on appraisals, and find that the appraisal-based index increases 40 percent less than the transaction price-based index during the bubble period, and that the price decline following the burst of the bubble is much smaller for the appraisal-based index.

[89] Geltner and Goetzmann (2000) construct a transaction-based index using the NCREIF data to show that the NCREIF appraisal-based index, which is widely used in the U.S., is excessively smooth. See Quan and Quigley (1991) and Clayton et al. (2001) for discussions of the sources of valuation errors and excessive smoothness of appraisal-based indices. According to these studies, property appraisers fail to acquire price data in a timely manner. Also, they tend to update prices only with a lag due to their slow decision process. In a related context, Shimizu et al. (2012) point out that appraisers tend to regard large price changes as outliers and therefore tend to exclude them in the construction of an index. Shimizu et al. (2012) argue that this at least partly contributes to excessive smoothness.

[90] See also the discussion in section 7.2.2 about the 'income approach' to appraisal valuation. When there is not a well-functioning asset transaction market, the income approach often becomes the major method of property appraisal, and then conventions and practices regarding income definition, future projection, and discounting to present value become overwhelmingly important. In some circumstances this has tended to result in very smooth valuations through time. For one thing, the way the income method is applied, it often tends to ignore the fact that much volatility and cyclicality in property asset market values results from changes over time in the opportunity cost of capital, that is, in the discount rate, rather than from changes in the expected future cash flow stream, see Geltner and Mei (1995) and Plazzi et al. (2010).

changes over time due to aging and renovation, so that even if indices are based on observations for a fixed set of property properties, appropriate quality adjustment is necessary. Moreover, the population from which the data used to create the indices is extracted changes over time. Since the purpose of these indicators is to capture changes in investment values of properties, they are estimated by taking investment properties as the population. As a result, if a given property is sold off and is no longer an investment target, it is removed from the index; if a property becomes a new investment target, it becomes part of the index. In other words, the properties which are the target of the index change over time. In this sense, these indices are not free from biases stemming from quality changes over time.

In summary, the advantages of property appraisals are:

- Even for highly heterogeneous commercial property, for which applying a regression model is difficult, it is possible to derive property price indices by performing quality adjustment via the filter of property appraisers;
- Even in regions where there are few or no transactions, it may be possible (although perhaps undesirable) to estimate price indices using property appraisals;
- There are also cases where, even though estimating the hedonic model is difficult due to the insufficient number of samples, estimation can be made possible by combining property appraisals with transaction prices; and
- There are cases where application of SPAR is made possible due to the existence of property appraisals.

The disadvantages are:

- Appraisal errors, in which appraisals deviate from market prices, occur frequently with property appraisals;
- There is a lagging and smoothing problem with property appraisals, which lag behind market changes and may smooth out or dampen those changes ([91]);
- There is a potential client influence problem;
- International comparison of appraisal indices is difficult because of different valuation practices and terminology; and
- Appraisal-based IRIs are not free from biases stemming from quality changes over time.

7.3. Stock Market Based Investment Return Indicators

While transactions-based price indices have been the major commercial property performance measurement innovation of the first decade of the 21st century in several countries, it is possible that stock market based IRIs will play that role in some countries in the second decade or beyond. The first regularly produced and published stock market based property return indicator (SMPRIs) of the type described in this section was launched for the Unites States by FTSE in combination with the National Association of REITs (NAREIT) in June 2012 and has been updated daily since then, as the FTSE-NAREIT PureProperty® Index Series ([92]).

Stock market based IRIs have several advantages, including the possibility of objective, replicable, daily-updated price information based on the highly information efficient mechanism of the public stock market. Stock market based IRIs are in principle directly investable, that is, they directly measure actual liquid market values of traded assets rather than a statistical estimate of value. Stock market based IRIs do not require sales of individual property assets, and so avoid the leakage of information caused by sales of entire portfolios of multiple properties at once, a growing phenomenon which effectively

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([91]) While property appraisals have the above disadvantages, de-smoothing methods and the like have been proposed with regard to the smoothing problem, so it is possible to partially resolve the problems with these prices by using such approaches, see Section 7.2.5 for more details

([92]) See Section 10.5.7.1

cuts into usable data available for direct transaction-based price based indices ([93]). Finally, stock market based IRIs offer the prospect of pan-regional multi-country indices, based on Real Estate investment Trusts (REITs) holding properties in numerous countries and several stock exchanges ([94]).

7.3.1. Stock market and property market valuation of property assets

Stock market based IRIs are made possible by the existence of a large and mature REIT sector within the stock market ([95]). REITs are publicly-traded firms that are essentially 'pure plays' in commercial property investment. That is, they are largely confined in their activities to only the ownership and operation of commercial investment property. They also must pay out most of their earnings as dividends. Thus, REITs are vehicles for investment in largely stabilized, operational commercial properties ([96]). As such, REIT equity share prices provide an indirect indication of the value of such properties (as levered by the REITs), and in particular how this value changes over time ([97]).

Changes over time in REIT equity share prices reflect changes in the value of the underlying properties as well as changes in the property composition of the REIT.

REIT equity share prices are made by the stock market, not the private property market in which the commercial property assets actually trade directly. The private property market and the public stock market do not always agree about the value of commercial property.

In the private property market assets trade directly in that market, a much greater number and aggregate value of property assets are owned privately outside of REITs, and the property market has a long history and is specialized in such assets. However, the stock market is extremely efficient at information aggregation and price discovery, and (related to that) is more liquid than the private asset market, with a much greater velocity of trading volume (turnover ratio) and highly developed and rapid public information and publication processes. Stock markets may often be freer of formal or informal constraints and norms governing the transaction or pricing processes that may prevail within the private property markets in some countries or market segments ([98]).

Evidence from several countries suggests that, when the REIT and private market valuations of commercial property differ in the aggregate, that difference tends to be mean-reverting (it tends to average toward zero), and the stock market valuation tends to lead in time the private market valuation. That is, major turning points often occur first in the REIT valuations. REITs now are major players in the property market in some countries, and growing more so. By the early 21st century there were over 100 actively traded public equity REITs in the United States (that is, REITs primarily investing in property equity as opposed to mortgages), with a total aggregate stock market capitalization over $400 billion, holding over $700 billion worth of property assets in some 29,000 individual property assets, more than twice the value and four times the number of assets in the NCREIF Index ([99]).

([93]) Transaction-based price indices require data on the sales prices of individual properties. When multiple-property portfolios are sold at once at a single bulk price, it is generally impossible to know with accuracy and objectivity how much of the transaction price is attributable to each individual asset in the portfolio. Even if hedonic information were available for the portfolio in the aggregate, it would not be reliable for use in a hedonic price index. In the case of repeat sales indices, only if the exact same portfolio is subsequently traded again in bulk can the portfolio sale be used in index construction, and this rarely happens. It is not uncommon for over 20% by value of United States commercial property investment to occur in portfolio bulk sales in recent years, and this proportion may be growing. (It tends to be greater during boom periods, and less during downturns.)

([94]) See Elonen (2013) for an analysis and demonstration of the feasibility and nature of stock market based IRIs for Europe. It is likely that stock market based IRIs are or will soon be feasible in other countries with well-developed REIT sectors, such as Japan, Korea, Hong Kong, Singapore, and Australia (among others). Stock market based IRIs for Japanese commercial property have been developed by Konagai (2009) and Shimizu et al. (2013).

([95]) In this section we will use the term 'REIT' to refer to any type of publicly listed 'pure play' firm specializing in commercial property investment, including property companies and listed unit trusts ('PUTs').

([96]) While REITs can engage in real estate development (construction of properties for their own portfolio), regulations often require them to be somewhat passive, such that they are generally not 'merchant builders' or construction firms, and many REITs in fact only acquire existing properties.

([97]) The impact of financial policy and the REIT equity share price is largely eliminated by the de-leveraging process, see the next subsection.

([98]) In other words, stock market share values may reflect a more free market equilibrium price for the trading of property assets, albeit indirectly and obfuscated to some extent by the effect of REIT entity level management.

([99]) The Elonen thesis project was able to create approximately 20 pure play type stock market based IRIs based on 68 publicly-traded European REITs (or REIT-like firms tracked by the FTSE-EPRA REIT Index for 'Developed Europe'). These 68 firms held some 11,000

With REITs being pure plays, stockholders investing in and trading REITs can be under no illusions that commercial property assets are fundamentally determining the value of their shares. In short, it might be that both the stock market and the private property market have something important and valid to say about the economic value of commercial property. Stock market based IRIs are a way to distil and focus that market's information and news about commercial property values in a way that is practical and useful to the investment industry and potentially for other users. In principle stock market based IRIs can provide an important third perspective on the commercial property market, complementing the perspectives of appraisal-based IRIs and transaction-based price indices previously discussed.

7.3.2. Computation of stock market based IRIs

In the stock market the prices of and dividends from REITs are available. Let P_t denote the stock price at the beginning of period t, and D_t the dividend payment in period t. The REIT capital (g_t), dividend (y_t) and total return (r_t) are defined by (where t may be measured in days)

$$(7.11) \quad g_t = \frac{\left(P_t - P_{t-1}\right)}{P_{t-1}},$$

$$y_t = D_t / P_{t-1},$$

$$r_t = y_t + g_t$$

Stock market based property return indicators (SMPRI) in general do three things:

i.   They remove the effect of financial leverage ('gearing') from the traded share prices of REIT stocks;
ii. They construct 'pure' portfolios of long and short positions in REIT stocks (and bonds) such that the portfolio provides exposure only to the target market sector or segment with no exposure to non-target sectors or segments (and the portfolio is itself at least in principle tradable or investable); and
iii. They optimize the diversification of the pure portfolios so as to minimize volatility caused by idiosyncratic risk in individual REITs.

There are two major steps in the construction of a SMPRI: delevering (degearing) the REIT equity returns, and constructing the targeted long/short portfolio of REIT holdings. Consider these in order.

Normally there is sufficient and timely information about the approximate degree of leverage of each firm, since the firms are publicly held and exchange-traded. Thus the delevering may be done at the level of each individual REIT, based on its capital structure and a cost of debt (of which the latter may be generic rather than REIT-specific).

The equity ratio e_t is defined as total stockholder's equity divided by the sum of total stockholder's equity and total liabilities. Let i_t the debt interest rate per period at time t. Assuming that the capital gain on the debt is zero, the returns are de-levered using the weighted average cost of capital (WACC) accounting identity,

$$(7.12) \quad ROA_t^g = g_t \times e_t,$$

$$ROA_t^y = y_t \times e_t + i_t \times \left(1 - e_t\right),$$

$$ROA_t^t = ROA_t^g + ROA_t^y = r_t \times e_t + i_t \times \left(1 - e_t\right).$$

These de-levered returns on assets (ROA) are input for a stock market based price index.

For example, suppose the share price of REIT 'X' at the beginning of the day was €50, the dividend paid during the day to shareholders as of the beginning of the day was €1.50, and the closing price ex dividend at the end of the day was €53.50. So the capital gain in share price (g_t) is equal to 7 per cent even after subtracting the dividend, the dividend return (y_t) is equal to 3 per cent and the total share price return (r_t) is equal to 10 per cent.

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individual property assets worth in approximately €350 billion. These included various overlapping indicators such as Europe-wide property sector indices, all-property county indices for several larger countries, Euro-zone versus Non-Euro indices, and several sector X country combination indices.

And suppose REIT 'X' has a capital structure that is 60 per cent equity and 40 per cent debt (with these percentages typically measured based on stock market valuation of the equity and book value of the debt).

Thus for our example REIT, at the beginning of the day total asset value per share ex dividend is €83.33 (= €50/0.6), including €50 equity and €33.33 debt. Finally, suppose the debt is interest-only, in our example 5 per cent per year (which is: 0.05*33.33 / 250 trading days/yr = €0.0067/day, or 0.05/250 = 0.02 per cent of the debt per day). Then the delevered return on assets ('ROA') of REIT X for that day is, for the income return:

$$ROA_t^y = \text{(Div + Int) / Assets} = (0.03^*0.60 + 0.0002^*0.40) / (0.60 + 0.40)$$
$$= (1.50+0.0067) / 83.33 = 1.81\ \%;$$

for the capital return ([100]):

$$ROA_t^g = \text{Share Gain/Assets} = 0.07^*0.60 / (0.60 + 0.40) = (53.5 - 50) / 83.33 = 4.20\ \%;$$

and the total return:

$$ROA_t^t = (0.10^*0.60 + 0.0002^*0.40) / (0.60 + 0.40)$$
$$= (1.5067 + 3.50) / 83.33 = 1.81\ \% + 4.20\ \% = 6.01\ \%.$$

The delevered returns on assets, given in Equation (7.12), are the input for SMPRIs. The vector of all n de-levered returns on assets for the n traded REITs in the index at time t is denoted by ROA_t. The de-levered returns are explained by the percentage value of assets held by the REIT in each market segment at time t, denoted by the matrix X_t. Each row of this matrix X_t sums up to 1. The model is given by ([101]):

$$(7.13)\quad ROA_t = X_t \beta_t + \varepsilon_t,$$

and can be estimated by generalized least squares, assuming that the error term is independently normally distributed with zero mean, where the variance of ε_{it} is provided by σ^2 times the inverse of (square root of) the total value of properties held by REIT I ([102]).

The market segment returns in period t are provided by the generalized least squares estimator of β_t

$$(7.14)\quad b_t = H_t ROA_t = \left(X_t' \, \Omega_t^{-1} X_t \right)^{-1} X_t' \, \Omega_t^{-1} ROA_t,$$

where Ω is a diagonal matrix containing the variance ε_{it} elements. The matrix H_t is a weight matrix. Each row i of this matrix H_t defines a hedge portfolio that eliminates exposure to all but one market segment i. Horrigan et al. (2009) show that each of these weighted portfolios would yield a pure return to the target segment while minimizing idiosyncratic REIT return variance. The market segment returns b_t are independently estimated for each period.

The mathematics of this regression are such that in the process of estimating the REIT holdings coefficients in the hedge portfolios (the b's), the regression actually produces a specification of the 'pureplay portfolios'. These are combinations of long and short positions in REITs such that the portfolio has complete 100 per cent exposure to the target segment and zero net exposure to any other segment, under the linear return model of Equation (7.13). Indeed, the procedure produces the most 'efficient' such portfolio, the one that minimizes the idiosyncratic volatility in the portfolio.

The price index per market segment is constructed by compounding the estimated market segment returns, where the index level in the base period is set to 100.

([100]) Note that unless explicitly adjusted, the *ROA* capital return in the SMPRI will not exactly be a same-property asset price change like that in the private market indices presented in previous sections, as it will also include the effect of REIT scale expansion due to retained earnings not paid out to stockholders. However, this consideration is minor in the U.S. and appears in the Elonen thesis to be minor in Europe as well, presumably because REITs pay out most of their earnings.

([101]) This is simply the classical 'weighted average cost of capital' (WACC) formula widely used in financial economics, in which the simple return to a portfolio is the linear combination of the returns to the individual assets in the portfolio weighted by their respective shares of the portfolio value at the beginning of the period.

([102]) This weighting reflects the fact that larger REITs tend to have less idiosyncratic volatility in their equity returns, due possibly to a stock size effect in the stock market and/or to the fact that larger REITs tend to have larger portfolios of more properties with therefore more diversification in their property asset holdings.

For example, suppose we are interested in computing SMPRIs for mutually exclusive and exhaustive geographic regions: East, South, Midwest, and West. Then we determine the percentage of each REIT's property assets that are in each of those four regions. We regress the *ROA*s onto those percentages. The resulting regression estimated coefficient on each region's holdings shares represents the stock market's implied *ROA* for that region for that day, according to the basic REIT linear return model (WACC):

$$ROA_{i,t} = X_{i,E,t} \, b_{E,t} + X_{i,S,t} \, b_{S,t} + X_{i,M,t} \, b_{M,t} + X_{i,W,t} \, b_{W,t},$$

where the X_i are REIT i's shares of its property assets in each of the four regions ($\Sigma X=1$), and the b's are the estimated coefficients which represent the estimated *ROA*s to the four regions (e.g., $b_{E,t}$ is the estimated ROA to the East Region in day t).

7.3.3. Data collection and preparation

Stock market based IRIs require for each individual real estate REIT stock the following data per period:

- stock market REIT prices;
- dividend payments;
- equity ratio: total stockholder's equity divided by the sum of total stockholder's equity and total liabilities;
- debt interest rate;
- percentage of asset value held by the REIT in each market segment, where market segment is defined by geography, sector and quality. The sum of the shares for each REIT sums up to one; and
- the total value of properties within the REIT.

Stock market REIT prices and dividends are quoted frequently (daily).

Equity ratios — needed to delever the returns — are available on a less frequent (yearly) basis. The same holds for the percentage of asset value held by the REIT in each segment, and the total value of the properties within the REIT. The cost of debt is a function of interest expense, preferred dividends, value of preferred shares, and debt. The low frequency of these input variables may seem problematic, however it should be noted that the variance within a year may be relatively small.

The cost of debt is generally not available for each individual property. Market wide average yields — available on a yearly basis — are commonly used.

7.3.4. Characteristics, advantages, and disadvantages

Stock market based IRIs, where they are feasible, have the following advantages:

- They are based on asset value indications from public stock exchanges, which are known to be highly fast and efficient information aggregation arenas, as a result, stock market based indices tend to be leading indicators for major turning points in the private (direct) property asset market;
- They can be produced at a daily frequency, far greater frequency than other types of indices;
- They represent liquid prices at which trades can actually be executed, thus representing true economic 'opportunity costs';
- They are IRIs which can measure total investment returns (including income) as well as capital returns; and
- They are not dependent on individual asset transaction sales or on appraisal valuations, obviating the small sample problem as well as problems caused by 'portfolio sales'.

Stock market based IRIs have the following disadvantages:

- They do not track the prices of property assets within the private (direct) property market, but rather only indirectly reflect the valuation of such assets by investors and traders in the stock market;
- They are fund or entity level metrics that include the effect of fund or entity (firm) level management, including dividend policy and retained earnings (e.g., plowback of earnings may cause an exaggeration of the price appreciation of individual static properties);
- Methods to delever (degear) equity share price returns may not be precisely accurate.

- Capital returns to SMPRIs reflect both depreciation as well as capital expenditures, and may also reflect scale expansion (retained earnings) of the REITs, thus requiring adjustment before they can be directly used in SNA applications in the capital formation accounts ([103]);
- They only reflect the valuations of the properties held by the firms traded on the stock exchange, which may not be perfectly representative of all commercial property in a given population; and
- Many countries do not yet have sufficiently large or well established sectors of specialized real estate investment firms ('REITs, or 'REIT-like' firms and listed unit trusts) trading in their stock markets.

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[103] This limitation does not apply to the use of SMPRI total returns for estimation of commercial property opportunity cost of capital for capital services outputs and inputs production accounts in the SNA.

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8 Additional indicators for commercial property

8.1. Introduction

The commercial property price indices and indicators discussed in the previous chapters of this text all focus essentially on the price dimension of temporal changes in the market value of commercial property assets. In the present chapter we turn to some other metrics relevant for tracking commercial property markets. These 'non-price' metrics are not the primary subject of this text, and will therefore not be covered in as much depth as the commercial property price indices and indicators. But in this chapter we will introduce and at least briefly discuss several potentially important metrics or information constructs.

The first set of metrics we will discuss in this chapter are all indicators of the conditions in commercial property space markets. It is important to recognise that the commercial property asset market, that has been the focus of the preceding (and subsequent) chapters in this text, is in fact one element in an overall commercial real estate system that also includes the space usage (rental) market, and the real estate financing and development industry. Together these three interconnected elements determine the status and health of the entire system. The system is depicted in Exhibit 8.1. At the top of the exhibit is the space market, with potential tenants on the demand side and landlords offering built space on the supply side. Equilibrium in the rental market determines rental prices and occupancy/vacancy rates, which results in a cash flow stream which is the fundamental source of value in the asset market, which is depicted in the lower right-hand side of the system. In the asset market investors owning property or seeking to buy property create an equilibrium pricing in the property asset market which can in a simple way be represented by a 'cap rate' (or net income yield), that is the annual net operating income [104] (or net rental income) as a fraction of property asset value. The net operating income divided by the cap rate gives asset prices, which are the essential information drivers of the development industry. Developers (and their financiers) compare the prices that assets command, and are expected to continue to command, in the asset market with the (expected) total costs of development (including land cost and necessary development profit), and if the benefit-cost analysis looks favourable then new construction is started. All of this is matched against financing considerations, in particular the cost of capital for the venture. After a period of construction this results in new physical supply of space being added onto the supply side of the space market back up at the top of the diagram.

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[104] See section 7.2.3 for a definition of net operating income. It is the actual rental income minus operating expenses plus other income like income from parking places.

Exhibit 8.1 The role of commercial property in the economy

The "Real Estate System": Interaction of the Space Market, Asset Market, & Development Industry

= Information gathering & use   = Causal flows
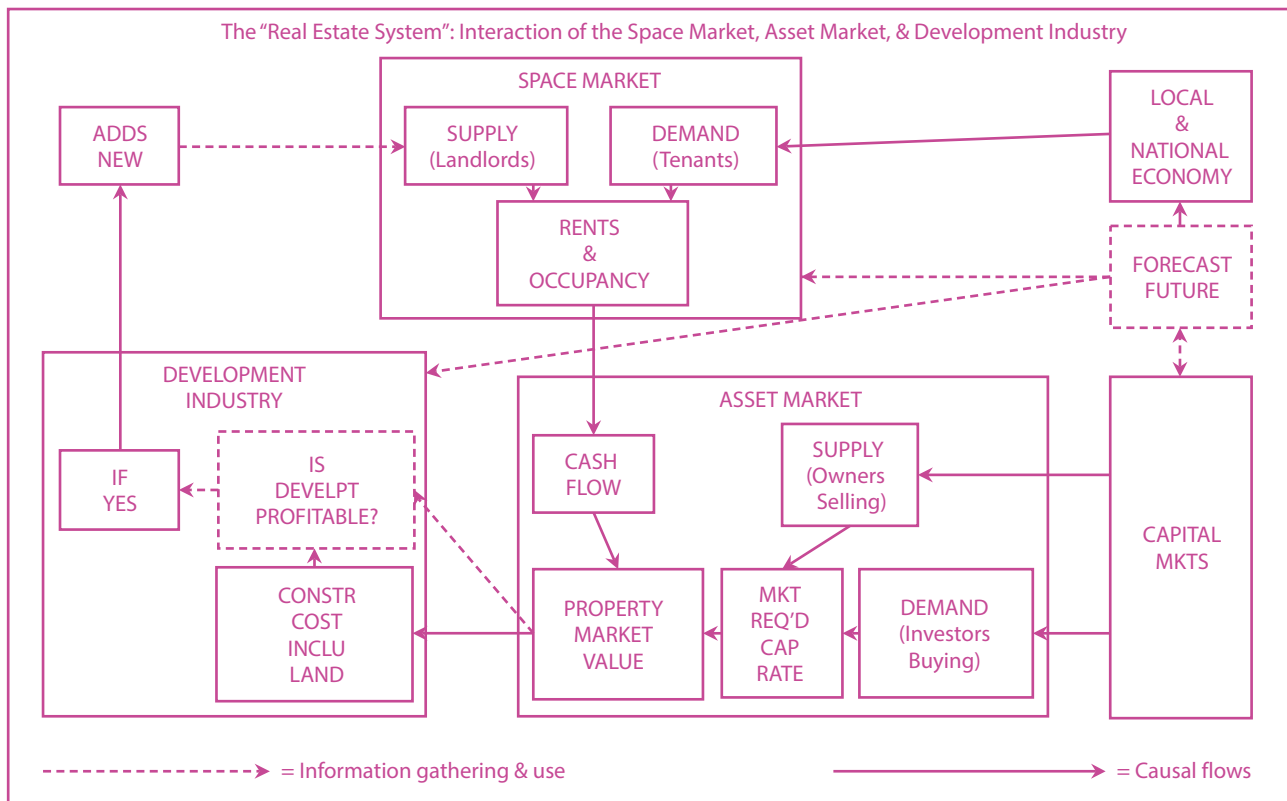
Exhibit 8.1 helps to clarify the fundamentally important role that the space market plays in the overall system, in particular as the fundamental source of value of the property assets traded in the property market, because without the operating cash flows generated by those assets from their contribution to space users in the space market, commercial property assets would have no value. Thus, indicators tracking the space market can be of great importance. This would include data on current rental prices, leasing terms (such as duration, concessions, options) , current vacancy (or occupancy) rates in the space market, as well as indicators of gross and net 'absorption' of space (amount of space leased during the period), and construction starts and completions.

Apart from indicators of the space market, this chapter also will treat some non-price indicators in the commercial property asset market, including net income yields (also known as 'cap rates') and asset market trading volume (which directly reflects 'liquidity' in that market).

This chapter is structured as follows. Sections 8.2, 8.3 and 8.4 relate to the space market. Section 8.2 describes the construction of rent indices for commercial property. Section 8.3 discusses vacancy rates. Vacancy directly impacts the cash flow for the landlord, and so the market value of the property. It also is a physical indicator of the balance of supply and demand in the space market. Section 8.4 provides some additional space measures, including construction starts, absorption and building permits. Section 8.5 concerns both the space and capital market with its discussion of property yields (cap rates). Yields are the current ratio between the property net (gross) operating income ([105]) (the numerator, coming from the space market) and property asset value (the denominator coming from the asset market). Section 8.6 shows that transaction prices and rents do not present the full picture of the dynamics in real estate markets and that number of sales and rents provide useful additional information. Section 8.7 concludes this chapter.

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([105]) A definition is provided in Chapter 7, Section 2.3.

8.2. Rent indices

A commercial property *price* index concerns both the market for space and assets. A commercial property *rent* index only relates to the market for space; the rent index is largely independent of changes in the market for assets, and can therefore be considered as an additional property market indicator.

8.2.1. Rent agreements

Geltner et al. (2014, p. 785) define a lease (rent agreement) as a 'contract between a holder of property rights and a consumer or user of at least some of those rights, covering a specified period of time'. Normally the tenant gets the possession and usage rights. In return the tenant has to pay periodically a rent.

The rent level is dependent on a number of characteristics of the rent agreement:

- **Location**. Location is an important variable for the determination of the rent level. Location is important on several levels, varying from a regional level to a specific site or location within a multi-tenant building;
- **Property characteristics**. In general, characteristics relating to the size, shape and configuration of the space are important for the rent level. Apart from these characteristics, floor number and architectural properties, construction year and age are of interest. Which specific property characteristics are important, depends on the property type, such as office buildings, warehouses, catering industry and retail. For offices the difference between a single- and multi-tenant building is important, as well as facilities in and around the building, like the presence of a restaurant, health club and parking facilities. For retail a broad front of the shop positively affects the sales and rent;
- **Date of lease**. The date of lease reflects the market conditions at date;
- **Term of lease**. Commercial leases have different lease terms. One would expect that short leases to have high rents, due to transaction costs for the owner. Apart from transaction costs, expectations of future rent levels influence the difference in rents between leases with a long and short term. In bullish (bearish) markets long term rents are higher (lower) than short term rents, see Gunnelin and Söderberg (2003);
- **Rent changes**. Rent agreements have different conditions with respect to rent changes during the lease length. Common types of rent change provisions are:
  - **Flat rent**: a fixed rent level throughout the lease term;
  - **Graduated rent**: the rent will increase on a priori specified dates by upfront specified amounts during the lease term;
  - **Revaluated rent**: the rent will change on a priori specified dates, however the amount of rent adjustment is unknown. The rent may be adjusted to market level or another `fair value' by independent appraisers. Depending on the rent agreement the adjustments can be upward-only or either direction;
  - **Indexed rent**: a rent is (partly) adjusted to a publicly observable and regularly recorded index, like the consumer or producer price index; and
  - **Percentage rent**: a part of the rent depends on the tenant' sales above a pre-set threshold. It is also called overage rent. Apart from the percentage rent the tenant normally pays a base rent. Moreover, the tenant may pay a security deposit that ' is retained by the landlord as a reserve and is refunded upon satisfactory completion of the lease including final payment of the base rent' (Benjamin and Chinloy, 2004).

Percentage rent agreements are common in the retail sector.

- **Operating expenses**. Rental agreements differ in the way operating expenses are being dealt with. On the one hand the landlord can pay all the operating expenses, like property taxes, insurance, electricity, heat, water, cleaning and maintenance. In this case, the landlord receives what is called gross rent. When the tenant pays the full operating expenses, the rent is called net rent. There are many in-between options, where the tenant pays specific parts of the operating costs, sometimes above a pre-set threshold;

- **Tenant**. Tenants may pay different rents for nearly identical properties. Prestigious tenants get a reduction on the rent, because they are supposed to have positive externalities. For example, the presence of anchor shops may positively affect the sales (and rent) of non-anchor shops;
- **Concessions**. Landlords may offer tenants incentives to rent the property, depending on the market situation. These concessions include lease buyout, free rent for a specified period of time, moving allowances, tenant improvement allowances, and so on;
- **Covenants**. Some contracts include specific covenants or provisions, such as a ban to sublet the property; and
- **Options**. A contract can contain several options, such as the right to renew the rent at the end of the term at a pre-set rent or market rent for a specified period of time. Another example of an option in a rent agreement is the right to cancel the rent prior to the end of the term by either the landlord or the tenant.

The Royal Institution of Chartered Surveyors RICS (2012, p. 31) defines market rent as 'the estimated amount for which a property would be leased on the valuation date between a willing lessor and a willing lessee on appropriate lease terms in an arm's length transaction, after proper marketing and where the parties had each acted knowledgeably, prudently and without compulsion'.

The phrase 'appropriate lease terms' reflects current practice in the market for the specific property, for example the common duration of the lease term and the size of the incentives (number of rent-free months). Note that 'appropriate lease terms' may differ over time and property markets. The incidence and size of incentives are larger in declining markets.

8.2.2. Measurement of market rent

The market rent can be best measured by new rent agreements ([106]). At that time the landlord and tenant negotiate the rent price, rental period, rent changes, and concessions, taking into account the market conditions at date. How the rent changes during the term of lease depends on the rent agreement (see previous section), but will in general differ from changes in rent prices of new rent agreements, in specific when the rent was initiated a long time ago.

Different measures of market rents per square meter (or foot) can be distinguished, in ascending order of precision and availability, see also McDonald (2002):

i. Asking rent;
ii. Contract rent on new leases in the first year;
iii. Consideration rent; and
iv. Net effective rent.

ASKING RENTS

Asking rents are relatively easy to obtain, for example from websites from brokers, but they are considered only a starting point in the negotiation between tenant and landlord. Asking rents may be a good proxy for a cross-sectional and spatial study of rents at a fixed point in time, though require an assumption that the (percentage) margin between asking and actual rent is constant across properties.

Dunse and Jones (1998) motivate the use of asking rents in their study on the existence of office submarket in cities by data availability; in general many more asking rents will be available compared to contract rents. A second reason is that incentives are in most cases unknown. Jennen and Brounen (2009) also use asking rents in their study on the Amsterdam office market in the period 2000 to 2005. They show for a subsample of their data — 88 observations for which both the asking and contract rent is available — that the correlation between asking rents and contract rents is high, being 0.88. There could of course be a difference in the margin between the two prices, but the differences (for a linear correlation) are the same for each property.

([106]) New rent agreements could also include renewals of existing rent agreements at the end of the lease term, depending on the options in the rent agreement, see previous section.

However, for the construction of indexes over a long time period — a time series context, asking rents are less appropriate, because differences between asking rent and negotiated contract rent and the size of concessions tend to be time varying, see for example Webb and Fisher (1996).

CONTRACT RENTS

Contract rents on new leases are more difficult to obtain and measure more accurate the market rent. However, it does not take into account rent concessions.

CONSIDERATION RENT

Wheaton and Torto (1994) define consideration rent as the total consideration divided by the lease term. The total consideration is the undiscounted sum of rental payments per square meter (or foot) to be paid over the full term of the lease. So, it accounts for rent free periods. It also takes into account pre-specified changes in the rent payments (graduated rent). However, the consideration rent does not deal with changes based on a priori unknown values, like revaluated rents and indexation rents, the latter based on the consumer or producer price index. It also excludes the cost of any tenant improvement.

NET EFFECTIVE RENT

Web and Fisher (1996) define the net effective rent as ' the annual-equivalent cash-flows of the present value of all cash flows that are explicitly identified in the lease contracts'. The net effective rent takes into account all known cash inflows and outflows over the entire lease term from the perspective of the landlord. The payments include the rental payments, taking into account rent free periods and pre-specified graduations, brokerage fees, the costs of tenant improvements, moving allowances, buyout allowances, and so on. In common with the consideration rent the net effective rent does not account for unspecified changes, like changes based on the consumer price index.

The net effective rent (NER) at time 0 can be calculated as follows, assuming rents being paid in advance and yearly cash flows for convenience,

(8.1) $$NER_0 = \sum_{t=0}^{T} \frac{NCF_t}{(1+d)^t} / \sum_{t=0}^{T-1} \frac{1}{(1+d)^t} ,$$

where NCF_t is the net cash flow in year t, d is the discount rate and T is the lease term.

The choice of the discount rate is debatable. Web and Fisher (1996) calculate for the Chicago Central Business District office market the discount rate as the contemporaneous treasury-bond rate that has the same maturity as the lease. Hendershott (1996) calculates for the Sydney office market the discount rate for the effective rent as the sum of the real risk-free rate, a depreciation rate, a risk-premium and an expense ratio. Hendershott et al. (2010) calculate the discount rate for the London City office market as the United Kingdom long bond redemption yield plus 0.02. An alternative indicator of the opportunity cost of capital (discount rate) for the rent could be the tenant's borrowing rate, the interest rate at which a bank would lend money to the tenant for a duration equal to the lease duration. Clearly this is normally greater than government bond yields.

Hendershott et al. (2010) show that the formula for the net effective rent simplifies to

(8.2) $$NER_0 = R\left(1 - \frac{1-(1+d)^{-T}}{1-(1+d)^{-P}}\right),$$

when the rent free period P is at the start of the contract, and apart from the flat rent (R) the contract has no other cash flows.

Webb and Fisher (1996) conclude that ' effective rents have much more volatility and provide a more accurate and timely representation of trends in the price of space than either asking rents or contract rents'.

Note that neither the consideration rent nor the effective rent corrects for the value of covenants and options. These corrections can however be quite substantial relative to the rent value.

8.2.3. Rent index construction

8.2.3.1. DATA AVAILABILITY

Rent agreements are private contracts between the landlord and the tenant. These contracts are not publicly recorded and therefore not open to public scrutiny. Data from rent agreements must come from private parties. However, owners of real estate are not always willing to disclose (detailed) information on recently negotiated leases. So, the construction of a commercial property rent index depends on the voluntary disclosure of rent agreements by real estate owners and brokers.

Real estate firms periodically (quarterly) publish market reports in which they quote rent levels for prime real estate in local markets (cities) for specific real estate categories (for example office markets, high street retail). A rent index could be based on these figures. A major drawback is that it is subjective information. Moreover, these numbers only refer to a property of standard size commensurate with demand in each location, of highest quality and specification, and located at the best location within the market. The changes in prime rents over time are not necessarily representative for the total market; the development of prime rents could differ from secondary rents.

When new contract rent information is available for individual properties, a rent index can be constructed by applying a hedonic rent model or a repeat rent model.

8.2.3.2. REPEAT RENT MODEL

Devaney (2010) provides one of the few examples of constructing a rent index from a repeat measure model. The repeat measures are rents for the same office building in different years, in this case initial contract rents. He applies this model to the City of London office market, covering a period from 1867 to 1959. Devaney uses a modified version of the standard repeat sales model, which produces an arithmetic value weighted rent index series, see Shiller (1991) for more details. For a general discussion of the repeat measurement (sale) model, see Chapter 5.

8.2.3.3. HEDONIC RENT MODEL

The structure of a hedonic rent model is identical to a hedonic model for sale prices, as described in Chapter 5. The main difference is that the sale price is replaced by some measure of the market rent (see Section 8.2.2), normally per square meter (or foot).

The hedonic model has been applied to construct rent indices for office markets. Wheaton and Torto (1994) derive an office rent index for a number of metropolitan areas in the US spanning the years 1979 through 1991 based on the consideration rent per year per foot. Webb and Fisher (1996) estimate an office rent index for the period 1985 to 1991 for the Chicago central business district using effective rents per square foot. Englund et al. (2008) construct a rent index for the Stockholm office market over the period 1977 to 2002 using contract rents per square meter.

A basic specification of the hedonic rent model is provided by

(8.3) $\ln R_i = \alpha + x_i' \, \beta + c_i' \, \gamma + d_i' \, \mu + s_i' \, \delta + \varepsilon_i, \; i = 1, \ldots, N,$

where R_i is a measure of the market rent, see section 8.2.2 for the different options. The subscript i indicates the individual property, N is the number of properties. ε_i represents the error term. This model is applied by for example Wheaton and Torto (1994), Webb and Fisher (1996), and Brounen and Jennen (2009a).

The vector x_i denotes the property characteristics with corresponding coefficient vector β. Examples of property characteristics for offices are: square meters of lease, total building square meters, number of floors, the floor the office is located on, parking facilities, restaurant facilities, building is part of a complex, construction year, building age, and air conditioning.

The vector c_i denotes the contract characteristics with corresponding coefficient vector γ. The contract characteristics include for example the lease term, variables related to rent changes (indexation option) and variables related to operating expenses (net versus gross rent).

The vector d_i is a dummy vector for the commencing date of the rent agreement, for example measured in quarters or years. The size of the vector is the number of periods. The vector has all 0 elements, except for the element corresponding to the commencing date of the rent agreement, being the constant in the regression ([107]). The corresponding coefficient vector μ provides the log rent indices.

The vector s_i is a dummy vector for the location, for example based on zip codes. The size of the vector is the number of locations. The vector has all 0 elements, except for the element corresponding to actual location of the property, being 1. The corresponding coefficient vector δ provides the log rent differences between locations. An alternative to the location dummies is to include locational explanatory variables, for example distance to the central business district, accessibility, household income, property tax rate, wage rate, and job availability. Bollinger et al. (1998) show that proximity of concentrations of support services and office workers is among the most important predictors of locational differences in office rents. This result has been confirmed by Jennen and Brounen (2009) who find that the rent level positively depends on office concentration.

Englund et al. (2004) emphasize that rental indices should not only be quality constant (i.e. control for changes in the mix of characteristics), but should also be maturity constant. Rent levels vary with contract length, assuming everything else to be equal. Moreover, the effect of the lease length on the rent level varies over time. Englund et al. compare rent indices with and without time-varying lease length coefficients. They show that indices can be substantially distorted if the lease term is not taken into account.

The interaction between the lease length and the time trend can be operationalized by defining L different lease length categories l. Each category is allowed to have its own time trend, represented by time dummy variables d^l with corresponding coefficient vector μ^l, indicating the log rent index for lease length category l. Including the interaction term between lease length and time trend leads to the following hedonic equation

$$(8.4)\ \ln R_i = \alpha + x_i'\,\beta + c_i'\,\gamma + \sum_{l=1}^{L} d_i^{l\prime}\,\mu^l + s_i'\,\delta + \varepsilon_i,\ i = 1,\ldots,N.$$

Apart from office and residential markets the hedonic model has rarely been used to construct real estate rent indices. One of the exceptions is the study of Hendershott (2013) for the retail market in the 11 largest US metropolitan areas, spanning the years 1982 through 2007.

Nase et al. (2012) conclude that hedonic studies on retail property are still embryonic when compared to offices and residential properties. According to Des Rosiers et al. (2005) this is most probably due to the confidentiality associated with retail transactions. It also holds that retail rents are even more difficult to define, because they may contain percentage rent, especially for in-line stores in shopping malls ([108]). Moreover, the studies that apply hedonic valuation models on retail rents, in general do not have a time series focus, but address the cross-sectional and spatial variation of retail rents. Sirmans and Guirdy (1993), Mejia and Benjamin (2002) and Des Rosiers et al. (2005) focus on spatial and non-spatial factors (like retail mix and retail image) in shopping centres. The studies of Hardin and Wolverton (2001) and Hardin et al. (2002) address retail neighbourhood centres. Gatzlaff et al. (1994) study the effect of an anchor tenant on non-anchor tenant rents.

([107]) Please note that one category has to be omitted to assure that the parameters are identified, being for example the first period for the time dummies and a reference location for the location dummies.

([108]) The dependent variable effectively becomes multi-dimensional: base rent plus percentage terms. The percentage terms include the basis (gross or net store revenues) and the exempt portion below which the percentage does not kick in, and the percentage share when it does kick in. The value of these percentage rent terms of course depends on the nature of the store and the shopping center. In other words, one practically would have to have a model of the value of the retail revenue just to obtain the values for the dependent variables in the hedonic rent model.

8.3. Vacancy rate

Vacancy is a physical indicator of the balance of supply and demand in the space market. It is similar to rent in that it indicates the current space market equilibrium. However, vacancy is a physical measure, and is often simpler to measure and easier to observe empirically than is the market rent.

Vacancy reduces the income for the investor, and so directly reduces the market value of the property. Even in case the property itself has no vacancy, rising general vacancy levels will reduce the market value, because of a higher risk that current tenants will not renew their contract at the end of the lease term. Apart from that incentives on rents tend be higher in times of relatively high vacancy rates, also leading to lower income for the investor. Finally, increasing vacancy will probably lead to lower future rent level such that the oversupply is mitigated by increasing demand.

Vacancy represents immediately vacant office floor space, currently not occupied, in all completed buildings. The vacancy rate is the vacant space divided by the total amount of space, both expressed in square meters, normally of net letting area. Space being built is not included in vacancy calculations. Sometimes the vacant space includes the space by sub-lettings.

Note that a building can be vacant but not offered for rent, while it can be offered for rent without being vacant.

Vacancy rates vary over submarkets and over time. The difference in vacancy rates can be substantial between primary and secondary markets, even within one city.

Note that the market needs some level of vacancy in order to work properly. Grenadier (1995) defines the 'natural vacancy rate as an equilibrium level of inventory of space, in the sense that both the matching process between landlord and tenant is facilitated, and that building owners hold an optimal buffer stock of inventory to meet future leasing contingencies'. The natural vacancy depends on expected demand, the degree of heterogeneity in both property characteristics and tenant needs, and the term structure of leases. Note that the natural vacancy rate is not observable, and can only be estimated from a model, see for example Hendershott et al. (1999), Englund et al. (2008), Brouwen and Jennen (2009b), Hendershott et al. (2010), and Diewert et al. (2014).

8.4. Additional space market indicators

The previous sections discussed rents and vacancy rates. This section gives some additional space market indicators, including:

• Construction starts and completions;
• Demolition and conversion to other uses;
• Gross and net absorption; and
• Building permits.

CONSTRUCTION STARTS AND COMPLETIONS

Construction starts represents future addition of new supply to the stock available in the market, normally measured by the total amount of floor space. Completions represent the total amount of floor space that has reached practical completion during the survey period. Note that in case of preleasing, new supply enters the market even prior to completion.

DEMOLITION AND CONVERSION TO OTHER USES

Supply can decrease due to demolishing properties or conversion to other uses, for example from office to non-commercial residential use.

GROSS AND NET ABSORPTION

Gross absorption measures the total amount of floor space for which leases were signed during the survey period, regardless where the tenants came from. Net absorption represents the change in floor space of the occupied stock within a market during the survey period. Net absorption can be both positive and negative.

Note that the following identity holds:

(8.5) Vacant space(t) = Vacant space(t-1) + net construction(t) – net absorption(t),

where net construction is construction completions minus the demolitions and conversions, measured by floor space.

BUILDING PERMITS

Prior to the construction of new or existing building, a building permit must be granted by a government or other regulatory body. The number of building permits (or the amount of floor space involved) issued in the survey period gives some indication of potential new supply to the stock.

8.5. Yields

Yields or cap rates are the current ratio between property net (gross) operating income ([109]) (the numerator, coming from the space market) and property asset value (the denominator coming from the asset market). Yields are widely used in commercial property asset markets as measures of asset price levels. They are a form of normalized prices in a market for heterogeneous goods. By normalizing on the current operating income, one controls, in an approximate manner, for the heterogeneity across the individual properties; the main component of operating income is rental income and differences in rental income between properties may reflect differences in the characteristics between properties. It remains an approximate, though widely used, measure.

