

COMMERCIAL PROPERTY PRICE INDICES AND INDICATORS:
REVIEW AND DISCUSSION OF ISSUES RAISED IN THE *CPPI*
STATISTICAL REPORT OF EUROSTAT (2017)

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Commercial property price indices (CPPIs) are needed to monitor financial stability, guide investment decisions by firms, and improve national accounts. Due to a lack of suitable data, however, reliable CPPIs are often hard to construct. Here we survey the current state of the CPPI literature and assess the contribution of the recently published Eurostat CPPI report.

Keywords: commercial real estate, hedonic price index, repeat-sales, appraisal index, national accounts, financial stability

1. INTRODUCTION

Since the Great Financial Crisis (GFC) a number of high-profile papers have illustrated how recessions and economic crisis are often preceded by downturns in real estate markets (see e.g. Leamer, 2007; Shiller, 2008; Reinhart and Rogoff, 2009; Jordà *et al.*, 2016). These papers illustrate the number of ways in which adverse developments in real estate markets can have systemic impacts on the financial system and the real economy. For national statistical institutes (NSIs), central banks, and other public agencies the message of this literature is clear: Great care should be taken in monitoring the fluctuations in real estate prices.

The last financial crisis was preceded by a real estate boom that was more dramatic in the residential than in the commercial sector (Chaney *et al.*, 2012). This circumstance—and it being easier to produce reliable indices for residential than for commercial properties—led NSIs and other public agencies to focus first on improving their residential property price indices (RPPIs) in the aftermath of the GFC. The *Eurostat Handbook on Residential Property Price Indices (RPPI Handbook)* can be seen as one of these efforts (see Eurostat, 2013).

Increasingly, however, the focus is shifting toward commercial property price indices (CPPIs). The increased attention on CPPIs is desirable for a number of reasons:

- Price changes in commercial real estate immediately impact on firms' investment behavior (Chaney *et al.*, 2012).

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- Commercial prices may react faster to changes in economic conditions than residential property prices (Zhu, 2005).
- Non-bank and cross-border financing in commercial real estate markets is becoming increasingly important, which opens up new forms of inter-connections and transmission channels to financial stability (European Systemic Risk Board [ESRB] 2018).
- Few good CPPIs exist.

CPPIs have many uses: They range from calibrating monetary policy, maintaining financial stability through macroprudential regulation, improving national accounts, evaluating firms' assets (to aid investment decisions and bank lending), to guiding private investment decisions. It is not possible for NSIs (or private sector providers) to construct *one* CPPI that can play all of these roles equally well. For example, an index carefully constructed to help improve productivity analysis in the national accounts is unlikely to be timely enough to help central banks detect asset bubbles or help private investors make investment decisions.

In December 2017, Eurostat published a report on CPPIs (Eurostat, 2017), written by four experts in the field: David Fenwick, Marc Francke, David Geltner, and Chihiro Shimizu. In addition, Erwin Diewert provided advice, while Mick Silver and Niall O'Hanlon edited the report. The CPPI report is written particularly with NSIs and central banks in mind. It discusses the academic literature on the construction of CPPIs and also provides an overview of the most important commercial property indices and indicators. A recurring theme is the role of CPPIs in the national accounts. Unlike the *RPPI Handbook* (Eurostat, 2013), the CPPI report does not recommend data and methodology and therefore is not described as a handbook. This categorical distinction vividly demonstrates the more open research agenda concerning CPPIs.

Here we summarize and review the contributions of the Eurostat CPPI report as well as some related literature. In particular, we address the definition and scope of CPPIs, their uses, data sources, and how they are calculated. We conclude by considering some future directions for research in the CPPI field.

2. THE CONCEPT OF A CPPI

2.1. *What Is a CPPI?*

A CPPI measures the quality-adjusted price change of commercial real estate over time. The construction of such quality-adjusted price indices is particularly challenging with commercial real estate: In addition to the heterogeneity between property types (different sectors, different purposes) there is large heterogeneity within property types (basically each property is unique).

2.2. *CPPIs Play Many (Potential) Roles*

Since the GFC there has been a growing awareness that central banks need to monitor financial stability and, if necessary, intervene to correct imbalances in asset markets (especially real estate). Reliable real estate indices (for residential and commercial markets) are an important part of this strategy. In this regard it is important to

have available real estate price indices that are timely and reflect current developments in the market. However, it will become increasingly clear throughout this paper that there often exists a trade-off in achieving timeliness and other desirable goals of CPPI construction (like complete market coverage or the sole use of transaction data).