Yields are also the way asset prices are quoted in the bond market. In essence the cap rate can be expressed as the sum of the risk free interest rate plus an asset risk premium minus the growth rate of the operating income, see Equation (8.10). Thus, tracking cap rates over time is like a way to track asset prices over time, except that it is really only the capital market component of the asset pricing. Asset prices of course can change apart from cap rate changes due to changes in the income generated from the space market (the numerator in the cap rate). But because the asset market plays such a large role in the temporal variation in asset prices, the tracking of cap rates becomes a very widely used way to track property asset market pricing across time. In effect, changes in the cap rate over time often largely reflect changes in the denominators, the asset values.

The gross initial yield (*GIY*) is defined as the potential gross income (*PGI*) divided by the asset value or transaction price (*AV*); the net initial yield (*NIY*) or capitalization rate (short: cap rate) is the net operating income (*NOI*) divided by the asset value or transaction price. The gross income multiplier (*GIM*) is the inverse of the *GIY*, and the net income multiplier the inverse of the *NIY*.

Realized capitalization rates can be used as a shortcut procedure to estimate the market value of a property by dividing its first year net operating income by the average realized capitalization rate of comparable properties.

The capitalization rate relates the space market (net operating income) and the capital market (asset value). We will look in more detail to important components driving the capitalization rate. The asset value at time *t* is the discounted sum of expected future cash flows, being the net operating income and the proceeds of sale at the end of the investment horizon *n*. The net asset value (net of transaction costs) can be expressed as

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([109]) Definitions of gross and net potential gross income are provided in Chapter 7, Section 2.3.

(8.6) $\left(1+tc\right)AV_t = \sum_{s=1}^{n} \dfrac{E_t\left[NOI_{t+s-1}\right]}{(1+E_t\left[d\right])^s} + \dfrac{E_t\left[AV_{t+n}\right]}{(1+E_t\left[d\right])^n}$,

where d denotes the discount rate and tc the transaction costs for purchasing the property (transfer tax, brokerage and notarial fees). The symbol $E_t[\ ]$ denotes the expectation of the term between the brackets at time t. The discount rate d reflects the risk characteristics that investors have to be compensated for. The discount rate can be seen as the sum of a risk-free interest rate and an expected risk premium that investors require on an ex ante basis for investing in the given asset.

If we make two additional assumptions, namely that the expected growth rate of *NOI* is *noi*, and that the average growth rate of the asset value over the investment horizon is equal to *p*,

(8.7) $E_t\left[NOI_{t+s}\right] = \left(1+noi\right)^s NOI_t$, $s = 1,\dots,n-1$

(8.8) $E_t\left[AV_{t+n}\right] = \left(1+p\right)^n AV_t$,

then we can express the capitalization rate as

(8.9) $\dfrac{NOI_t}{AV_t} = \dfrac{1+tc-\left(\left(1+p\right)/\left(1+d\right)\right)^n}{1-\left(\left(1+noi\right)/\left(1+d\right)\right)^n} \times \left(d-noi\right)$.

From this formula we can conclude:

- The main component is $d - noi$. If the average growth rate of the net operating income is equal to the average growth rate of the asset value, so $p = noi$, the first term is essentially 1 (apart from the impact of transaction costs), so the cap rate is equal to the discount rate minus the expected growth rate of net operating income:

(8.10) *Cap rate = d – noi = Riskfree rate + Asset Risk premium – noi.*

- The higher the discount rate, the higher the cap rate.
  - An increase in the risk-free interest rate increases the cap rate.
  - A higher assumed ex ante risk for the specific property increases the cap rate.
- The higher the expected growth rate of the net operating income, the lower the cap rate will be.
- The higher the expected average growth rate of the asset value, the lower the cap rate will be.

When investors have an optimistic view on the future, low discount rate, and/or high expected rent and/or asset value growth rates, the cap rate is low and vice versa.

Note that cap rates tend to be relatively insensitive to inflation. Recall that the cap rate is (approximately) the risk-free rate plus the asset risk premium minus the growth rate. Inflation tends to get reflected in both the risk-free rate and in the growth rate, and therefore to cancel out in the cap rate.

Average cap rates are normally presented per market segment (geography, use and quality). Changes in aggregate cap rates over time could reflect changes in the various components, both at the space and capital market: the risk-free interest rate, the assumed ex ante risk for the market segment, and changes in the expected growth rates of net operating income and asset values.

8.6. Number of Transactions

Transaction prices and rents do not provide the full picture of the market dynamics, see Chapter 5, Section 5.2.2. Therefore it is recommended not only to provide price and rent indices, but also the number of sales and rents per period, and their average value.

8.7. Concluding remarks

This chapter discussed a number of important additional indicators for commercial property markets; market rents, vacancy, yields, construction starts and completions, demolition and conversion to other uses, gross and net absorption, building permits, and number of sale and rental transactions.

Rent and vacancy are indicators for the space market. Market rent indices may be difficult to measure for various reasons. Firstly, rent contracts are not publicly recorded, and hard to collect. Secondly, in order to produce a reliable rental index, one needs not only to have individual market rents, but also contract lengths, rent free periods, and the value of covenants and options. Thirdly, rental indices should not only be quality constant (i.e. control for characteristics), but should also be maturity (i.e. control for contract lease length) constant; rent levels vary with contract length, assuming everything else to be equal.

The second space market indicator is vacancy, which is a physical measure of supply and demand in the space market, and is often simpler to measure and easier to observe empirically than is the market rent.

Yields are widely used in commercial property asset markets as, effectively, measures of asset price levels. They are a sort of normalized way of quoting prices in a market for heterogeneous goods. By normalizing on the current income (space market) one controls, in some way, for the heterogeneity across the individual assets.

Transaction volume is an important measure for the asset market: the price of real estate is not a sufficient statistic for the state of the market. Relative changes in transaction volume over the market cycle tend to be at least as high as relative changes in prices. Moreover, transaction volume per period can be used to construct constant liquidity price indices.

8.8. References

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9 Data sources

9.1. Overview

Access to relevant data is critical to the compilation of Commercial Property Price Indicators. In practice, compilers of commercial property price indices (CPPIs) and other indicators exploit two sources of data:

- *Documentation relating to the registering of transactions when the ownership of the commercial property changes*. In theory registrations should give the verifiable transaction or market price. The indices so derived are referred to as transaction-based indices; and
- *Appraisals that give an assessment of value*. These appraisal values may be derivatives from an administrative system, e.g. valuations carried out by the revenue authorities for taxation purposes or by companies for their annual accounts, or may be carried out specifically by professional valuers for the purpose of constructing a CPPI or other Commercial Property Price Indicators. The indices, so derived, are referred to as appraisal-based indices. Appraisal-based indices are compiled for a range of purposes and this influences the coverage and basis of the appraisal valuations that are used — see Section 9.3.

Both data sources are exploited in *hybrid approaches* to index production such as the SPAR method (described in Section 6.3) and the approach being pursued by the ECB (covered in Section 10.2.1).

Appraisals are at times used in the absence of good quality information on transaction prices, although there are certain disadvantages. Although the target or ideal index is one that is based on transaction prices, the latter may often not be readily available, due to the low number of transactions occurring in smaller markets, and can be expensive to collect. As mentioned above, sometimes indices are compiled using a combination of transactions and appraisals ([110]).

However, transactions data may be used when good quality appraisals are lacking; and it can be more expensive to hire appraisers to regularly and frequently value properties than to collect transaction price data. Certainly in places where the commercial property asset market is pretty active and where accounting standards require firms to carry assets on their books at historical cost (rather than at current market value), appraisals will tend to be scarcer than (and more expensive than) transaction price data. This is true for most of the commercial property market in the United States. It is also the case that appraisers tend to rely heavily on transaction price data themselves to arrive at their valuations, unless such transaction data is not available or they are not being assigned to estimate 'market value'.

At the other end of the spectrum, for stock market-based indicators of commercial property, such market valuations are the appropriate measure to value portfolios. Thus, in a growing number of countries specialized firms, or funds, often referred to as '*real estate investment trusts*' (REITs), are listed on public stock exchanges. If a sufficient number of such firms owning a sufficient number and value of

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([110]) For a number of countries IPD have developed experimental hybrid indices, which combine transaction information with valuation data to enable valuation-based indices to better reflect current transaction price movements in commercial property markets. The experimental IPD 'Transactions Linked Indices' (TLI) employ hedonic-style regressions in a methodology first developed at MIT for the NCREIF Index (referred to as 'Transaction Based Index' – TBI). The IPD development work is being undertaken in conjunction with the University of Reading. Further information is available from the website IPD.com. The procedure is also essentially very similar to the 'SPAR' method described in Chapter 6.3, only the SPAR approach uses simple ratios rather than regression modelling.

commercial properties are traded then it may be possible to develop what may be referred to as stock market based property return indices (SMPRIs). These are not transaction-based price indices of real assets.

The data for other indicators of analytical interest in monitoring the commercial property market, such as measures of rent and yields come from a variety of different sources, usually from private sector organisations. The alternative types of indices are outlined below.

9.2. Commercial property price indices: transactions

Transactions based indices are in principle the preferred type of CPPI.

CPPIs based on the actual transaction prices of a constant-quality basket of representative properties, or which use statistical methods to estimate such constant-quality price movements, have the advantage of not only following national accounts concepts ([111]) but also of being more objective than valuation based indices. ([112]).

All property transactions are or should be recorded in administrative sources, such as land registries: transactions are also often subject to transfer and property taxes and prices are captured both to record the ownership change and to levy the tax. Thus, administrative sources are the main source of information on transaction prices and also on sales volumes. But the amount of metadata recorded against each sale can vary from one data source to another as well by country.

In terms of the data collection necessary for compiling transactions based indices, a number of practical difficulties can arise:

- *A lack of transparency*. Compared with residential properties, the buying and selling of commercial property is not always very transparent. This lack of transparency can originate either from complexities in the contracts of sale — transfers of commercial property can be very intricate — or from the evasion of duties imposed by the revenue authorities on sales of property. In addition, factors such as the existence of tenancy agreements, and planning consent for redevelopment etc., can impact on expected future returns and can affect the transaction price, but these factors may not always be recorded along with the price in official registries etc.;
- *A lack of timely data from a transparent source that can be independently verified*. Official data on transaction prices can be difficult to obtain and the sale of a commercial property may not be registered until some months after the transaction has taken place. The recorded price cannot be verified independently as to whether it was the actual transaction price (see previous bullet point);
- *Small numbers of transactions*. The buying and selling of commercial property can be relatively infrequent which limits the use of this data source in compiling frequent indices (quarterly, monthly etc.), particularly in smaller commercial property markets ;
- *Heterogeneity*. Commercial properties are more heterogeneous than residential dwellings, requiring mechanisms to ensure a property price index tracks the prices of like-for-like properties over time. Yet the low numbers of transactions and limited information on the properties being transacted often makes it difficult to use traditional quality adjustment methods to account for the change in the mix of properties sold; and
- *Reliability*. The systems for registering a transaction of a commercial property and its price are not well developed in many countries with the reliability of the price observations registered open to question, given their association with taxation purposes. *The above d*ifficulties mean that in reality there may be a lack of sufficient and reliable observable prices in consecutive periods to facilitate the computation of a price index that is not confounded by lack of data or changes in the different mixes of commercial properties and property characteristics entering the index at each computation.

([111]) See SNA 2008, Chapter 2, C3.

([112]) Of course, transaction-based indices also can exhibit problems, such as statistical noise, and even lagging or temporal aggregation, depending on the nature of the available transaction data and the index construction methodology (See discussion in Chapter 5).

Methodologies for dealing with such inadequacies exist and are referred to in earlier chapters, but the extent of the missing data problem, both in respect of the numbers and timeliness of transactions and in terms of detailed information on the properties that have been transacted, can confound the situation beyond the capabilities of the available statistical techniques. In addition, access to comprehensive information on transactions is not always forthcoming, leading to limited availability. It is for these reasons that it is important for countries to make efforts to improve the quantity and quality of commercial property transaction data collection and compilation. In current practice, in some cases the best fall-back is the use of appraisal-based indices or hybrid approaches even though in principle a direct transaction based index is preferred for constructing official statistics.

Despite the practical difficulties referred to above, it is possible in many cases to apply methods that address and overcome the data difficulties. For example, reasonably useful and reliable quarterly transaction based (repeat sales) indices have been computed with as little as 400-500 repeat sales observations per decade (as long as the transactions don't completely dry up during downturns in the market).

Even if transaction-based databases are relatively scarce at present, it would seem plausible that in the future they could be developed if national authorities take the initiative to instigate or help support such database development. In principle, they could often be cheaper to develop than appraisal-based databases, because it should be cheaper to extract a transaction price from a readily available database, e.g. from an official register of transactions, than to hire an appraiser to do an appraisal of a commercial property. Furthermore, appraisers ultimately have to rely on transaction price evidence to come up with estimates of 'market value'. But the potential to use transactions is dependent on the availability of registers giving transaction prices.

9.3. Commercial property price indices: valuations

Appraisal-based indices overcome some of the data source difficulties associated with transaction-based indices and it is for this reason that valuations sometimes pre-dominate as a source of data for computing CPPIs, despite the drawbacks outlined in a previous chapter. .

Valuations can be obtained either from existing administrative systems, e.g. where valuations are undertaken by tax authorities as a basis for levying taxes or by corporations for filing company accounts, or from special data gathering exercises which are carried out for the specific purpose of computing an index. Generally, valuations undertaken for other purposes, such as providing collateral against a bank loan, or for internal accounting between different parts of a business, are not used. Such valuations can be infrequent and are often unregulated. The frequency of valuations will depend not only on the purpose behind the valuation but also on the economic circumstances and the particular situation in individual countries e.g. the frequency of valuations relating to the re-financing of loans. The main sources of information on commercial property values are discussed below in terms of their potential usefulness (and drawbacks) for CPPI compilation.

- *Administrative systems.* Valuations which originate from administrative systems avoid the collection costs associated with customised data collection. However, the user will have limited influence over the composition of the data in terms of the definitions followed and the collection of supplementary information (metadata) required for the computation of an index but not needed for the collection of taxes. For instance, the compiler of a hedonic commercial property price index will require a lot of detail on the price-determining characteristics of a commercial property to adjust the valuation for variations in these characteristics to facilitate the computation of a 'constant quality' or 'constant mix' price index. Such information may not be needed by the tax authorities and therefore may not be part of an administrative system. Valuations generated by administrative systems can also be infrequent and can be subject to significant time-lags. They may reflect inconsistent and/or politically influenced criteria. The data may be difficult to access. Nevertheless, if valuations are undertaken regularly, they should, in theory, represent an expert and objective judgement on how much a property would sell for and, therefore, have the potential to be a useful data source that can

be exploited at minimal cost. Administrative data may offer great promise, not only for valuations (assessments) but also for transaction price data. But this promise may require some effort and motivation to develop. Valuations conducted by private sector organisations are addressed below.

- *Systematic valuations* undertaken specifically for input into a price index used to benchmark changes in commercial property values and for constructing appraisal-based indices as substitutes for transaction-based indices. These will be costly to collect but will have the advantage of being custom-designed for the specific purpose of producing a database of prices for the computation of an index. Customised data collection should be able to avoid many of the pitfalls associated with the use of administrative data. Definitions, survey design and quality assurance of the data are more under the control of the collection agent, appointed by the compiler. But that said there is a marked lack of a standard set of international and sometimes national guidelines relating to the carrying out of valuations. While surveyors or valuers — for valuations undertaken for a specific purpose such as the submission of a tax return — may operate within guidelines laid down by their professional body or by the national Government, these guidelines can vary between countries and also may not be universally applicable within a country. In addition, all valuations, to a greater or lesser degree, rely on judgement. Thus, there can be conspicuous differences between one set of valuations and another. This can be the case, for instance, with valuations conducted by different commercial data suppliers. In addition, there is the question of defining and selecting the commercial units to be valued.

- *Valuations collected by commercial data suppliers for portfolio management*. Most appraisal-based indices are by-products of the investment information reporting process of investment management firms and funds. In many economies commercial property represents a substantial component of private and commercial investments. Property portfolio managers require data on how their portfolios are performing both individually and against the sector as a whole. Changes in the values of commercial property are also an economic indicator in their own right and the change in the value of property portfolios are closely followed by economists and market watchers etc. To meet these data requirements, private sector organisations collect detailed data on commercial properties (prices, property characteristics, property condition etc.) from all available sources to produce various indices relating to commercial property, including valuations, investment return, and rent prices. Valuations, which are at the heart of these indices, are often frequent and cover the major markets (but in varying depth). As such, these private sector organisations have the potential to provide a rich data source for index compilers although these are not constant-quality appraisals — rather they compare the estimated value of an asset between two points in time, not taking into account the aging effect i.e. the valuations will include the effect of depreciation.

- As data, including property characteristics, are collected at the level of individual properties, index compilers have the potential to control for the mix of properties within each market. Data are also generally available for different property sectors such as the retail, office, industrial and commercial residential sectors etc. However, as private companies or associations collect the data, access to the data may not be free of charge. Additionally, data are collected to meet the specific requirements of professional portfolio managers and may therefore not fully align with the statistical requirements normally used by NSIs when assessing potential data sources. In particular, the coverage of commercial data sources may be limited to professionally managed property portfolios only, thus in general smaller landlords or owner-occupied commercial properties will not be covered ([113]). Unlike most official statistics, such providers may not have or use representative samples, random samples or otherwise, as the total universe of properties or transactions is not their primary concern. More so than compilers of transaction-based indices, compilers of valuation-based indices for portfolio management generally focus on those properties which fall within the professionally managed property sector. As the main aim of investors is to measure their 'total investment return' the valuation concepts used by these data providers can also vary from, for instance, concepts used in residential property price indices. In particular, surveyors estimate the potential future return from an asset as well as the corresponding value of the property itself.

Valuation rules and guidelines can vary considerably from one country to another as well as between individual surveyors within a country. Guidelines for surveyors can come from trade organisations such

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([113]) There are organizations relating to owner-occupied property, such as the National Association of Corporate Real Estate – NACORE, the Building Owners & Managers Association – BOMA, the Institute of Real Estate Management – IREM, and the International Council of Shopping Centres (ICSC, just for retail property). These organizations do collect a lot of operating data for owner-occupied properties, such as expenses per square foot and so forth. But they don't collect or produce valuation data. Of course, owner-occupied properties that are rarely if ever transacted and that aren't part of the investments markets are unlikely to be covered by any type of data-collecting private organization, at least in terms of the asset valuation.

as the Royal Institution of Charted Surveyors (RICS) in the United Kingdom, or they can be defined by law, as in Germany. In other countries professional guidance is more elusive. Therefore, comparing indices internationally or aggregating indices compiled from these data sources across country markets should be approached with some caution. In some cases appraisers are appointed by the property owners or managers that are members of the index-producing association or firm. This can be an issue, as the valuations that go into the index are essentially 'self-reported' by the owners and managers of the properties. In some cases, such as in the United States, the valuations reported into the index are not always actual professional appraisals made by independent professional appraisers, but rather are internal valuations done by the fund itself.

- *Valuations for the financing or re-financing of commercial property.* It is very difficult for any rules to be sufficient to entirely overcome the huge pressure on appraisers to bias their appraisals toward valuations that support the lending transactions. Only if the appraisers are hired by and paid by an independent agency not linked to either the borrower or the lender can one have a system that would have a chance of being reasonably free of such pressure. This adds to the range of uncertainty around some valuations, depending on the purpose and motivation.

Clayton et al. (2001) identified some issues relating to the quality of valuations, regardless of data sources and the extent to which they are reliable. There is evidence to suggest that valuations can suffer from significant estimation error ([114]). There has also been much discussion over whether such valuations are over-influenced by past prices. The latter, because it is systematic across valuations generally, can result in a smoothed index, that doesn't fully reflect the real situation and in particular the price volatility that can take place at turning points. The inference is that appraisal-based indices are not so good at identifying turning points — a drawback that has a bearing on most index applications. For instance, when using the index as an analytical input into monetary policy and inflation targeting. Most users of CPPIs for economic modelling and management of the economy have a particular interest in the early detection of turning points. The preferred data source for compiling a CPPI can be contingent on the use of the index. User need in terms of the statistical, analytical and behavioural characteristics of the index is an important determining factor.

In many instances valuations are undertaken not in the first instance 'specifically for input into a price index' but rather to fulfil the requirements for reporting investment returns to investors, based on accounting standards and often on statutory requirements especially relating to pension funds. For example, in the United States the Employee Retirement Income Security Act of 1973 (ERISA) requires pension fund real estate investments to be appraised at least once every three years. Investment reporting 'information standards' promulgated by industry associations such as the CFA Institute also require appraisals generally at least annually for each property. It is for these requirements that fund managers pay for regular appraisals of all their properties. The potential for compiling appraisal-based indices as by-products of investment reporting depends on the statutory and industry information standards requirements.

9.4. The treatment of outliers

Quality assurance of the raw data, particularly with regard to price, is important so that indices are not adversely influenced by miss-recording of transaction prices or incorrect valuations. In large part effective editing depends on the successful identification of outliers.

For indices exploiting register-based information on transactions and for indices based on valuations much of the outlier detection focuses not only at looking at extreme values but also on uncovering logical errors, e.g. where there is a transcription of the sale or valuation date, or sales that are not in scope e.g. multiple sales of a portfolio of properties which cannot be un-bungled. For example, for a

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([114]) Academic studies in the United States and United Kingdom indicate that the standard deviation (or 'standard error') of an individual valuation of an individual commercial property as of a given point in time is typically on the order of 10% of the property value, even in exceptionally favourable circumstances it probably exceeds 5% and may often exceed 10%. If one wants to think of a '95% confidence range' around such individual valuation it would be around twice that standard error, or on the order of +/- 20% of the property value. However, individual random error is reduced and filtered at the aggregate level or in statistical index estimation procedures.

SPAR index, detecting ratios of appraisal to transaction prices outside a given range may also be used to initiate a review of the data.

9.5. Commercial property price indices: weights

A CPPI comprises a set of prices or valuations and a set of transactions or stocks, which are then combined to produce an index. Most indices that are currently available are transaction-weighted rather than stock-weighted.

The point has already been made in earlier chapters that the conceptual basis of a CPPI, and in consequence the method of its construction, should be apposite to the purpose of the index and the use to which it is to be put. For instance, the price dynamics of the commercial property market for monitoring commercial property inflation as experienced by purchasers may best be measured by collecting transaction prices and weight these according to the value of those transactions. On the other hand, valuing the commercial property stock for wealth measurement and for measuring indebtedness in the context of a financial stability or soundness indicator to measure risk exposure, requires the sample of transacted property to be supplemented by price information on non-transacted property or for the former to be representative of the characteristics of the commercial property stock as a whole.

A number of possible sources of data may be drawn upon for determining the stock of commercial property, depending on local circumstances. For example, data on the stock of commercial property may be obtained by interrogating land registry information or a census of commercial property. It should be noted that particular care should be taken if the aim of the index compiler is to create a stock-weighted index, which is based on valuations undertaken by private sector organisations that serve the professional investment market. As observed above, the coverage of commercial properties by such valuations is generally restricted to those that are professionally managed and the latter are not necessarily representative of the total stock of commercial property.

9.6. Stock-market based property return indices: stock market based data

As described in Chapter 7.3, stock market based property return indices (SMPRIs) track the valuations of commercial property assets held by specialized publicly listed firms and funds often referred to as 'real estate investment trusts' (REITs — and we will use this acronym as a label for all such firms and funds whether technically named as such or not). REITs are characterized by being essentially 'pure plays' in that they are highly specialized, doing almost nothing but investment in commercial (income producing) properties. They also often are relatively passive, with a limited role for active property construction or trading, but rather acting primarily as vehicles for holding and managing income-producing property assets, typically with varying degrees of financial leverage. SMPRIs can in principle be meaningful where a sufficient number of REITs own a sufficient number of properties that can be regarded as reasonably representative of an important part of the commercial property population and subject to the portfolios not changing significantly over time. SMPRIs endeavour to largely remove the effect of financial leverage, and to target specific indices onto specified commercial property segments or sectors. The property asset valuations measured and tracked by SMPRIs reflect stock market valuations, not the direct value indications of the private property market provided by transaction price evidence from the private property market. The advantages and disadvantages of SMPRIs are noted in section 7.3.4. Here we briefly describe the typical types of data sources that can be used to construct and produce SMPRIs.

The basic source of data will come from the public stock exchanges on which REIT equity shares trade. A hallmark of stock exchanges is the quantity and quality of public information they provide. Stock exchanges typically not only publicly report share price information on a high frequency and very up-to-date basis, but they also require listed firms to provide high quality and standardized regular and frequent financial and operating statements and reports. Such primary source data from the exchanges and the firms are often gathered and compiled and analysed by private information vending firms. Sometimes such firms, and/or industry associations of REITs, also obtain and provide additional information about the firms.

SMPRIs require information on REIT share prices, dividends, financial structure (debt/equity ratios), and the characteristics of each REIT's property asset holdings such that estimates can be made of the percentage of each REIT's total assets in each category or type and location of property that is of interest. For example, if the SMPRIs are to target region X sector segments then information is required on the relative magnitude or value of each REIT's property holdings by region and sector. Typically the share price and dividend information can be obtained directly from the stock exchanges or from secondary sources that compile stock market returns data. The required data on financial structure can usually be obtained most readily for index production purposes from secondary sources such as private information trading companies and REIT industry associations.

9.7. Other indicators relating to the commercial property sector

In general, national accountants employ depreciation schedules for all types of assets in the economy, including for commercial buildings.

There are two major types of data useful for developing better depreciation schedules. Asset transaction price (or appraised valuation) data can be useful to estimate depreciation if there is sufficient hedonic data about the properties, including most importantly, the age of the structure. In addition, data on the age of building structures at the time when they are demolished can be used to estimate survival curves and life expectancy for structures. Sources of transaction price and property characteristics data (including building age) may include public administrative sources such as discussed in Section 9.2, as well as private sources such as real estate investment firms and funds, or information vending firms that compile such data. These same sources may also supply data on the age of structures to be demolished, though data of this nature may also come from other administrative sources such as building permitting and inspection agencies. Information vendors serving the construction industry may also be a source of such data.

Apart from depreciation data, listed in Chapters 3 and described in Chapter 7, were a number of other indicators relating to the commercial property sector, in addition to commercial property price indices. The examples given below represent a disparate range of statistics used to analyse the complex functioning of the commercial property sector and its relationship to the rest of the economy. Data on *property investment transaction volumes* are important for gauging the health and status of the property investment industry, and can be an indicator of asset bubbles. Data on *rents* and *occupancies* and *leasing* are similarly important. Data on *debt in the commercial property market* are generally collected by financial regulatory agencies and central banks, and are vital indicators of the health and status of the investment industry.

The data sources for all these varied types of data are similarly varied, but mainly involve special data collections by the compilers rather than the use of readily available data. Examples include IPD's Net Debt and Gross Debt, expressed as percentages of net asset value (NAV) and the figures on Gross Yields. In the United States, investment capital flows are gathered and reported along with other ancillary information by information vending firms. Derived statistics, such as the Capital value-to-GDP ratio, similarly are drawn from a number of official and unofficial sources.

9.8. References

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10 Commercial Property Price Indicators currently available

10.1. Overview

Transaction-based indices and appraisal-based indices are published by a number of public and private sector suppliers of Commercial Property Price Indices (CPPIs) but the supply and use of such indices is generally not so well developed compared with residential property price indices — particularly for transaction-based indices which form the basis of indices needed for most official purposes. Neither has there been any significant move to the adoption of an internationally recognised harmonised methodology. This was recognised in the IMF Data Gaps Initiative, which provided the impetus for the current document. In reality, there are relatively few 'official' CPPIs produced by National Statistical Institutes (NSIs) and private sector providers are dominated by a small number of suppliers mainly producing appraisal-based indices. There has been limited exploitation of administrative data sources. In practice, the methods used for constructing CPPIs can be constrained by the limitations of the available data. The data required to construct the target index, once defined, are not always available on a regular and timely basis, if at all. Moreover, even where suitable data are available to construct a price index to meet the needs of one set of users, the data may not fit the requirements of another set of users [115].

This chapter describes the range of available indices. Some case studies are also presented.

The case studies illustrate how the inherent problems associated with the construction of a commercial property price index are confronted by compilers — the lack of transparency; the heterogeneity associated with commercial properties; and the relatively small number of transactions that take place.

The existing CPPIs give a hint of how much is possible in terms of overcoming the inherent challenges associated with developing and compiling indices for what is an important segment of the economy and of the financial system. The existing indices also illustrate the range and variety of different types of CPPI methodologies available to the compiler and the scope for innovation in the implementation and administration of CPPIs to produce fit-for-purpose indices.

The indices described below, such as Statistics Denmark's CPPI and the ECB/IPD European index project, provide important indicative examples of the practical potential to compute CPPIs. The Statistics Denmark CPPI is a useful example of the use of administrative appraisal (or assessments) data and the

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[115] Exploiting available data sources on transactions can have a high upfront cost and can be costly to maintain due to the inherent problems with exploiting administrative data for statistical purposes. Conducting custom-designed appraisal surveys to obtain valuations of a representative sample of commercial properties can also be prohibitively expensive and the valuations, themselves, require specialised expertise. Moreover, even when there is access to suitable data, the methodologies used to compile Commercial Property Price Indices can also be beset with inherent problems: most particularly, that transactions of individual commercial properties are infrequent and commercial properties have unique characteristics, resulting in heterogeneity in different dimensions, many of which are difficult to measure objectively or go unrecorded. In addition, the commercial property market can lack transparency leading to an absence of all the necessary information for index construction and to ambiguities in terms of the contracts of sale. The latter is particularly problematic when compiling transaction-based indices. These problems can be compounded by the lack of a conceptual and methodological framework that reflects the distinctive needs of different users for indices that fulfil different objectives. The timeliness and frequency of data can also be an issue but less so compared with a residential property price index, where unlike a commercial property price index, there is a greater requirement by users for indices to be produced on a monthly basis with a minimum time-lag.

SPAR method. The ECB methodology is indicative of the potential to exploit and integrate currently available data sources to produce an amalgam of CPPIs that serve the main user need for comparable and relevant indices in the context of official statistics. The ECB work is very much work in progress at this time.

10.1.1. Harmonisation, methodologies, definitions and coverage

There is also a distinct lack of harmonisation in both the definitions and methodologies followed in the computation of the available indices and in the valuations of commercial properties, which often underlie them. This limits the opportunity for making meaningful international comparisons of trends in commercial property prices and confounds comparative economic analysis, leading to an undermining of the value of the available indices to some users. In addition, coverage and the coding of different types of commercial property vary between index compilers and there have been limited attempts to achieve statistical integration by using common coding between CPPIs and, say, construction statistics. For example, Eurostat's Classification of Types of Construction (CC) ([116]) is designed to serve different purposes such as statistics on construction activities, building and housing censuses and construction price statistics. The classification principles of CC are based mainly on the technical design resulting from the special use of a structure (e.g. commercial buildings, road structures, waterworks, pipelines) and, particularly for buildings, on its main use including a distinction between *residential* and *non-residential*. It defines the latter as 'constructions which are mainly used or intended for non-residential purposes. If at least half of the overall useful floor area is used for residential purposes, the building is classified as a residential building'. This may be a useful distinction for, say, construction starts, but is unlikely to meet the needs of users of CCPIs who will require a more detailed and different cataloguing of commercial buildings. However, such a cataloguing, in turn, will not facilitate a comparative detailed analysis of different indicators of activity needed for the monitoring of the commercial property market: such an analysis of activity in the commercial property sector will be complicated by a statistical fog resulting from the use of different classifications. Similarly, other classifications are also of limited value. For instance, the classification of products (CPA) only distinguishes the non-residential buildings in industrial buildings, commercial buildings, and other non-residential buildings. The issue of classifications is further compounded by the fact that commercial properties are relatively heterogeneous ([117]).

10.1.2. Compiling a database of commercial property prices: incomplete data, outliers, data and index quality

Data quality needs to be considered in the context of the intended use of the data. It can be observed that the CPPIs currently published are usually compiled with one purpose in mind, depending on the provider and particularly whether a transaction-based or appraisal-based index is being computed. There are a number of issues confronted by the index compiler some of which are illustrated in the case studies.

Incomplete data (missing variables) Robert Hill (2013) proposes a solution—See also Bokhari and Geltner (2012) and Silver (2016)—for dealing with significant/systematic occurrences of incomplete records (in respect of sales of residential property):

- "One particular data problem often encountered is missing observations for some characteristics. For example, the bedroom count may be missing for a certain percentage of the dwellings in the data set. This problem can be dealt with by deleting from the model any characteristics that are particularly prone to having missing observations, or alternatively by omitting all dwellings that have an incomplete list of characteristics. Neither of these solutions is particularly appealing. Both throw away potentially useful data. An alternative solution is to simply set all missing observations to zero or

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([116]) See http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:Classification_of_types_of_construction_(CC)
([117]) See CPA group 5312

some other default value. This, however, may also create distortions and perhaps bias. In my opinion, the problem of missing observations should be dealt with in one of two ways. The first approach can only be used in combination with the imputation method. This approach requires a number of hedonic models to be estimated for each period each with varying combinations of explanatory variables. The imputed price for each dwelling is then calculated from the hedonic model that includes exactly the same list of characteristics that are available for that particular dwelling. In this way, all the available and relevant information is used when imputing the price of each dwelling".

- *Quality checks on complete data (where prices and characteristics are available)*. Given the heterogeneous nature of commercial properties it may not be possible, or it may be inadvisable to apply arbitrarily specified edits on price and characteristics. O'Hanlon (2011) describes how the Irish Central Statistics Office identifies outliers using Cook's Distance. The hedonic regression is run twice. The first run identifies outliers (based on sizes of residual and leverage of each record). Observations which have a Cook's distance above a specified threshold are excluded from a second run of the hedonic regression — from which the index is generated. Ideally, the compiler should continuously review the impact of removing outliers (for example this could be done simply by comparing indices generated from a dataset with outliers excluded and included), to ensure that the removal of outliers does not introduce a systematic bias into the index.

- *Initial volume/value checks on transaction data e.g. for* outliers. Period-on-period total volume and value checks may be performed for each period for which data is received to ensure no systematic errors are present (e.g. large number of missing transactions, duplication of transactions from a previous period, missing data. However, it is possible, particularly in smaller markets, that small numbers of high value transactions can introduce considerable volatility into value totals. Additionally, there may be seasonal trends in volumes and values if businesses are more likely to invest in, or dispose of, property assets at certain times in the year — for example in response to the tax rules. Individual transaction values which fall outside specified thresholds can be manually assessed against asking/guide prices contained in real estate agent listings. If the compiler does not have access to a historic database of listings it may be possible to search online for property listings as they often remain on accessible on real estate websites for several months after their sale. However, this manual plausibility-type checking of prices can be resource intensive, introduces a subjective element unless there are clear guidelines, and thresholds should be set accordingly.

- *Timeliness/Lagging data*. The timeliness of the recording (and reporting) of property transactions may vary. For example, whilst returns for the assessment of stamp duty (a taxation on the transfer of property) must be filed within a pre-specified period of the execution of transfer in many countries this may relate to some months after the transaction and, additionally, there can be a significant number of late reports. Where there are lags in the registration /recording of property transactions it may be necessary to publish first results as provisional and then finalise after a specified lag (for example +3 months). In such cases it is recommended that the compiler monitors (and publishes detail on) the size of revisions between provisional and final results

10.2. Availability of official indices

Key uses of CPPIs in the context of the requirements of Governments and international institutions include macroprudential management and financial stability analysis. CPPIs form part of the official statistical system where governments and international institutions work in partnership to produce relevant, reliable and comparable statistics.

At a European level, the European Central Bank (ECB) ([118]) has started releasing experimental quarterly Indicators of Commercial Property Prices (ICCP) for the European Union (EU), the Euro area and for some individual EU member countries ([119]) in fulfilment of its mandate to fill gaps in the official statistics needed by the European System of Central Banks (ESCB).

([118]) ECB progress towards a European Commercial Property Index. Andrew Kanutin, European Central Bank, Ottawa Group, Copenhagen, May 2013.

([119]) Austria, Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, Poland, Portugal, Spain, Sweden and the United Kingdom.

An earlier stock-taking exercise of EU member countries, undertaken by the ECB in 2010, identified the availability of stock and price information on commercial property [120] in 25 countries: with monthly data being available for seven countries; quarterly data being available for fourteen countries; bi-annual data in one country; and annual data in the remaining three. But only in four countries did the national statistical institute or national bank compile statistics on commercial properties [121]. In most cases the main providers of data were the large real estate companies or commercial advisory services, specialising in research and consultancy services for investors in the commercial property market. Some, such as the Investment Property Data Bank (IPD), also compile commercial property price indices.

The situation is similar outside of Europe. The main players in the production of commercial property price indices are in the private sector — few national statistical institutes or central banks collect data on commercial properties and even fewer compute indices.

10.2.1. The ECB's experimental quarterly Indicators of Commercial Property Prices

The ECB's experimental Indicators of Commercial Property Prices (ICPP) are designed not only to broadly meet the needs of most potential main-stream users of such indices but also to provide some elements of the building blocks necessary to permit the computation of limited variants of the index that can then be used for more specific analytical purposes. The basic requirement was articulated at the preliminary stage. The requirements were for a quarterly constant-quality Euro area indicator of commercial property prices, covering all types of commercial property, country-wide. It was also stated that ideally the index should be based on transaction prices and be disaggregated into four categories: office buildings; retail; industrial; residential 'owned or developed for commercial purposes, for example by a professional property company or a private-sector institutional investor'. The ability to generate a geographical breakdown was also considered advantageous.

The ECB saw the compilation of interim indices as a short-term measure that did not change the long-term aim of regular publication of comparable national CPPIs by individual euro area countries and of European aggregates derived from countries data. The ECB intends to continue developing the experimental CPPIs to enhance them and address their limitations and subsequent developments e.g. in data sources developed by national statistical institutes.

Conceptually, the target index is transaction-based similarly to the majority of residential property price indices (RPPIs). Coherence and statistical integration between different data sets is given importance by the ECB in order to facilitate analysis.

In practice most of the available indices are appraisal-based indices compiled predominantly by private-sector organisations as measures of the performance of investments in commercial property. A number of potential issues are identified here:

- *Sample selection bias* arising from the use of a non-representative sample of the commercial properties;
- *Late detection of turning points due to systematic 'smoothing' of the index*, resulting from the tendency of appraisers to attach importance on historical comparable or past transaction prices when forming an opinion on the current value of a property. There tends to be an inherent trade-off between valuation accuracy, on the one hand, versus temporal lag bias on the other hand. The appraiser's job is typically to minimize the valuation error for individual property appraisals. The main way to improve valuation precision is to look at comparable sales transactions. But the only way to look at more comparable sales transactions is to reach back farther in time to find the comparable sales. In a rapidly moving market the resulting estimate of the current value can be too influenced by the previous valuation;
- *Dynamic samples*. The make-up of the portfolios of property being valued can sometimes change over time due to divestments and the acquisition of new property;
- *Relatively short time-series*. Many of the available indices do not go very far back in time; and
- Harmonisation in definitions and practices when it comes down to making valuations.

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[120] Not all countries necessarily have commercial property price indices as such, but have data that could be used to compile them.

[121] Commercial Banks provided information in four countries; notaries in two; universities, research institutes, and associated government agencies in four.

The issue of dynamic samples was addressed in the compilation methodology for producing ICPP for the European Union and the Euro-area.

The ECB took a pragmatic approach and determined that the interim indices should be based on appraisal prices obtained from IPD ([122]), supplemented by better national data where the latter existed ([123]), rather than attempting already at the beginning of the Bank's statistical work to compute an ideal index that was without methodological flaws.

Two separate data sets have been used: prices data based solely on professional valuations; or if available, prices data obtained by combining valuations with information on actual transactions. IPD obtains information from a wide-range of sources related to professional investors in real estate.

Valuations are based on open market valuations of real buildings under management in portfolios, at the time of reporting, and are defined in the United Kingdom as 'the price that would be agreed between a willing buyer and a willing seller within a reasonable negotiating period net of purchaser's costs e.g. legal fees and taxes' i.e. excluding such costs ([124]). Thus, a change in stamp-duty, for instance, will not be reflected in the index. This is identical to the approach for RPPIs where the transaction costs (as opposed to the transaction price) are also not included. It should also be noted that valuations aim to take account not only of the cost of the asset but also of the value of potential future returns ([125]). However, it can also be noted that the valuation guidelines used in each property market are country specific and may not be strictly comparable. The calculation of valuations starts from asset prices, which are aggregated to sector (retail, industrial etc.) and national aggregates. Coverage is kept constant over five consecutive quarters to counteract the effect of the divestment of portfolios or new portfolios joining the sample so that year-on-year movements in the index reflect changes in prices rather than a change in the mix of properties covered. But there is no mix-adjustment to ensure the valuations or transactions reflect the overall structure of the commercial property market and no quality-adjustment to allow for changes in the standards of, for example, office buildings that have been refurbished to be more environmentally friendly, cheaper to run and more geared up for new technology.

Three valuation-based commercial property price headline indicators are computed:

- **Total return** is calculated as the change in capital value, less any capital expenditure incurred, plus net income, expressed as a percentage of capital employed over the period concerned. *Total value* is then arrived at by estimating the value of future income (i.e. using discounted cash flows ([126]) for the rental income) ([127]).

([122]) Investment Property Databank (IPD) compiles Commercial Property Price Indices and other data for a number of countries as part of its commercial information business that supplies market data and performance analysis for the owners, investors, managers and occupiers of real estate. See references in earlier chapters.

([123]) At the time of the writing of this Handbook, only Statistics Denmark, Deutsche Bundesbank, Banca d'Italia, the Bank of Greece and Narodowy Bank Polski had submitted country-wide CPPIs compiled nationally.

([124]) As previous mentioned, in practice, because of the cyclical conditions of demand in the market, the valuation price can diverge from the price that would be settled if a transaction were to take place.

([125]) In the appraisal profession there is a formal distinction between what is generally referred to as 'Investment Value' and what is generally referred to as 'Market Value'. The latter is the most likely price at which the property would transact. The former is what the property is worth to a given specified owner assuming it would not be sold but would be held indefinitely (hence, just the present value (PV) of perpetual income stream for that owner). Investment Value is more difficult to quantify than Market Value, both conceptually and empirically. The relationship between Investment Value and Market Value would tell a given owner whether they should be a buyer (holder) or seller of the specified property (sell if MV > IV). The concept of Investment Value (or the related concept of 'Fundamental Value') is defined in Chapter 4, but it is suggested that CPPIs should better be based on (an appraiser's valuation of) Market Values, and this is indeed what most of the pre-existing appraisal-based CPPIs have been based on, at least in places like the US, UK, Canada, Australia, Netherlands, all the indices produced by IPD. One use for Investment Values (or Fundamental Values) is to compare them with Market Values to try to identify or quantify a current asset price bubble in the property market. However, other more objective metrics such as changes in price/income ratios in combination with inflation-adjusted price-change metrics and measures of capital flows may be better for that purpose.

([126]) A valid concern in this methodology is that the future cash flow projections and yields used for discounting are not harmonised across markets and are instead chosen by individual valuers. Nonetheless, within a market segment it is not believed that the approach taken within a particular country would deviate significantly.

([127]) What discount rate to use for this type of calculation is a subject of great debate and is not harmonised between the different reporting country data-sets. Ideally the rate should be based on something fully observable in the market – perhaps from some Over-the-counter (OTC) instrument, done directly between two parties without supervision of an exchange, or a benchmark interest rate (potentially with a fixed margin above – e.g. LIBOR + 2 percentage points). The problem of taking actual OTC data is the issue of collecting what is a very market sensitive piece of information. As such it was one of the reasons why the ECB eventually chose to avoid using this approach in its final methodology.

- **Income return** is calculated as net income expressed as a percentage of capital employed over the period concerned.
- **Capital growth** is calculated as the change in capital value, less any capital expenditure incurred, expressed as a percentage of capital employed over the period concerned.

The computation formulae are given in the Table below.

Table 10.1 Computation Formulae

Total return	**Where:**
With respect to a single month total return is defined as: $TR_t = \dfrac{(CV_t - CV_{t-1} - CExp_t + CRpt_t + NI_t)}{(CV_{t-1} + CExp_t)} * 100$	TR_t is the total return in month t
Income return $INCR_t = \dfrac{NI_t}{(CV_{t-1} + CExp_t)} * 100$	CV_t is the capital value at the end of month t $CExp_t$ is the capital expenditure (includes purchases&developments) in month t
Capital growth $CVG_t = \dfrac{(CV_t - CV_{t-1} - CExp_t + CRpt_t)}{(CV_{t-1} + CExp_t)} * 100$	$CRpt_t$ is the capital receipts (includes sales) in month t NI_t is the day-dated rent receivable during month t, net of property management costs, ground rent and other irrecoverable expenditure

In addition, the IPD calculates an experimental transaction-based index. This is a model-based hybrid index which combines transaction information, edited to exclude outliers, with the IPD valuation data described above.

Sales from the preceding six months are collated and a corresponding set of 'reference' capital valuations for each sector is compiled using valuations two quarters prior to the quarter being analysed ([128]). The natural log of the sale price to capital value is computed for each sector. Dummy variables are used to identify the main property type and the country of each asset in the dataset. The numbers of dummy variables are constrained by the limited number of observations. Dummy variables are defined to strike a balance between disaggregation and representation. France is set as the 'base case' of the model because of good data coverage and the large size of the market. Indices for the United Kingdom are based on a United Kingdom model due to the relatively large sample size available.

An Ordinary Least Squares (OLS) regression is then run for every quarter in the time period to generate regression coefficients for the computation of predicted sale prices for assets that were not traded. Two predictions are made for properties held in each quarter. First, a start price is predicted using coefficients from the regression on the sale sample for the preceding period. Second, an end price is predicted from output for the regression on the sale sample for the current period.

The regression model has the following form.

$$\ln P = \beta_0 + \beta_1 \ln A + \sum \delta_j C_{i,j} + \sum \lambda_k S_{i,k} + \varepsilon$$

where

([128]) Valuations are linearly interpolated between actual valuations where the latter are carried out biannually or annually valued countries, as in the case for many European countries. Thought is being given to whether explanatory variables can be found to enhance this process of interpolation to give more accurate estimates of the intervening values.

P	equals the sale price in Euros
A	is the appraised capital value for two quarters prior to sale in Euros
C_j	are 0/1 dummy variables for j countries
S_k	are 0/1 dummy variables for k sectors of the real estate market
ε	is a random error term

This model — to correct for appraisal lagging and smoothing bias by using contemporaneous transaction price evidence across the sample of properties trade — is essentially an approach to enhance or improve an appraisal-based index, and is very comparable to the Sales Price Appraisal Ratio (SPAR) method described in Chapter 6 and employed in the 'TBI' and 'NTBI' indices in the United States which are described in Section 10.5.2.1 of the present chapter. In theory the regression-based model here allows more sophisticated econometric enhancements than the simple ratio-based SPAR approach and the use of separate regressions each period (as opposed to a pooled time dummy specification) allows the 'fixed effects' of the differences between prices and appraisals (the countries and sectors effects) to vary over time. It does, however, require larger transaction samples than the pooled specification. Further, the model, as outlined above, constrains β_1 to be the same across all countries and sectors, though given sufficient observations, this constraint might well be relaxed.

These predicted prices are in log form rather than cash terms. The predicted log prices are transformed into prices as follows.

$$\hat{P} = \exp\left(\ln\hat{P}\right) \times \exp\left(\frac{\hat{\sigma}^2}{2}\right),$$

where σ2 is the mean squared error of the regression generating the predicted price.

The percentage change between total end prices and total start prices for a particular country or sector represents a log value-weighted capital return figure derived from transaction evidence, which are then chain-linked with the corresponding figures for the surrounding quarters to create an index.

In practice, the small number of transactions that take place e.g. in times of financial stress and low market liquidity, can necessitate a multi-source approach, using the hybrid transaction prices and valuations, as the dummy variables in the calculation described above may not be sufficiently reliable. It can be noted that there are econometric enhancements that can be employed in the regression model and the index construction process, to help deal with index noise and the problem of small samples. Such techniques are reviewed in Chapter 5 and Chapter 6 and their effectiveness can be illustrated in Sections 10.3.2 and 10.5.3 below, though see also Bakhari and Geltner (2012) and Silver (2016).

The commercial property prices of a country should ideally be weighted by the total value of the commercial property in that country or the value of the annual turnover, depending on the conceptual basis of the index i.e. whether it is a stock or transaction based index. In practice, the principles underlying the concept cannot always be followed due to a lack of data.

European Union and Euro area aggregates are computed using weights that are either compiled by IPD from their own estimates of the capital value of the professionally managed investment market in each country or from national data supplied by individual Member States where the latter exists and is deemed to be of reasonable quality.

An investigation of the sources for weights was undertaken. Three sources were looked at and aggregate indices computed using gross fixed capital formation, GDP and stocks.

- *National accounts non-financial data* using either gross fixed capital formation (for transaction weights) or balance sheet data (for volume weights). The data relates to *other buildings and structures* (AN. 112) from the European System of Accounts (ESA 2010). A volume based weighting scheme using balance sheet data was found not to be feasible due to low country coverage e.g. at the time of the study no data was available for Spain and Portugal. A transaction weighting scheme was feasible with data being available for both the nominal gross fixed capital formation at current prices and the volume of grossed fixed capital formation derived from the application of relevant price indices.

- *GDP weights*: The main advantage of using a weighting scheme based on GDP results is comprehensive country coverage although there can be a significant time lag before the data become available.
- *Stock of enterprises* as an indication of the demand for commercial property and a proxy for stock of transaction volume. This approach takes no account of the size of the property. Again, country coverage was not comprehensive at the time of study and the data was even less timely than for GDP weights.

The study showed that the weighting scheme between countries could vary significantly depending on which data source was used.

A decision was made to use GDP weights. This was based on practical rather than conceptual issues. Users prefer transparency and simplicity in the methods used. GDP weights were considered to be relatively transparent: they can be updated relatively quickly and do not suffer any issues relating to missing observations. They are also relatively stable, unlike weights based on Gross Fixed Capital Formation data which it was found could be quite volatile. The use of GDP weights also was consistent with the methodology used for residential property indices for newly-built homes.

A moving 5 year average of GDP weights was applied.

The ECB is looking to supplement these experimental indices with other indicators such as vacancy rates to enhance the potential for analysis.

10.2.2. Statistics Denmark's quarterly Commercial Property Price Index

Statistics Denmark computes a quarterly Commercial Property Price Index using the SPAR (Sale Price Appraisal Ratio) method on sales data extracted from an electronic land registration system. The land registration system supplies data on a weekly basis but the index is calculated quarterly.

Four categories of commercial property are covered and separately distinguished by the index.

- *Mixed (residential and business)*. Business use has to be at least 25 percent of the property value.
- *Business only*. This category covers properties containing only business premises. However, this code shall apply even if the business property includes housing for a caretaker, janitor or the like, where that use is less than 25 per cent of the property value. The term 'business' includes, for instance: shops; offices; hotels; restaurants; cinemas; 'larger' guesthouses; banks; crafts and workshops that are not factories; the practice premises of commercial doctors & dentists; hairdressing salons; auto service stations.
- *Factories and warehouses*. 'Factories' include not only major industries such as dairies, slaughterhouses, sugar factories, brickworks, but also larger workshops. Also included are: gas plants; electricity generating stations; water plants; where there are private or concessionary companies which make sales to a wide group of consumers.
- *Agriculture*. This category covers property (land &building) used for agriculture that has a minimum area of 550 hectares. The property does not have to be classified as agriculture in the land register. It can include an element of residential accommodation e.g. a farmhouse. But properties where the agricultural use is purely secondary in relation to the use for residential are categorised as residential.

If a number of different businesses are run from a commercial property it is categorised according to 'main' use.

Five key figures or 'indicators' are collated:

- Number of registered sales in reference period.
- Average price per property sold in each of the above mentioned property categories.
- Purchase price as a percentage of taxable value.
- Number of sales in price calculation.
- The purchase price per square hectare (applies to agricultural property only).

The sales that are included in the price calculation consist of properties.

- That have no special circumstances associated with the sale that might make it atypical or difficult to ascertain what is sold of the true price e.g. the seller is a public authority or the estate being sold consists of a number of properties.
- Where no critical information about the sale is missing.
- Where the price is not considered an outlier and therefore suspect.

For agricultural properties, only sales where the buyer is a private individual are included — for other properties this condition doesn't apply so properties can be purchased by a private equity company.

For the index calculation the SPAR method is used: the price index is calculated by indexing the ratio between the purchase price and the appraisal value i.e. to obtain the SPAR-value which is the price term used in the index. In the Statistics Denmark CPPI, the SPAR-value is calculated as the arithmetic average purchase price divided by the arithmetic appraisal price as follows.

Statistics Denmark followed the SPAR method because it was felt that its advantages out-weighed its disadvantages.

$$\text{SPAR}_{\text{value weighted}} = \frac{\frac{\sum \text{price}}{n}}{\frac{\sum \text{appraisal}}{n}} = \frac{\sum \text{price}}{\sum \text{appraisal}}$$

where n is the number of sales.

Thus the SPAR-value may also be interpreted as the sum of the purchase prices divided by the sum of the appraisals values. The above equation can be re-formulated as.

$$\text{SPAR} = w_1 \cdot \text{spar}_1 + w_2 \cdot \text{spar}_2 + \dots + w_n \cdot \text{spar}_n$$

where

$$w_i = \frac{\text{appraisal}_i}{\sum \text{appraisal}} .$$

This means that the appraisal value is used as a current weight. Therefore, the higher the appraisal, the higher is the weight. Because of latter, this class of SPAR method is usually referred to as the value-weighted SPAR-method.

The price index is calculated by indexing the SPAR-value, as shown in the above equation, as follows.

$$I_t = \frac{\text{spar}_t}{\text{spar}_{t-1}} \cdot I_{t-1}$$

where

I_t : Price Index in period t

Spar_t : Spar value in period t

The value-weighted SPAR-method facilitates the calculation of the growth contribution of each sale which can be used for analytical purposes and for investigating the common-sense and usefulness of the index.

In every 'even numbered' year the Tax Authority provides Statistics Denmark with new appraisal values that need to be incorporated into the index calculation, noting that the index calculation is only valid if the appraisal is based on the same period in both the numerator and denominator. The time-lag involved is about nine months i.e. Statistics Denmark will receive the appraisal for any given year in or about September or October of the following year.

Introducing the appraisal base period, the index formula becomes:

$$I_t = \frac{\mathrm{spar}_t^{\mathrm{bp}}}{\mathrm{spar}_{t-1}^{\mathrm{bp}}} \cdot I_{t-1}$$

The index is subject to revision. The first calculation of the quarterly price index is performed on approximately 90 per cent of all sales; the index is then revised for two subsequent quarters until virtually 100 % of sales are covered.

The new tax assessments are incorporated into the provisional figures published in the calendar year in which they are received from the Tax Authority and the revised figures are published in the first quarter of the next year. As the appraisals from the Tax Authority are received with a nine month time-lag this means that the tax assessments in the final index are a year out-of-date. This limits the extent of backward revisions whilst ensuring that the weights of the final index are reasonably up-to-date and accurate.

10.2.3. Hong Kong SAR: The Commercial Property Price Index compiled by the National Statistics Office

Hong Kong SAR has a small but densely populated land mass with a large and relatively homogeneous property market ([129]). The real estate market is relatively transparent and highly liquid, in part due to the absence of capital gains tax on property transactions and also to other relatively low selling costs. As a result, the transaction rate for both commercial and residential property is very high with an average of more than 100,000 transactions per year, since the 1990s, representing about 10 per cent of all private stock of real estate. Over the same period, just under a quarter (23 per cent) of transactions were repeat sales. Moreover, all transaction data are publically available from the Land Registry of the Hong Kong SAR, where all transfers of ownership of property have to be registered. The Land Registry holds the transaction price, the transaction data and the building address and age. Against this background, and noting the importance of the real estate market to the Hong Kong SAR economy ([130]), it is not surprising that the Land Registry transaction data are seen as having the potential to make it possible for compilers to compute transaction-based real estate price indices based on the repeat sales methodology ([131]). The latter applies to commercial as well as residential property price indices.

The Rating and Valuation Department (RVD) is generally considered to be the primary source of information on commercial property prices in Hong Kong SAR. It has been computing a transaction-based CPPI on a quarterly basis since 1979. It covers all transactions of commercial property and separate indices are compiled for office, retail and industrial properties. In addition, for office properties separate indices are published for three grades of property (Grades A to C) ([132]) and for core district locations ([133]).

Although the RVD index is transaction-based and uses actual price data (price per saleable floor area) recorded in the Agreement for Sale and Purchase (ASP), the information for keeping quality constant is based, in part, on valuations. The latter uses a regression-based mass appraisal technique (with rental returns and inputs from valuers). The quality difference is calculated by reference to *rateable value*, which is defined as 'an estimate of the annual rental value of the property at a designated valuation reference date, assuming that the property was then vacant and to let' ([134]). The adjustment procedure is similar

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([129]) The residential property market is particularly homogeneous.

([130]) Compared with other countries, the real estate market accounts for a relatively high proportion of the wealth of Hong Kong and also has a bigger influence on other industries and sectors such as the financial markets and government finances.

([131]) Real Estate Price Indices in Hong Kong, K.W.Chau, S.K.Wong, C.Y.Yiu and H.F.Leung, The Journal of Real Estate Literature, Volume 13, Number3, 2005.

([132]) Grade A offices are better than Grade B and C offices in terms of design, facilities and management. Office location is not a factor to be considered for grading.

([133]) Core districts refer to Central, Sheung Wan, Wanchai, Causeway Bay and Tsimshatsui. They are the CBDs of Hong Kong.

([134]) RVD is obliged to produce rateable values periodically for nearly all properties in Hong Kong for input into the calculation of Government rents and rates.

to the hedonic approach, except that the rateable value is assessed from rental data supplemented by inputs by professional valuers. The details of the mass appraisal approach can be found in Stevenson (1997) ([135]).

10.3. Commercial Property Price Indices and other indicators compiled by non-government entities

The previous section focused on official CPPIs i.e. those CPPIs produced, collated, and disseminated by national governments, their agencies, and the international bodies which link them and which attempt to closely conform as far as is possible to international definitions and classifications. The current section reviews and presents examples of the wide-range of CPPIs produced by non-government organisations. It does not cover all of the non-official indices produced by non-government entities but aims to give a representative cross-section of the indices available.

10.3.1. Worldwide: IPD (Investment Property Databank Ltd)

Most of IPD's outputs are based on valuation data, with the consequence that the frequency of publication is constrained by the frequency of the available valuations. Although more investors are now starting to report valuations on a quarterly basis, valuations are predominantly annual, giving insufficient data for IPD to publish quarterly indices in the majority of European markets. To furnish the user need for more frequent publication of indices across national markets and of Eurozone & Pan-European composite series, IPD has been working with the University of Aberdeen in researching the viability of more frequent Transaction Linked Indices (TLIs) ([136]). IPD compiles annual appraisal-based indices for most European countries and for seven countries outside Europe, and at a greater frequency where the underlying valuations are available. A Pan-European Annual Property Index has been compiled since 2004 and a Global Annual Property Index since 2008, both in collaboration with KTI, Finland. The indices cover commercial real estate directly held in professionally managed portfolios. All four main market sectors are included — Retail, Office, Industrial and Residential — and separate indices are produced for each as well as aggregates. Indices can normally be further disaggregated into detailed sub-sectors, such as regions, size bands etc. Indices are value-weighted i.e. each property contributes in proportion to its capital value. The indices are compiled on the basis of open market valuations for investment purposes, undertaken by property professionals, to a standard definition of capital value in each national market. However, these definitions are not necessarily standard across countries ([137]).

IPD also compiles *Property Fund Indices,* which provide an indication of the total returns investors have received and can expect to receive from their unlisted fund investments. These indices are compiled on the basis of objective reports on fund returns computed on a like for like basis, i.e. objective and following a pre-defined common set of rules or conventions, irrespective of investor, manager or commercial pressure. They complement the Commercial Property Price Indices ([138]).

([135]) The Use of Mass Appraisal Techniques for rating Valuation in Hong Kong, W.J.McCluskey and A.S.Adair (Editors), Computer Assisted Mass Appraisal: An International Review, London, Ashgate Publishing Group, 1997.

([136]) The collaboration was with Dr. Steven Devaney of the Property Group in the Business School at the University of Aberdeen. Dr. Devaney subsequently moved to the Henley Business School.

([137]) IPD Index Guide. Edition Eight, 2012.

([138]) Fund-level indices can reflect not just the pure returns to the underlying physical property assets but also any leverage the fund has, the effect of property trading and development by the fund (if any), and the fund-level administrative expenses and fees charged the investors. Thus they can reflect the actual net experiences of the investors (although sometimes the fund-level returns are reported gross of fees). Such fund-level indices are also produced in the U.S. by NCREIF and by PREA (the latter in conjunction with IPD).

Supplementary indices for analytical purposes are compiled on a monthly basis relating to *total return, income return* and *capital growth* based on the following computations.

$$TR_t = \left(\frac{\left(CV_t - CV_{(t-1)} - CExpt_t + CRpt_t + NI_t \right)}{CV_{(t-1)} + CExpt_t} \right) \times 100$$

$$INCR_t = \left(\frac{\left(NI_t \right)}{CV_{(t-1)} + CExpt_t} \right) \times 100$$

$$CVG_t = \left(\frac{\left(CV_t - CV_{(t-1)} - CExpt_t + CRpt_t \right)}{CV_{(t-1)} + CExpt_t} \right) \times 100$$

where

TRt	is the total return in month t
CVt	is the capital value at the end of month t
CExpt	is the capital expenditure (includes purchases & developments) in month
CRptt	is the capital receipts (includes sales) in month t
NIt	is the day-dated rent receivable during month t, net of property management costs, ground rent and other irrecoverable expenditure.

The basic approach to the experimental *Transaction Linked Indices (TLIs)* is to compare prices from transactions completed in the market place with previous valuations for those same assets to give an indication of market movements between those time points [139]. Sale prices for properties that have sold in each period are regressed on to preceding valuations and a set of dummy variables that indicate the location of the property concerned and sector of the market to which it belongs. The results of these regressions capture the way in which prices typically differ from valuations in that period. Once regressions have been estimated for each quarter, the coefficients from these regressions are used to conduct a mass appraisal of all unsold assets in the IPD database each period. Two predictions of price are generated for each property; one that uses the preceding quarter's coefficients and one that uses the current quarter's coefficients. These sets of predictions can then be summed to give aggregate price estimates for all properties in a sector, in a country or across Europe as a whole. The change between the first and second estimate then provides a transaction linked and value-weighted estimate of capital growth, which can be chain-linked with those for other quarters to produce longer run transaction linked indices. This is similar in principle to the SPAR method used by Statistics Denmark, described earlier.

Computation of TLIs consists of five stages:

• *Stage 1 — extracting the dataset*. The data set currently used to create TLIs is the same as that used to create IPD's standard Valuation Based Indices(VBIs) but supplemented with a small number of transactions from contributing funds collected quarterly to facilitate regular quarterly updating for those markets without a quarterly valuation regime [140]. Gross sale prices, capital valuations and indicators of the asset type and location are also extracted from the VBIs dataset in order to generate capital growth figures [141];

• *Stage 2 — filtering the dataset*. Rules and filters are applied to properties entering the model and mass appraisal stages to ensure that adequate prior history is available to undertake the estimations that the latter are not distorted by outliers. The following rules and filters are used:
  – To ensure relevant and sufficient data, the removal of: properties that do not have a predominant usage of retail, office, industrial or residential [142]; any cash flow or valuation data for periods prior

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[139] Transaction Linked Indices – Construction. IPD Technical Documentation, June 2012.

[140] While the number of transactions is 'small' in any given period relative to the total population of properties covered by the index, the transaction samples will usually consist of all transactions in each period within the data-contributing members' portfolios of properties. For example, this is the approach for the TBI in the USA: it is a 'census' not a sample of such transactions relating to the IPD population. Though, the IPD members constitute a non-random sample of all commercial property owners, implying that the entire IPD population of properties is a sample, though non-random and potentially non-representative.

[141] Gross sale price is the sale price paid to the vendor prior to the deduction of any sale costs. Meanwhile, capital valuations in the IPD database are recorded net of purchaser costs and gross of any seller costs.

[142] Predominant usage is defined by there being >50%of estimated rental value in one usage.

to 2001; any assets remaining in the sample, that are not standing investments for at least two quarters prior to the period being analysed; any assets that have been sold as a development.

- To exclude extreme cases, the removal of: any properties that have a total return of greater than 100 per cent or less than 50 per cent in the two quarters prior to the period being analysed; assets where the capital value is greater than €1 billion or less than €12,500 in the quarters preceding the period being analysed;

- *Stage 3—performing the regressions*. The model draws on two consecutive quarters of data as, due to the low liquidity of property investments, there are insufficient sales in just one quarter for stable models to be estimated and usable indices to be produced. For example, the model for Q4 2010 draws on sales completed during Q3 and Q4 of 2010. The reference set of valuations is the two quarters prior to the quarter in which the asset in the sample was sold. This procedure is adopted to ensure that the valuations in the model are independent of the sale prices, as a valuation conducted during sale negotiations may be influenced by information from those negotiations. In the case of biannually & annually valued countries the valuations used may be interpolations between actual valuations;

The natural log of the sale price and the capital value in each case are computed and dummy variables are created to identify the main property type and the country of each asset in the dataset. Then an OLS regression is run for each and every quarter in the time period using the following form.

$$\ln P = \beta_0 + \beta_1 \ln A + \sum \delta_j C_{i,j} + \sum \lambda_k S_{i,k} + \varepsilon$$

Where

P   equals the sale price in Euros.
A   is the appraised capital value for two quarters prior to sale in Euro.
C   are 0/1 dummy variables for j countries.
S   are 0/1 dummy variables for k sectors of the real estate market.

- *Stage 4 — mass appraisal of all assets*. The coefficients from the regressions are used to predict sale prices for assets that were not traded. Two such predictions are made for properties held in each quarter: a start price using coefficients from the regression on the sale sample for the preceding period; an end price from output for the regression on the sale sample for the current period. For example, Q4 2015 predicted start prices are derived from the regression on Q2-Q3 sales and predicted end prices are derived using the regression on Q3-Q4 sales ([143]).

It should be noted that the predicted prices are in log form rather than cash terms as it is the latter that is required for generating indices. Whilst a simple exponential transformation would yield estimates of prices in levels, such estimates would be biased (see Fisher *et al.*, 2007). The predicted log prices are transformed in the following manner to correct for this bias.

$$\hat{P} = \exp\left(\ln\hat{P}\right) \times \exp\left(\frac{\hat{\sigma}^2}{2}\right)$$

where the sigma-squared is the mean squared error of the regression generating the predicted price; and

- *Stage 5 — generation of the index*. The transformed start and end prices are summed for all assets within a particular country or sector and the percentage change between the two totals represents a value-weighted capital return figure derived from transaction evidence. These rates of change are chain-linked with those from the adjacent quarters to form a time-series.

The composition and construction rules for IPD indices are reviewed regularly by independent, non-executive bodies, referred to as Index Consultative Groups. Data quality, data capture and computation

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([143]) It can be noted that there is an alternative approach to applying the above-described regression model. Instead of mass appraisal of a (presumed) entire 'population', if one views the regression estimation database as a 'sample', one can apply the regression prediction to a specified 'representative property' each period, and construct the price index from that representative property's predicted value. Such a property could be defined based on average characteristics as at some base period, hence producing a 'Laspeyres' type index, which may be preferred for some official statistics or SNA uses.

control processes are overseen by IPD's Business Assurance Unit. The mandate for the unit, which reports directly to an independent Business Audit Committee, is to define quality procedures, audit data flow and reporting operations for all IPD services.

10.3.2. United States: The Moody's/Real Capital Analytics (RCA) Commercial Property Price Index

The Moody/RCA Commercial Property Price Index is compiled from a transaction price database put together by RCA. It uses the repeat sales index methodology ([144]) and is value-weighted based on transactions rather than stocks ([145]). The index is subject to revision as more data becomes available.

The particular application of the repeat sales methodology deployed by Moody's/RCA includes a number of procedures designed to enhance the reliability of the index:

- The use of a three-stage estimation procedure first developed by Case and Shiller (1987) where the squares of the residuals from a first-stage least-squares repeat sales regression are regressed on to a constant and the time between the buy and sell, and the estimated coefficients from that second-stage regression are used in a third-stage weighted least-squares repeat sales regression so as to correct for the heteroskedasticity which results from the tendency for repeat sales observations with longer spans between the buy and the sell to exhibit greater random price noise. This improves the precision of the resulting repeat sales index, helping to reduce noise in the index caused by estimation error;
- The deployment of a correction procedure devised by Goetzmann (1992) to address arithmetic/geometric bias without which the indices would tend to show a slightly lower than true long-term trend rate of price change - the bias caused by the difference between geometric and arithmetic means;
- Time-weighted dummy variables are used for lower frequency (longer interval) underlying regression models to mitigate temporal aggregation bias, the smoothing and lagging that tends to occur when return indices are based on prices of transactions that occur throughout each period rather than all at the end-date of each period. This procedure was first suggested by Bryan and Colwell (1982) ([146]);
- A 'pooled' regression model specification is used to compute from 'panel data' the underlying directly-estimated market segment indices. The ten underlying 'building block' indices, for instance, are all estimated in a single regression run on the entire RCA repeat sales dataset, with multiple sets of time-dummy variables interacted with the market segments. Such a model maximizes the use of the data set and increases the degrees of freedom in the regression, thereby increasing the reliability of the index estimation;
- A two-stage frequency-conversion procedure, developed recently by Bokhari and Geltner (2011), is deployed to further reduce the estimation error. The repeat sales regression models underlying the indices are estimated at an annual frequency, separately in twelve versions staggered across the twelve months of the year in terms of the beginning and ending months of the 'years' (defined as consecutive 12 month intervals, not necessarily calendar years). These twelve overlapping staggered annual indices are then combined using a mathematical process known as the Moore-Pinrose Generalized Inverse Matrix, to obtain an optimal estimate of the monthly-frequency index implied by the twelve overlapping annual indices. The estimation error and noise in the indices are reduced as a result of the larger observation sample sizes accumulated over the 12 month intervals. The outcome is that better quality indices are produced on relatively small or narrow market segments — the latter increase in statistical reliability more than off-sets the slightly lagged turning points that inevitably arise in the pricing histories. The work undertaken by Moody's/RCA indicates that the two-stage

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([144]) The repeat sales method is is presented in depth in Chapter 5 section 5.8.

([145]) The transactions are rolling 10-year average transactions, which are viewed as adequate proxies for stocks. Only to the extent that different property market segments tend to have different average holding periods among investors will transactions fail as a proxy for stocks for purposes of construction of weights, and such major deviations in holding periods by segment are not viewed as likely in the U.S. property investment industry.

([146]) For a description of temporal aggregation and an analysis of how the time-weighted dummy-variables mitigates the problem, see: Geltner, D.; 'Temporal Aggregation in Real Estate Return Indices', AREUEA Journal 21(2) 141-166, 1993; and: Geltner, D. 'Bias & Precision of Estimates of Housing Investment Risk Based on Repeat sales Indexes: A Simulation Analysis', Journal of Real Estate Finance & Economics, 14(1/2): 155-172, January/March 1997. Note that time-weighting is not applied *within* months, but only in regressions where the frequency is less than monthly (such as quarterly or annual).

frequency-conversion procedure obviates the need for other noise filters that can introduce greater bias and have proven to be less effective, such as the ridge regression procedure introduced by Goetzmann(1992,op.cit.).

By way of example, Figure 10.1 below shows four underlying staggered annual indices based on four quarterly starting dates for annual indices starting 1st January, 1st April, 1stJuly,and 1st September, labelled, 'CY', 'FYM', 'FYJ', FYS' respectively, 'FY' referring to 'fiscal years'. These are the blue, two green and light pink lines in the chart, which display 4 quarter segments, or breakpoints, once every four quarters. The quarterly-frequency index, using two-stage frequency conversion procedure, is the dark pink line. Note that the latter exactly touches each of the underlying annual indices at each of the 'annual indices' break points. Thus, the annual frequency returns, across any 4 quarter span of time within the two-stage frequency-conversion procedure index, exactly matches the annual frequency return of the corresponding annual-frequency index governing that span of time.

Figure 10.1 Illustration of Two-Stage Frequency-Conversion Procedure
ATQ Derived Quarterly Index New York Metro Office Properties
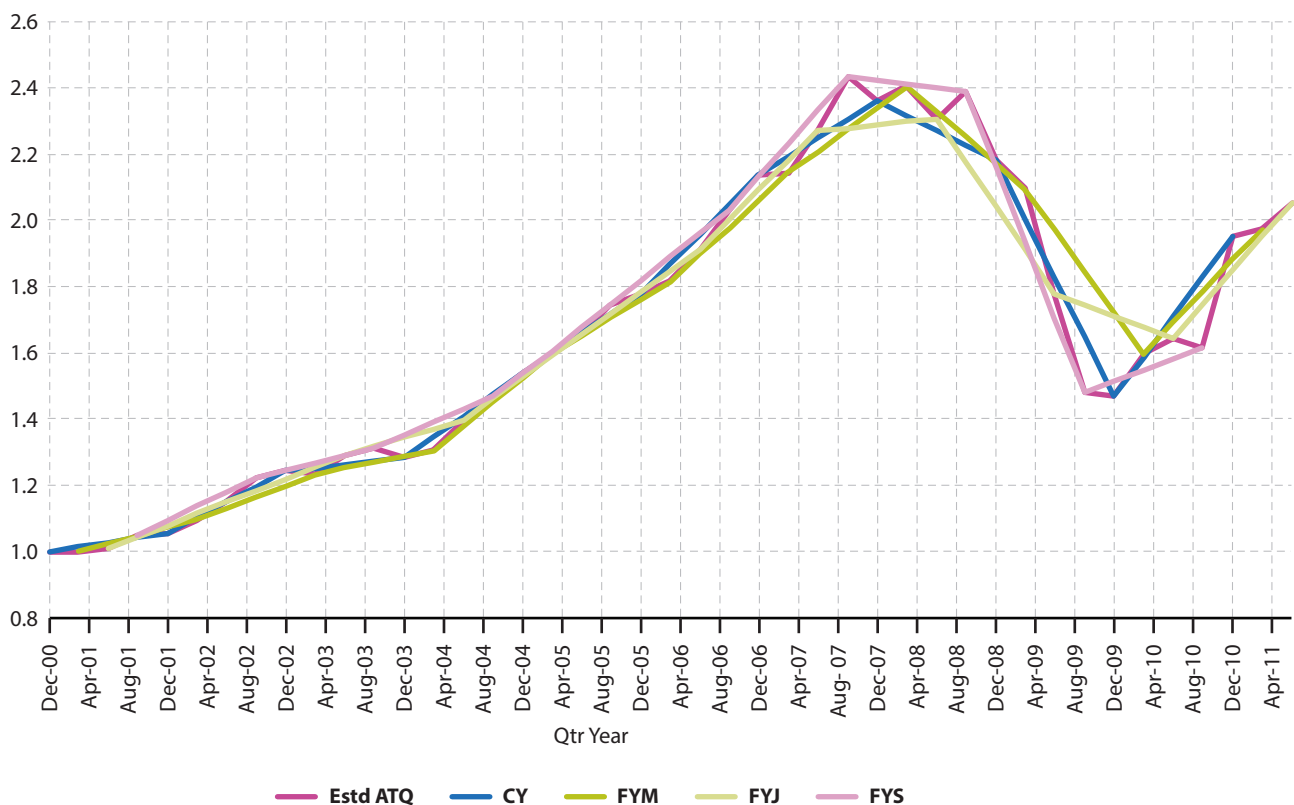
10.3.3. Hong Kong SAR: The Jones Lang LaSalle indices

These are valuation-based indices based on a portfolio of properties that can change over time. They were first published in 1984 and are available quarterly. There are separate indices for retail property, offices and the industrial sector. The index for retail property is restricted to three core districts of Hong Kong SAR: Central, Wanchai/Causeway Bay and Tsimshatsui. The index for offices covers one additional district: Hong Kong East. The index for industrial property includes, since 2002, separate indices for warehouses, flatted factories ([147]) and industrial/office buildings. These indices are similar in construction to those produced by IPD.

([147]) Flatted factories are high-rise multi-tenanted developments with common facilities such as passenger and cargo lifts, loading/ unloading bays and car parks.

10.3.4. Hong Kong SAR: FPD Savills

FPD Savills also publishes appraisal valuation-based commercial property price indices for Hong Kong SAR. It has published quarterly indices since 1992, covering the residential, office, retail and industrial sectors. The FPD office index is constructed solely for Grade A ([148]) offices, and the FPD retail index for prime street shops. Sub-indices of the FPD industrial price index are also published covering: industrial; godowns ([149]); and industrial/office buildings. The FPD Index controls for quality variation. This is done through undertaking the periodic valuation of a "standard unit" in a sample of properties in each of the sectors listed above. Index values are then computed by taking the simple average of the quarterly continuous compounded returns of the values. The sample includes actively transacted properties, and its composition can change over time to adjust for changes in building age. Further details can be obtained from the *Technical Note* (July 2002), which is published jointly by the company and the Centre for Real Estate and Urban Economics, University of Hong Kong.

There follows four case studies: one relating to Japan, one to the United States of America, one to Hong Kong SAR and the other to Denmark. They provide useful insights not only into the practical issues relating to alternative index constructions but also into the issues arising from the availability of alternative measures and the strengths and weaknesses of those measures as well as their relative usefulness to different users. In all countries a selection of different measures are available from different compilers using different data sources.

10.4. Case Study: Japan

10.4.1. Introduction

Compared to other advanced countries, relatively large amounts of real estate information have been produced in the past, and are currently being produced. This is not only because Japan experienced what was considered to be the 20th century's largest real estate bubble from the second half of the 1980s to 1990, but also because, since World War II, the country has undergone three real estate bubbles and three periods of economic turmoil that followed their collapse. Thus, fluctuations in property prices in Japan can have enormous consequences for the performance of the economy and can be partly associated with the relative limited availability of land for commercial development and the fact that it is inelastic ([150]). It is against this background that real estate information has been actively disclosed and published in the form of various indices and associated statistics. As the prices at which real estate is traded are not included in the official property register, various surveys are conducted: of real estate prices, investment returns, yields, vacancy rates, and other relevant information. Nevertheless, many indicators and the analysts using them, failed to effectively identify market conditions appropriately in the periods leading up to and during real estate bubbles in Japan.

10.4.2. The Multi prices for one property

In Japan, property price information is published by various government offices: the *Land Market Value Publications* (*LMVP*) and *Transaction prices* by the Ministry of Land, Infrastructure, Transport & Tourism (MLIT); *Land Price Surveys* by each prefecture; *Land value for Inheritance Tax* by the National Tax Office; and the *Land value for Property Tax* by each municipal office. Apart from the transaction prices published by MLIT, all three are appraised property prices, but an appraisal price for a given property can vary between the different government offices. A number of the published indices relate to land prices.

([148]) It is unclear whether the definition of a Grade A office is the same as that used by index computed by the Rating and Valuation Department.

([149]) A warehouse or other storage place at a port.

([150]) In the 1980s land prices in Japan surged upward in a 'speculative bubble'. Land prices then fell for 11 straight years between 1990 and 2001. It is obvious that in this case the supply of land is perfectly inelastic and the drop in prices resulted from a decrease in demand

When many real estate characteristics are examined in determining a real estate appraisal value, the statistical noise that would otherwise occur, from errors or a lack of precision in the appraisal values of various transactions of different property types, is removed. In consequence appraisal value data is, in theory, straightforward to use in calculating real estate price indexes. In particular, since it is possible to continue to collect an appraisal value of a property of a fixed type at a fixed point, there is no need for quality adjustment. However, it can be noted that divergences of real estate appraisal evaluations from given market conditions can be potentially problematic.

In July 1980, prior to the occurrence of the real estate bubble of that decade, the Japan Association of Real Estate Appraisal defined fair value as referring to the fair value representing the market value that would be produced in a rational free market for real estate that has marketability, and stated that this is the value realized when market conditions are communicated sufficiently and multiple buyers and sellers with no ulterior motivation exist in a market where supply and demand are able to operate freely with no market control ([151]). However, this definition required revision during the bubble era.

In 1990, at the peak of the bubble, it was still defined as fair value representing the market value that would be produced in a rational free market for real estate that has marketability. Thus, valuations were performed in a manner that suppressed soaring real estate prices. As a result significant divergences arose between real estate appraisal values and transaction prices. This supported the notion that the ideal value should be determined using a price that diverges from the market conditions. However, when real estate prices are determined based on this notion, the problem of market control occurs. Accordingly, in 2002, after the collapse of the bubble, the definition was changed to the fair price representing the market value that would be produced in a market meeting conditions assumed to be reasonable in the present socio-economic circumstances for real estate that has marketability. In other words, insofar as is possible, appraisers should target the price that will be transacted in the market conditions pertaining when performing evaluations.

This kind of discussion offers extremely important pointers when attempting to create real estate price indexes using real estate appraisal value. Even if one looks only at Japan, the definition of the price that should be represented by appraisal value changes over time insofar as market conditions change. In addition, in the case of attempting international comparisons, definitions vary between respective countries and prices are determined based on different methods. In such a case, it is not possible to create internationally comparable indexes.

Discussions surrounding real estate appraisal values have provided many important pointers when it comes to considering the transaction prices of commercial real estate. It has been suggested that, in commercial real estate market transactions, the transacted price level may change significantly based on the characteristics of different sellers and buyers, rather than transaction prices being determined by a competitive market. This is discussed in Chapter 9 on data sources.

In addition to general appraisal value, there are a few property-related taxes and assessments for which appraisals are undertaken: each municipal head carries out valuations for local property tax; the prefectural governor undertakes valuations for property acquisition tax; the director of the tax office undertakes valuations for inheritance tax and gift tax; and the local tax officer estimates values for registration tax when there is a change of ownership. Because the purpose and underlying market assumptions of each assessment differed, the valuations from these different sources often differed potentially leading to a serious mismatch between, for example, local property tax and inheritance tax, particularly during property price bubbles. This lack of coherence was eventually partly addressed through the Land Basic Law 1989 and the Comprehensive Land Policy Promotion Outline 1991. Since 1992 the value for inheritance tax is set at 80 per cent of the level of the Land Market Price Publication while the value for property tax aims to be 70 per cent of the same Land Market Price Publication level ([152]). In 1999 the ratio between the smoothed taxable value (from property tax assessment) and the full-value, was, on average, 51.2 per cent for commercial land but was more than 20 per cent and less

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([151]) In 1964 (Showa 39), when the modern appraisal evaluation system was inaugurated, fair value was defined as the fair value that it is presumed would be realized in cases where the real estate has existed for a reasonable period of time in the general free market and the market conditions are communicated sufficiently to sellers and buyers, who also have no ulterior motive, which strongly contradicts the price formed by the market.

([152]) For the property tax assessment, the assessment value is smoothed through a 'rate of burden adjustment' in order to avoid sudden increases in tax charges.

than 40 per cent for 27.1 per cent of commercial land. In the extreme case for 1.5 per cent of commercial land, it was under 20 per cent during the bubble period ([153]).

As the Land Market Price Publishing gives a base for public property valuations and for valuations for private transactions, the accuracy of the published land value affects all appraised land value in Japan.

It should be noted that in recent years, in addition to these ordinary appraisal values used for taxation, property has been appraised and assessed periodically for other purposes such as disclosing information to investors in the real estate investment market and evaluating the performance of real estate investments.

In general, appraised property prices should be determined using the comparable approach (market comparison), cost approach, and income approach ([154]), but in Japan, it is said that investment property should be appraised and assessed focusing on the income approach such as the Discount Cash Flow (DCF) method.

As described above, there are different appraised values even for the same property depending on the appraisal and assessment methods used. Moreover, there have been moves for private businesses to obtain information on transaction prices through data collection and market research (Nikkei Real Estate Price Information) ([155]).

10.4.3. Commercial Property Price Indices

CPPIs using such information or based on independent surveys have been published by both the public and private sectors. Table 10.2 indicates commercial property price indices available in Japan.

MLIT uses *Land Market Value* Publications to publish the average of price fluctuation rates for each point in each prefecture or area compared to the same period of the previous year. The *Japan Real Estate Institute* has published the Urban Land Price Index (ULPI) since 1936.

Since September 2001, when J-REITs property funds were listed on stock exchanges, investors have been able to more easily obtain information on appraised property prices and transaction prices in the real estate investment market, and this led to the publication of the *IPD Property Index (*IPD) and the *ARES J-REIT Property Index* (ARES). In both cases the information is divided into two categories. The first one includes the index, the object of which is to observe land price change in time series. The second one consists of information, which provides the estimated land price in certain areas.

([153]) According to the Ministry of Public Management, Home Affairs, Posts and Telecommunications.

([154]) In property appraisals, the comparable approach is an oft-used transaction case comparison method in which property prices are inferred from transaction prices. In some countries it is the most prominent technique. Another method, the cost approach, appraises land and buildings separately. For example, with regard to land, in cases where an appraisal amount for taxation purposes (e.g., property taxes) may be used, this method attempts to estimate the overall property price by calculating the building price separately and then adding together the separately calculated land and building prices. Yet another method, known as the income approach, determines property prices based on revenue and the discount rate. It can be noted that when determining asset price based on a present value model — asset price changes based on income and discount rate — the discount rate has a major effect on this determination. Of course, the determination of discount rates involves some judgment and takes into account comparisons between property, stocks, and securities.
These three perspectives on valuation — market comparison, cost, and income — are widely promulgated in official professional appraisal practice norms and procedures, not only in Japan but in many other countries. Problems arise with each perspective when the objective of the appraisal is to estimate the most likely transaction price, i.e. the 'Market Value', of the property in question.
In the income approach, the present value is extremely sensitive to the discount rate applied to the projected future cash flows of the property. If the objective is to estimate the property's Market Value, then the discount rate should be the opportunity cost of capital (OCC) faced by investors (potential purchasers of the property). This OCC is most directly and accurately reflected in the expected returns implied by the prices at which similar properties are currently trading. In other words, the discount rate should be such as to give a present value of the property indicated by the transaction prices of similar properties trading in the property market (adjusted of course for differences in the income earning projections for the different properties). This takes us back to the 'market comparison' approach, in practice, even though we are going through the motions of the 'income approach'.
In the cost approach, it is straightforward enough to estimate the replacement cost of how much it would cost to construct a similar building new today. But how to value the effect of depreciation on that structure cost is far from straightforward and difficulties are also encountered on how to estimate the current value of the land. Again, if the objective is to estimate the current Market Value of the subject property, then the method for accounting for structure depreciation and for land value must be guided by what price similar properties (land + buildings) are selling for today in the property market. Thus, once again, we are effectively back to the 'market comparison' approach even though we are going through the motions of the 'cost approach'.

([155]) *Nikkei Real Estate Information* has been issued by Nikkei Business Publications

Thus, the ULPI had been the only single index available for a very long time (starting in 1936), but new indexes such as the IPD Property Index and the ARES J-REIT Property Index have recently joined the group. The methodology of index construction of the Urban Land Price Index (ULPI) and the latter three indexes are entirely different. The ULPI estimates the trends of land prices, and the other indexes measure the investment return; income return, capital return and the total return (income return + capital return). The ULPI is based on the appraisal of the certain land sites, half-yearly. In contrast, the Land Market Valuation Publication (LMVP) and its assessed value for tax purposes aims to investigate price levels on either appraisal value, market estimate or transaction information.

Figure 10.2 Land Market Price Publication and Urban Land Price Index

Legend:
— Land Market Value Publication: Commercial
— Land Market Value Publication: Industrial
— Urban Land Price Index: Commercial
— Urban Land Price Index: Industrial
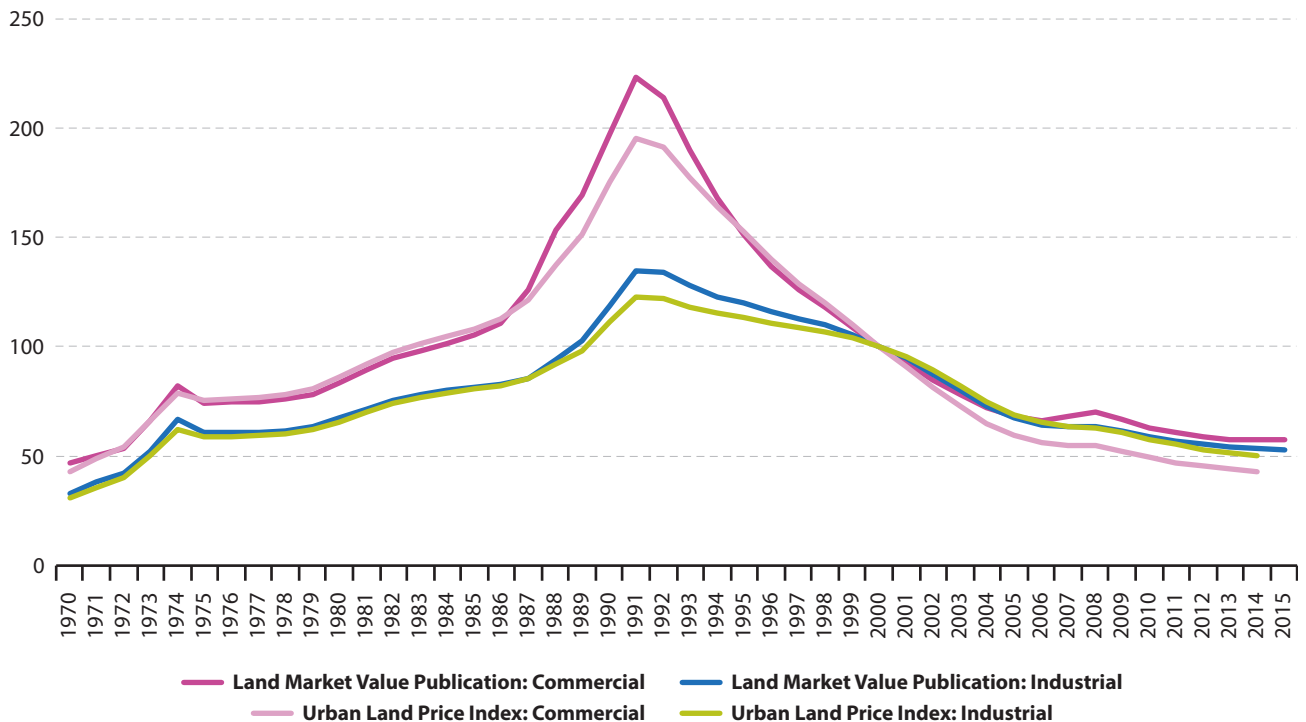
Figure 10.2 shows trends in officially appraised values and urban land price indices for commercial and industrial land. Although the number of points investigated and the frequency of investigation for the former are different from those for the latter, there is no large difference between the two indices relating to commercial land and the two indices relating to industrial land, because both are indexes based on appraisals and assessments ([156]).

There are lessons to be learned from this. First, there is the issue of comparability. Results calculated separately using different methods lack comparability and can lead to confusion. In view of this, when it comes to attempts to develop internationally comparable indexes, insofar as is possible, a common calculation method must be used. Second, it is extremely important to ensure the stability and continuity of index provision by building them into policy management. In view of this, the Japanese experience makes it clear that the public sector should assume a major role as a leading administrator of real estate price indexes.

([156]) In addition, there were different series of CPPI in Japan; the *MUTB-CBRE Real Estate Investment Index* by Mitsubishi-UFJ Trust Bank & CB Richard Ellis, the *STIX real estate investment index* by Sumitomu-Mitsui trust bank research institute, the *Sumitomo Life Insurance Research Institute Index* published by the Sumitomo Life Insurance Research Institute. However, *MUTB-CBRE Real Estate Investment Index* ceased reporting of the index in 2010, *STIX real estate investment index* ceased in 2008 because it had become difficult to obtain the raw data. Besides these, reporting of the *Sumitomo Life Insurance Research Institute Index* published by the Sumitomo Life Insurance Research Institute ceased reporting of the index in 2008 because it had become difficult to obtain the raw data. Besides these, reporting of the *Sumitomo Life Insurance Research Institute Index* ceased with the institute's demise. From 2000 to 2005, when expansion of the real estate investment market was anticipated, there was a glut of commercial real estate price indexes. However, from 2005 to 2010, companies continued to go out of business or ceased performing index provision activities. Furthermore, since they were calculated using differing methods, the trends showed by the indexes varied and this caused confusion among users.

Table 10.2 Property Price Indexes in Japan

Survey	Organisation	Use	Source	Coverage	Frequency	Availability*
Japan Commercial Property Price Index	Ministry of Land, Infrastructure, Transport and Tourism	Office, Retail, Warehouse, Factory, Apartment, Commercial Land and Industrial Land	Transaction price	All Japan	Monthly or Quarterly	2008
Land Market Value Publication	Ministry of Land, Infrastructure, Transport and Tourism	Land for commercial, residential and industrial real estate	Appraisal value	All Japan	Annual	1970
Urban Land Price Index	Japan Real Estate Institute	Land for commercial, residential and industrial real estate	Appraisal value	223 cities	Biannual	1936
ARES Japan Property Index	The Association For Real Estate Securitization	Office, Residential, Retail, Logistics, Hotel and others	Net income and capital value	J-REIT Funds + Unlisted Funds	Monthly	2001
IPD Japan Monthly Property Index	IPD: Investment Property Databank	Office, Residential, Retail, Logistics, Hotel and others	Net income and capital value	J-REIT Funds + Unlisted Funds	Monthly	2001
JREI Office Index (JOIX)	Japan Real Estate Institute	Office	Estimated net income and capital value	13 major cities	Biannual	2002
MUTB-CBRE Real Estate Investment Index	Mitsubishi UFJ Trust and Banking Corporation & CB Richard Ellis	Office	Estimated net income and capital value	13 major cities	Annual	1970-2010
Sumitomo Trust Property Index (STIX)	The Sumitomo Trust and Banking & STB Research Institute	Office	Estimated net income and capital value	Tokyo and Osaka	Annual	1976-2008
Farmland Value And Rent Survey	Japan Real Estate Institute	Farmland	Transaction price and rent (based on survey)	All Japan	Annual	1913
Timberland Value Survey	Japan Real Estate Institute	Timberland	Transaction price (based on survey)	All Japan	Annual	1940

* Availability means that the data is available from this year.

Figure 10.3 compares trends in the capital returns for property used for offices as seen from the ARES, IPD, and JOIX indices. It indicates that the ARES and IPD indices, which use similar data sources and compilation methodologies, and the JOIX index all show almost the same trend, and that all indices move smoothly.

Figure 10.3 Capital Return: ARES, IPD and JOIX
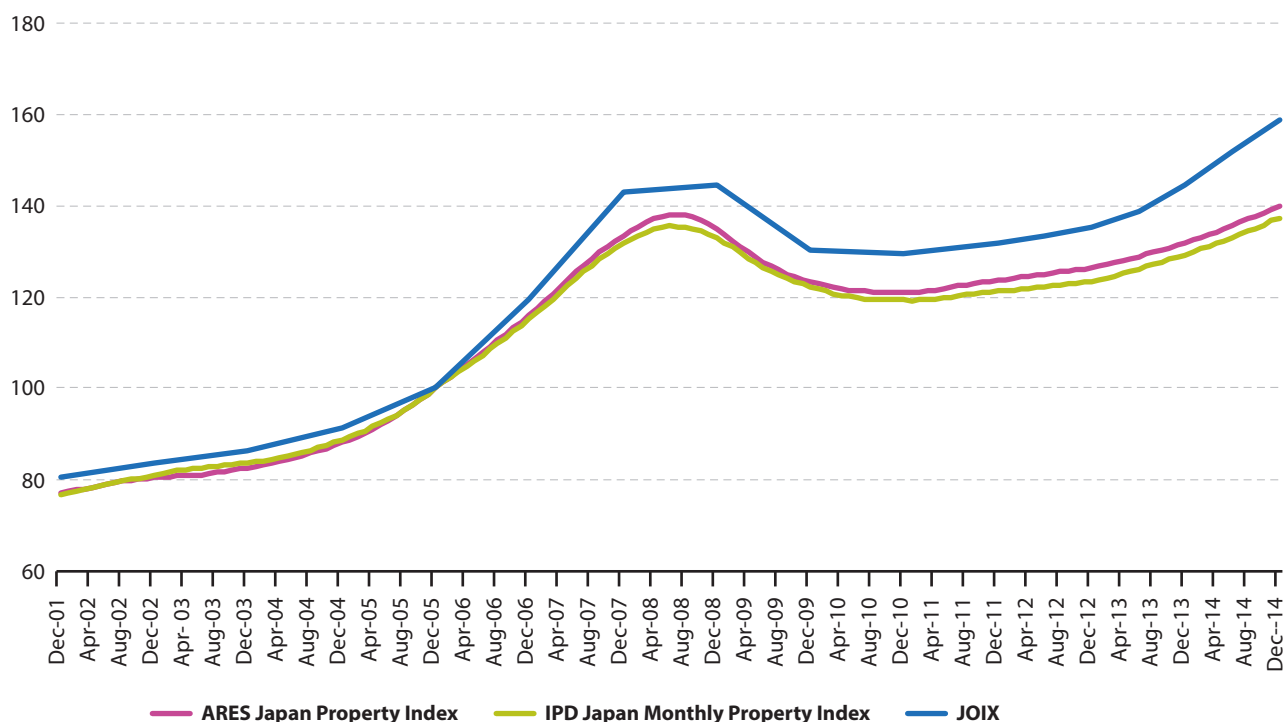
In Japan, property price indices for agricultural or forest land have also been examined and published since the pre-war period. Before World War I, in 1913, the government started investigations of such indices prior to those for housing and commercial land because agriculture was a key industry. Since forestry also accounted for a large percentage of the total industry, price indices for the latter industry began to be estimated in 1940.

10.4.4. New official CPPI in Japan

Against this background, in 2010, the Japanese government launched an initiative to establish a suite of property price indices, using information on transaction prices, as part of its official statistics. This followed the presentation of a report by the International Monetary Fund (IMF) and the Financial Stability Board (FSB) on major financial and economic information data gaps which identified the need for such indices and supporting their construction. The project was led by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), and included representatives from the Bank of Japan, the Financial Services Agency, and various Government ministries plus the Japan Association of Real Estate Appraisers, and the Real Estate Information Network System for East Japan (REINS), which had accumulated information on market property prices. Academics and other experts also participated in the project and due consideration was given to the advancement of knowledge resulting from the compilation of the *Handbook on Residential Property Prices Indices (RPPIs)*. The project members first used the information on transaction prices collected by MLIT to compute a house price index based on *the rolling window hedonic method*, which receives support from that Handbook.

The project team has also developed and now publishes a CPPI. The MLIT Commercial Property Price Index takes actual transaction data on commercial property to compute quarterly indices, also using the *rolling window hedonic method* ([157]), for the whole of Japan and for metropolitan areas.

([157]) The applied explanatory variables used in the hedonics are as below: distance to nearest station; distance to prefectural capital; office density; population; floor area ratio; site area; building age; total floor area; total number of floors; wooden dummy; urbanization promotion area dummy; low-rise residential area dummy; contact road width and prefecture dummy. In order to adjust to structural changes, the hedonic function is estimated using the rolling window hedonic model with a rolling period of 13 months. The approach represents an appealing but very data demanding methodology which relies heavily on an appropriate model specification. From an index construction perspective there is also the need to specify an agreed 'representative property'.

Trial indices have been computed for:

- Building with land: for major cities' office buildings; regional cities' office buildings; retail facilities in the centre of Tokyo; neighbourhood stores; stores along train lines; hotels; warehouses; factories; and
- Vacant land: advanced and semi-advanced commercial land; normal commercial land; neighbourhood commercial land; commercial land along train lines; distribution land; industrial land.
- Prices data are collected via field surveys where MLIT send questionnaires to nearly all buyers of commercial property, as indicated by land ownership transfer registrations. The index relies on respondents to complete these questionnaires on a voluntary basis. The number of cases per year is approximately 11,000. The indices have an inherent time-lag as the data used to construct the indices relate to transactions one year earlier. Indices for each prefecture are computed and the weighted average of these, based on the total number of transactions in each prefecture (as per the above mentioned survey), then form the national index and the indices for the Tokyo metropolitan, Nagoya and Keihanshin.

Indices have been calculated retrospectively back to April 2008.

Transaction indices, relating to land prices and based on the same approach, are also being developed.

Figure 10.4 below shows the rolling window hedonic indices by property type and figure 10.5 the corresponding indices for land-type.

It is interesting to note that the prices for factories are more volatile than for retail, offices or warehouses, showing a seasonal variation. The type of land — whether commercial or industrial — appears to have little influence on the trend in land prices. It would also seem to suggest that there has been relatively little volatility in prices despite the world financial crisis and the economic shock in Japan of March 2011 following the earthquake and tsunami.

Figure10.4 J-CPPI: Rolling window hedonic indexes by property types (Mean 2010Q1:Q4 = 100) Land with structure
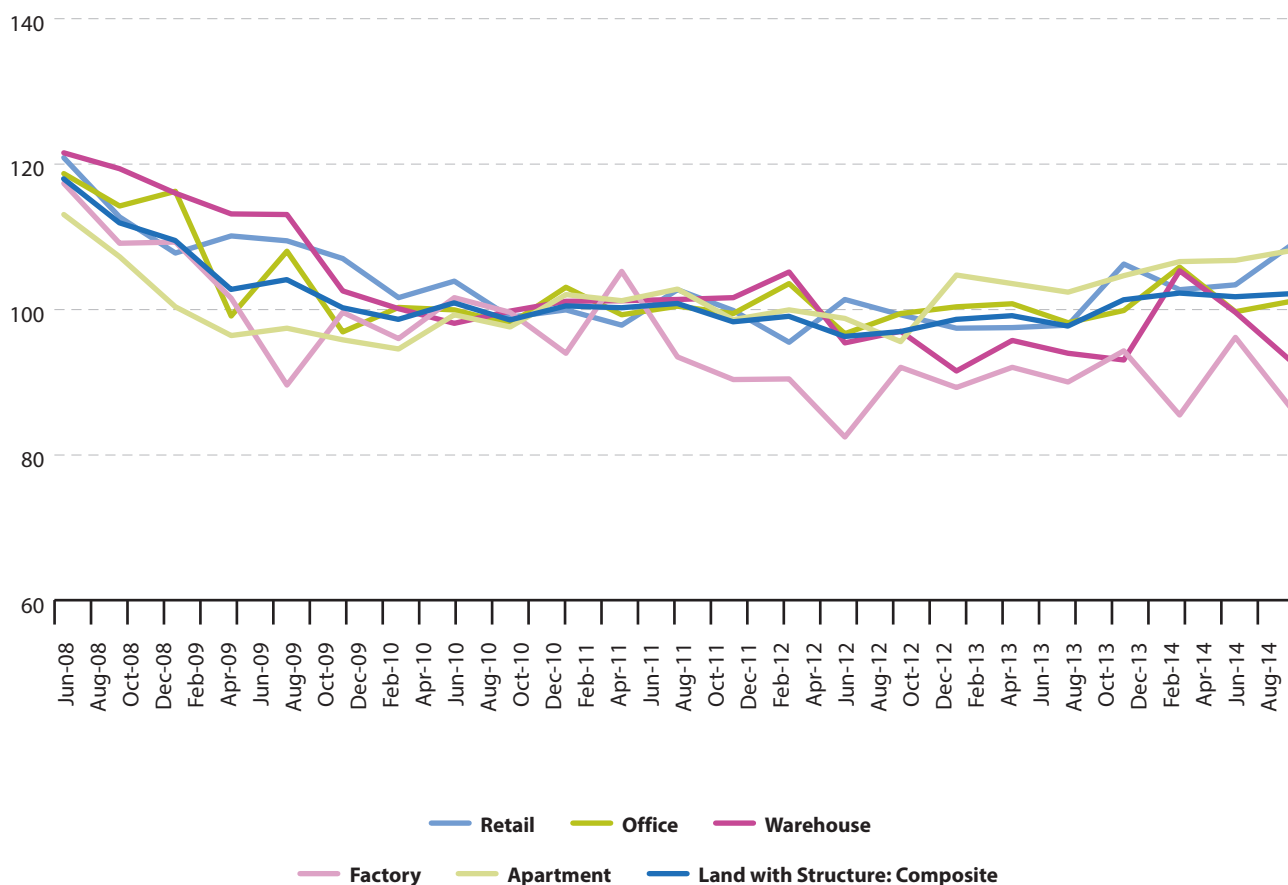
Figure 10.5 J-CPPI: Rolling window hedonic indexes by property types (Mean 2010Q1:Q4 = 100)

Land

Legend: Commercial Land · Industrial Land · Land: Composite · Linear (Industrial Land)
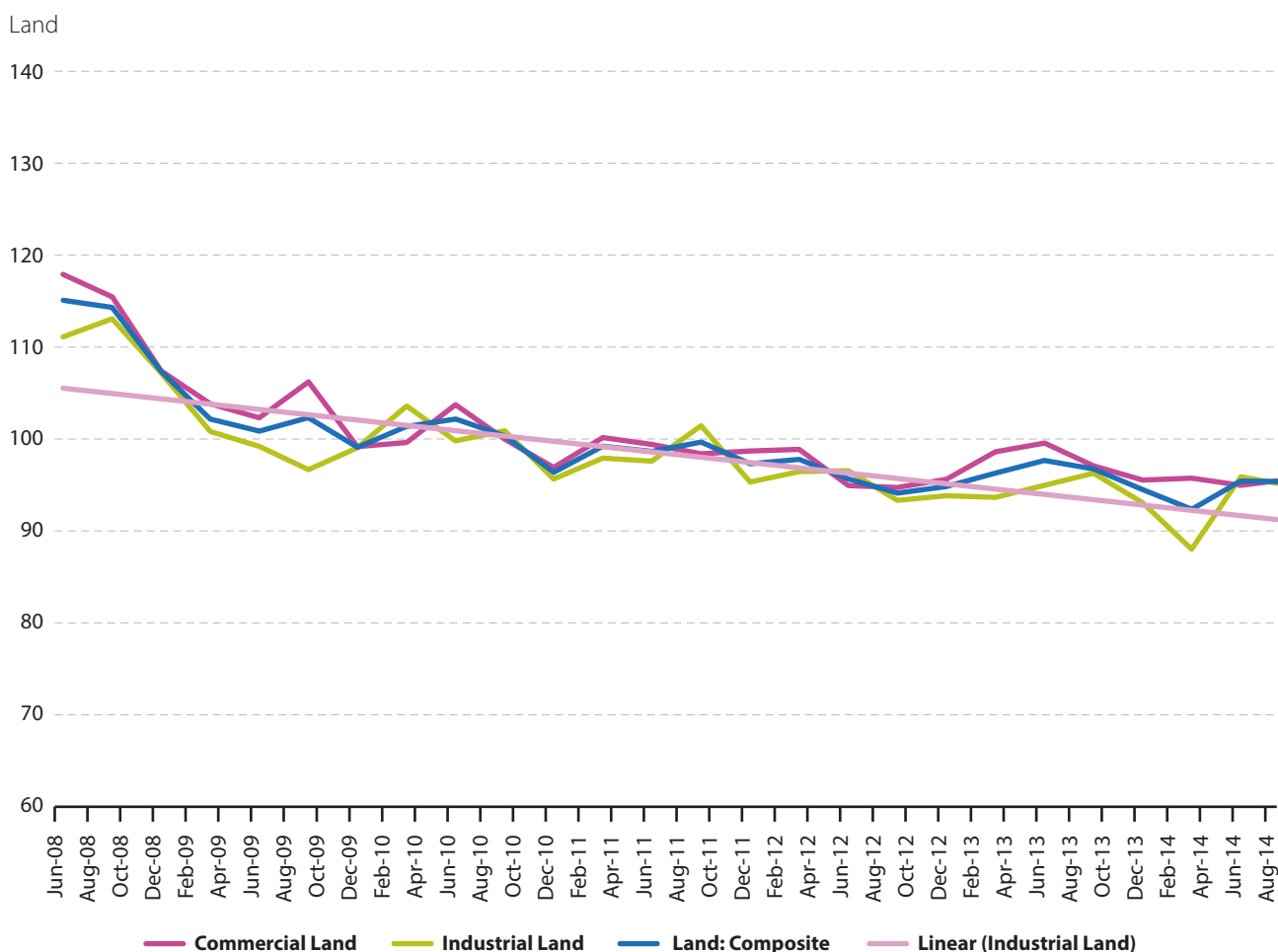
10.4.5. Additional indicators for commercial property

During the real estate bubble and after its collapse in 1990, Japan was forced to reflect seriously on policy concerning the organization of real estate information.

A panel of experts set up by government pointed out that it was important to appropriately grasp not only property prices but also trends in the trading of real estate. In 1991, MLIT started to investigate trends in land transactions based on register data. Through these investigations, the Ministry considered short-term transactions, which saw a change of ownership within two years of purchase, as highly speculative and decided to monitor such transactions. But the real estate bubble had already begun to burst by the time when such a monitoring system was introduced, and therefore, these investigations were cancelled or downscaled in the second half of the 1990s. Early in the 2000s, the progress in the computerization of register information enabled the Ministry of Justice and MLIT to jointly monitor trends in land transactions using information on changes of registered landowners.

In the middle of the 1990s, as property prices fell after the collapse of the real estate bubble, it was perceived that there was a growing need to monitor property prices appropriately — referred to as 'fundamental prices'. Under these circumstances, in 1996, the Japan Real Estate Institute began to establish a National Office and Apartment Rent Index. These investigations involved selecting cities and using real estate appraisers to survey office and house rents and investment yields nationwide. Furthermore, in the second half of the 1990s, the private sector began to provide many indicators as it moved to build a real estate investment market. In addition to the ARES and IPD indices mentioned above, surveys of house rent levels, vacancy rates, yields, and others were carried out, and such indicators were published. Worthy of attention among those indicators are the Japan Real Estate

Institute's Japanese Real Estate Investor Survey, the Xymax Real Estate Institute's Rent Diffusion Index, and the Sumitomo Mitsui Trust Research Institute's Implied Cap Rate. The type of supplemental data shown in Table 10.3 below is an important addition to the range of information available to the analyst as asset market pricing alone does not present a complete and fully articulated picture of the commercial property market. Ideally such additional measures are synchronized with the asset market pricing data, that is, they are consistent with it in terms of the definition of the markets or property populations that are covered.

Table 10.3 Additional commercial property indicators in Japan

Survey	Organisation	Use	Source	Coverage	Frequency	Availability*
National Office and Apartment Rent Index	Japan Real Estate Institute	Office and residential	Appraisal rental value	All Japan	Annual	1995
Retail Rent Trend	Japan Real Estate Institute and BAC Urban Projects	Retail	Asking rent	9 major cities	Biannual	2008
The Japanese Real Estate Investor Survey	Japan Real Estate Institute	Office, Residential, Retail, Logistics and Hotel	Yield (based on survey)	Tokyo + 13 major cities	Biannual	1999
Assumed Achievable Rent	CBRE Japan	Office	Assumed achievable rent	Tokyo, Osaka and Nagoya	Quarterly	2005
Vacancy and Asking Rent	CBRE Japan	Office	Vacancy and asking rent	Tokyo + 14 major cities	Quarterly	1996
Vacancy and Asking Rent	CBRE Japan	Logistics	Vacancy and asking rent	16 prefectures	Quarterly	2001
Rent Diffusion Index	Xymax Real Estate Institute	Office	Contract rent	Tokyo	Quarterly	2000
Implied Cap Rate	Sumitomo Mitsui Trust Research Institute	Office, Residential, Retail, Logistics, Hotel and others	Net income, market value of debt and equity	J-REIT market	Weekly	2005

*Availability means that the data is available from this year.

The Japanese Real Estate Investor Survey used a questionnaire to ask institutional investors such as insurance firms, pension funds, and developers about investment returns for the geographical areas and real estate categories it chose. The Rent Diffusion Index did not pay attention to the rate of change in office rents, but when new contracts were concluded for the offices it observed, it calculated as a diffusion index the difference between the number of those which saw their rent rise and that of those which saw their rent fall. The Sumitomo Mitsui Trust Research Institute's Implied Cap Rate is an indicator of yields estimated paying attention to the real estate market, the prices of J-REITs (stock prices), and the value of fund management firms as the J-REIT market grew.

Specifically, the Sumitomo Mitsui Trust Research Institute paid attention to the characteristics of J-REIT management firms whose assets consisted mainly of real estate. In addition to the information on financial results disclosed by these firms, it used the information disclosed in a timely manner on the acquisition of additional property and the transfer of existing ones during the term under review as well as on capital procurement. And it collected data on the net operating income (NOI) generated from the entire real estate owned by the firms, the market capitalization that constituted corporate value, total interest-bearing debts, and guaranty deposits and key money collected from tenants to calculate the Implied Cap Rate using the following formula:

SMTRI Implied Cap Rate = NOI generated from the entire real estate owned by J-REIT management firms/ (Market capitalization + Net interest-bearing debts + Guaranty deposits and key money collected from tenants).

Figure 10.6 Xymax Office Rent DI and SMTRI-Implied Cap Rate
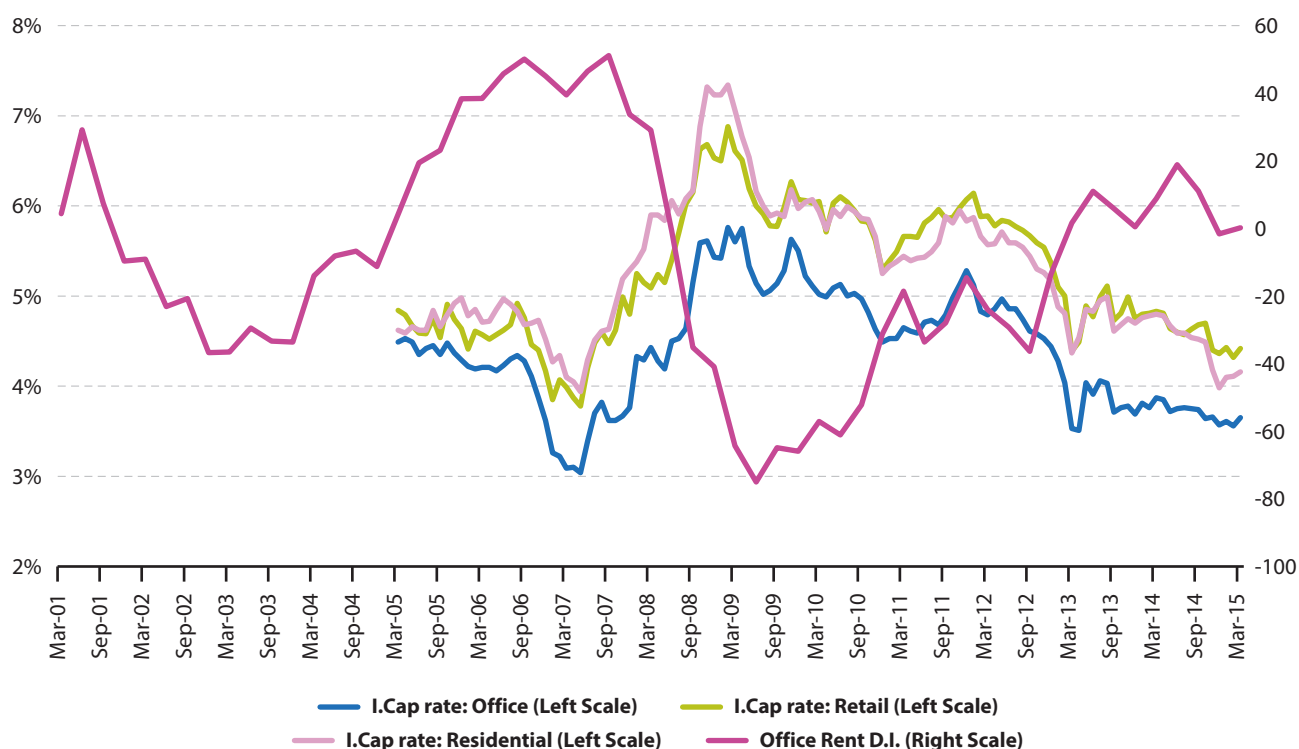
Figure 10.6 presents Xymax Office Rent DI and SMTRI Implied Cap Rate monthly indices for offices, commercial facilities, and houses. SMTRI Implied Cap Rate, which is also calculated on a weekly basis, can be computed with an extremely high frequency. Note that the combination of the cap rate index and the NOI index for the Office sector suggests a considerable asset pricing recovery in that sector during 2010-12, in contrast to the indication provided by the prototype rolling-window official CPPI for Offices in Figures 10.4 and 10.5.

One general point to pay attention to is that many of these indicators are provided to the real estate investment market, and the data used to calculate them are also gathered from the investment market.

If the aim is to use commercial property price indices as part of the public statistics, it can be argued that the latter should cover not only the investment market but also the market for owner-occupied property. The market turnover for owner-occupied property is much larger in size than the real estate investment market in terms of transactions although the value of the stock of commercial property assets is probably higher. In addition, there is a geographical bias because most of the areas targeted for investment are unevenly distributed in large cities.

10.5. Case Study: the United States

In the United States seven different commercial property price indices compiled by seven different producer organisations constitute the major price indices currently being used in the real estate investment industry ([158]). The seven producer organizations include two joint ventures which collaborate

([158]) The Green Street Advisors (GSA)-CPPI, which has often been cited in the *Wall Street Journal* and other press or industry publications in recent years, is not included for two reasons. First, the GSA-CPPI is not an example of a pure, rigorous type of price index compilation

on two of the index products. Of the seven producer organizations, all are in the private sector and five are for-profit firms.

The seven index products represent three major types of index construction procedures and their corresponding types of underlying data sources: appraisal based, transaction based, and stock market based.

Transaction based indices, which have been the major innovation in the past decade for tracking commercial property prices in the United States, have been able to address some of the aforementioned problems with appraisal based indices. They are not viewed as a replacement to appraisal based indices, rather, the two types of indices are viewed as valuable complements to one another, and both types are widely used.

10.5.1. Appraisal-based indices

There are two appraisal-based indices: one produced by National Council of Real Estate Investment Fiduciaries (NCREIF) and the other by The Investment Property Databank (IPD).

10.5.1.1. NCREIF PROPERTY INDEX (NPI)

The NCREIF Property Index (NPI) has been published quarterly (within 25 days of the end of the quarter) since the fourth quarter of 1977 and is based on all of the properties held by NCREIF's data-contributing members for or on behalf of tax exempt investment institutions, primarily pension funds [159]. The NPI largely tracks so-called 'core' commercial real estate assets in institutional investment portfolios. These comprise relatively large, prime properties in the private apartment, industrial, office, and retail usage type sectors. Most of the properties tend to be in major metropolitan areas. NCREIF requires its members to report a valuation each quarter for each property. Members are strongly encouraged to base such reports on updated valuations; however, an independent or 'external' appraisal is not required every quarter, though usually this is done at least annually and in recent years often more frequently. The properties in the index are 'stabilized' at the time they enter the index, meaning at least 60 per cent leased. Once a property is in the index it remains in the index no matter what its subsequent occupancy (unless or until it is sold or its owner pulls out of NCREIF or it is subject to major redevelopment). By the second quarter of 2001, the NPI was tracking over 7,000 properties worth about $340 billion.

In Figure 10.7 below, the dark pink line shows, from inception at the end of 1977 through to the second quarter of 2013, the official NPI appreciation index. The latter is value-weighted and net of capital expenditures. The blue line above it does not remove capital expenditures and therefore tracks the actual same-property price change in the NCREIF Index properties i.e. it is akin to a standard CPPI [160].

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methodology, in the sense that it is not based purely on either consummated market prices (property transactions or stock market trades) or professional appraisals and compiled via a transparent and replicable general statistical process that has been vetted in the academic literature. Second, from an empirical perspective, the type of property asset price information which the GSA-CPPI provides seems to be spanned or bracketed by the other types of indices included in this case study. But it is worth noting that the GSA-CPPI well tracks, and leads in time, the available transaction based price indices that are based directly and purely on consummated market prices in the private property market. And the GSA-CPPI well tracks, but lags in time behind, the stock market based property price index included in this case study. For a rigorously based and transparently documented index of CRE market values, the transaction based indices would be the first choice. And for a leading indicator of those private market values, an index based directly on relevant stock market share prices would be the first choice. The GSA-CPPI falls somewhere in between these two. This is not to say that the GSA-CPPI is not a useful and interesting information product, and its use in industry and press attests to that.

[159] Includes some endowment funds, but for the most part pensions and endowments hire specialized real estate investment management firms to manage properties for them in 'separate accounts', or they invest in real estate through various types of funds operated by such specialized real estate investment management firms. It is these investment management firms that make up the bulk of NCREIF's data-contributing membership.

[160] ( )As of 2014 NCREIF was in the process of developing a 'Market Value Index' (MVI) which would more closely track commercial property market values, similar to the gross-of-capex dark (higher) line in Figure 10.7 (but the NCREIF MVI will attempt to filter out the effect of major renovations within the index properties).

Figure 10.7 NPI Official Appreciation, Price Growth & Consumer Price Index, 1978-2013

- Consumer Price Index
- NPI Official Appreciation (Net of CE)
- NPI Price Growth (current $$)
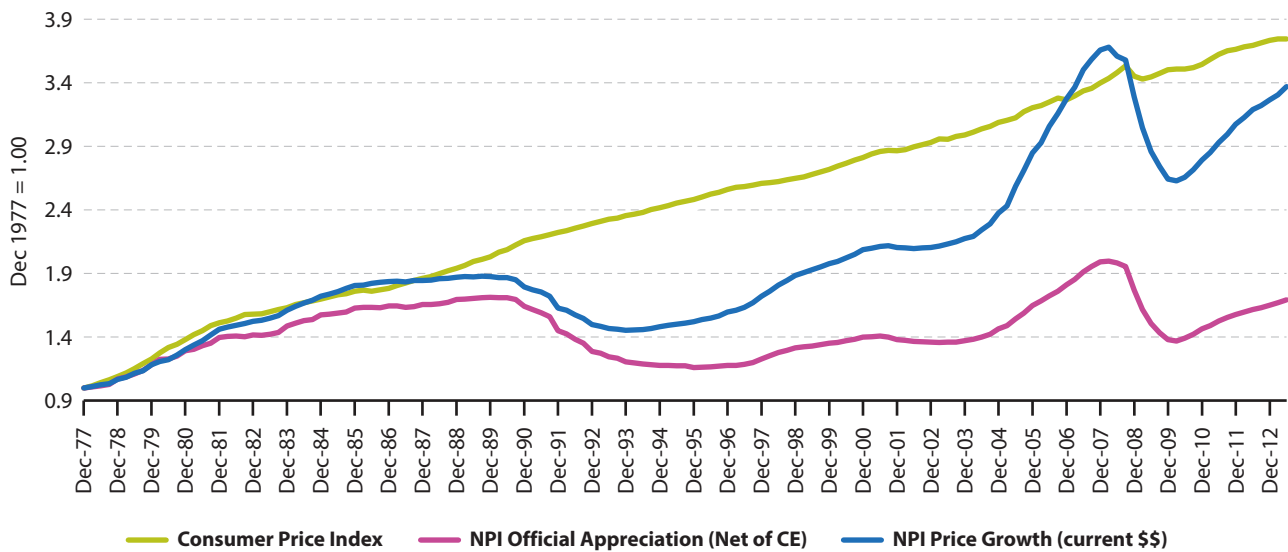
Another difference is that the blue line is an equal-weighted index, but we can note that, as shown in Figure 10.8 below, the equal-weighted version of NCREIF appreciation is, on average, only 0.2 percentage points per annum below the value-weighted version ([161]).

Figure 10.8 NPI Appreciation Index, Value - vs Equal - Weighted

- Equal-Weighted
- Value-Weighted (official)
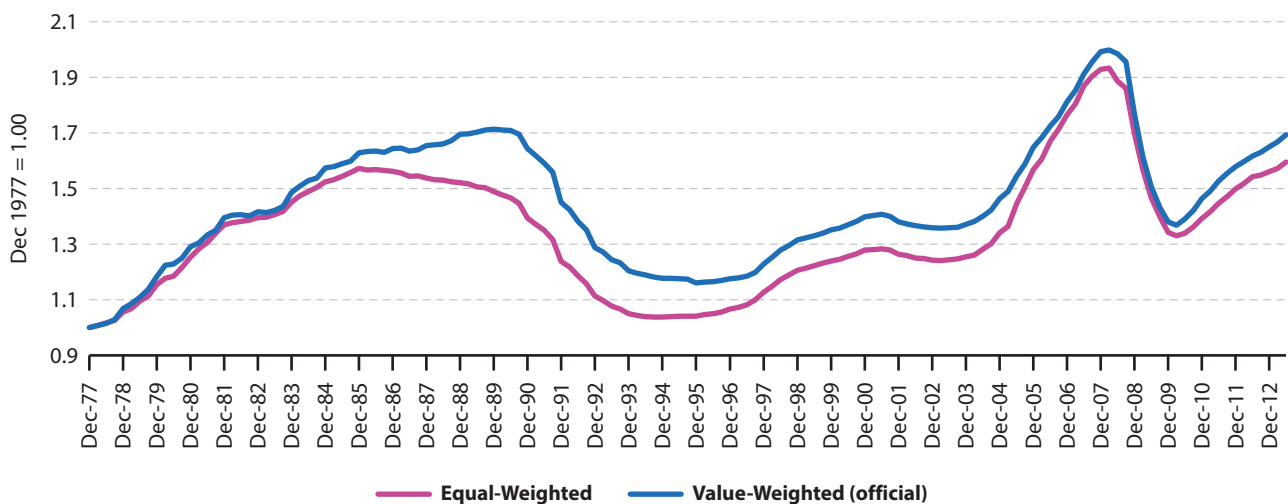
Returning to the first graph, the compound annual growth rate (CAGR, or geometric mean) over the period has been 3.8 per cent for inflation (as measured by the CPI), 3.5 per cent for NCREIF property price growth (in nominal terms, hence – 0.3 per cent in real terms net of inflation), and 1.5 per cent for the official NPI appreciation return — the latter suggesting that capital expenditures averaged about 2 per cent of property value per year).

[161] Normally the aggregation of an appraisal-based CPPI such as the NCREIF or IPD indices is by 'value-weighting' the individual property returns. Thus, each property's return is multiplied by the fraction of its property's starting value in the overall aggregate index starting value at the beginning of the period, and the resulting value-weighted returns are summed across all the properties in the index as of the beginning of the period. This type of value-weighting of the returns produces an index which shows the return that would have been achieved by a single portfolio consisting of all of the properties in the index as of the beginning of the period. Such value-weighting makes particular sense if the index is viewed as representing an entire 'population' or 'universe' of subject properties of interest. This perspective is most appropriate for investors or analysts wanting to use the index for 'benchmarking' purposes, to compare the performance of a particular portfolio or investment manager with the 'universe' of all (or most) such investment managers or portfolios that are competing and representative of the same type of investments. The alternative method of aggregating the individual property returns, using equal-weighting, produces a smoother index as it is less susceptible to changes in the appraised values or actual prices of a few very large properties.

10.5.1.2. IPD U.S. INDEX

The Investment Property Databank (IPD) U.S. Property Index is an appraisal based index, which was launched in 2008 with an inception date of December 1998. As IPD is a private for-profit firm, it is less restricted than NCREIF in the types of data-contributing members and includes both tax-exempt and taxable domestic and foreign investors. Coverage relates to properties entirely located within the United States, which are held in open-end funds, closed-end funds, and separate accounts. There is significant overlap in definitional terms between IPD's members and properties and NCREIF's although the IPD index, at just over 3,000 for their quarterly index, has fewer properties. As with the NPI, the IPD Index is based on the income and property valuations (generally appraisal-based) as reported by the member firms but tends to be skewed more toward the larger, global investment management firms, particularly those running major open-end funds in which properties need to be reappraised frequently.

Since 1998 IPD's All-Property flagship U.S. Index has produced a geometric mean total investment return of 8.11 per cent per annum, while the NPI over that same period produced 8.58 per cent, and the two indices are highly positively correlated.

Although the metrics and index computation and construction procedures used by IPD and NCREIF are quite similar, they do differ in point of details, most particularly, unlike NCREIF's, IPD requires that all properties in an index be reappraised as of the end of each and every reporting period. Thus, IPD indices tend to be less affected by reported valuations of some properties not truly reflecting updated re-valuations of all of the properties as of that current period thus causing additional temporal lag bias. It is because of this requirement that IPD, unlike NCREIF, produces separate indices at the annual and quarterly frequencies. Some properties are reappraised annually but not quarterly, and those properties are not included in IPD's quarterly indices.

These appraisal-based indices have some of the well documented and important strengths, of commercial property price indicators — strengths which are generic to most, if not all, appraisal-based indices. Namely:

- They cover *all* of the properties in the index constituent population, not just those that happen to sell, resulting in a larger and more representative sample. For example, in the NCREIF Index during 2012, with an average of 7,238 properties in the index population, only 628 sales occurred, an average of only 2.2 per cent per quarter.
- Detailed records are typically maintained on every property in the index population resulting in much more information being available than for the average transaction-based index — information which is of analytical value.
- The professional appraisal procedures are standardized to a considerable extent, and in the United States, as in many other countries, are based on highly developed procedures and conventions [162].

On the other hand, these indices also have some disadvantages or weaknesses.

- Unless required to, property owners do not generally have their properties re-appraised regularly or frequently because of the costs involved. In the United States, the Financial Accounting Standards Board (FASB) generally requires real estate asset values to be reported at historical cost rather than marked to current market value, as may be more prevalent in many other countries where International Financial Reporting Standards (IFRS) rules typically require 'fair value' reporting. Thus, the vast majority of properties in the United States are not regularly re-appraised so appraisal-based indices end up being applicable to a much smaller population of properties than transaction based indices. Furthermore, that population is not necessarily representative of the broader population of commercial properties in the United States. As noted, in the following paragraphs, the largely pension-fund owned properties comprising the NCREIF and IPD indices tend to be the much larger and relatively more expensive properties concentrated in a relatively few favoured locations.
- They are ultimately subjective and, in large part, self-reported judgements, estimates of what a property *would* sell for, as distinct from what a property actually *did* sell for.

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[162] The sophistication and maturity of the commercial property appraisal profession varies across countries. The U.S. may be a relatively mature and sophisticated case, though probably less so than the United Kingdom.

• They can exhibit a temporal lag bias and/or a smoothing bias due to their heavy dependence on evidence about historical market values observed in actual transaction prices — a bias which over time can vary in magnitude and can also differ across countries [163].

10.5.2. Transaction-based indices

In the United States, transaction-based indices have been able to address some of the aforementioned problems with appraisal based indices and have been the major innovation in the past decade for tracking commercial property prices in that country. Arguably these are the most pure and direct type of indicators of the most fundamental type of data about commercial property price performance. Yet they are very challenging and fraught with a number of theoretical, empirical and practical issues, as demonstrated in earlier chapters. In the context of the different uses to which CPPIs are put in the United States, they are not viewed as a replacement to appraisal based indices, rather, the two types of indices are viewed as valuable complements to one another, and both types are widely used.

There are several ways to construct a transaction based price index. Most simply (and too simplistically), some indices published in the United States have been computed historically using the average or median price per square foot of all the properties sold in each period, ignoring the fact that commercial properties are very heterogeneous. Not surprisingly, this can lead to incorrect results. Most recently, during the 2008-09 crash some indicators of average or median price per square foot at first went up — not because prices were rising, but rather because there was a 'flight to quality': the only deals that could get done were on 'trophy' assets i.e. on good quality real estate [164]. Such a simplistic methodology should be avoided where ever possible.

Against this background, there are three major 'families' of transactions-based indices of commercial property prices currently being regularly published in the United States. Each reflects a different database source. In order of historical development and first publication, these are: NCREIF, Real Capital Analytics, and CoStar.

10.5.2.1. THE NCREIF TRANSACTIONS BASED INDEX (NTBI)

The *TBI* index was launched at MIT in early 2006 with the support of NCREIF, and in 2011 was taken over by NCREIF and is now known as the '*NTBI*'. When first launched it took professional appraisals of each 'transacted' property — appraisals undertaken not long before each transaction occurred — and regressed the transaction price against the appraisal value plus using time dummies to produce an 'hedonic-type' of transaction price index. To construct the index, the regression results were combined with an index of changes in the appraised values (adding back any capital expenditures), using the time-dummy coefficients from the regression to represent the average difference each period between the transaction prices and the appraisals, and using the appraisal-based index to represent the change in appraised values over time. In theory this should have mitigated the problem of omitted variables bias.

When NCREIF took over production and produced the *NTBI* [165] a simplified approach — the SPAR method, which doesn't necessitate formal regression modelling was adopted. The average ratio of sales price to recent appraised value among all the properties sold each period is computed, and this ratio is multiplied by the corresponding appraisal based index value level, each period.

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[163] Any variation across countries will put into question the validity of international comparisons.

[164] Commercial properties are not only heterogeneous at the individual property level, but the asset market also tends to cleave and segment in the sense that different price dynamics can often apply in different types of locations (such as major metro areas versus non-major ones, central business districts versus suburbs) or at different scales of property (high versus low investment price points), as well as among different usage type sectors (apartment, office, retail, industrial etc.). These different price dynamics can reflect differences in financial capital sources as well as differences in the physical supply and demand in the space markets. The point to note on the latter is that asset values derive not just from the fundamentals of the future rental income streams the properties can generate in the space market, but also from the opportunity cost of capital (OCC) in the asset market, in effect, the discount rates the capital market applies to capitalize the expected future income streams. The relevant OCC can vary dramatically over time, not only reflecting changes in interest rates but also in risk premium, the capital market's preferences for real estate versus other asset classes or for different types of real estate. Capital flowing into or out of real estate sectors can significantly influence asset pricing.
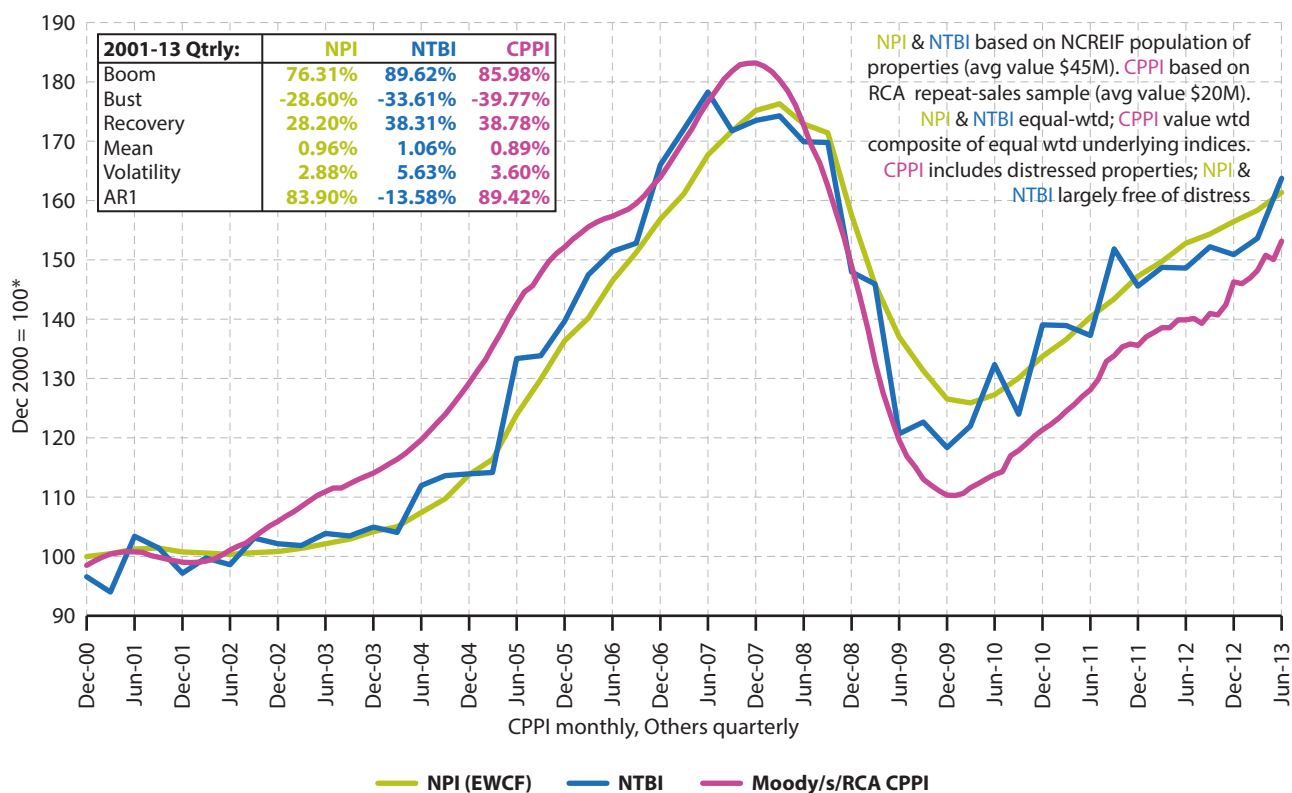
[165] See Geltner (2011). This technical white paper is available on the web.

SPAR indices of transactions prices can only be applied in a limited context where there is good, consistent, regularly updated appraisal information for the sold properties. In effect in the United States, this is presently limited more or less to the NCREIF and IPD populations of properties. Where *TBI*-type indices can be produced, they provide an interesting insight into the difference between appraisal based and transaction based price indices (for the corresponding same population of properties).

Figure 10.9 below depicts such a comparison over the period 2001-2013. The light green line is the traditional appraisal-based *NPI* indexed to 100 as of the end of 2000. The blue line is the corresponding transaction based *NTBI* over the same period, indexed to have a starting value such that the two series have the same overall average level ([166]).

Note that while the *NTBI* and *NPI* broadly track each other, the transaction-based *NTBI* appears to lead the appraisal-based index in terms of the timing of the major turning points. The 2000s decade peak occurred about 3 quarters earlier in the *NTBI* than in the *NPI*, and the trough occurred one quarter earlier. Also the transaction-based index compared to the appraisal-based index is a bit more volatile (5.6 per cent versus 2.9 per cent quarterly volatility), and has somewhat greater cycle amplitude (33.6 per cent peak-trough drop versus 28.6 per cent). The extremely high quarterly first-order autocorrelation in the *NPI* reflects the appraisal smoothing and lagging phenomenon discussed elsewhere in Chapter 7, while the slightly negative AR1(autocorrelation) statistic in the *NTBI* likely reflects a modest amount of noise in the index. Part of the difference in quarterly volatility between the two indices is due to noise in the *NTBI*, and part is due to appraisal smoothing and stale appraisals in *NPI*.

Figure 10.9 Transaction Based NTBI & CPPI Compared to Appraisal Based NPI, 2001-13

2001-13 Qtrly:	NPI	NTBI	CPPI
Boom	76.31%	89.62%	85.98%
Bust	-28.60%	-33.61%	-39.77%
Recovery	28.20%	38.31%	38.78%
Mean	0.96%	1.06%	0.89%
Volatility	2.88%	5.63%	3.60%
AR1	83.90%	-13.58%	89.42%

NPI & NTBI based on NCREIF population of properties (avg value $45M). CPPI based on RCA repeat-sales sample (avg value $20M). NPI & NTBI equal-wtd; CPPI value wtd composite of equal wtd underlying indices. CPPI includes distressed properties; NPI & NTBI largely free of distress

CPPI monthly, Others quarterly

—— NPI (EWCF)   —— NTBI   —— Moody/s/RCA CPPI

* Transaction based indices starting value set to equate 2001-13 average price level to appraisal based index. (does not affect returns)
Source: NCREIF, RCA (July2013)

([166]) This does not affect the index longitudinal relative price changes, which are the only information provided by the index, as the starting value for any longitudinal relative value index is arbitrary. It makes sense for the transactions based and appraisal based indices to have very similar average levels over a complete asset market pricing cycle such as is represented by the historical period covered by the graph, as appraised values on average over the cycle correctly estimate the average transaction prices. Note also that for comparability to the transactions based indices, the version of the NPI presented in Figure 9 is equal-weighted (instead of value-weighted like the official NPI) and is gross of capital expenditures (i.e., tracks asset value changes including the effect of capital improvements).

10.5.2.2. THE MOODY'S/RCA COMMERCIAL PROPERTY PRICE INDEX SERIES (CPPI)

The Moody's/RCA *CPPI* is the current version of one of the longest regularly published repeat sales index of commercial property in the United States. The *CPPI* is based on the Real Capital Analytics Inc. (RCA) database, which seeks to capture all commercial property sales over $2.5 million, a cutoff roughly distinguishing between professional investment properties and other smaller properties many of which are owner-occupied. This also roughly corresponds to a cutoff below which non-bank sources of debt or equity financing (such as life insurance companies, REITs, private equity, foreign investors, and commercial mortgage-backed securities) have generally not been available [167]. As of 2013 RCA had over 180,000 transactions in their database, yielding approximately 30,000 repeat sales observations in the *CPPI* (i.e. 60,000 transactions) [168] and about 1,000 new repeat sale observations valid for the index have been recorded per month, representing sales of around $20 billion per month [169].

The Moody's/RCA *CPPI* is a hierarchical suite of 20 indices with some being composites of others. The *National All-Property* composite index is shown by the red line in the graph in the previous sub-section. This index tracks a much broader population of properties than NCREIF, with a much smaller average price point (approximately $20 million to NCREIF's $45 million), and is based on the rather different methodology of repeat sales rather than SPAR or appraisal-based estimation. Nevertheless the *CPPI National All-Property Index* shows a similar path of price change. The biggest difference at this broad-brush level is that the *CPPI* fell farther during the 2008-09 crash, losing almost 40 per cent of its peak value, compared to just under 34 per cent and 29 per cent for the *NTBI* and *NPI* respectively. These are small differences in the depiction of the overall picture of the property market and suggest that for some purposes and situations the different indices may be interchangeable leading to the practical feasibility of developing and comparing CPPIs from different environs. However, the usefulness of the latter depends on whether these different indices can always serve as proxies for one another

10.5.3. Sparse data, noise filtering, and frequency conversion

As noted in previous chapters, commercial property asset price indexing is more challenging than that of residential real estate in part due to the generally much smaller transaction sample sizes. Transaction based indices will often exhibit considerable noise without some sort of noise filtering or smoothing treatment. Thus the volatile appearance of the indices in the graphs presented above give an idea of what transactions based indices can look like without any noise filtering, even based on samples of several tens of thousands of transactions in a little over a decade. Yet the most straightforward and common methods of smoothing, such as moving average or exponential smoothing, tend to induce a delay or temporal lag bias into the indices, which can be a major drawback in some contexts.

A fair amount of academic literature has focused on ways to deal with sparse data, whether it be in residential or commercial property applications. Two major methods of noise filtering or dealing with sparse data have primarily been used so far in the regularly published commercial property transaction based indices introduced in the United States. These include the Bayesian ridge regression procedure first introduced by Goetzmann (1992), and the two-stage frequency conversion (2SFC) process described in Bokhari & Geltner (2012). Neither the ridge nor the 2SFC technique introduces much temporal lag bias, the main problem with many more common smoothing methods [170].

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[167] In the repeat sales database used in the CPPI, once a first-sale exceeds the $2.5 million threshold as measured in 2010 constant-purchasing-power inflation-adjusted dollars, the observation remains in the database even if the second-sale falls below $2.5 million, but first-sales below $2.5 million are excluded, so as to avoid upward bias in the index.

[168] Not all transactions have a second-sale corresponding to the same property, or pass the index filters

[169] During the trough of the Financial Crisis in 2009 this number was only about 300 RS observations representing $3-$4 billion of second-sales transactions per month.

[170] However, see Bokhari & Geltner (2012) for further discussion. It is likely that the 2SFC process does cause some occasional slight temporal lagging, particularly around major turning points in the pricing. This is likely due to some remnant temporal aggregation in the underlying annual frequency repeat sales regressions (see Geltner, 1997) even though time-weighted time-dummy variables are employed (see Byron & Colwell, 1982). The Goetzmann (1992) Bayesian ridge process was used both in the original version of the CPPI and in the MIT regression-based version of the TBI. (See also Gatzlaff & Geltner, 1998, and Fisher *et al*, 2007.) However, the Bayesian ridge involves more subjectivity than the 2SFC process and ultimately proved to be less effective at filtering noise from the indices. The NTBI currently employs no noise filter.

Other noise filtering techniques have been proposed in the academic literature. However, many of these involve time parameterizations or curve-fitting ([171]). These can work well for one-off research studies of an overall history. But they can be sluggish at identifying a pricing turning point in 'real time' as a production index is updated each month with the latest transaction price evidence.

The Moody's/RCA *CPPI* appears as smooth as it does in Figure 10.9 largely because it is constructed using a 2SFC process in which the underlying repeat sales regressions are estimated at an annual frequency, thereby allowing on average 12 times the effective sample size per index period ([172]). This method is referred to as 'ATM' (for Annual-To-Monthly), and it accounts for the CPPI's very high quarterly first-order autocorrelation. This method of noise filtering replaced the Bayesian ridge regression technique used in the earlier ('Moody's/REAL') version of the *CPPI* ([173]).

10.5.4. Market segmentation in the CPPI

As noted earlier, commercial property is not only heterogeneous at the individual property level, but the asset market tends to break into numerous segments — each of which can have different pricing dynamics. Furthermore, the asset market segmentation is not necessarily constant over time, but may evolve with changes in the finance industry and capital markets ([174]). Therefore it is advantageous to structure a system of indices that will well reflect this phenomenon. Of course, there is no single or permanent solution to this challenge, but the Moody's/RCA *CPPI* provides an illustrative example.

Figure 10.10 below describes the index system suite. The basis of the system is a set of ten monthly-updated 'building-block' indices that are directly estimated by regression modelling of the RCA repeat sales database. These indices are equally weighted across repeat sale observations, because equal weighting is generally most efficient from a statistical perspective, less susceptible to being thrown off by a few large individual property deals. However, the underlying assumption in any regression model is that the sample is drawn from a single population. Thus, the ten building-block indices represent ten market segments that attempt to capture the more abiding differentials in asset pricing behaviour. Several dimensions are reflected therefore in the ten underlying market segments: traditional property sectors (apartment, industrial, office, retail); central business district (CBD) versus suburban locations; and the 'market tier' of the metropolitan location. The objective is that within each of the ten underlying market segments there should be more homogeneity and more persistence in the homogeneity. For example, CBD office properties tend to be larger and more expensive than suburban offices, so the two types are not mixed within the same underlying directly-estimated index.

'*Major Markets*' are identified as the metro areas of Boston, New York, Washington DC, Chicago, San Francisco Bay, and Los Angeles. These six metros account for nearly half of all of the commercial property trading by value of sales. They have consistently attracted capital from major domestic and foreign institutions much more strongly than other locations. They also tend to be somewhat physically or politically supply constrained in terms of new property development. As a result, the *CPPI Major Markets* exhibit a tendency toward separate price dynamics, both in the short run and long run. The same is true between CBD and suburban markets especially in the office sector.

Five sectors (apartment, industrial, retail, CBD-office, and suburban-office) are tracked separately for the *Major Markets (MM)* and the *Non-Major Markets (NMM),* resulting in the ten building-block indices labelled 'Tier 4' in Figure 10.10 below.

The ten other higher level, more aggregate indices in the *CPPI* system, labelled in the other index tiers in the graph, are all constructed directly or indirectly from the ten building-block indices by value-weighting the building blocks based on the dollar volume of trading in the RCA database. For example,

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([171]) See, for example, McMillen & Dombrow (2001), or Hodrick & Prescott (1997).

([172]) Twelve different versions of the annual regressions are run, with starting dates staggered by one month. A generalized inverse matrix is used to optimally fit the resulting staggered annual indices to a monthly-frequency value levels series. The resulting process exactly preserves each underlying 12-month-span price-change return. See Bokhari & Geltner (2012), and Geltner *et al* (2012).

([173]) The index was branded by RCA subsidiary Real Estate Analytics LLC (REAL) during 2007-11. Substantial methodological changes were introduced with the new RCA-branded version in 2012, including getting rid of the ridge regression.

([174]) For example, before the advent of commercial mortgage backed securities (CMBS) as a major source for CRE finance, $10,000,000 was often viewed as the lower limit on the size of 'institutional' real estate investment properties. CMBS brought that threshold down to perhaps around $2,500,000 by the first decade of the 21st century.

the average weighting within the Tier 3 composite *CBD-office Index* is 76 per cent on *Major Markets* and 24 per cent on *Non-Major Markets*. In the composite apartment index of Tier 2 and 3, the *Non-Major Markets* outweigh the *Major Markets* by an average of 63 percent to 37 percent. At the top level, the Tier 1 *National Composite* ('headline') index has a 73 percent weight on the Tier 2 composite commercial index and a 27 percent weight on the apartment composite ([175]).

Figure 10.10 Moody's/RCA CPPI Index Suite

An Articulated System of Building-Block & Composite Indices
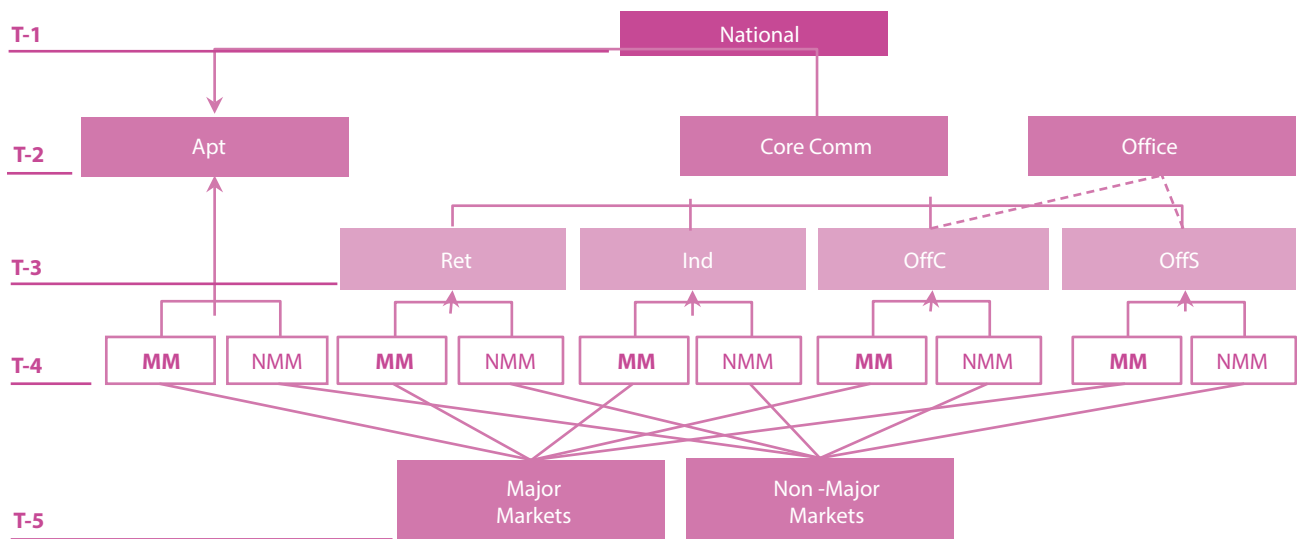
In late 2012, shortly after launching the re-branded Moody's/RCA *CPPI*, Real Capital Analytics launched a new series of highly granular CPPIs produced solely by RCA and labelled the *RCA US CPPI Series*. This is a suite of approximately 186 (some overlapping) repeat sales indices based on the same database and same methodology as the previously described Moody's/RCA *CPPI*. The additional methodology and index construction protocols that have made the greater granularity possible, in spite of the much smaller sample transaction sample sizes, include a reduction in index publication frequency from monthly to quarterly, the introduction of simple rolling-average smoothing (with the trade-off of accepting some temporal lag in the indices), and the provision for 'blending' the granular indices with higher-level (more aggregate) indices during periods of sparse transactions ([176]).

The breakdowns within the *RCA US CPPI* suite as of 2013 included:

- **30 Regional Indices:** These include indices for 5 contiguous multi-state regions and 6 property type sector groupings;
- **20 State Indices:** These include all-property indices for the 20 largest US states (by commercial real estate activity);
- **100+ Metro/Market Indices:** These include indices for all-property, core commercial (office, retail, and industrial combined), and the apartment sector (separately), for 34 geographic metros/markets/ submarkets;
- **25+ Property Attribute Indices:** These indices include specialty cuts by property type, size, and type of investor (seller).

Figure 10.11 below gives an idea what these highly granular transaction based indices look like. They enable much finer market segmentation and analysis of the determinants and correlates of commercial real estate asset price dynamics, albeit with some loss of frequency, timeliness compared to the Moody's/RCA suite, and occasionally some loss of market segment 'purity' due to the blending ([177]).

([175]) The value-weighting is constructed in a manner similar to stock market indices, with the weights re-set at the beginning of each year on the basis of the rolling 10-years previous cumulative RCA transaction volume (a proxy for the relative size of the standing stock), with monthly returns within the year reflecting a 'buy-and-hold' portfolio starting from those weights.

([176]) The degree of blending is explicitly reported with the index results.

([177]) In 2013 RCA has launched a UK CPPI index suite.

Six Major Metro & Nine Example Non-Major Metro All-Property Indices

RCA CPPI: Example Metro-Level CRE Price Indices

Example of Transaction Price Index Granulairty: Moodys/RCA CPPI, 6 Major Metros

Boston   Chicago   DC Metro   LA Metro   NYC Metro   SF Metro
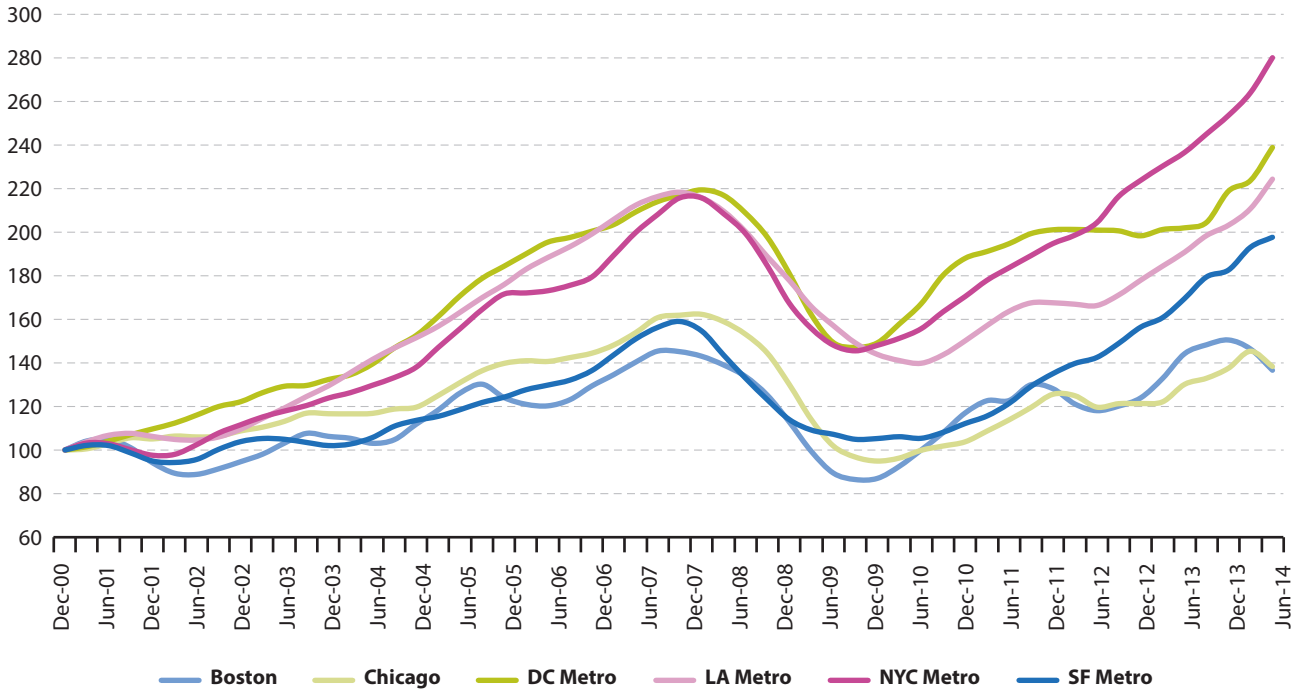
Example of Transaction Price Index Granulairty: Moodys/RCA CPPI, 9 Non-Major Metros

Atlanta   Denver   Las Vegas
Miami/Sofia   Philadelphia/Baltimore   Phoenix
San Diego   Seattle   Austin/Dallas/Houston
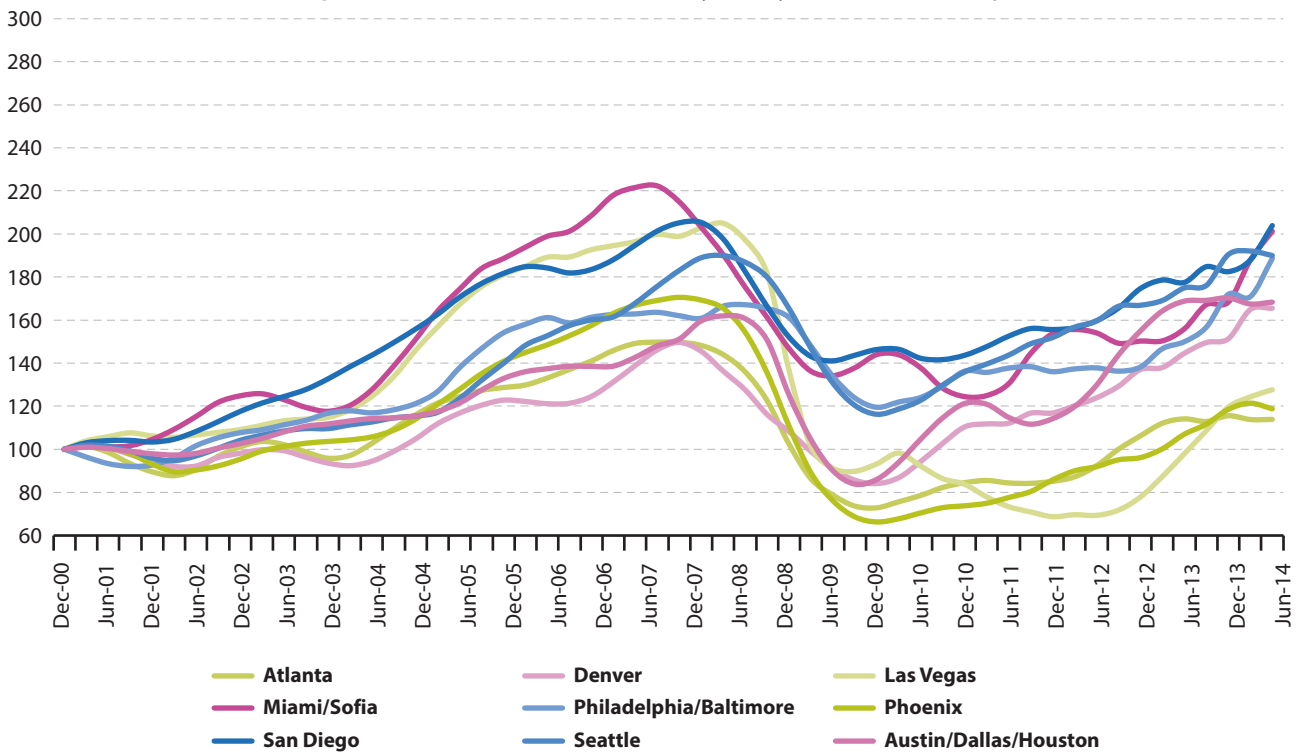
Index series contains over 180 granular CRE price indices
Indices are quarterly, employ moving-average smoothing, and employ some "blending" with higher-level
(more aggregate) indices during periods of sparse data if necessary

10.5.5. The CoStar Commercial Repeat sales Index Series (CCRSI)

In 2010 CoStar Group launched their own repeat sales index, the *CoStar Commercial Repeat Sales Index (CCRSI)*, based on the same general type of econometrically rigorous regression model as the Moody's/REAL CPPI, but using CoStar's more extensive database of property transactions. The *CCRSI* is a suite of some 50 CPPIs tracking virtually all commercial properties (down to properties with rental building area of 2,500 square feet or 10 units for apartment buildings). The *CCRSI* consists of 5 levels of indices: national composite, segmental (investment grade, general commercial, non-residential commercial), regional (Northeast, Midwest, South, and West), sectorial (Office, Retail, Industrial, Apartment, Hotel, and Commercial Land), and regional-sectorial (North East Office, etc.). Most high level indices are available in both equal-weighted and value-weighted versions ([178]). In addition, 150 metro-level hedonic indices, such as New York office, Chicago industrial, are also available upon request, for a fee.

Unlike RCA, which limits its focus to larger professional investment properties, CoStar attempts to include in their database virtually all commercial properties regardless of size (at least down to around $150,000 in value). As of 2013 CoStar had well over one million properties in their database, yielding over 125,000 post-filter repeat sales observations for the *CCRSI* which is published going back through 1998. Through 2013, total dollar trading volume since 2000 was $566 billion, with almost 1,000 new 2nd-sales observations per month ($4.5 billion) in recent years.

As of 2013 there are approximately 50 regularly published *CCRSI* indices, including:

- **2 National Composite:** One equal-weighted the other value-weighted;
- **2 National Market Segment Indices:** One Investment Grade, the other General. Investment Grade properties consist of larger-sized, reasonable-quality properties that match the type most often purchased by institutional investors. More specifically, this category includes 4-Star and 5-Star office properties that have more than 35,000 square feet of rentable building area (RBA), or industrial buildings larger than 80,000 square feet of rentable building area (RBA), flex buildings larger than 55,000 square feet of RBA, retail properties larger than 25,000 square feet of RBA, multifamily buildings with 90,000 square feet of RBA or 10 rental units, and more than 125,000 square feet of RBA for hotels. Any properties not meeting the Investment Grade criteria belong to the General Commercial category;
- **2 National Value-Weighted Breakouts:** One just of apartment (multi-family rental) properties, the other for commercial properties *excluding* apartments;
- **10 National Property Type Sector Indices:** Four equal-weighed and four value-weighted each for: apartment, industrial, office, retail; and two equal-weighted for: hotel, and commercial land
- **8 Regional All-Property Indices:** Four equal-weighed and four value-weighted each for: Northeast, Midwest, South, and West;
- **4 Prime Metros Property Type Sector Indices:** Equal-weighted, one each for apartment, industrial, office, retail. 'Prime Metros' are the largest seven to 10 metro areas by trading volume within each property type sector;
- **16 Region X Type Breakout Indices:** The four sectors within each of the four regions (per above), equal-weighted;
- **2 National Non-Distressed Indices:** Equal-weighted, one each for the composite and the investment grade. These indices exclude distressed properties, which includes auction sale, deed in lieu of foreclosure, distress sale; foreclosure; real estate owned (REO) sale; and short sale.

10.5.6. Another layer of market segmentation: 'General' and 'Investment' properties in the CCRSI

An interesting feature of the *CCRSI* is that CoStar breaks out the index into two major market segments (mutually exclusive and exhaustive), which they label 'Investment' property and 'General' property. Investment properties are larger and more typical of the types of properties favoured by professional investment institutions. The CoStar classification of investment property probably roughly corresponds

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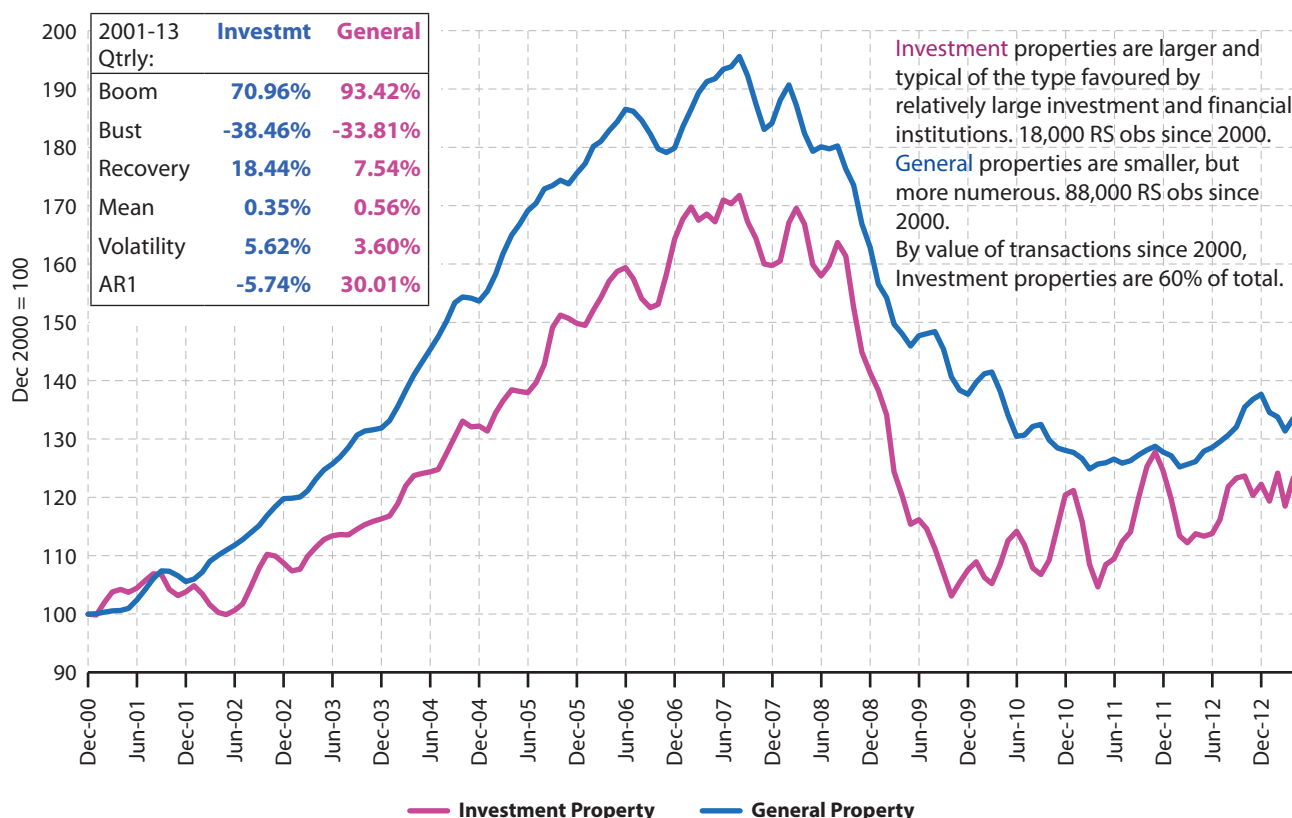([178]) Unlike in the Moody's/RCA CPPI, CoStar's value-weighted indices are not composites of lower-level equal-weighted indices, but rather are directly estimated property-level indices in which the RS observations in the underlying regression are weighted by their initial sale price value. (See Shiller, 1991.)

to the $2.5 million lower-bound cutoff similar to the CPPI population, although CoStar uses physical criteria rather than a value-based cutoff. Of 106,000 *CCRSI* repeat sales observations since 2000, 88,000 are of general properties and 18,000 are investment properties. Through 2013, total dollar trading volume since 2000 of the investment properties was $388 billion, while general properties were $178 billion. During 2013 the count has been averaging roughly 150 new 2nd-sales observations per month for investment properties (around $3 billion), 800 for general properties ($1.5 billion).

The *CCRSI General Index* is a unique source for tracking the smaller U.S. commercial properties, which account for the vast majority of all commercial property assets but perhaps only about half of the value of the stock (and less than half the dollar volume of trading). The graph below compares the *CCRSI Investment* and *General price indices* starting in 2001. Note how different the price dynamics have been between the major properties in the Investment index versus the smaller properties in the *General index*. It appears that the smaller properties grew more in price during the period of price increases of the 2000s (93 per cent to 71 per cent), and then fell less far during the financial crisis (34 per cent to 38 per cent). However, in the subsequent recovery the smaller properties had not yet rebounded as much through 2013 (18 per cent versus 8 per cent). The result is that both segments as of 2013 were about equally far below their respective peaks, in relative terms (down a little more 30 per cent below the peak) ([179]).

The *CCRSI* Investment index appears considerably more noisy than the corresponding Moody's/RCA *CPPI All-Property Index* (which is also essentially 'investment' property), probably in part because the *CPPI* has more repeat sales observations and in part because the *CCRSI* employs less noise filtering. At the quarterly frequency the *CCRSI* has volatility of 5.6 per cent versus 3.6 per cent in the *CPPI*.

Figure 10.12 CoStar CCRSI General & Investment Monthly Prices, 2001-2013

2001-13 Qtrly:	Investmt	General
Boom	70.96%	93.42%
Bust	-38.46%	-33.81%
Recovery	18.44%	7.54%
Mean	0.35%	0.56%
Volatility	5.62%	3.60%
AR1	-5.74%	30.01%

Investment properties are larger and typical of the type favoured by relatively large investment and financial institutions. 18,000 RS obs since 2000. General properties are smaller, but more numerous. 88,000 RS obs since 2000.
By value of transactions since 2000, Investment properties are 60% of total.

— Investment Property   — General Property

Source: CoStar Group (July 2013)

([179]) The differential price performance since the peak probably substantially reflects the different types of financing sources available to the two different market segments. During the worst of the financial crisis in 2008-09 non-bank sources of capital virtually completely froze up, causing Investment property to plummet in value. The more locally-based relationship lending of small-scale bank financing for the General properties did not dry up as completely. But after 2009 non-bank financing sources bounced back strongly, while banks, especially small to medium size local and regional banks, remained saddled and constrained, in no small part due to excessive commercial mortgage lending during the peak. This again demonstrates the importance of market segmentation for tracking commercial property prices.

10.5.7. Stock market-based indices

While transaction-based indices have been the major commercial property performance measurement innovation of the first decade of the 21st century in the United States, it can be argued that stock market-based indices have several advantages, most particularly the possibility of objective, replicable, daily-updated price indicators based on the highly information efficient mechanism of the stock market. Stock market-based indices directly measure actual liquid market values of traded 'financial' assets rather than a statistical estimate of value. Stock market-based indices do not require sales of individual property assets, and so avoid the leakage of information caused by sales of entire portfolios of multiple properties at once, a growing phenomenon in the United States which effectively cuts into usable data available for transaction based indices ([180]). Finally, it has been argued that, in the European context, stock market based indices offer the prospect of true pan-European indices, based on REITs holding properties in numerous European countries and several European stock exchanges ([181]).

Stock market based indices are made possible by the existence of a large and mature REIT sector within the stock market. 'REITs' are publicly-traded firms that are essentially 'pure plays' in commercial property investment. That is, they are largely confined in their activities to only the ownership and operation of commercial investment property. They also must pay out most of their earnings as dividends. Thus, REITs are vehicles for investment in largely stabilized, operational commercial properties ([182]). As such, REIT equity share prices provide a direct indication of the value of such property (as levered by the REITs), and in particular how this value changes over time.

Of course, this property valuation is made by the stock market, not the private property market in which the commercial property assets actually trade directly. The private property market and the public stock market don't always agree about the value of commercial property. In the private property market assets trade directly in that market, a much greater number and aggregate value of property assets are owned privately outside of REITs, and the property market has a long history and is specialized in such assets. On the other hand the stock market is extremely efficient at information aggregation and price discovery, and (related to that) is more liquid than the private asset market, with a much greater velocity of trading volume (turnover ratio) and highly developed and rapid public information and publication processes.

Evidence suggests that, when the REIT and private market valuations of commercial property differ in the aggregate, that difference tends to be mean-reverting (it tends to average toward zero), and the stock market valuation tends to lead in time the private market valuation. That is, major turning points often occur first in the REIT valuations. REITs now are major players in the property market in the United States. By the early 21st century there were over 100 actively traded public equity REITs in the United States (that is, REITs primarily investing in property equity as opposed to mortgages), with a total aggregate stock market capitalization over $400 billion, holding over $700 billion worth of property assets in some 29,000 individual property assets, more than twice the value and four times the number of assets in the *NCREIF Index* ([183]).

Stockholders investing in and trading REITs can be under no illusion that commercial property assets are fundamentally determining the value of their shares. In short, it seems most correct to say that both the stock market and the private property market have something important and valid to say

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([180]) Transaction based indices require data on the sales prices of individual properties. When multiple-property portfolios are sold at once at a single bulk price, it is generally impossible to know with accuracy and objectivity how much of the transaction price is attributable to each individual asset in the portfolio. Even if hedonic information were available for the portfolio in the aggregate, it would not be reliable for use in a hedonic price index. In the case of repeat sales indices, only if the exact same portfolio is subsequently traded again in bulk can the portfolio sale be used in index construction, and this rarely happens. It is not uncommon for over 20% by value of U.S. CRE investment to occur in portfolio sales in recent years, and this proportion may be growing. (It tends to be greater during boom periods, and less during downturns.)

([181]) See Elonen (2013) for an analysis and demonstration of the feasibility and nature of stock market based indices for Europe. The Elonen thesis can be downloaded from the web at the address indicated in the bibliography for Chapter 7.

([182]) While REITs can engage in real estate development (construction of properties for their own portfolio), they in the U.S. they are generally required to hold properties at least four years and on average 10 years. Thus, REITs are not 'merchant builders' or construction firms, and many REITs in fact only acquire existing properties.

([183]) The Elonen thesis project was able to create approximately 20 pure play type stock market based CRE property price indices based on 68 publicly-traded European REITs (or REIT-like firms tracked by the *FTSE-EPRA REIT Index* for 'Developed Europe'). These 68 firms held some 11,000 individual property assets worth in approximately €350 billion. These included various overlapping indicators such as Europe-wide property sector indices, all-property county indices for several larger countries, Euro-zone versus Non-Euro indices, and several sector X country combination indices.

about the value of commercial property. Stock market-based indices are a way of distilling and focusing that market's information and news about commercial property values in a way that is practical and useful to the investment industry. In principle, they can provide an important third perspective on the commercial property market, complementing the perspectives of appraisal-based and transaction based indices previously discussed.

### 10.5.7.1. THE FTSE NAREIT PUREPROPERTY® INDEX SERIES

The *FTSE-NAREIT PureProperty® Index Series (FNPP)* was launched in June 2012, and the indices have been updated daily by the FTSE since then. The series provides both total investment returns (including income) as well as capital returns (which as previously noted are closely comparable to an asset price change index) for Apartment, Health Care, Hotel, Industrial, Office, and Retail properties located in the domestic USA. In addition to a 'headline' national all-property index, which is a composite of the four regional indices weighted by the estimated values of REIT property holdings in each region, the targeted 'pure' indices (and portfolios) currently being published include the following 21 sub-indices: geographical (East Region Index; Midwest Region Index; South Region Index; West Region Index); property sector (Apartment Index; Health Care Index; Hotel Index; Industrial Index; Office Index; Retail Index); and region by property sector (East Region Apartment Index; Midwest Region Apartment Index; South Region Apartment Index; West Region Apartment Index; East Region Office Index; Midwest Region Office Index; South Region Office Index; West Region Office Index; East Region Retail Index; Midwest Region Retail Index; South Region Retail Index).

The *FNPP* is considered 'quality adjusted' in the sense that the property asset holdings of the constituent REITs do not tend to change within a single trading day, the frequency of the index returns. Furthermore, the purchase or disposition of properties by the REIT does not in general or in principle cause a change in the value of the firm, hence, no impact on the return. (In general, asset purchases and sales occur at or near market value, hence, approximately zero net present value from the perspective of the stockholders.) The capital returns in the *FNPP* property index series do reflect the effect of plowback of retained earnings, including both capital improvement expenditures on existing properties as well as possible accretion of the stock of properties held by the firm. However, this effect is small, as most earnings must be paid out as dividends according to REIT rules. (And this consideration does not affect the total investment return, which consists of asset capital value change plus dividends and debt service paid out.)

The *FNPP* does not normally face any historical revisions, as the stock price history and data relevant for computing the *FNPP* series is complete and final as of each date and does not change subsequently. The regressions underlying the indices are purely cross-sectional (across REITs) within each day, and are not based on estimates requiring subsequent revision.

For an indication of how the *FNPP* indices relate to direct private property market transaction price based indices of investment performance, Figure 10.13 below compares four regional *FNPP* indices versus the corresponding *NCREIF NTBI* for the same geographic regions.

Figure 10.13 Comparison of Daily FTSE NAREIT PureProperty Cumulative Total Return Indices with Corresponding NCREIF NTBI Transaction Based Total Return Indices for Same Geographic Regions, 2000-2012.
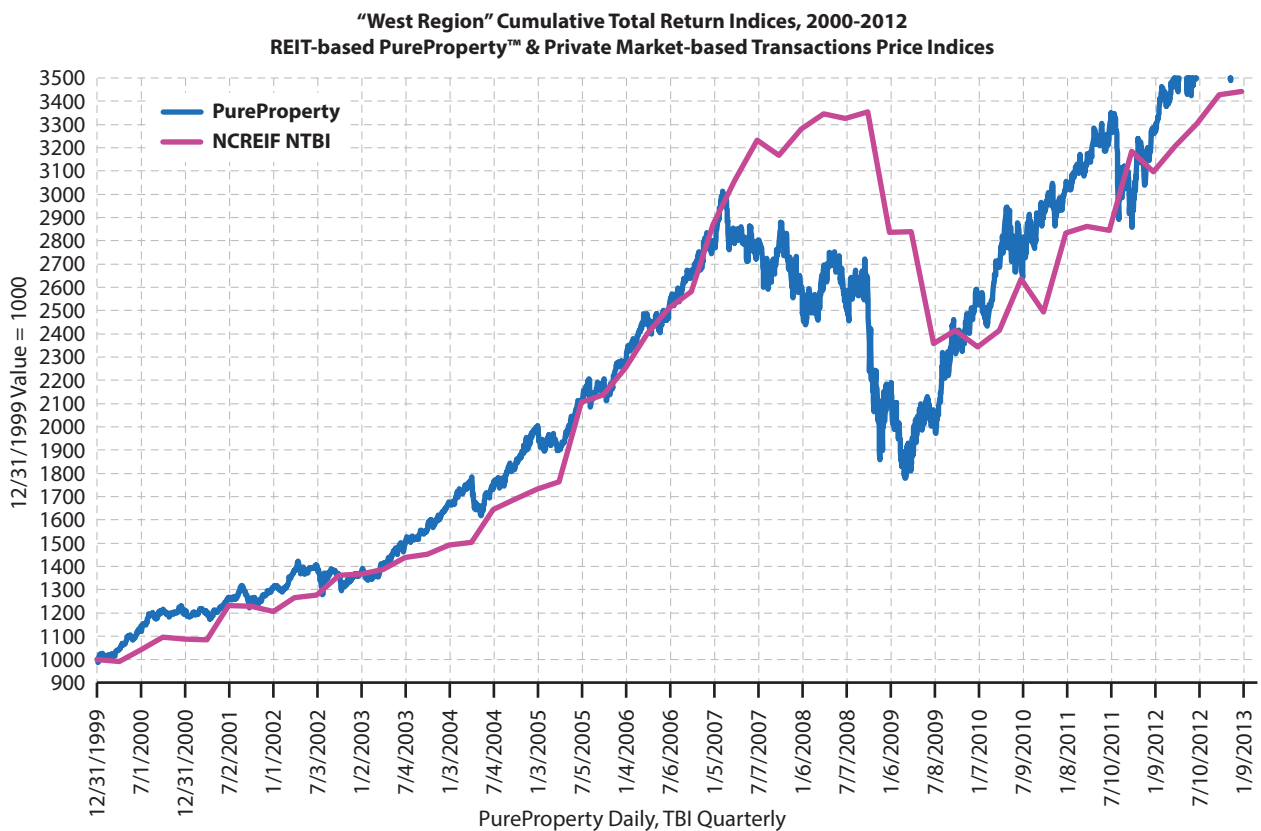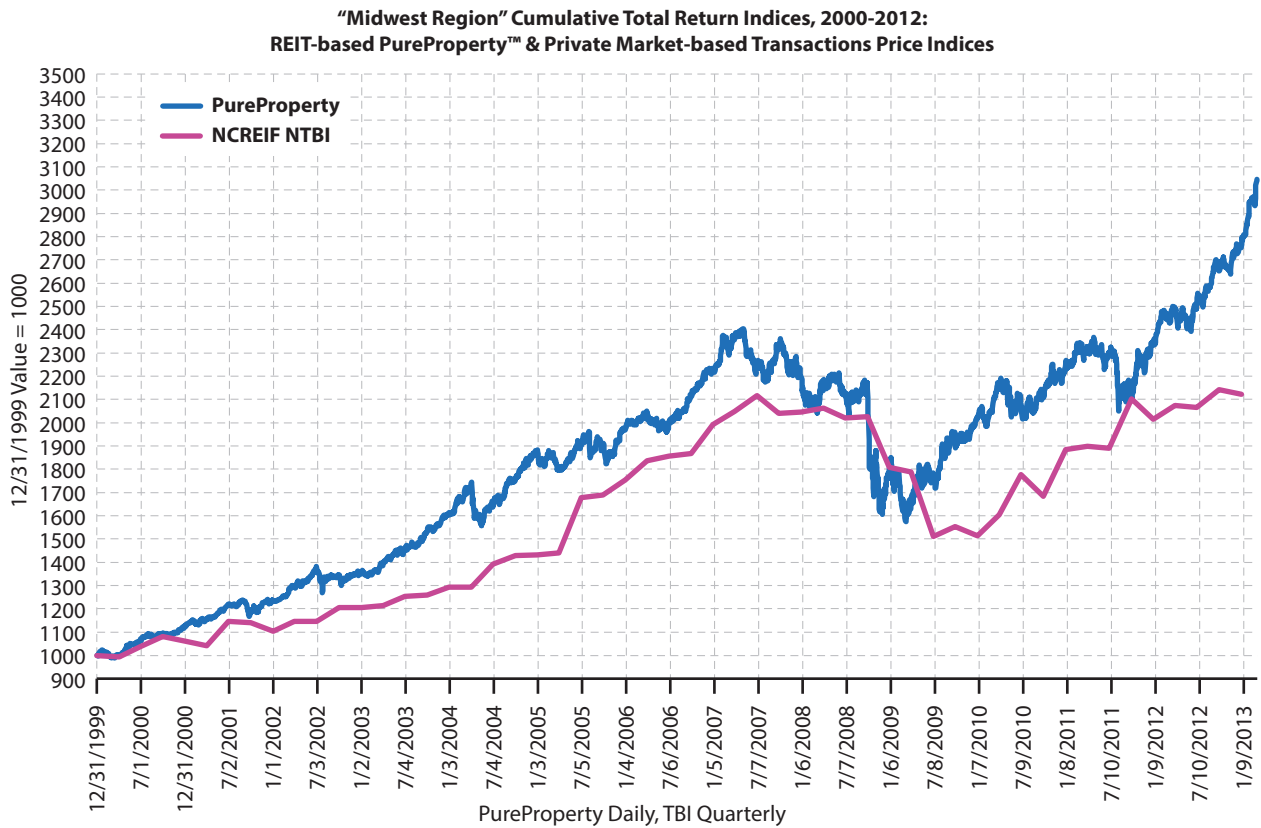
"Midwest Region" Cumulative Total Return Indices, 2000-2012:
REIT-based PureProperty™ & Private Market-based Transactions Price Indices

PurePoperty Daily, TBI Quarterly

"West Region" Cumulative Total Return Indices, 2000-2012
REIT-based PureProperty™ & Private Market-based Transactions Price Indices

PureProperty Daily, TBI Quarterly

**"East Region" Cumulative Total Return Indices, 2000-2012:
REIT-based PureProperty™ & Private Market-based Transactions Price Indices**

PurePropety Daily, TBI Quarterly

**"South Region" Cumulative Total Return Indices, 2000-2012:
REIT-based PureProperty™ & Private Market-based Transactions Price Indices**

PurePropety Daily, TBI Quarterly
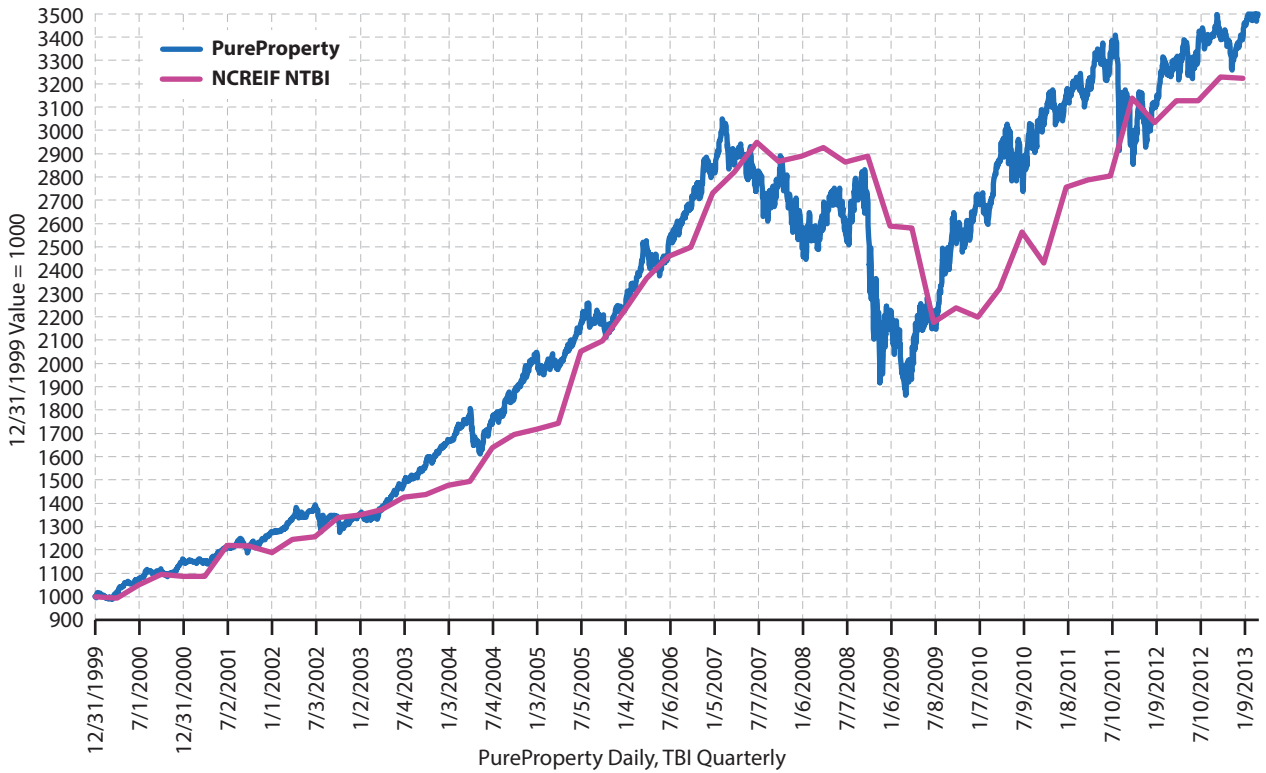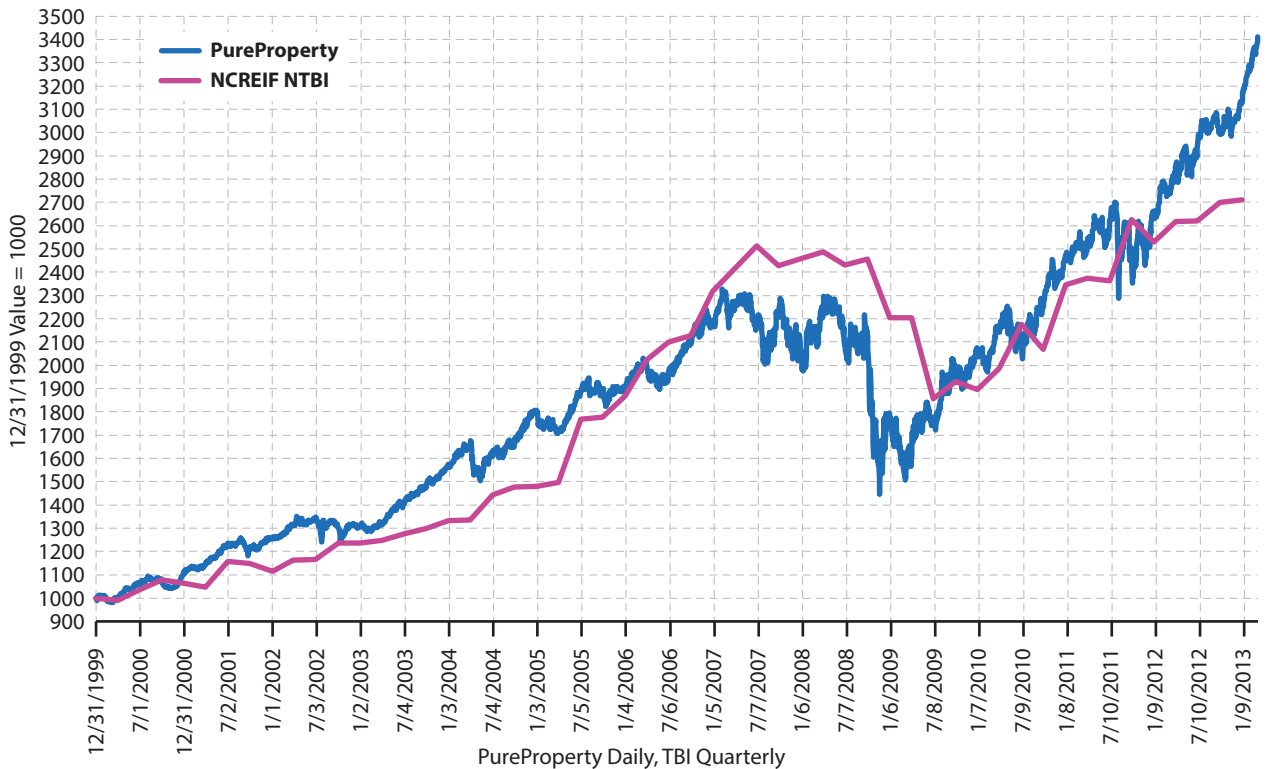
It should be noted that the *PureProperty Index* describes the same general price history at the big picture level as the direct private market based indices, but the daily-updated *FNPP* tends to lead the private market based indices in the timing of the major turning points in the cycle. The *PureProperty Index*

appears to show greater short-run volatility, and to exhibit some transient price movements that are not echoed in the private market based indices. However, if we controlled for frequency of information updating, for example by reporting the *PureProperty Index* only at the end of every quarter or year, then it would have about the same volatility as the transaction based private market indices, over the 2000-12 period examined. The four charts shown have the same vertical scales, so it is apparent that the *FNPP* and NCREIF-based indices trace the same long-run big picture result, but with the stock market based index leading, and providing much more frequent information updating. For example, the East and West regions had higher overall return trends than the South and Midwest regions during the 2000-2012 period, in both the NCREIF-based and the stock market-based indices.

10.6. Case Study: Hong Kong SAR

10.6.1. Introduction

Hong Kong SAR is known to be one of the most active real estate markets in the world. The real estate market is also one of the most transparent and, unlike many other countries, the properties are relatively homogeneous. Since the 1990s, there have been, on average, more than 100,000 transactions per year, which represent close to 10 per cent of all private stock of real estate in Hong Kong SAR (see Figure 10.14 below). The abundant volume of transactions of relatively homogeneous properties in a small geographical area provides a very favourable environment for the construction of real estate price indices. In particular, the number of repeated sales has been very high: 23 per cent of the transactions were repeat sales in a 10 year cycle. This rate of transactions is among the highest as compared to previous repeat sales studies as shown in Table 10.4. There are several reasons for this high liquidity. First, since there is no capital gains tax in Hong Kong SAR, the costs of transaction are greatly reduced. Furthermore, it is a very small place with a highly mobile population within the city. The cost of moving from one place to another is relatively low. Lastly, as previously noted the real estate market is very transparent and efficient. All transaction data is publicly available (although not for free) since real estate transactions have to be registered and kept with the Land Registry of the Government of the Hong Kong SAR. The Land Registry provides information such as transaction prices, transaction dates, building age and addresses. The transaction price is the price as stated in the deed of assignment.

Figure 10.14 Number of Transactions as a Percentage of Total Private Domestic Building Stock
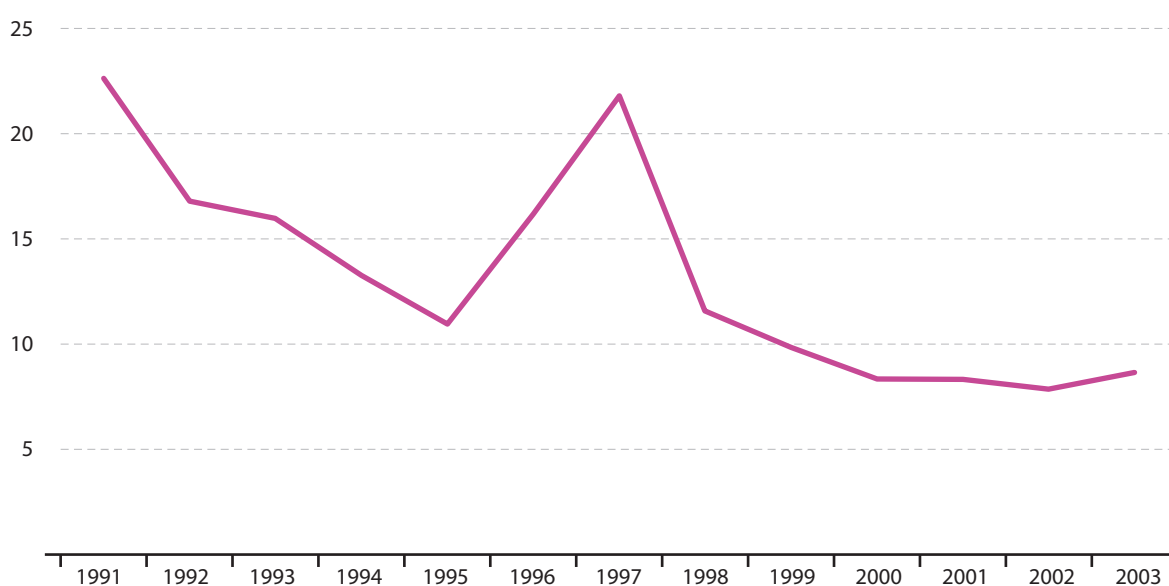
Table 10.4 A comparison of the proportion of repeat sales used in major studies

References	Proportion of Repeat sales Pairs to Total Number of Transactions (%)	Period of Study (Years)
Mark and Goldberg(1984)	32.1	23
Gatzlaff and Haurin (1997)	31.9	24
Clapp etal.(1991)	25.0	7
Englund, et al.(1998,1999)	20.7	12
Case, et al.(1991)	7.3	7
Hill, et al.(1997)	9.3	6
Meese and Wallace (1997)	6.6	18
Steele and Goy(1997)	5.9	3
Case and Shiller(1987)	4.1	16
Abraham and Schauman (1991)	2.5	19
Hong Kong SAR	23.0	10

This transparency, together with the homogeneous nature of housing units in Hong Kong SAR, has enhanced the liquidity of the real estate market.

10.6.2. Existing Index Sources in Hong Kong SAR

There are four main providers of price indices: (1) the Rating and Valuation Department (RVD); (2) Jones Lang LaSalle (JLS); (3) FPD Savills (FPD); and (4) Centa-City (CC). Their indices differ by coverage and construction methodology. Their characteristics are described below, with a summary given in Table 10.5.

Both the *JLL Index* and the *FPD Index* are valuation-based and are vulnerable to the problem of valuation smoothing. Although the *CC Index* is transaction-based, it only covers a limited market segment of residential developments. The *RVD Index* has wide coverage, but its quality adjustment procedure relies on valuation. According to the Land Registry, the numbers and values of property transactions averaged 10,000 units and HK$28 billion per month, respectively, between 1991 and 2003. In light of the high volume of transactions, there is a clear need and potential for the establishment of transaction-based indices to represent the performance of each property sector in Hong Kong SAR.

In principle, the repeat sales method is particularly suitable for Hong Kong SAR because of the existence of a very active secondary real estate in a highly geographically concentrated area (see previous table). Hong Kong University began computing repeat sales indices for the commercial sector but discontinued doing so because the error margins of the derived indices were relatively large and there was no obvious demand for yet another index. There was also some concern regarding sampling bias from repeat sales. Properties subject to frequent transactions were excluded in attempt to address this issue. No further work was undertaken.

10.6.2.1. THE RATING & VALUATION DEPARTMENT INDEX

The longest price index series in Hong Kong SAR is provided by the Rating and Valuation Department (RVD). The RVD has published quarterly indices for four major property sectors in Hong Kong SAR, namely residential, office, retail, and industrial properties, since 1979. Monthly indices have also become available since 1993. Examples of studies using these indices include Brown and Chau (1997), Chau (1997) and Webb, Chau and Li (1997).

Apart from aggregate indices, the RVD also compiles indices for some sub-sectors of residential and office properties. For residential properties, sub-indices are available for: five unit sizes (Class A to

E) ([184]); two locations (urban and the New Territories); and for a basket of actively transacted residential developments. Office properties are classified into three grades (Grade A to C) ([185]) and one location (core districts) ([186]). No sub-indices have been compiled for the retail and industrial sectors.

The methodology of constructing the *RVD Index* is transaction-based, but the information for controlling quality constant is partially valuation-based. This method uses actual price data (price per saleable floor area) recorded in the Agreement for Sale and Purchase (ASP) of transacted properties in each sub-sector (by property types) as the basis for index construction. As such, the *RVD Index* virtually covers all transacted properties in Hong Kong SAR. On the other hand, a regression-based mass appraisal technique (with rental returns and inputs from valuers) has been adopted to adjust the transaction price for variations in quality. Quality difference is quantified by rateable values, which is defined as "an estimate of the annual rental value of the property at a designated valuation reference date, assuming that the property was then vacant and to let" ([187]). The adjustment procedure is in effect similar to the hedonic approach, except that the rateable value is assessed from rental data supplemented by inputs by professional valuers. The details of the mass appraisal approach can be found in Stevenson (1997). Further details on the construction of the *RVD* indices can be obtained from the Technical Notes published by the RVD ([188]).

Because of its wide coverage and long history, the *RVD Index* forms the primary source of price indices in Hong Kong SAR. The Index can be retrieved from http://www.rvd.gov.hk/mobile/en/property_market_statistics/index.html (for recent figures) or Hong Kong Property Review (for historical figures), which is published by the RVD periodically.

10.6.2.2. THE JONES LANG LASALLE INDEX

Jones Lang La Salle (JLL), property consultants, provides the other source of price indices with a long history. The firm began publishing quarterly indices in 1984, which cover residential, office, retail and industrial properties. Examples of studies using the JLL indices include Newell and Chau (1996), Chau, MacGregor and Schwann (2001) and Schwann and Chau (2003).

The *JLL residential* indices do not cover all residential properties, but only the high-end segment: luxury and large housing units ([189]). The *JLL retail* indices include only those street shops that are located in these three core districts: Central, Wanchai/Causeway Bay and Tsimshatsui. The *JLL office* indices have similar geographic coverage, except that one more district, Hong Kong East, has been added since 2001. Sub-indices are also available for each of the districts. For the industrial sector, JLL published an overall industrial index prior to 2002, after which it has been replaced by three indices, namely warehouse, flatted factories and industrial/office buildings.

The *JLL Index* was computed by the periodic valuation of a portfolio of properties using 'standard valuation procedures'. The portfolio is not fixed— new properties may be added and existing properties may be removed —but its composition has not been revealed to the public. The date of valuation is from the start of each quarter, so the *JLL Index* should be taken as period start data.

Recent figures for the *JLL Index* can be accessed from the Hong Kong SAR section at http://www.research.joneslanglasalle.com. Historical figures are available in the *Greater China Property Index* and *JLW Property Index Hong Kong*, which are published periodically by the company.

([184]) Class A units are the smallest (<40m²), while Class E units are the largest (over160m²). Area is measured in terms of saleable area.

([185]) Grade A offices are better than Grade B and C offices in terms of design, facilities and management. But office location is not a factor that is considered for grading.

([186]) Core districts refer to Central, Sheung Wan, Wanchai, Causeway Bay and Tsimshatsui. They are the central business districts of Hong Kong SAR.

([187]) The Department has to produce rateable values periodically for nearly all properties in Hong Kong for the purpose of calculating the Government rent and rates (a kind of tax). See Your Rates and Government Rent at http://www.rvd.gov.hk/en/publications.htm for details.

([188]) See http://www.rvd.gov.hk/en/doc/statistics/15technotes.pdf.

([189]) The terms "luxury" and "large" have not been defined by Jones Lang La Salle.

10.6.2.3. THE FPD SAVILLS INDEX

FPD Savills is another property consultant that provides valuation-based price indices for Hong Kong SAR. It has published quarterly indices since 1992, covering the residential, office, retail and industrial sectors. There are two indices for residential properties: one for luxury housing units and the other for mass housing units. The *FPD office index* is constructed solely for Grade A offices ([190]), and the *FPD retail index* for prime street shops. Most importantly, the FPD industrial indices are the first index source that disaggregates industrial use into three types: industrial, godowns and industrial/office buildings. Therefore, the *FPD industrial indices* have been a useful source of information for measuring and forecasting the performance of various types of industrial building.

The *FPD Index* controls for quality variation, by the periodic valuation of a 'standard unit' in a sample of properties in each sector. Index values are then computed by taking the simple average of the quarterly continuous compounded returns of the values. The sample includes actively transacted properties, and its composition may change overtime to adjust for changes in building age. Further details can be obtained from the *Technical Note* (July 2002), which is published jointly by the company and the Centre for Real Estate and Urban Economics. All index series and technical notes can be conveniently downloaded at the company website: http://www.savills.com.hk/research/hk/asia-pacific-real-estate-investment-country-guides.aspx.

10.6.2.4. THE FPD CENTA-CITY (CC) INDEX

The *FPD Centa-City (CC) Index* has been provided by the property agency, Centaline, since 1992. It only covers housing units in large-scale residential developments in Hong Kong; other property types are excluded ([191]). A large-scale residential development will be included in the sample if it is actively transacted (*i.e.*, high trading value and volume) and is representative of a district. The *CC Index* not only provides an aggregate index for all housing units in the sample, but it also provides disaggregated indices for housing units in each constituent development. Consequently, the disaggregated indices are useful for analysing the price changes of individual developments.

Unlike other indices described previously, the methodology of constructing the *CC Index* is purely transaction-based. The index is quality adjusted using the hedonic pricing model, which holds property attributes (e.g. floor levels, views and orientations) constant. This statistical approach is feasible because there are abundant transactions of large-scale residential developments, and property attributes are relatively homogeneous within a development. Transaction prices are collected from the Land Registry, which registers the Agreement for Sale and Purchase (ASP), and thus the price, of all transactions, to construct the *CC Index*.

Since property transactions take time (2-3 weeks), the registration date usually lags behind the date on which the price was actually agreed upon between buyers and sellers when signing the Preliminary Agreement for Sale and Purchase (PASP). However, the PASP is usually not registered and is thus not publicly available. To remove this time lag issue, Centaline uses the deals closed by its agents to construct the weekly *CC Leading Index*. In principle, this *CC Leading Index* should reflect market information faster than other ASP-based indices, but whether it is representative of the market depends on its market share of total transactions ([192]). Both the *CC Index* and the *CC Leading Index* can be down loaded at the company's website: http://www1.centadata.com/cci/cci_e.htm.

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[190] There is no clear definition of 'Grade A' in the FPD office index, and so it may or may not be consistent with the definition used by the RVD Index.

[191] Large-scale residential developments, which are also known as housing estates, are common in Hong Kong. They refer to the entire housing development (*i.e.*, a group of residential buildings) that is developed by the same developer and share the same common facilities such as swimming pools, tennis courts, club houses, property management etc.

[192] Centaline claims that its market share exceeds 20%. See http://202.72.14.202/cci/notese.htmfordetails.

Table 10.5 A Summary of Hong Kong SAR Real Estate Price Indices

	RS	RVD	JLL	FPD	CC
Period	1991-2001	1979-present	1984-present	1992-present	1992-present
Frequency	M	M,Q	Q	Q	W,M
Sample	All repeat transactions	All transactions	A portfolio of properties	A standard unit	ASP and PASP of 51 large-scale residential developments
Quality Adjustment	Repeat sales	Appraisal	Appraisal	Appraisal	Hedonic pricing
Coverage Residential	Overall	Overall	Luxury	Luxury	Large-scale residential
Office	3 locations (HKI,KLN,NT) Presale properties Overall	5-unit sizes(A-E) 2 locations (urban and NT) Popular large-scale residential developments Overall	Large and luxury Core districts	Mass Grade A	NA
Retail	Overall	Grade (A,B,C) Core districts Overall	4 locations(C,WC/ CWB, TST,HKE) Prime street shops 3 locations(C,WC/ CWB, TST) Warehouse	Prime street shops	NA
Industrial	Overall	Flatted factories	Flatted factories Industrial/Office	Industrial Godown Industrial/ Office	NA
Web Availability	Yes	Only recent figures	Only recent figures	Yes	Yes

Notes: W=weekly; M=monthly; Q=quarterly; ASP=Agreement for Sale and Purchase; PASP=Preliminary Agreement for Sale and Purchase; HKI= Hong Kong Island; KLN= Kowloon; NT= New Territories; C= Central; WC= Wanchai; CWB= Causeway Bay; TST= Tsimshatsui; HKE= Hong Kong East.

10.6.3. A comparative analysis of the alternative indices

A comparative analysis shows that as a whole, the indices within each sector follow a similar trend, indicating that they at least reflect the commonality that exists in each property sector. However, on closer inspection, some indices diverge systematically, mostly because they are constructed for different segments in each property sector. For example, in the residential sector, the *JLL Index* is based on a portfolio of luxury housing, while others included other classes of housing. It is also instructive to note that this also applied to the experimental repeat sales index. These divergences due to differences in coverage can be seen from the graph below, using indices for offices for illustrative purposes.

Figure 10.15 Office indices
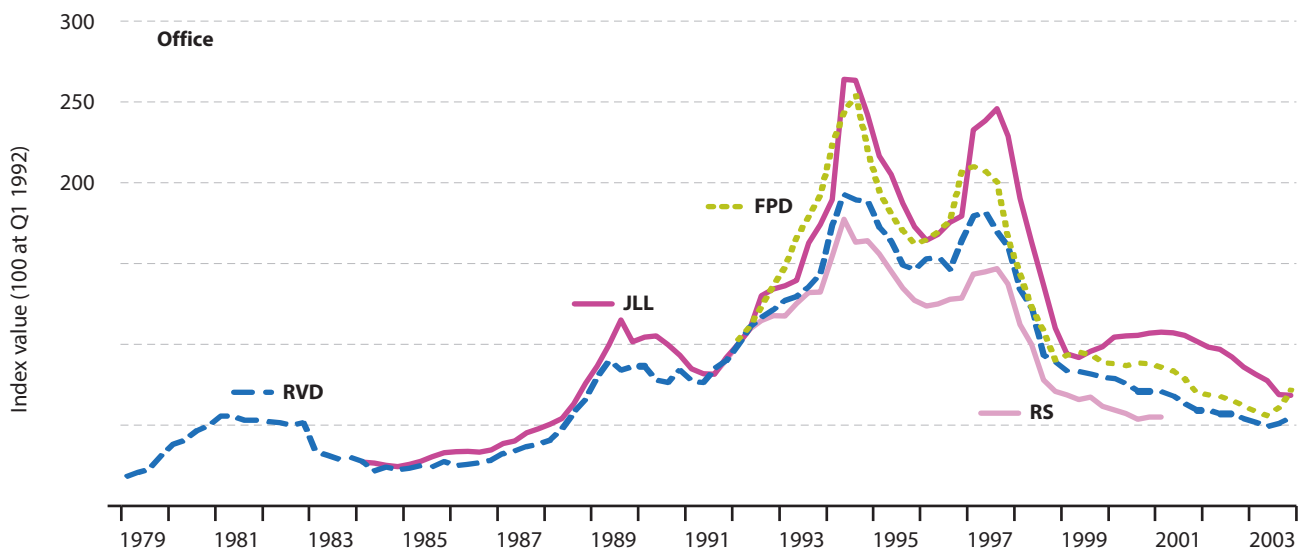
Note: The RS Index is for all offices; the RVD Index is for all offices; the JLL Index is for offices in core districts; and the FPD Index is for Grade A offices.

Figure 10.16 Retail indices
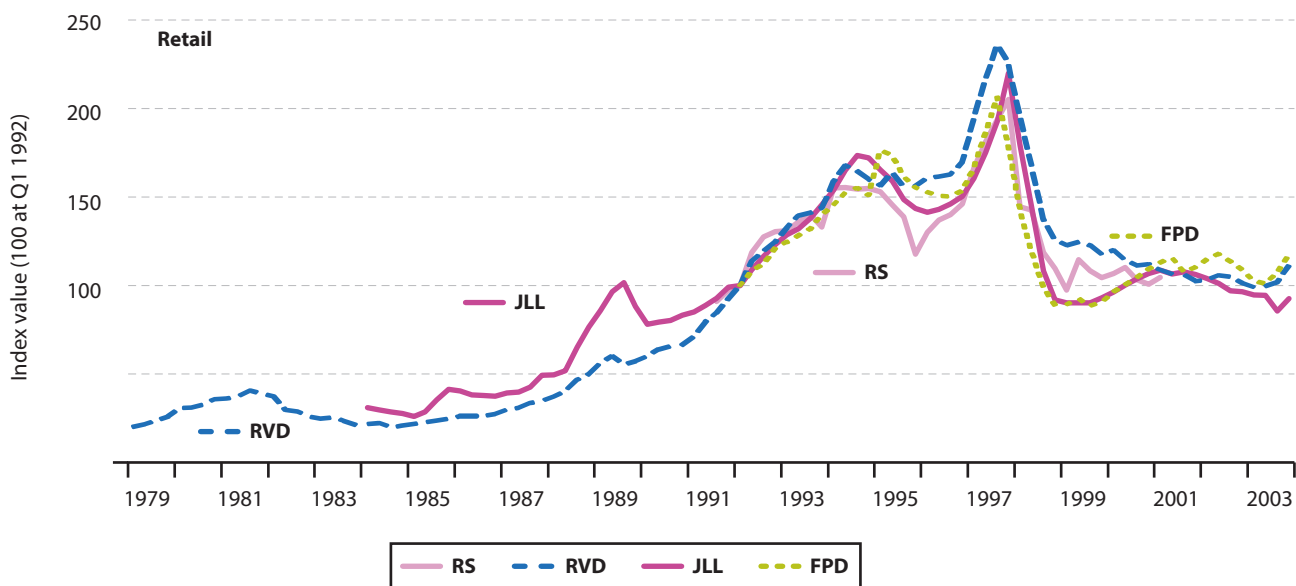
Note: The RSI index is for all retail premises; the RVD Index is for all retail premises; the JLL Index is for prime street shops; and the FPD Index is for prime street shops.

Figure 10.17 Industrial indices
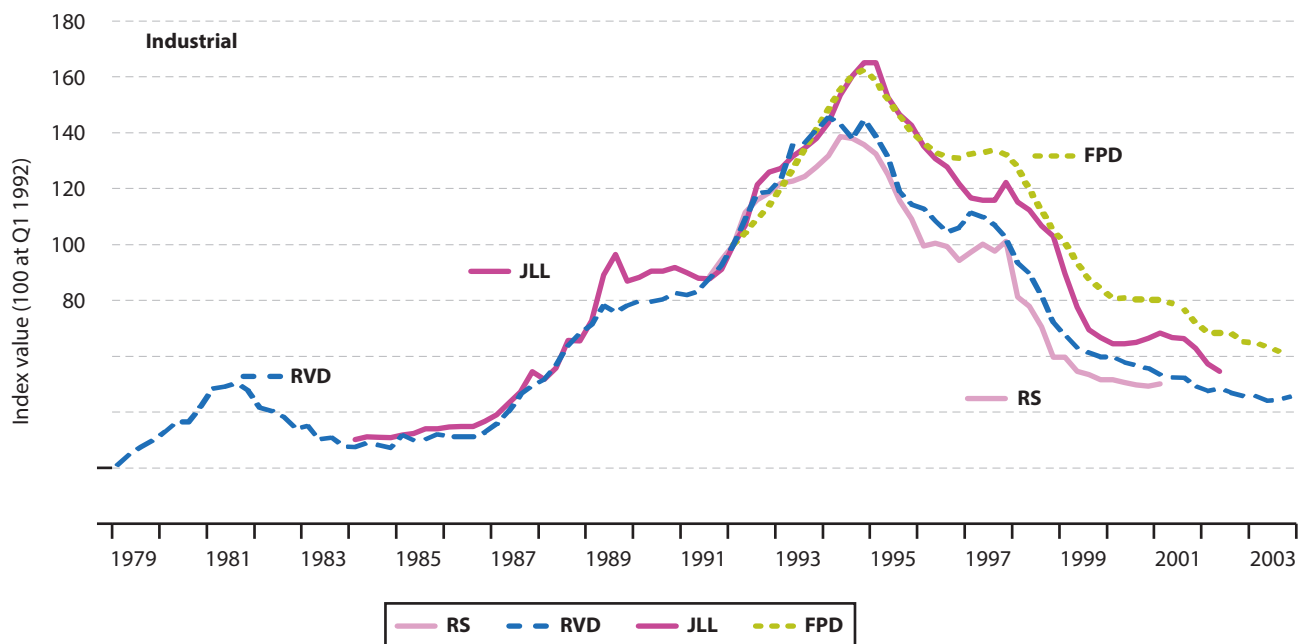
Note: The RS Index is for all industrial premises; the RVD Index is for all flatted factories; the JLL Index is for all industrial premises; and the FPD Index is for industrial premises.

Tables 10.6 to 10.8 give the mean, standard deviation, minimum and maximum of their index returns in each property sector during their overlap periods of 1992-2001. Returns are defined as continuously compounded returns, which are calculated on a yearly basis by $rt = \ln(lt) - \ln(lt-4)$.

Table 10.6 Office Annualised Returns (1992-2001)

	RS(%)	RVD(%)	JLL(%)	FPD(%)
Mean	-8.4	-5.4	-1.2	-3.8
Std.Dev.	25.2	26.3	35.6	31.8
Min.	-66.1	-60.8	-73.2	-63.8
Max.	34.9	40.1	63.8	42.5

Table 10.7 Retail Annualised Returns (1992- 2001)

	RS(%)	RVD(%)	JLL(%)	FPD(%)
Mean	-1.5	-0.3	-0.8	-0.4
Std.Dev.	22.7	22.9	28.7	25.9
Min.	-62.8	-58.5	-87.4	-73.6
Max.	34.0	37.1	38.0	31.7

Table 10.8 Industrial Annualised Returns (1992- 2001)

	RS(%)	RVD(%)	JLL(%)	FPD(%)
Mean	-9.7	-8.4	-6.5	-3.4
Std.Dev.	16.7	15.7	18.1	15.4
Min.	-52.8	-35.2	-43.4	-25.1
Max.	19.7	21.8	24.1	21.4

10.7. Case Study: Denmark

10.7.1. Official statistics produced by Statistics Denmark

Statistics Denmark publishes quarterly and annual statistics for commercial properties. The quarterly statistics are published approximately 3 months after the end of the reference period. The yearly statistics are published approximately ten months after the reference year and are regarded as final figures ([193]). The statistics cover all sales of commercial property that are registered in the electronic land registration system. In practice, this means that almost 100 per cent of sales are included in the final figures.

The commercial properties are divided into four main groups:

- Residential and business properties (total)
- Business properties (total)
- Industrial properties and warehouses (total)
- Agricultural properties
- Total
- - 2-5 hectares
- 5-10 hectares
- 10-15 hectares
- 15-30 hectares
- 30-60 hectares
- 60-100 hectares
- Over 100 hectares
- 10-100 hectares
- Over 60 hectares

An overall index for the four main groups is not calculated and neither are sub-indices computed for different sizes of agricultural properties.

Amongst others, the following statistics are also produced in addition to price indexes.

- Number of registered sales
- Average price per property
- Purchase sum per hectare/m^2 (hectare for agriculture and m^2 for building sites)
- The SPAR-value

No commercial property price indices are calculated for regions and provinces; nor are price indices computed for municipalities or postal codes. However, some other indicators are published, both quarterly and yearly: as shown in the following tables.

Table 10.9 Commercial Property statistics: regions and provinces

Regions and provinces	Quarter	Year
Price index	-	-
Number of sales in the price calculation	√	√
Number of registered sales	√	√
Average price per property	√	√
Purchase sum per hectare/m2*	√	√
SPAR-value	√	√

*Note: Only for agricultural properties and building sites

([193]) Each quarterly data is published three times, i.e. each quarter is revisable twice before the numbers are declared as final. The yearly data is not revisable.

Table 10.10 Municipalities and postal codes

Municipality and postal code	Quarter	Year
Price index	-	-
Number of sales in the price calculation	√	√
Number of registered sales	√	√
Average price per property	√	√
Purchase sum per hectare/m2*	√	√
SPAR-value	√	√

Note: Only for agricultural properties and building sites

It should be noted that from the second quarter 2011, data for municipalities and postal codes are only available as online data for sale ([194]).

The sale of property is typically registered close to the acquisition date. For example, if the contract date is the 1st February 2013, but the acquisition date is the 1st August 2013, then that sale will typically be registered close to the 1st August 2013 and thereafter sent to the Tax Authorities, who forward all of the registered sales to Statistics Denmark on a weekly basis. The statistics therefore are based on data from the electronic land registration system. The different dates are shown in the figure below.

Figure 10.18 Dates in connection with sales of real property
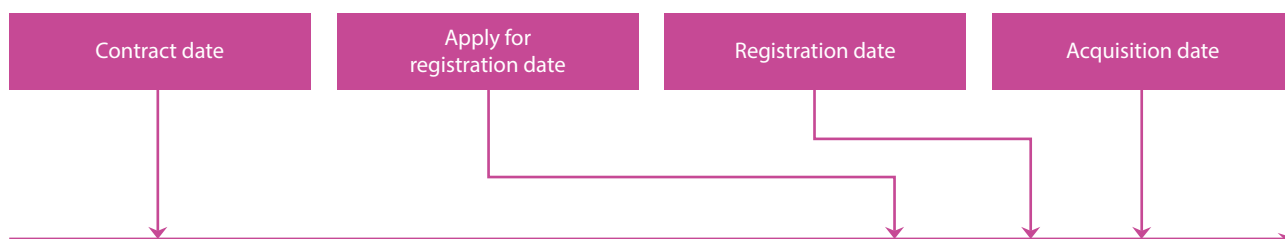
When the quarterly statistics are published for the first time, approximately 90 per cent of the total numbers of commercial properties are registered and therefore included in the statistics. When a reference quarter is published the third time, the data are declared as final and will no longer be revised.

Thus the data is relatively timely and the revisions are within reasonable limits.

10.7.1.1. METHODOLOGY

Statistics Denmark follows the SPAR methodology and is a good example of how administrative appraisal or assessment data can be used to develop a system of CPPIs.

The indexes are calculated using the average SPAR values as follows.

$$\text{Index}_t = \frac{\text{appr}_t}{\text{appr}_{t-1}} \cdot \text{Index}_{t-1}$$

where:

Index_t: Price index in period t
Appr_t: Appraisal value in period t

Every second year, the Danish Tax Authorities make a new valuation of each property (an appraisal value) using hedonic regressions. In even years, valuations are made for commercial properties and in odd years valuations are made for residential properties.

([194]) Only payment data bank is available on www.dst.dk/betalingsdatabank

The newest appraisal year will be the most accurate to use since it takes into account changes in the general price level and changes in the building stock. Therefore, the new appraisals are used in the index compilation as soon as it is practically possible. The new appraisals are reflected from the 3rd quarter of the following year. For example, the 2012 appraisals were used in the CPPI's for 2013Q3 and the indices for 2013Q1 and 2013Q2 were revised accordingly. When shifting to a new appraisal year, an 'overlapping appraisals method' is used.

Corrections to potential bias in the registration pattern are undertaken, based on the assumption that the disparity in the registration pattern of property transactions with different price levels is stable over time, i.e. the proportions and type of property transactions received follow the same pattern in the electronic land registration system at a given point of interrogation.

Statistics Denmark also calculates a 'contributions to growth'. The growth contribution of each sale is computed using the value-weighted SPAR-method as follows:

$$\text{Growth contribution}_i = w_i \cdot \left(\frac{\text{spar}_i}{\sum \text{SPAR}_{t-1}} - 1 \right)$$

The following example shows how this works out in practice.

Let the information for periods t-1and t be as shown in the table below:

Table 10.11 Information for calculating the growth contribution

Period t-1	Price	Appraisal	Spar-value	Weight
Property 1	1.410.000	920.000	1,5326	0,1369
Property 2	4.200.000	3.400.000	1,2353	0,5060
Property 3	2.800.000	2.400.000	1,1667	0,3571

Period t	Price	Appraisal	Spar-value	Weight
Property 4	4.900.000	4.000.000	1,2250	0,5333
Property 5	1.850.000	1.900.000	0,9737	0,2533
Property 6	1.500.000	1.600.000	0,9375	0,2133

For period t-1 the average value-weighted SPAR-value can be calculated as follows.

$$\text{SPAR}_{\text{value\_weighted}} = \frac{\sum \text{price}}{\sum \text{appr}} = \left(\frac{1.410.000 + 4.200.000 + 2.800.000}{920.000 + 3.400.000 + 2.400.000} \right) \cdot 100 = 125.1$$

Alternatively, the average value-weighted SPAR-value can be calculated by weighting the individual spar-values using the individual appraisals as weight, as follows.

$$\text{SPAR}_{\text{value\_weighted}} = \left(1,5326 \cdot 0,1369 + 1,2353 \cdot 0,5060 + 1,1667 \cdot 0,3571 \right) \cdot 100 = 125.1$$

It is worth noting that since property 2 has the highest appraisal value at t-1, the average SPAR-value (125.1) is relatively close to the spar-value of property 2 (123.5).

The average value-weighted SPAR-value at time t is 1.10.

The growth contributions can be calculated as follows.

$$\text{Growth contribution}_{\text{property4}} = 0.5333 \cdot \left(\frac{1.2250}{1.251} - 1 \right) = -0.011 \ (-1.1\,\%)$$

$$\text{Growth contribution}_{property5} = 0.2533 \cdot \left(\frac{0.9737}{1.251} - 1 \right) = -0.056 \ (-5.6\%)$$

$$\text{Growth contribution}_{property6} = 0.2133 \cdot \left(\frac{0.9375}{1.251} - 1 \right) = -0.054 \ (-5.4\%)$$

The price index has decreased by.

$$-0,011 + (-0,056) + (-0,054) = -0,121 \ (-12,1 \ \%)$$

This can also be checked by calculating the price index.

$$\text{Index}_t = \frac{\text{appr}_t}{\text{appr}_{t-1}} \cdot \text{Index}_{t-1} => \text{Index}_t = \frac{1,10}{1,251} \cdot 100 = 87,9 \ (\text{where period } t-1 = 100)$$

The decline from index=100 in the previous period t-1 to the index 87.9 in the period t is exactly 12.1 percentage, i.e. the sum of the individual growth contributions.

Statistics Denmark uses the growth contributions for the checking of errors, focusing on the sales that contribute most to the development in the price index.

The main disadvantages of a SPAR-method, from Statistics Denmark's perspective, are as quoted in the general literature on the subject i.e.:

• The method cannot deal with new buildings as they do not have an appraisal value;
• Implementing a new appraisal will typically revise historical data as it is only available approximately one year after the reference period;
• The method cannot adequately deal with depreciation of real estate;
• The method cannot adequately deal with major repairs or renovations of real estate;
• The method is entirely dependent on the quality of the base period assessment information with the potential for systematic error in the appraisals; and
• The issue of revisions.

Statistics Denmark also notes two issues specific to the Danish situation. Firstly, for agricultural properties, many farmers sell a part of their land (e.g. 2 hectares out of 100 hectares land), but the appraisals are only made for the overall property, including all buildings and land. Therefore, these partial sales are ruled out from the index calculation. However, the variable for partial sale in the electronic land registration system does not always capture partial sales, which means that some partial sales are included in the index calculations. Secondly, the small number of transactions in each period makes the price indices fluctuate and vulnerable to revisions, since they are first compiled before the total number of sales for a given reference period have been registered.

10.7.1.2. STATISTICS PRODUCED BY OTHERS

The Danish Tax Authorities produce some statistics on commercial properties but the main source of published statistics comes from Statistics Denmark. It is the latter that are designated as official statistics. IPD also publish indices relating to commercial property that follow their methodologies used in other countries.

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11 | Annexes

11.1. CPPIs and Decomposition for Land and structure components

11.1.1. The Residual Approach for Valuing a Commercial Property

A country's stock of commercial properties is a component of its national wealth. Hence, a price index is required for commercial properties so that balance sheet estimates of real wealth by component can be formed [195]. SNA Balance Sheet estimates of national wealth distinguish between the structures component of commercial property and the land component. Thus in order to construct Balance Sheet estimates for national assets, it will be necessary to decompose commercial property values into separate land and structures components and to construct price indexes for each of these components.

In this section, an approach to the valuation of commercial properties that is similar to that used by national income accountants to construct capital stock estimates will be explained. The approach is called the *national balance sheet accounting approach to the construction of commercial property price indices* by Diewert and Shimizu (2014) and it is called the *residual approach* by Eurostat and OECD (2014). The approach requires information on overall property values at a specific point in time, along [196] with imputed values of the structures that sit on the properties at the same point in time. This imputed value is taken to be the current replacement cost for the structure and it can be estimated using normal national income accounting techniques [197]. Thus an imputed value for land can be defined as property value minus imputed structure value. In order to form a constant quality price index for a commercial property, estimates of property value and structure value would have to be available for the two points in time that are being compared, along with estimates of the amount of structure depreciation that took place between the two periods. The information required and the computations that are necessary to form a commercial property price index will be laid out in some detail in what follows, under the assumption that assessed values, or appraised values, for a sample of commercial properties are available. The analysis below is taken from Diewert and Shimizu (2014) [198].

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[195] A price index for the stock of commercial properties is also of some use to central bankers and mortgage lenders who are interested in monitoring property prices for the possibility of bubbles in their countries.

[196] This property value could be the market value of the property if it was sold around the beginning of the accounting period under consideration or it could be the appraised or assessed value of the property at the beginning of the accounting period.

[197] These techniques are explained in detail in Schreyer (2001) (2009), Diewert (2005) and Eurostat and OECD (2014).

[198] The hedonic regression model that was estimated in this paper is essentially a variant of the builder's model that has been used in the residential property context except that appraised values were used as the dependent variables and a geometric depreciation model was estimated instead of a straight line model. See Chapter 8 in Eurostat (2013), Diewert, de Haan and Hendriks (2011) (2014) and Diewert and Shimizu (2013) for applications of the builder's model in the residential context.

Diewert and Shimizu's study used published information on the Japanese Real Estate Investment Trust (REIT) market in the Tokyo area ([199]). They used a balanced panel of observations on 50 single property REITs for 22 quarters, starting in Q1 of 2007 and ending in Q2 of 2012. The variables that were used in their paper were V, the assessed value of the property ([200]); CE, the quarterly capital expenditures made on the property during the quarter; L, the area of the land plot in square meters (m²); S, the total floor area of the structure in m²; A, the age of the structure in quarters and a construction cost index for new buildings of the type of commercial property under consideration.

Diewert and Shimizu postulated that the assessed asset value of REIT n in quarter t, V_{tn}, was equal to the sum of three components:

- The *value of the land plot* V_{Ltn} for property n in quarter t;
- The *value of the initial structure* on the property, V_{Stn}, and
- The value of the cumulated (but also depreciated) capital expenditures on the property made in prior periods, V_{CEtn}.

Thus they assumed that the following asset value decomposition held for property n in period t ([201]):

(11.1) $V_{tn} = V_{Ltn} + V_{Stn} + V_{CEtn}$;   n = 1, ... ,50 ; t = 1, ... ,22.

The appraised values, V_{tn}, on the left hand side of equations (11.1) were known and the problem is to determine plausible values for the components on the right hand side of equations (11.1). Moreover, in order to form constant quality property price indices, it is necessary to decompose the values on the right hand side of equations (11.1) into price and quantity components. The methods used by Diewert and Shimizu will be explained below.

First consider the decomposition of the property land values, V_{Ltn}, into price and quantity components. Diewert and Shimizu assumed that the following equations held:

(11.2) $V_{Ltn} = P_{Ltn}Q_{Ltn}$; $Q_{Ltn} = L_{tn} = L_n$;   n = 1, ... ,50 ; t = 1, ... ,22

where L_n (equal to L_{tn}) was the area of the land plot for property n, which, of course, was constant from period to period), and P_{Ltn} is the price of a square meter of land for property n in quarter t (which is not known yet).

Diewert and Shimizu valued the structure portion of the property value using the usual Perpetual Inventory Method for forming capital stocks. If the structure on a property was a new one, its value should be approximately equal to its cost of construction. Diewert and Shimizu used an external estimate of the 2007 construction cost for a prestige office building in Japan that was provided by Turner and Townsend (2012), which was approximately 300,000 yen per square meter (m²). This initial construction cost was projected forward using an official construction cost price index P_{St} for quarter t in their sample ([202]). This construction cost index was constructed by the Construction Price Research Association which is now an independent agency but prior to 2012 was part of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), a ministry in the Japanese Government. The quarterly values were constructed from the Monthly Commercial Construction Cost index for Tokyo for reinforced concrete buildings. Thus an approximation to the cost (in yen) of a square meter of new commercial property construction in quarter t is 300,000 times $P_{St}S_{tn}$ where P_{St} is the construction price index per m² for Tokyo for quarter t and $S_{tn} = S_n$ is the floor area for property n in period t. Diewert and Shimizu then assumed that the *quarterly geometric (or declining balance) depreciation rate* for an office building in their sample was $\delta_S \equiv 0.005$ or 0.5 % per quarter ([203]). Thus the structure value for property n in quarter t (where the age of the structure in quarters at time t is A_{tn}) should be approximately equal to:

([199]) The REIT data were supplied by the commercial property firm, MSCI-IPD, Japan.

([200]) The REITs were chosen so that each REIT consisted of a single commercial property located somewhere in Tokyo. The assessed values are reported at the end of each quarter. However, the actual assessments take place either during the quarter or prior to it. Diewert and Shimizu regarded the published assessed values as approximations to the true market values of the property as of the beginning of the relevant quarter.

([201]) This assumption is a strong one. In particular, Diewert and Shimizu assumed that capital expenditures immediately add to asset value, an assumption that is unlikely to hold precisely.

([202]) The index was normalized to equal 1 for the first quarter in their sample.

([203]) Hulten and Wykoff (1981; 387) obtain annual geometric depreciation rates for office buildings in the U.S. around 1% for continuing structures and around 2.5% when premature retirement is taken into account. Other studies often obtain higher rates. Diewert and

(11.3) $V_{Stn} = 300{,}000\ P_{St}S_{tn}(1-\delta_S)^{A(t,n)}$; $n = 1, \dots ,50$; $t = 1, \dots ,22$

where $A(t,n) \equiv A_{tn}$. Thus Diewert and Shimizu obtained the following decomposition of V_{Stn} into price and quantity components:

(11.4) $V_{Stn} = P_{Stn}Q_{Stn}$; $P_{Stn} \equiv P_{St}$; $Q_{Stn} \equiv 300{,}000\ S_{tn}(1-\delta_S)^{A(t,n)}$; $n = 1, \dots ,50$; $t = 1, \dots ,22$

where P_{St} is the known official construction price index for quarter t (lagged one quarter), S_{tn} is the known floor space for property n in quarter t (this is typically constant across quarters), $A(t,n)$ is the known age of REIT n in quarter t and $\delta_S = 0.005$ is the assumed known quarterly geometric structure depreciation rate. Thus V_{Stn} and its price and quantity components can be calculated using equations (11.4).

Finally, Diewert and Shimizu needed to determine how much capital expenditures contributed to property asset values. This was a more difficult task ([204]). Define the capital expenditures of property n in quarter t as CE_{tn}. A deflator was required in order to convert these nominal expenditures into real expenditures. It is difficult to know precisely what the appropriate deflator should be. Diewert and Shimizu simply assumed that the official construction price index, P_{St}, was a suitable deflator. Thus they defined *real capital expenditures* for property n in quarter t, q_{CEtn}, as follows:

(11.5) $q_{CEtn} \equiv CE_{tn}/P_{St}$; $n = 1, \dots ,50$; $t = 1, \dots ,22$.

Both CE_{tn} and P_{St} were known and so the q_{CEtn} could also be determined. However, Diewert and Shimizu also required starting capital stocks for these capital expenditures and a geometric depreciation rate that determines how these capital expenditures are written off over time. It was difficult to determine an appropriate depreciation rate for capital expenditures since this problem has not been studied very extensively (if at all) in the literature. Diewert and Shimizu attempted to estimate an appropriate depreciation rate but were not completely successful in their attempts. In the end, they simply assumed that the quarterly geometric depreciation rate for capital expenditures was $\delta_{CE} = 0.10$ or 10 % per quarter ([205]). The next problem they faced was the problem of determining the starting stock of capital expenditures for each property, given that they did not know what the capital expenditures were before their sample period. They provided a solution to this problem in two stages. First, they generated *sample average real capital expenditures* for each property n, q_{CEn}, as follows:

(11.6) $q_{CEn} \equiv \sum_{t=1}^{22} q_{CEtn}/22$; $n = 1, \dots ,50$.

Their next assumption was that each property n had a starting stock of capital expenditures equal to depreciated investments for 20 quarters (or 5 years) and equal to the property n sample average investment, q_{CEn}, defined above by (11.6). Thus their *starting stock of CE capital* for property n was Q_{CE1n} defined as follows:

(11.7) $Q_{CE1n} \equiv q_{CEn}[1 - (1-\delta_{CE})^{21}]/\delta_{CE}$; $n = 1, \dots ,50$.

The REIT capital stocks for capital expenditures can be generated for quarters subsequent to quarter 1 using the usual geometric model of depreciation recommended by Hulten and Wykoff (1981), Jorgenson (1989) and Schreyer (2001) (2009) as follows:

(11.8) $Q_{CEtn} \equiv (1-\delta_{CE})Q_{CE,t-1,n} + q_{CE,t-1,n}$; $t = 2, 3 , \dots , 22$; $n = 1, \dots , 50$.

Note that Q_{CEtn} is now completely determined for $t = 1, \dots ,22$ and $n = 1, \dots ,50$ and the corresponding price P_{St} is also determined. Thus an estimated value for the stock of capital expenditures of REIT n for the beginning of period t, V_{CEtn}, can be determined by multiplying P_{St} by Q_{CEtn}:

(11.9) $V_{CEtn} \equiv P_{CEtn}Q_{CEtn}$; $P_{CEtn} \equiv P_{St}$; $t = 1, \dots , 22$; $n = 1, \dots , 50$

Shimizu (2014) in a later section of their paper estimated a builder's model with a geometric depreciation rate and found that the assumption of a 1/2 percent quarterly depreciation rate was justified for their sample of properties.

([204]) Crosby, Devaney and Law acknowledge the importance of capital expenditures in explaining property value but they also point out the scarcity of research on this topic: 'Other important issues are the roles of maintenance expenditure and replacement investment.... Thus, expenditure is central to interpreting depreciation rates but it has received little attention in much of the commercial real estate literature'. Neil Crosby, Steven Devaney and Vicki Law (2012; 230).

([205]) After 20 quarters or 5 years, only 12% of a initial real investment in capital expenditures contributes to asset value; after 40 quarters or 10 years, only 1.5% of a initial real investment in capital expenditures contributes to asset value.

where the Q_{CEtn} are defined by (11.7) and (11.8).

Now that the asset values V_{tn}, V_{Stn} and V_{CEtn} have all been determined, the price of land for property n in quarter t, P_{Ltn}, can be determined residually using equations (11.1) and (11.2) [206]:

(11.10) $P_{Ltn} \equiv [V_{tn} - V_{Stn} - V_{CEtn}]/L_n$;   n = 1, … ,50 ; t = 1, … , 22.

The above material shows how Diewert and Shimizu constructed estimates for the price of land, structures and capital expenditures for each property n for each quarter t (P_{Ltn}, P_{Stn} and P_{CEtn}) and the corresponding quantities (Q_{Ltn}, Q_{Stn} and Q_{CEtn}). They used this price and quantity information in order to construct *quarterly value aggregates* (over all 50 properties in the sample) for the properties and for the land, structure and capital expenditure components; i.e., they made the following definitions:

(11.11) $V^t \equiv \sum_{n=1}^{50} V_{tn}$; $V_L^t \equiv \sum_{n=1}^{50} V_{Ltn}$; $V_S^t \equiv \sum_{n=1}^{50} V_{Stn}$; $V_{CE}^t \equiv \sum_{n=1}^{50} V_{CEtn}$;   t = 1, … , 22.

At this point, normal index number theory can be used to decompose the value aggregates defined in (11.11) into price and quantity components, where the individual property price and quantity components for the land, structure and capital expenditures have been defined using equations (11.2)-(11.10). Denote the aggregate chained Fisher (1922) price indices that correspond to the value aggregates V^t, V_L^t, V_S^t and V_{CE}^t by P^t, P_L^t, P_S^t and P_{CE}^t respectively. Because the price of structures for each property was proportional to the exogenous official construction price index for Tokyo, the aggregate Fisher structure price index, P_S^t, turned out to equal the official construction price index, P_{St} defined earlier [207]. Similarly, the Fisher price index of capital expenditures, P_{CE}^t, defined above also turned out to equal the official construction cost index, P_{St}.

The price series P^t, P_L^t, P_S^t and P_{CE}^t can be used to deflate the corresponding aggregate value series defined above by (11.11), V^t, V_L^t, V_S^t and V_{CE}^t, in order to form *implicit quantity or volume indexes*; i.e., define the following aggregate quantity indexes:

(11.12) $Q^t \equiv V^t/P^t$; $Q_L^t \equiv V_L^t/P_L^t$; $Q_S^t \equiv V_S^t/P_S^t$; $Q_{CE}^t \equiv V_{CE}^t/P_{CE}^t$;   t = 1, … ,22.

Q^t can be interpreted as an estimate of the real stock of assets across all 50 properties at the beginning of quarter t, Q_L^t is an estimate of the aggregate real land stock used by the REITs [208] and Q_{CE}^t is an estimate of the real stock of capital improvements made on the structures up to quarter t since they were constructed.

The *overall constant quality commercial property price index* P^t that Diewert and Shimizu (2014) obtained for their sample of Tokyo office properties is graphed on Figure 11.1 below along with the official construction price index P_S^t (which acts as a constant quality price index for both the structure and capital expenditure parts of property value) and their constant quality land value index P_L^t.

There is an additional price index (or price indicator [209]) that Diewert and Shimizu computed and is shown on Figure 11.1. If capital expenditures and depreciation of the structures on the properties is ignored, each property could be regarded as having a constant quality over the sample period. Thus each property value at time t for REIT n, V_{tn}, can be decomposed into a price component, P_{tn}, times a quantity component, Q_{tn}, which can be regarded as being constant over time. Units of measurement for the land component of each property can be chosen so that each property's land quantity is set equal to unity. Thus the price and quantity data for the 50 properties in the sample have the following

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[206] This application of the Residual Theory of Land Value is a key point in principle, and it has very broad implications for the construction of CPPIs that can be decomposed into land and structure components. In particular, the Residual Theory allows great flexibility in the type of 'starting point index', whether it be appraisal-based (as in this Tokyo office example) or transactions-based (including SPAR or repeat sales). The particular model used in this Annex is just one example.

[207] The chained Laspeyres and Paasche price indexes for structures were also equal to the official index (and so were the corresponding fixed base indexes). And since the quantity of land was fixed for each property, the chained (and fixed base) Laspeyres and Paasche land price indexes were also equal to the chained Fisher land price indexes.

[208] This remains constant over time since the quantity of land used by each property remained constant over time.

[209] A price index holds quality constant between the two periods being compared. A price indicator is an approximate price index that does not necessarily attempt to hold quality constant. Capital expenditures and depreciation of the structure cause the value of a property that is compared at two points in time to change due not only to pure price change but also due to quality change. Thus the Diewert and Shimizu *asset value price index* should be more properly called a *property price indicator*. Repeat sales indexes should also be regarded as price indicators since the quality of the properties in the 'index' are not held constant between sales periods (due to capital expenditures and depreciation of the structure).

structure: $Q_{tn} \equiv 1$; $P_{tn} = V_{tn}$ for t = 1, ... , 22 and n = 1, ... , 50. The *asset value price index* ([210]) for period t for this group of properties is the following Lowe (1823) ([211]) index:

(11.13) $P_A^t \equiv \sum_{n=1}^{50} P_{tn} Q_{1n} / \sum_{n=1}^{50} P_{1n} Q_{1n} = \sum_{n=1}^{50} V_{tn} / \sum_{n=1}^{50} V_{1n}$;   t = 1, ... ,22.

The Diewert and Shimizu asset value overall price index, P_A^t, is graphed in Figure 11.1 below, along with the overall commercial property price index P^t, where the method used to construct P^t might be termed a *national accounts method* for constructing a property price index. We also show the corresponding national accounts land price index P_L^t and the official structures construction cost price index P_S^t, which was used as a price deflator for both capital expenditures and the estimated value of the structure ([212]).

Figure 11.1 Asset Value Price Index PA and Accounting Price Index P, Price of Structure and Price Index for Land PL.
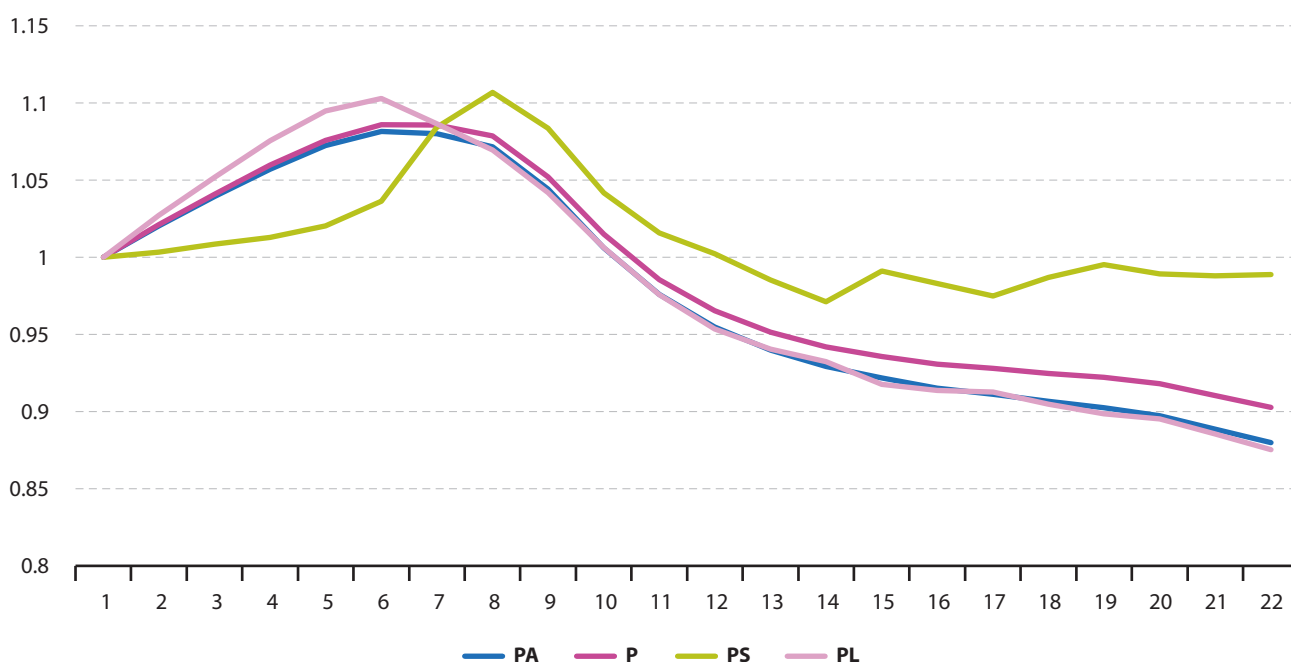
It can be seen that the asset value price index P_A^t defined was consistently below the more accurate national accounts index P^t and the gap widened over time ([213]). In the Japanese sample of commercial properties, the estimated average land value divided by total property value turned out to be 74.7 %; i.e., approximately 75 % of the property value is due to land value. In the United States, the land ratio is much lower, so that the bias in the asset value price index would be correspondingly much larger, since it is the neglect of net structure depreciation that causes the differences in P^t and P_A^t ([214]).

Strengths and weaknesses of the Residual Approach to the construction of commercial property price indices are summarized below. The strengths of the approach are as follows:

• The approach is fully consistent with the usual Perpetual Inventory method that is used by national income accountants to construct estimates for the capital stock of commercial property structures;

([210]) This type of asset value index (or indicator) is of interest to property investors and mortgage lenders (as are repeat sales indexes); see Geltner, Miller, Clayton and Eichholtz (2014; 657-662).

([211]) A Lowe index is a fixed basket price index where the quantity basket remains fixed over the sample period.

([212]) P_A^t, P^t, P_S^t and P_L^t are listed as PA, P, PS and PL in Figure 11.1.

([213]) The (geometric) downward bias in the asset value price index in the Diewert and Shimizu sample of properties was about 0.5 percentage points per year, which is fairly significant over long periods. However, for some short run monitoring purposes, this bias may not be that important.

([214]) Since the asset value price index is a variant of the repeat sales index that is frequently used to construct property price indexes, we expect that these repeat sales indexes also have a substantial downward biases compared to indexes that take structure depreciation into account.

- The information required to implement the method is fairly substantial, but is less than the amount of information on the characteristics of commercial properties that would be required in order to implement a hedonic regression approach to index construction ([215]). Here is a list of the information required to implement the Residual Approach for a group of commercial properties ([216]): (i) quarterly information on the assessed or appraised values for the properties, the V_{tn}; (ii) the floor space area of the structure on each property, the S_{tn}; (iii) the size of the land plot for each property, the L_n ([217]); (iv) the age of the structure in quarters at time t for property n, the A_{tn}; (v) nominal capital expenditures on the property for each quarter, the CE_{tn}; (vi) an index of construction costs, P_{St} (as well as a cost per m² for at least one quarter); (vii) an appropriate index for the deflation of capital expenditures; (viii) a geometric quarterly depreciation rate for the type of structures in the group of properties under consideration, δ_S and (ix) a geometric quarterly depreciation rate for capital expenditures, δ_{CE};
- The Residual Approach, implemented using quarterly assessed values or appraised values, is the only method that can deal adequately with the problems of sparse sales and property heterogeneity; and
- The method is relatively easy to explain to users

The weaknesses of the Residual Approach are as follows:

- The method is completely dependent on the quality of the appraisals, the quality of the assessments in the case where the property tax authorities attempt to estimate the market values of commercial properties, or on the quality of the transaction based asset value index that may alternatively be used as the starting point index in the process;
- The appraisals or assessed values (or any type of starting point index) may be of high quality for a particular quarter but they may not be updated on a frequent basis (the stale appraisals problem);
- Appraisals and assessed values tend to miss turning points in the property market; i.e., they lag behind the turning points in the prices of commercial properties ([218]);
- The method is dependent on having reasonably accurate depreciation rates for both the structure and for capital expenditures;
- There is little accurate information available on the appropriate depreciation rate for capital expenditures, and structure depreciation rates are frequently based on out of date studies;
- The construction cost index and capital expenditure deflator may not be very accurate;
- Information on the floor space area of the structures may be missing;
- If property tax assessment data are used, information on capital expenditures may be missing; and
- When there is a collapse in a region's property markets, the method may impute negative prices for land.

This completes the description of the Residual Approach to the construction of a CPPI.

11.1.2. Obsolescence, structure depreciation and demolition depreciation

The hedonic regression models that were described in a previous chapter are useful for decomposition of land and structure component because they facilitate the accurate estimation of structure

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([215]) A hedonic regression approach to the construction of a CPPI that used the sale prices of properties as the dependent variable requires at least the information that is used in the present approach but it requires additional information on the characteristics of the structure and on neighbourhood characteristics. The present approach does not require this additional information on characteristics of the structure and the property because the structural and environmental characteristics of each individual property remain more or less constant across periods (except for the age of the structure).

([216]) The need for some of these data items can be avoided if certain other information is available, such as information about land value as a fraction of total property value as a function of structure age, and structure depreciation rates as a function of structure age. It is also possible to start with an asset value index that is not appraisal-based but transaction price based, such as a repeat sales or SPAR type of index, using such index to estimate the value change of specific property assets analogous to the use described here of the appraisal-based index, provided that the necessary additional information about land value fractions, depreciation, and capital expenditures is available. There are other possible approaches to addressing the depreciation and capital expenditures data needs besides the specific approach reported here. It is worth noting that most investment oriented appraisal-based indices, and all REITs, are required to report expenditures on capital improvements on a regular basis (these are the 'indicators' described in Chapter 7 of this Handbook).

([217]) Land plot areas are not actually required in order to implement the method but they are required if an average price per m² for land is required.

([218]) See Shimizu and Nishimura (2006), Cannon and Cole (2011) and Devaney and Diaz (2011) on biases in appraisal information.

depreciation which, of course, is required for the national accounts. The depreciation estimates that are generated by those models are estimates that apply to structures that continue in existence over the sample period. However, there is another form of structure depreciation that is not addressed by the hedonic regression methodology: namely the loss of residual structure value that results from the *early demolition* of the structure. This problem was noticed and addressed by Hulten and Wykoff (1981) [219] and by Schreyer (2001) (2009) who followed the Hulten-Wykoff methodology. This methodology recognizes that similar assets are retired at different ages and so depreciation estimates are formed that are *averages* of the depreciation rates which result with varying ages of retirement. The problem with this methodology is that while it will give the right answer for a large group of production units, it will not provide an accurate description of each *individual* firm's capital services input. Below, we will describe the methodology suggested by Diewert and Shimizu (2014) to address this problem [220].

Their solution to the problem of measuring the effects of early retirement of a building requires the existence of data on the date of construction and the date of retirement of each building in the class of buildings under consideration, and for the region that is in scope [221]. Komatsu, Kato and Yashiro (1994) collected dates of construction and dates of retirement data for reinforced concrete office buildings in Japan for the reference year 1987. Thus for each age of building s (in years), they were able to calculate the number of office buildings of age s (in years), N_s, as of January 1, 1987 along with the number of office buildings of age s, n_s, that were demolished in 1987 for ages s = 1, 2,...,75. Given this information, they were able to calculate the *conditional probability*, ρ_s, that a surviving structure of age s at the beginning of the year would be demolished during 1987; i.e., they defined ρ_s as follows:

(11.14) $\rho_s \equiv n_s / N_s$;   s = 1, ... ,75.

Under the assumption that the conditional probabilities have persisted through time, the *unconditional probability* π_s that a building of age s is still in existence at the beginning of the year 1987 is defined as follows:

(11.15) $\pi_0 \equiv 1$; $\pi_s \equiv \pi_{s-1}(1-\rho_s)$;   s = 1, ... ,75.

It can be seen that the series π_s are a building counterpart to *life expectancy tables*; i.e., the births and deaths of a population of buildings are used to construct the probability of building survival as a function of age, instead of the probability of individual survival as a function of age.

Once the probabilities of survival π_s have been determined, then the conditional probabilities of demolition ρ_s can be determined from the π_s, using equations (11.15) above [222]. For the Japanese data, the conditional probabilities of demolition are very low for the first 20 years or so of the building's life. From 20 to 42 years these probabilities gradually increase from 1.4 % to about 11 % and then the probabilities fluctuate around the 10 % level from age 43 to 67. Finally, after age 67, the conditional probabilities of demolition increase rapidly to end up close to unity at age 75.

Remember that the (single) geometric depreciation rate for continuing office structures in Tokyo that Diewert and Shimizu (2014) estimated for Japanese commercial office buildings, was about 0.5 % per quarter. Diewert and Shimizu (2014) formed a rough approximation to the possible magnitude of *demolition depreciation* using the life table information provided by Komatsu, Kato and Yashiro. We will now explain how Diewert and Shimizu constructed their rough estimate of demolition depreciation.

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[219] 'Any analysis based only on survivors will therefore tend to overstate both the value and productivity of estimated capital stocks'. Charles Hulten and Frank Wykoff (1981; 377). Wear and tear depreciation is often called *deterioration* depreciation (in the U.S, the term is 'physical obsolescence') and *demolition* or *early retirement depreciation* is sometimes called *obsolescence* depreciation. In the U.S. it is referred to as 'Economic Obsolescence' or 'External Obsolescence'. In the U.S. appraisal and commercial real estate industries 'depreciation' is typically said to result from three forms of 'obsolescence': 'physical', 'functional', and 'economic'. 'Functional obsolescence' refers to the structure losing value because changes in users' preferences causes the structure's design or characteristics to be no longer optimal for its design usage. Physical and functional obsolescence tend to occur slowly and gradually over time. Economic obsolescence may be either gradual or sudden (e.g., if a new highway interchange is built near a property, or a nearby nuclear power plant springs a leak…). Crosby, Devaney and Law (2012; 230) distinguish the two types of depreciation and in addition, they provide a comprehensive survey of the depreciation literature as it applies to commercial properties. Depreciation is also explicated in Geltner, Miller, Clayton and Eichholtz (2014) Chapter 5.

[220] A similar approach, consistent with Hulten & Wyckoff (1981) but with more modern methods of life expectancy estimation, is presented in Bokhari & Geltner (2014).

[221] Usually, land registry offices and/or municipal authorities issue building permits for the construction of new buildings and demolishment permits for the tearing down of buildings. It may be difficult to classify buildings into the desired economic categories.

[222] Define $\rho_0 \equiv 0$.

Suppose that the *annual wear and tear geometric depreciation rate* is 2 % so that the annual δ is 0.005. Suppose further that investment in Tokyo office buildings has been constant for 75 years. Normalize the annual structure investment to equal unity in constant yen units. Finally, suppose that the Komatsu, Kato and Yashiro survival probabilities π_s apply to the hypothetical steady state investment data. Thus after 75 years of steady investment the constant yen value of the Tokyo commercial *office building stock* can be K defined as follows:

(11.16) $K \equiv \pi_0 + \pi_1(1-\delta) + \pi_2(1-\delta)^2 + \dots + \pi_{75}(1-\delta)^{75}$.

The corresponding real value of *wear and tear depreciation* Δ is defined as follows:

(11.17) $\Delta \equiv \delta\pi_0 + \delta\pi_1(1-\delta) + \delta\pi_2(1-\delta)^2 + \dots + \delta\pi_{75}(1-\delta)^{75} = \delta K$.

The corresponding amount of *demolition depreciation* D is defined as each component of the surviving capital stock on the right hand side of equation (11.17), $\pi_s(1-\delta)^s$, multiplied by the corresponding conditional probability of demolition, ρ_s; i.e., define D as follows:

(11.18) $D \equiv \rho_0\pi_0 + \rho_1\pi_1(1-\delta) + \rho_2\pi_2(1-\delta)^2 + \dots + \rho_{75}\pi_{75}(1-\delta)^{75}$.

Once the surviving capital stock K, the amounts of wear and tear depreciation Δ and demolition depreciation D have been defined, the *average wear and tear depreciation and demolition depreciation rates*, δ and d, are defined as the following ratios:

(11.19) $\delta \equiv \Delta/K$; $d \equiv D/K$.

Of course, the assumed annual wear and tear depreciation rate of 0.02 turns out to equal the average wear and tear depreciation rate defined in (11.19) and the average demolition depreciation rate d turns out to equal 0.01795. Thus for Diewert and Shimizu's Tokyo office building data, *it is likely that demolition depreciation is approximately equal to wear and tear depreciation*. Note that the sum of the two depreciation rates is approximately 3.8 % per year.

The demolition depreciation rates estimated by Diewert and Shimizu are only rough approximations to actual demolition depreciation rates. The actual rates of demolition depreciation depend on actual investments in commercial property office buildings in Tokyo for the past 75 years and this information was not available. However, the above calculations indicate that accounting for premature retirements of buildings adds significantly to the wear and tear depreciation rates that are estimated using hedonic regressions on continuing buildings. Thus it is important that national statistical agencies construct a data base for building births and retirements so that depreciation rates for buildings that are not retired can be adjusted to reflect the loss of building asset value that is due to premature retirement.

The analysis presented in this section does not invalidate the hedonic regression approach for constructing constant quality price indices for commercial properties, since price indices compare like to like, and therefore only apply to continuing structures. As a by-product of the builder's model, statisticians can form estimates of wear and tear depreciation for buildings that remain in use. The analysis in this section simply warns the reader that wear and tear depreciation is not the entire story: there is also a loss of asset value that results from the early retirement of a building that needs to be taken into account when constructing national income accounting estimates of depreciation.

11.2. Land

Chapter 3 referred to the lack of a well-defined conceptual framework underpinning land price indices (LPIs) and that, despite the fact that land represents a valuable asset — the price movements of which are relevant in analysing the wider economy in terms of identifying asset price bubbles and as a lead indicator of property prices — the availability of data on land prices is relatively sparse. Thus, data directly or exogenously indicating land prices, suitable for constructing independent quality-controlled land price indices, will generally be very difficult to obtain for commercial land, in sufficient quantity and depth for the practical construction of such indices.

Importantly, however, as described in Annex 11.1, LPIs can be constructed as derivatives of property asset price indices (CPPIs) provided good indices of construction prices are available. In addition, in some circumstances, the need for an explicit, separate LPI distinct from the corresponding (whole property) CPPI can be obviated by application of the Residual Theory of Land Value within the Gross Fixed Capital Account. Just as the original structure 'quantity' is updated by the perpetual inventory method and the application of a construction cost index and depreciation schedule, so can the land (non-produced, non-consumed financial asset) value component of the whole property be updated by application of the (whole property) revaluation or CPPI and the Residual Theory. The land 'quantity' in any property does not change over time, and the structure 'quantity' diminishes only with depreciation. Using the construction cost index and depreciation to update the structure value (construction price index times depreciated quantity), this perpetual inventory structure value can be subtracted from the updated whole property value (based on disaggregate revaluations or else on an appropriate aggregate CPPI) to arrive at the land value. (This exercise can also imply an LPI as a by-product, a land value deflator, since land 'quantity' remains constant in any given property.) Thus, the Residual Theory of Land Value can be invoked to obtain the necessary LPI or land value data for national accounting purposes, given a good CPPI and good construction cost indices and depreciation schedules.

The need to have an aggregate source of information about land value fractions, in particular at the time when new structures are built (the time when the asset first enters the Gross Fixed Capital Formation account) arises from the fact that it may not always be possible to obtain the necessary land/structure value breakdown in the disaggregate (asset specific) reports. It may be more likely to obtain good total property value data at the time a new asset enters the accounts, than to obtain a good disaggregate, specific-asset breakdown of the land and structure components at that time. Thus, aggregate level data on land value fractions can be useful. Such data can also be useful in deriving LPIs from total property asset price indices.

As discussed in Annex11.1, what is needed is a generic, empirically or analytically based Table of 'General Development Land Value Fractions' (GDLVFs). This provides at-construction land value fractions (representing the opportunity cost of the land at that time, as a fraction of the total newly developed property value, not generally the historical acquisition cost of the land). Such GDLVFs will vary by types and locations of commercial properties. Such a table could be developed by surveying developers. This is also a type of data for which administrative property tax assessment of the land value component might be relatively reliable, when the construction is new. Thus, tax assessment authorities could also be a source of data for the GDLVF. The GDLVF could also conceivably be developed analytically, using option value theory and/or other basic urban economic theory about optimal development and redevelopment. (e.g., See Chapter 4 in the widely-used urban economics textbook, Denise DiPasquale & William Wheaton, 'Urban Economics & Real Estate Markets', Prentice-Hall, 1996). There are also other analytical approaches that could also be used to get an idea about land value fractions, including linear additive separable hedonic price models, or by combining census and national accounts data on property value and structure value, as outlined by Davis and Heathcote (2007) and Davis and Palumbo (2008). Some of these approaches would need to be combined with a good depreciation schedule to get to the land value fraction for new construction.

The importance of the Residual Theory of Land Value is emphasized by the challenges in attempting to directly value land exogenously, as opposed to the reliance we're proposing on the Residual Theory. The remainder of this annex will review some of these challenges.

A basic problem is that the use to which land is put, or can potentially be used for, can be a pertinent price-determining factor in its value ([223]). But such data is not always readily available and, moreover, transactions can often be speculative i.e. undertaken in the anticipation of a possible future change in use. Also what data does exist can vary substantially from one country to another. Comparisons between countries can be confounded by the absence of such a breakdown and by the lack of an internationally agreed classification. An added complication in both the conceptual definition and empirical observation of direct land values is that of freehold versus leasehold properties, referring in this case to long-term ground leases. In countries where leaseholds are very common, this issue may present a problem.

([223]) Most particularly, the price-determining characteristics of land, such as whether a Greenfield site has planning permission for commercial or industrial use, or a Brownfield site is considered to have good potential for future development.

The above problem is well-illustrated by the limited availability of comparable data within the European Union. At the European level, only one public database currently exists: Eurostat collects some data at NUTS 0 (national level) on land prices (Euro per hectare) and rents, which is based on an annual questionnaire sent to National Statistical Institutes. In addition, the European Environment Agency (2010) has analysed land prices, taxes and use patterns in Europe. While this focuses on land use and environmental policy, it does highlight the lack of coherent data sets available, and notes the potential use of land price indices in identifying land use changes. Thus it concludes that: 'One problem is that there are many types of land price indices in different countries, making it difficult to decide which index should be analysed. A further problem is the many sources for land prices. Methodologies vary. And in some countries, 'real' (i.e. market) land prices differ from those declared to the government and thus registered in the official statistics'. The relatively small number of transactions can also be a limiting factor. Data are generally obtained from land registers and private companies.

It can be noted that there are a number of characteristics that all data sources share.

- The uniqueness of land means that plots of identical size in the same location can vary substantially in price e.g. if one plot being sold for house construction has a nice view and another doesn't.
- The absence of standard plot sizes means that prices will need to be converted to a unit value such as price per hectare.

For a 'transactions' database it is also pertinent to note that.

- There are likely to be more records relating to land prices in rural areas than land prices in urban areas due to the relative scarcity of land in urban areas. In consequence of the scarcity of information relating to urban land, estimates of the price or value of building land in urban areas are likely to be at best 'approximations', regardless of the data source used for compiling LPIs. A further consequence is that such estimates are likely to be quite volatile.
- Following on from the above, sample sizes are likely to be small at and below the regional level, and for different types of land use.

Under a valuations approach, a set of 'typical or standardised' commercial land plot types will need to be developed.

The United Kingdom provides an example of the 'standardised' valuation approach. In the United Kingdom, by law details of all property and land transactions have to be supplied to the Valuation Office. With around 100 Chartered Surveyors and 80 local offices, the Valuation Office used to publish estimates of annual average land prices and indices for agricultural land (separated into arable, dairy, and mixed use, with and without buildings), residential building land, and industrial land. These were based on valuations using local knowledge and expert judgement informed by recent transactions. Data for agricultural land were produced for selected districts (Counties) within NUTS 1 regions ([224]). Average prices and indices for industrial and residential building were estimated for 20-23 urban areas (cities) with at least two cities per NUTS 1 region. But it is pertinent to note that no data was collected for Inner London or for the centres of larger urban areas due to a lack of availably of natural building land. The valuations referred to 'Typical' properties called 'Beacons', which were tightly defined. For example, a 'Beacon' property for residential building land was defined as 'a suburban site of 0.5 hectare'. The site is then valued based on:

- Price of land per hectare of site area;
- Price of land per habitable room; and
- Price of land per square metre completed space GIA (Gross Internal Area measured internal to living space only i.e. excluding common parts and garages etc. but including bathrooms and corridors etc. within living units).

The values should be provided on the assumption that land is situated in a typically average Greenfield edge of centre/suburban location for the area. In addition, it should be assumed that services are

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([224]) The NUTS classification (Nomenclature of territorial units for statistics) is the common statistical classification of territorial units in order to enable collection, compilation and dissemination of harmonized regional statistics of the European Union: NUTS 1, 2 and 3, respectively — moving from larger to smaller territorial units. Above NUTS 1 is the 'national' level of the Member State. NUTS subdivides the territory of the European Union and its 28 Member States into 98 NUTS 1 regions, 272 NUTS 2 regions and 1315 NUTS 3 regions. More information can be found at http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:NUTS

available to the edge of the site and that it is ripe for development with planning permission being available. The values provided should assume a maximum of a two-storey construction with density and affordable housing ratios to be based on market expectations for the locality. The values should be regarded as illustrative rather than definitive and represent typical levels of value for sites with no abnormal site constraints and a residential planning permission of a type generally found in the area.

Thus, the land is valued on the basis of a relatively prescriptive description of what type of accommodation would be expected to be built. In principle, such valuations can be used not only for producing valuation-based price indices but also for differentiating the price of land from the price of a structure but doubts have been expressed about how useful such an exercise would be in practice.

Data sources are generally the same as for commercial buildings, although as already noted there is less availability.

- *Land registries.* These universally record the ownership of all properties and land within their jurisdiction and, as such, are a prime candidate for compiling LPIs although the usefulness of registers depends on the amount of detailed information recorded for each transaction. For example, the land registries for the United Kingdom include a 'price paid data set' for all residential properties transacted but the purchase of land is not covered by these data sets. Entries for the specific parcels of land parcel can be looked up in the register if the details are known e.g. the registration reference number of the sale or details of location. But even when a registration can be found the information is of limited use as the United Kingdom land registries operate under what is referred to as a 'general boundary rule', which records the boundary of the land on a map but which gives no information on plot size. Land use and the purchase price are also not generally recorded [225].
- *Tax office records.* In most countries, the purchase of dwellings and of land is subject to a transaction tax or stamp duty, which is often proportional to the sales price. But the amount of detail recorded can vary and is often a function of the tax structure. For example, land use may be recorded or might be implied if different types of land attract different levels of taxation. It is worth noting that transaction tax is generally applied to the total value of both the land and the building and so tax records rarely separate out the values of the land and the structure. This can be a widespread problem, especially for commercial property, because of its tendency to locate in central highly built-up places. There are often few transactions of actually vacant land parcels in comparable locations. The value of land is much more difficult to observe empirically or directly, than the value of the built real property (land & building together). So, in theory it may make more sense to take the CPPI of the built properties as the fundamental empirical information, and then use the Residual Theory of Land Value to derive the implied corresponding LPI.
- *Valuation Offices.* Most countries have a valuation office (or a section of the tax authority) that periodically re-values all properties including land for the purposes of taxation. In principle, this could be a source of data for a valuation-based LPI. Again, the potential use of such data will depend on individual country circumstances. In Germany, according to the German Federal building code (Baugesetzbuch), a copy of each contract and land transaction has to be sent to the valuation committees in each Lander, in order to maintain and update land transaction databases. This information is then used to determine approximate values for land. The data from these committees has been used by the German Federal Statistics Office to produce a quarterly index of residential building land.
- *Other valuers & real estate agents.* Land, like dwellings, is often transacted by property agents and prior to sale is subject to professional valuation by the potential purchaser or by the providers of finance such as banks. A survey of real estate agents (and possibly banks in some countries) presents a possible source of data for land prices. In the United Kingdom, the Royal Institution of Charted Surveyors (RICS) also produces periodic surveys of agricultural land prices. Large land agents such as Savills also produce occasional reports on land prices in which they act for either the vendor or purchaser. But such surveys may not meet the data needs for the regular production of LPIs given the difficulties of obtaining and maintaining a representative sample of agents, and the limited numbers of transactions that may result. There is also the issue of how realistic such valuations are — the generic problem associated with appraisal-based indices.

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[225] The price paid data excludes all property transactions which involve: a corporate body; a company; a business. This is in contrast to prices relating to transactions of residential properties. For more information, see: http://www.landregistry.gov.uk/market-trend-data/public-data/price-paid-faq#m15.

- *Government departments and local municipalities*. In Spain, the Ministry of Housing is responsible for national policy in matters relating to access to housing, construction, urban planning, land use and architecture, as well as for public investments in these areas. To carry out its policy role, the ministry monitors the prices of housing and urban land. The Spanish Autonomous Communities have Regional Ministries for Territorial Planning and Housing that manage policies in these areas as well as gather data. For example, Andalusia's Regional Ministry of Agriculture and Fisheries monitors rural and agricultural land prices and rural land use. Many other local authorities in Spain monitor land prices in their territories.

Data sources for transaction weights for an LPI are likely to be the same as those for prices. For stock weights, the land registry and/or land use censuses and surveys may be useful data sources, but this will depend on the range of detailed data that these sources contain.

As mentioned in earlier chapters, while acquisitions and sales of land in the national accounts generally cancel each other out at the level of the total economy, this may not be the case within sectors due to inter-sector transactions — zero-sum transactions within a sector are important consideration in the monitoring and analysis of the financial system. Thus, when looking at the needs of national accountants, the availability of appropriate data can act as a severe constraint on the compilation of statistics within specific sectors of the economy.

As noted, the derivation of residual LPIs is a potentially very useful way around these challenges.

At the time of writing the 2015 *Eurostat-OECD Compilation guide on land estimations* was published providing a detailed outline, examination and guidance on land valuation with particular attention paid to standards and the context of the national accounts.[226]

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[226] Available at: http://unstats.un.org/unsd/EconStatKB/KnowledgebaseArticle10434.aspx

12 CPPI Glossary

Acquisitions approach
An approach in which consumption is identified with the goods and services acquired in some period (as distinct from those wholly or partially used up for purposes of consumption).

Aggregate
See aggregation.

Aggregation
Combining, or adding, different sets of transactions or other metrics to obtain larger sets of transactions or such metrics to form an **aggregate**. The larger set is described as having a higher level of aggregation than the sub-sets of which it is composed. The term 'aggregation' is also used to mean the process of adding or averaging the values of the lower-level aggregates to obtain higher-level aggregates.

Amortisation
For mortgages or debt liabilities in general; amortisation is the gradual reduction of a debt or liability, especially by means of equal periodic payments at stated intervals which, in total, are sufficient to repay the capital or principal at the end of the given period and to pay interest on the outstanding balance throughout the period. Under *American accounting rules;* amortisation according to the FASB Generally Accepted Accounting Principles (GAAP) rules uses the term 'amortization' also to apply, in effect to, 'depreciation' i.e. write-downs of capital improvement items, such as certain building components and equipment, as well as tenant improvements associated with long-term leasing, and even broker's leasing commissions. In this usage the amortization does not include any interest component, merely the writing down (and current expensing) of the undiscounted historical amount of the expenditure.

Asking price
The posted price at which a property is offered for sale. The asking price can be adjusted during the process of buying and selling a property until the final transaction price is reached.

Assets
An asset is a store of value representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time. It is a means of carrying forward value from one accounting period to another. Assets may be financial in nature or not (SNA 2008 3.5).

Asset market
In the CPPI context typically referring to the property asset market: the market for the ownership of real property assets, a branch of (or segment of) the capital asset markets (which may also include, for example, stock shares and bonds).

Assessed value or appraisal
Valuation of the market value of a property. Valuations are normally estimates of individual property market values made by professional valuers or appraisers or assessors. Valuations may be needed to obtain credit finance. In some countries assessments are performed on the government's behalf for (property) tax purposes. In commercial property, valuations are required to be made at regular and frequent intervals for assets held in investment funds, for reporting fund values to the investors. Such valuations or appraisals have been widely used to construct commercial property price and total

investment return indices in a number of countries. Assessed property values are also referred to as appraisals. See also Sale Price Appraisal Ratio method.

Attributes
The physical and locational characteristics or features of a property and/or of a property transaction that are reflected in the market value or transaction price of the property.

Axiomatic (test) approach
The approach to index number theory that determines the choice of index number formula, on the basis of its mathematical properties. A list of tests is drawn up, each test requiring an index to possess a certain property or satisfy a certain axiom. An index number may then be chosen on the basis of the number of tests satisfied. Not all tests may be considered to be equally important and the failure to satisfy one or two key tests may be considered sufficient grounds for rejecting an index.

Base period
The base period is usually understood to mean the period with which all the other periods are compared. The term may, however, have different meanings in different contexts. Three types of base period may be distinguished:

- the price reference period — the period that provides the prices to which the prices in other periods are compared. The prices of the price reference period appear in the denominators of the price relatives, or price ratios, used to calculate the index;
- the weight reference period — the period for which the expenditures (or inventory standing stock) serve as weights for the index. If the expenditures are hybrid (i.e., if the quantities of one period are valued at the prices of some other period), the weight reference period is the period to which the quantities refer;
- the index reference period — the period for which the value of the index is set equal to 100.

It should be noted that, in practice, the duration of the weight reference period for CPPIs varies considerable from one CPPI to another. The weight reference period is often longer than the frequency of the CPPI to which the weights are applied. CPPIs are typically calculated quarterly or annually, the duration of the price reference period being a quarter or a year. Thus, the weight and price reference period may not coincide in practice, at least when a CPPI is first calculated, although the price and index reference periods frequently coincide. Many commercially produced CPPIs have continuously evolving weights, as they reflect or represent a dynamic population of properties defined by some membership or 'universe' or sampling criterion.

Bias
A systematic tendency for a calculated price index (or more broadly, any statistical inference) to diverge from some ideal or preferred index (or 'population' statistics), resulting from the method of data collection or processing or the index formula or statistical inference method used. See also sample selection bias.

Capital improvement expenditures
Capital improvement expenditures (often referred to as 'capex') are infusions of financial capital into the property in order to increase the value of the property asset relative to what it would be without the infusion. In commercial property capex is often internally financed from the net operating cash flow generated by the property, thereby reducing the net cash flow taken out by the property owner during the period when the improvement is paid for. If the capex rises to the level of 'major repairs and renovations', then in principle it is treated in the SNA as capital formation (SNA 2008 20.61). Major renovations are often not financed solely internally by the net cash flow generated by the property, but rather require new additional external capital to be applied.

Capital taxes
Capital taxes consist of taxes levied at irregular and infrequent intervals on the values of the assets or net worth owned by institutional units or on the values of assets transferred between institutional units as a result of legacies, gifts inter vivos or other transfers. They include capital levies and taxes on capital transfers: (SNA 2008 10.207)

Capital value -observed
The *observed* value of a freehold or leasehold asset as opposed to a periodic value such as rent.

Capital value — estimated

The *estimated* 'going rate (valuation)' for an investment based on a willing buyer and a willing seller. This represents an estimate of both the current value of the asset and an estimate of the future returns of the investment.

Capital value growth

The change in capital value from one period to the next or between two points in time. Often defined as the percentage annual compounded increase in monthly (or other frequency) capital values, expressed as a percentage of the capital employed each period. Capital value growth can be defined as either net or gross of internally financed capital improvement expenditures.

Capitalization Rate

Also referred to as 'cap rate'. Two widely used meanings. One is the discount rate used to convert future money values into present value, or more generally to convert money values across time (forward via compounding or chain-linking, backward via discounting). The other meaning is the current net income yield of an investment, that is, the annual rent that is passing as a percentage of the capital value.

Chain (or chained) index

An index number series for a long sequence of periods that is obtained by linking together index numbers spanning shorter sequences of periods. A chain index, computed according to some index number formula (such as Laspeyres or Fisher indices), is the product of period-on-period (or period-by-period) indexes, which are computed with the same formula. See also Linking.

Characteristics

The physical and economic attributes of a good, service or property that serve to identify it and enable it to be classified. For commercial property these relate to both the structure (the building) and the location/land (including the neighbourhood or district).

Characteristics prices hedonic approach

An hedonic regression method based on the change in the estimated values of the parameters for the characteristics (also known as 'attributes') of the (average or 'representative') property sold in a fixed period, or average of periods, i.e. the shadow prices of the characteristics, determines the property price index.

Component

A set of the goods and services that make up some defined aggregate. Also used in the context of decomposing the property price (index) into land and structure components, or into pure price and quantity components. Also may be used in the context of composite indexes to refer to the constituent indexes from which the composite index is constructed.

Composite Index

An index constructed as the aggregate or average of component or constituent indexes (or sub-indexes) that are less aggregated than the composite index. Composite indexes are typically weighted averages of their components, reflecting some sort of weighting criterion. See *aggregation*.

Consistency in aggregation

An index is said to be consistent in aggregation when the index for some aggregate has the same value whether it is calculated directly in a single operation, without distinguishing its components, or whether it is calculated in two or more steps by first calculating separate indexes, or sub-indexes, for its components, or sub-components, and then aggregating them, the same formula being used at each step.

Consumer Price Index (CPI)

A periodic price index (usually monthly or quarterly) compiled and published by an official statistical agency that measures changes in the prices of consumption goods and services acquired or used by households.

Consumption of fixed capital

Consumption of fixed capital often referred to as depreciation in commercial accounting but not in the SNA, is the decline, during the course of the accounting period, in the current value of the stock of

fixed assets owned and used by a producer as a result of physical deterioration, normal obsolescence or normal accidental damage (SNA 2008 10.25). See also depreciation.

Coverage

The set of properties of which the prices are actually included in a price index. For practical reasons, coverage may have to be less than the ideal scope of the index. That is, the types of property actually priced may not cover all of the types that are sold or belong to the stock of commercial property.

Current period, or comparison period

In principle, the current period refers to the most recent period for which the index has been compiled or is being compiled. The term is widely used, however, to mean the comparison period; that is, the period that is compared with the base period, usually the price reference or index reference period. It is also used to mean the later of the two periods being compared. The exact meaning is usually clear in the context.

Data cleaning

Procedures, often automated, used to delete entry errors in data sets, such as observations which are deemed implausible, or outliers.

Deflating

The division of the change in the current value of some aggregate by a price index (in this context referred to as a deflator), in order to estimate the change in the volume.

Depreciation

The permanent decrease in the economic value of a structure or the stock of commercial property through physical deterioration or obsolescence over time. See also consumption of fixed capital. In commercial property depreciation is generally recognized to occur due to one or more of three sources or types of obsolescence: physical obsolescence (wear and tear), functional obsolescence (changes in technology, preferences and needs of building users), and economic (or 'external') obsolescence (evolution of the highest and best use of the site away from that for which the existing structure was built). In national accounts depreciation is generally considered a change in 'quantity' of property rather than a component of pure price change.

Domain

An alternative term for the scope of an index.

Drift

A chain index is said to drift if it does not return to unity when prices in the current period return to their levels in the base period. Some types of chain indexes are liable to drift when prices fluctuate over the periods they cover.

Durable consumption good

A consumption good that can be used repeatedly or continuously for purposes of consumption over a long period of time, typically several years. Commercial structures are an extreme form of a durable consumption good due to their very long expected lifetime. This has led to different approaches to the measurement of commercial property prices.

Economic approach

The economic approach to index number theory assumes that the quantities are functions of the prices, the observed data being generated as solutions to various economic optimisation problems. See also axiomatic or test approach.

Economic obsolescence

Also known as external obsolescence. The loss in value of an existing building structure on a site because a change in the highest and best use (HBU) of the site makes it more profitable to demolish the existing building and replace it with a new (different type, size, quality) building that conforms to the new HBU. Economic obsolescence can render a structure obsolete even though the property may still be able to earn positive net rents (even perhaps undiminished net rents) with the pre-existing building on it. If the new HBU is sufficiently more valuable than the use to which the pre-existing structure was designed, and/or it is too expensive to convert the existing structure, then the profitability of the redevelopment can more than make up for the opportunity cost of the existing structure.

Editing
The process of scrutinising and checking the prices reported by price collectors. Some checks may be carried out by computers using statistical programs written for the purpose. See also data cleaning.

Elementary aggregate
Usually defined as the lowest aggregate for which expenditure data are available and used for index construction purposes. Elementary aggregates also serve as strata for the sampling of properties to be priced. The values of the elementary aggregates may be used to weight the elementary price indexes to obtain higher-level aggregate indexes.

In the context of a sales-based property price index, the term elementary aggregate may refer to an index estimated directly on a sample drawn from a population that is deemed sufficiently homogeneous such that the index represents a single effective population of properties and/or a single well integrated property asset market or sub-market.

Estimated Rental Values (ERV)
An estimate of the rent, which a property is likely to command in the open market at a given time.

Fisher price index
The geometric average of the Laspeyres price index and the Paasche price index. The Fisher index is symmetric and superlative.

Fixed assets
Fixed assets are produced assets that are used repeatedly or continuously in production processes for more than one year. The distinguishing feature of a fixed asset is not that it is durable in some physical sense, but that it may be used repeatedly or continuously in production over a long period of time, which is taken to be more than one year (SNA 2008 10.11). Fixed assets include all structures and in particular buildings.

Fixed weight indexes
An abbreviated description for a series of weighted arithmetic averages of price relatives of price indexes where the weights are kept fixed over time. In a commercial property price index context, the weights can be sales (expenditure) weights or stock weights.

Freeholder
A legal entity, holding an estate 'fee simple absolute in possession'.

Functional obsolescence
The process of permanent loss in value of a building structure, usually gradually, due to the building's attributes and characteristics becoming less desirable for its users, typically due to technological change (e.g., advent of fiber-optic wiring for buildings), and changes in preferences and needs (e.g., demand for 'green' office environments, need for automobile access).

Geometric Laspeyres index
A weighted geometric average of the price relatives using the expenditure shares (or other weighting basis, such as stock weights) of the price reference period as weights.

Goods
Physical objects for which a demand exists, over which ownership rights can be established and for which ownership can be transferred between units by engaging in transactions on the market. Commercial properties can be viewed as a type of good.

Gross fixed capital formation
In the SNA, gross fixed capital formation for commercial properties consists of the value of producers' acquisitions of new and existing commercial properties less the value of their disposals of commercial properties of the same type (SNA 2008 10.64). [This should exclude the cost of land, which is classified in the SNA as a non-financial, non-produced asset (SNA 2008 10.9).] This will normally primarily represent the net value of new development as well as major repairs and renovations on existing properties (SNA 2008 20.61). See also fixed assets.

Headline rent

The rent apparently being paid, that may not take account of concessions such as rent-free periods. Also often referred to as 'asking rent' or 'quoted rent'.

Hedonic regression

The estimation of a hedonic price model, using regression techniques, that predicts the price of the property as a function of its characteristics (relating to the structures as well as the location). See also hedonic imputation approach, hedonic characteristics' approach, and time dummy variable hedonic approach.

Hedonic imputation approach

An approach to estimating a quality-adjusted property price index where "missing" prices are imputed using a hedonic regression model. The "missing" prices might, for example, be the imputed prices of properties in period t of those sold in period 0. The model parameters are re-estimated in each time period.

Highest & Best Use (HBU)

The most profitable use to which a land parcel can be put. The type (and size and quality) of structure that maximizes the value of a land parcel.

Hybrid (repeat sales) models

A regression-based method to estimating property price indexes which combines repeat sales and hedonic approaches.

Identity test

A test under the axiomatic approach that requires that, if the price of each item remains the same between the periods compared, the price index must equal unity.

Imputed price

The price assigned to an item (e.g. a property) for which the price is "missing" in a particular period. This may be done using hedonic regression methods. See also hedonic imputation approach.

Index reference period

The period for which the value of the index is set at 100 (or, alternatively, 1).

Indexation

The regular adjustment of a rent in accordance with a specified index e.g. a CPI.

Integrated market

A market in which all participants and all traded goods can compete equally with each other, such that the 'Law of One Price' prevails throughout the market, that is, the same good cannot trade at different prices at the same time, within an integrated market.

Investment value

In real estate appraisal of commercial property, the estimated value of a property asset (or other investment claim) for a particular specified owner, apart from or separate from the current exchange value (market value) of that asset, in other words, as if the asset would be held by the specified owner for a long time without selling it on the market.

Investment yield

Annual rent that is passing as a percentage of the capital value. This can be expressed as either net or gross of annual operating expenses borne by the landlord. (See also Capitalization rate.)

Jevons price index

An elementary price index defined as the un-weighted geometric average of the sample price relatives, or equivalently, the ratio of un-weighted geometric means in the two periods compared.

Land

Land consists of the ground, including the soil covering and any associated surface waters, over which ownership rights are enforced and from which economic benefits can be derived by their owners by holding or using them. (2008 SNA 10.175) In national accounting land is generally regarded as being neither produced nor consumed. In the context of CPPIs, land usually refers to urban land,

as distinguished from agricultural or natural resource land. As relevant to commercial property (as distinguished from infrastructure and parks, for example) urban land derives its value solely from its ability to serve as a site for a building structure, either in the present or the future.

Land market
The land market generally refers to the market for vacant, un-built land parcels. In the CPPI context, this would be the market for vacant lots that can be built with commercial structures. The market for vacant commercial land is often very thin. Combined with the uniqueness of land parcels, this makes direct observation of land market value as if vacant difficult to observe.

Land value component
The component of the total property value that is attributed to the land as distinguished from the built structure on the property. The land component includes the effect of the location and site on the highest and best use of the property as if vacant. Generally the land component of a built property is not traded separately from the structure, Consistent with the notion that land is neither produced nor consumed, the quantity of land in any given property is completely inelastic in its supply. Considering this, the traditional Residual Theory of Land Value from urban economics and real estate valuation practice defines the value of the land component as the residual of the property total value minus the value of the structure, with the latter based on opportunity cost in the much more elastic construction industry (minus the effect of accumulated depreciation).

Laspeyres price index
A price index in which the quantities of the goods and services refer to the earlier of the two periods compared, the price reference period. The Laspeyres index can also be expressed as a weighted arithmetic average of the price relatives with the expenditure shares in the earlier period as weights (or other basis of weighting for assets, such as stock value). The earlier period serves as both the weight reference period and the price reference period.

Lessee
A party to whom a property has been let i.e. the Tenant.

Lessor
The party letting the property (i.e. the Landlord).

Linking
Splicing together two consecutive series of price observations, or price indexes, that overlap in one or more periods. If the two sequences overlap by a single period, the usual procedure is simply to rescale one or other sequence so that the value in the overlap period is the same in both sequences and the spliced sequences form one continuous series. See also chain index.

Lowe price index
A price index that measures the change between periods 0 and t in the total value of a set of goods and services at fixed quantities. The quantities do not necessarily have to consist of the actual quantities in some period. The class of indexes covered by this definition is very broad and includes, by appropriate specification of the quantity terms, the Laspeyres and Paasche indexes.

Lower-level index
A sub-index component of a composite index as distinct from an aggregate index.

Market
The institution or process by which goods or services are voluntarily exchanged 'at arm's length' (see below) among owners, generally for money or money equivalents.

Market prices
Market prices for transactions are defined as amounts of money that willing buyers pay to acquire something [for example a commercial property] from willing sellers; the exchanges are made between independent parties and on the basis of commercial considerations only, sometimes called 'at arm's length'. Thus, according to this strict definition, a market price refers only to the price for one specific exchange under the stated conditions. A second exchange of an identical unit, even under circumstances that are almost exactly the same, could result in a different market price. A market price defined in this way is to be clearly distinguished from a price quoted in the market, a world market price,

a going price, a fair market price, or any price that is intended to express the generality of prices for a class of supposedly identical exchanges rather than a price actually applying to a specific exchange (SNA 2008 3.119). Market prices under this definition equate to transaction prices. See also transaction prices.

Matched models approach
The practice of pricing exactly the same property, in two or more consecutive periods. It is designed to ensure that the observed price changes are not affected by quality change. The change in price between two perfectly matched products is sometimes described as a pure price change. See also repeat sales. Statistical techniques have also been developed to produce 'matched samples' that are not exactly the same property but are sufficiently similar on all the dimensions that affect value such that through a large sample statistical process a similar type of quality controlled price index can be produced. The hedonic imputation approach imputes the prices of properties sold in one period to allow matched comparisons in another.

Market rent or rental value
The best rent at which a property might reasonably be expected to be let with vacant possession in the open market, with a willing landlord and tenant, taking full account of all terms of the tenancy offered.

Market value
The value of a property at a certain point of time, or the price that would result if the property would be sold in a 'free market'. Often described as the most likely market price at which a given property or set of properties would transact. Also or alternatively (but similarly) defined as the mean or probabilistic expectation of the ex-ante probability function governing the market price as of a given point in time. Market value must be estimated, whereas market prices can be empirically observed. See also market prices.

Median index
A price index that tracks the change of the median property price over time. The median is the middle of a (sample) distribution: half the scores are above the median and half are below the median. The median is less sensitive to extreme scores than the mean and is often preferred to the mean as a measure of central tendency in highly skewed distributions.

Mix adjustment
A term used to describe procedures, which attempt to remove or reduce the effect of changes in the mix (composition) of the sample of properties sold in one pricing period compared to another. See also quality adjustment.

Monetary transactions
A monetary transaction is one in which one institutional unit makes a payment (receives a payment) or incurs a liability (receives an asset) stated in units of currency (SNA 2008 3.55)

Non-produced assets: Commercial property contracts and leases
Contracts and leases are classified in the SNA 2008 (3.44) as a type of non-produced non-financial asset. Contracts and leases for commercial property may represent an asset to the holder when the agreement restricts the general use or supply of products covered by the agreement and thus enhances the benefits accruing to the party to the agreement beyond what would accrue in the case of unrestricted supply. These assets come into existence when the agreement is made and the enhanced benefits become apparent.

Obsolescence
The process of permanent loss in value in the structure on a property due to physical obsolescence (wear and tear), functional obsolescence (changes in technology, preferences, needs), or economic obsolescence (also known as 'external' obsolescence, caused by the highest and best use of the site evolving away from that for which the current structure was designed). See also Depreciation.

Offer price
The price a potential buyer says he will be willing to pay for the property. Also referred to as Bid price.

Opportunity cost

The value of what is currently and actually given up in order to acquire, or by the decision not to sell, a good or service (such as a property asset). Opportunity cost is generally the way economists prefer to measure costs (as distinguished from 'sunk costs', and also from business accounting historical or 'book' values). As stated in the SNA, opportunity cost is 'the cost of using, or using up, some existing asset or good in one particular process of production is measured by the amount of the benefits that could have been secured by using the asset or good in alternative ways. Opportunity cost is calculated with reference to the opportunities foregone at the time the asset or resource is used'. Opportunity cost is the preferred basis of accounting for costs in the SNA. (SNA 2008 1.65.) Also see 'Sunk costs'.

Outlier

A term that is generally used to describe any extreme value in a set of survey data. In a property price index context, it is used for an extremely high or low property price or price relative, which requires further investigation and should be deleted if deemed incorrect. Outliers may also be determined as having excessive residuals after having taken account of price-determining characteristics in an hedonic regression.

Owner-occupied commercial property

Commercial property that is occupied by the owner of the property.

Paasche price index

A price index in which the quantities of the goods and services considered refers to the later of the two periods compared. The later period serves as the weight reference period and the earlier period as the price reference period. The Paasche index can also be expressed as a weighted harmonic average of the price relatives that uses the actual expenditure shares (or other basis of weighting for assets, such as stock value) in the later period as weights.

Physical obsolescence

The process of physical deterioration of a building structure as it ages. Physical obsolescence can often be forestalled or reduced by application of capital improvement expenditures to the property.

Price reference period

The period of which the prices appear in the denominators of the price relatives. See also Base period.

Price relative

The ratio of the price of an individual property in one period to the (imputed) price of that same property in some other period. Also used to refer to the price ratio for a constant quality set of properties or a quality-controlled price index.

Prime property

A term used to define property of particular interest to investors. Broadly, prime property is likely to be a modern or recently refurbished building, finished to a high specification, well situated in a commercially strong geographical location and let to a good tenant. In the USA, 'Class A property' carries virtually the same meaning as 'prime property'.

Produced assets: property

Produced assets such as commercial property, are non-financial assets that have come into existence as outputs from production processes that fall within the production boundary of the SNA 2008 (10.9). In commercial property, the built structure is a produced asset, but the land is not.

Pure price change

The change in the price of a property of which the characteristics (values of the attributes) are unchanged, or the change in the property price after adjusting for any change in quality or quantity (due to renovations, extensions and depreciation).

Quality change

A change in the (quality determining) characteristics (the values of the attributes) of a good or service. In the case of property this includes both depreciation of the structure and renovations, such as the modernisation of foyers, lifts and lighting, the introduction of improved IT infrastructure or air conditioning systems etc.

Quality adjustment

An estimated adjustment to the change in the price of a property of which the characteristics change over time that is designed to remove the contribution of the change in the characteristics to the observed price change. In other words, an adjustment in a price changes so that it reflects that of a constant quality ('quantity') of property. Different methods of estimation, including hedonic methods, may be used in different circumstances. These methods are also be used to control for compositional or quality mix changes over time in the samples of properties sold. See also mix adjustment.

Quantity of land

The quantity of land refers to the SNA-defined quantity or volume measure for the land component of a property. Consistent with the principle that land is neither produced nor consumed, and that it is supplied completely inelastically within any given property, the quantity of land would be deemed to not change across time within any given parcel (SNA 2008 20.41). However, the SNA also allows for changes in quality of products over time to be reflected in measures of quantity (so as to adjust for quality differences as defined above), so that not all of the value change is attributed to pure price change (SNA 2008 15.65, 15.76, 15.82-84). For example, suppose a new subway station is built near a commercial property, increasing the value of the property by increasing its land (location) value. SNA guidelines could permit this to be treated as an increase in the quantity of land ('quality adjustment'), estimated perhaps for example by a hedonic value model.

Quantity of structure

The quantity of structure refers to the SNA-defined quantity or volume measure for the structure component of a property. One way to define this that may work well with national accounting in the aggregate is to reduce the quantity of structure proportionately (relative to its amount when new) by a depreciation or amortization schedule based on estimates of the average life expectancy (to demolition) of the given type of structure, including the typical effects of typical rates of capital improvement expenditures for extending such life expectancy. However, as with the quantity of land noted above, the SNA also allows more nuanced methods to be applied that reflect changes in the structure attributes over time and in particular that reflect the effect of capital improvement expenditures (major repairs and renovations as capital formation, SNA 2008 20.61).

Real estate / realty / real property

A generic term for all types of fixed property and land (commercial and non-commercial). Includes the land and any structures permanently attached to the land. (Excludes personal property such as furniture or mobile homes not permanently attached to the ground.)

Repeat sales method

A method to compile a property price index based on the relative price differences between two (or more) sales of the same property over time. Repeat sales indices estimate constant-quality price change in a property sample under the assumption that the property attribute values (characteristics) remain constant within each property between the consecutive repeat sales.

Representative property

A property, or category of properties, that accounts for a significant proportion of the total expenditures within some aggregate, and/or for which the average price change is expected to be close to the average for all properties within the aggregate. In the context of price indices based on hedonic values that are combinations of attributes and their shadow prices, the representative property is the set of attribute values that are used to define the price index based on the hedonic price model.

Residential property

Property zoned for and used for personal residence, such as single-family homes, townhouses, multifamily apartments, condominiums, and coops. Residential property is sometimes excluded from the definition of commercial property;, however, income-producing residential property (rental property) is often included with commercial property (especially if it is owned for profit in the private sector as distinguished from public or social housing).

Reweighting

Replacing the weights used in an index by a new set of weights.

Rolling window approach
An approach where a 'window' of a fixed number of time periods is chosen to compute the initial (property) price index. The time series is subsequently updated by moving this window, comprising a fixed number of time periods, one period forward in time—"gaining" a new period and "losing" an old one—and linking the last period-on-period index change to the existing time series.

Sales based index
An index whose weighting (across component sub-indexes or constituents) is based on the proportion of total sales represented by each constituent.

Sample
A (random or non-random) selection of elements from a population. In the commercial property context, the properties sold in some time period can be viewed as a sample from the stock existing as of that time period.

Sample selection bias
Bias in an index that can result when the sample is not representative of the population. For example, in the commercial property context, the sample of properties may either not be representative of price changes of the higher-priced properties of all sales (which is particularly relevant for a sales based index) or not be representative of the stock (which is relevant for a stock based index). If all sales are observed, there will be no sample selection bias in a sales based property price index. If sales tend to be representative of the stock (e.g., an equal proportion of the stock of all types of properties are sold each period), then there will be little difference between a sales based or stock based index.

Sampling frame
A list of the units in the universe from which a sample of units can be selected. The list may contain information about the units, which may be used for sampling purposes. Such lists may not cover all the units in the designated universe and may also include units that do not form part of that universe.

Securitisation
The conversion of assets into tradable securities, that is, relatively small, homogeneous units amenable to trading on a public exchange or clearinghouse.

Service charge
The amount a tenant pays for services provided by the landlord.

Scope
The set of products for which the index is intended to measure the price changes. The coverage of an index denotes the actual set of products included, as distinct from the intended scope of the index.

Selling (or transaction) price
The actual or final transaction price of a property. In some jurisdictions this may not always equate to the price recorded on administrative data sets such as land or property registries. The actual or final transaction price generally excludes any transaction-based taxes or duties that may be levied on sales. Such taxes and duties which may or may not be based on the transaction price are normally paid separately

Space market
The market for the occupancy or tenancy of commercial built space. The rental market. On the demand side are user-occupiers of the space. On the supply side are landlords, the owners of the property assets.

Specification
A description or list of the characteristics that can be used to identify an individual type of commercial property that is to be priced. Also refers to the specific mathematical model or formula (equation) used in econometric estimation, often in price index construction. The specification details the variable that are included and the mathematical functional for (such as log/log, log/linear, linear/linear, etc).

SPAR method
An acronym for Sale Price Appraisal Ratio method, an approach to constructing a property price index which combines current period selling prices with appraisals (assessed values) pertaining to some earlier or base period.

Stratification method
In the context of a property price index, the sample of properties sold is subdivided into a number of relatively homogeneous strata or cells, according to a (limited) number of price determining characteristics, such as location, type of commercial property (office, retail and industrial etc.). More detailed quality mix adjustments should then be made to average price change measures within a stratum. Stratification can result in unreliable measures if the first-stage stratification is by a limited number of price-determining variables and only average prices are used in the within-stratum second stage. This method is also referred to as "mix adjustment."

Stratification should also be used in conjunction with other methods to control for quality mix changes, for example with hedonic regression, repeat sales or SPAR methods.

Stock based index
An index whose weighting (across component sub-indexes or constituents) is based on the proportion of the total standing stock of properties represented by each constituent.

Stock market based indices
A type of index tracking the pricing and investment performance of commercial properties based on stock market quotations of commercial property companies' and funds' share prices as traded in a stock market.

Structure value
The component of the total value of a property that is attributable to the built structure on the property (the produced fixed asset, in SNA terminology), as distinguished from the land. As the structure is not normally sold separately from the land of the property parcel, there is usually no active market for structures as such, and structure value may be defined or measured in various ways. Perhaps the most common and traditional method is to look to the construction market, which is normally active and competitive with prices that represent opportunity costs and that can be empirically observed. However, this raises the issue of how to account for the fact that an existing structure is not the same as an otherwise similar new structure (whose construction cost could be readily estimated). This leads to the need to account somehow for accumulated depreciation or obsolescence in the structure. (See 'Depreciation' and 'Obsolescence'.)

Sub-market
Also referred to as 'market segment'. A portion of a market that is not completely integrated with the rest of the market, enabling different prices to prevail, to some degree, at the same time between the sub-market and the rest of the market.

Sub-index
A component or constituent index within an aggregation structure to construct one or more composite index(es).

Sunk cost
An amount that was historically paid or incurred in the past for a good or service, as distinguished from the market cost or market value prevailing today for that same good or service. Sunk costs are generally considered by economists to be less relevant (or indeed, completely irrelevant) for current decision making and valuation purposes. For example, if you paid $100,000 for your flat last year, but now it is only worth $80,000, then $80,000 is the relevant cost to use in considering whether to accept an offer of $90,000 for it. The $80,000 figure would be referred to as the current 'opportunity cost'. (See also, Opportunity cost.)

Superlative index
Superlative indexes are a class of index number formulas a property of which is that they make symmetric use of reference and current period quantity information, though not all index number formula with this property are superlative. Superlative index number formula has particularly good properties from an index number theoretic point of view. Examples are the (arithmetic) Fisher and the (geometric) Törnqvist index.

Symmetric index
An index that treats both periods symmetrically by attaching equal importance to the price and expenditure (or stock) data in both periods.

System of National Accounts (SNA)
A coherent, consistent and integrated set of macroeconomic accounts, balance sheets and tables based on internationally agreed concepts, definitions, classifications and accounting rules. Gross fixed capital formation expenditure forms part of the SNA.

Total return
The sum of the change in capital value of an asset or investment plus any net cash flow provided by the asset or investment, between the beginning and end of a period of time, expressed as a percentage of the value of the asset or investment as of the beginning of the period of time. Also known as the Holding Period Return (HPR). Periodic total returns can be compounded over multiple periods of time, and may be expressed as a time-weighted average return (usually per annum) defined as either the arithmetic or geometric average across the periodic returns. Each period's simple HPR can be divided into a capital change and an income return component which sum to the total return. The total return is normally defined based on current market values or prices and actual cash flow of income. Thus, internally financed capital improvement expenditures are deducted (not part of the return) either from the income or capital change component. In commercial property, the capital return component of a total return index is normally identical or very similar to the periodic price change movement in a quality controlled price index.

Transfer of ownership costs
All costs associated with acquiring and disposing of assets may be described as costs of ownership transfer. The costs of ownership transfer consist of the following kinds of items: Professional charges or commissions incurred by both units acquiring or disposing of an asset such as fees paid to lawyers, architects, surveyors, engineers and valuers, and commissions paid to estate agents and auctioneers; All taxes payable by the unit acquiring the asset on the transfer of ownership of the asset; Any tax payable on the disposal of an asset; Any delivery and installation or dis-installation costs not included in the price of the asset being acquired or disposed of; and Any terminal costs incurred at the end of an asset's life such as those required to render the structure safe or to restore the environment in which it is situated (SNA 2008 10.51). Also referred to as transaction costs.

Transaction prices
Prices actually paid by purchasers and received by sellers. See also market prices.

Time dummy variable (hedonic) approach
One of the main hedonic regression approaches to constructing a (property) price index. In the standard log-linear time dummy variable model, the coefficients for each price determining characteristic (property attributes) are constrained i.e. fixed over time, and the price index numbers can be directly computed from the time dummy coefficients (through exponentiation). This allows the entire historical index to be estimated from a single regression run on the pooled database of all transactions over all periods of time. This can enable smaller samples to be used to produce an historical index provided there are sufficient transactions in each index period. However, it is more difficult to separate out pure price versus pure 'quantity' changes with the time-dummy hedonic approach as contrasted with the imputed hedonic (or chained hedonic) that estimates separate purely cross-sectional regressions for each period in the index and defines the index based on a representative property. The time-dummy hedonic is also referred to as the pooled hedonic or pooled regression hedonic method.

Unit value or average value
The unit value of a set of homogeneous products is the total value of the purchases/sales divided by the sum of the quantities. It is therefore a quantity-weighted average of the different prices at which the product is purchased/sold. Unit values may change over time as a result of a change in the mix of the products sold at different prices, even if the prices do not change. Unit values are relatively less useful for commercial property price indexing because the products are not homogeneous. Nevertheless, as a short-hand or approximations unit values are often referred to in the industry, such as price or rent per square meter or per hectare of land.

User cost
The cost incurred over a period of time by the owner of a fixed asset or consumer durable as a consequence of using it to provide a flow of capital or consumption services. User cost consists mainly of the depreciation of the asset or durable (measured at current prices and not at historic cost) plus

the capital, or interest, cost. In the case of commercial property, because it normally includes a land component as well as a structure (where only the latter is subject to depreciation), user cost may often be mitigated to greater or lesser degrees (at least in nominal terms) by positive appreciation in the total property value (including the land component).

User approach
An approach to measure the current period consumption service derived from the ownership / use of a property, in which the consumption in some period is identified with the consumption of property and services actually used up by business to satisfy their needs and wants (as distinct from the consumption goods and services acquired). In this approach, the consumption of property in a given period is measured by the values of the flows of services provided by the stocks of property owned by businesses. These values may be estimated by the user costs.

Valuation
The process of estimating the value (usually the market value) of a property—also referred to as appraisal. In real estate appraisal, other types of values besides 'market value' are also recognized and defined, including for example 'investment value'. (See Investment value.)

Value
In national accounting terminology, value equals price times quantity. The value of the expenditures on a set of homogeneous products can be factored uniquely into its price, or unit value, and quantity components. Similarly, the change over time in the value of a set of homogeneous products can be decomposed uniquely into the change in the unit value and the change in the total quantities. There are, however, many ways of factoring the change over time in the value of a set of heterogeneous products into its price and quantity components.

In the commercial property context, value may also refer to a single property. The 'price' of a property is actually a value as it is made up of the 'quantity' of structure times the price of structure plus the 'quantity' of land times the price of the land that the structure is built on i.e. the total or combined price. However, in real estate, 'value' is also distinguished from 'price' in that price refers to an actual transaction and can be observed directly empirically, whereas value refers to a most likely or expected price of an asset that may not be currently engaged in being transacted.

Weight reference period
The period of which the expenditure shares (or for an asset index possibly the stock value shares) serve as the weights as in a Lowe index. There may be no unique weight reference period when the expenditure shares for the two periods are averaged, as in, for example, the Törnqvist index, or when the quantities are averaged, as in the Walsh index. See also base period.

Weights
In a CPPI context, the weights are generally expenditure (sales) or stock value shares that sum to unity by definition. They are used to compile average price relatives within individual stratum of properties, say office properties within a capital city, or across strata of properties.

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Commercial property price indicators: sources, methods and issues

Developments in the real estate sector can have a strong impact on the economy, in particular on the financial system. For that reason, policymakers need relevant statistical information, including reliable indicators, to help identify the emergence of systemic risks originating in the real estate sector. While the statistical coverage of the residential real estate market has much improved over the last decade, the commercial property sector was given less attention. The importance of measuring commercial property price indicators and the difficulties in properly doing so, particularly in the context of official statistics, were the driving force behind the production of this report. The primary aim is to outline concepts, methods, data sources and key issues so as to better inform compilers and users. The report makes a first attempt at setting out the wide range of challenges linked to the measurement of commercial property. It provides a basis for further work in this new area of statistics.

'Commercial property price indicators: sources, methods and issues' was written by leading academics in index number theory and experts in the compilation of real estate indicators. Its development was coordinated by Eurostat, the statistical office of the European Union, with the collaboration of Bank of International Settlements (BIS), European Central Bank (ECB), International Monetary Fund (IMF), Organisation for Economic Co-operation and Development (OECD), under the aegis of the Inter-Secretariat Working Group on Price Statistics (IWGPS).

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