In the past few years, Eurostat and the European Central Bank (ECB) have pushed for standardization of methods across the European Union. For the ECB, monetary policy and ensuring financial stability require that CPPIs are constructed in a similar way in different EU countries, so that they can be directly compared. Other international agencies, such as the IMF or BIS, are also interested in establishing and improving CPPIs across countries.

In Europe, the push for increased efforts toward the construction of reliable CPPIs also comes from the European Systemic Risk Board (ESRB), which is mandated to carry out the macroprudential oversight of the financial system within the EU to contribute to the prevention or mitigation of systemic risks.¹ The ESRB has published a number of analyses and recommendations concerning the European commercial real estate market and is pushing initiatives to improve data harmonization and availability throughout the EU (see ESRB, 2015, 2017, 2018).

In addition to the traditional roles of CPPIs (monetary oversight, macroprudential regulation, private investors), the Eurostat report discusses applications to the national accounts. There, CPPIs have two potential roles through which they could improve the measurement of economic activity and productivity: first, to estimate the value of stocks of (existing) commercial property, and second, to act as deflators for the measurement of changes in commercial real estate stock values (see Diewert and Shimizu, 2019).

For CPPIs to become properly useful to the national accounts they need to provide a decomposition of property values into price and volume (quantity) components for both the structure and the land parts of the property (see chapter 11 of the Eurostat report, Wong *et al.*, 2018; Diewert and Shimizu, 2019). This separation between land and structure is the main difference in the statistical needs for CPPIs between the national accounts community and other users. As this separation is of less importance to other market participants, it has so far been neglected in privately run CPPIs and indicators. But, once in existence, the land part of such a CPPI could become an important economic indicator for the state of the wider economy and in particular to identify asset price bubbles.²

2.3. *Definition of Commercial Real Estate*

While it is clear that different categories of commercial real estate exist (we all know that offices are different from factories), the definition of commercial real estate—and particularly its segmentation into different categories—is not as straightforward as it may seem at first glance. Some alternatives for defining the scope of commercial real estate are discussed in chapter 4 of the Eurostat CPPI report. The authors note that there is little guidance from official statistics on this

¹See Regulation (EU) No. 1092/2010 of the European Parliament and of the Council of 24 November 2010 on EU macroprudential oversight of the financial system and establishing an ESRB (Official Journal of the European Union, 2010).

²Also, Wong *et al.* (2018) illustrate how the distinction between land and structure can improve the construction of repeat-sales indices.

point, as the term “commercial property” is not well defined in the System of National Accounts (SNA) (United Nations, 2008) or other official sources.³

In principle, commercial property can be segmented along various dimensions: by production sector (e.g. steel, automobile, textiles, and agriculture), by type of use (e.g. trade building, office building, industrial building, and rental housing), by geographic region (region A versus region B, or urban versus rural), or by physical quality (e.g. size, heating system, and energy efficiency).⁴ The extent of geographical stratification depends on the purpose of the index and the quality of the data. Similarly, decisions need to be made about how to segment the market with respect to production sector and type of use. From a practical point of view it seems natural to first segment the market according to use: Compare offices with offices and warehouses with warehouses. Given that data are already scarce, segmenting the market further by industry may be difficult. After all, a warehouse that stocks shoes today may be used to stock car parts tomorrow. However, (further) segmentation according to industry type could be useful in a national accounts setting. In particular, as stated in chapter 4 of the CPPI report, if a country wants to use the CPPI to measure multifactor productivity of its industries according to SNA 2008, this might require a decomposition of CPPIs into industry types.⁵

What then are the main types of commercial real estate? Chapter 4 of the CPPI report provides the following taxonomy based on the segmentation of the German Property Federation (1998):

- 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 nonresidential buildings
- Other structures

Of these categories, the most frequently transacted are office buildings, and for this reason most existing CPPIs concentrate on this market.

Differentiation according to location is important for all real estate, and this is especially true for commercial real estate. Recent price trends for commercial properties show that prices for well-located, high-quality properties in major cities have increased more than the overall market (ESRB, 2018). This implies that, at least when the data allow it, a further differentiation into prime and other locations at city level is desirable.

³They state two potential exceptions that provide possible taxonomies of commercial property types: the “Classification of types of Construction” (CC) (United Nations, 1998) and a similar proposal produced by German government institutions and industry participants (German Property Federation (ZIA), 2016).

⁴Also, as emphasized in chapter 4 of the Eurostat CPPI report, the use—as well as the characteristics—of properties can change over time, so that any segmentation of commercial property needs to allow for some dynamics.

⁵As already discussed earlier, a decomposition of commercial real estate into land and structure would also be useful in this regard.

3. DATA ISSUES WITH CPPIs

For the construction of RPPIs, the *RPPI Handbook* (Eurostat, 2013) clearly recommends using actual transaction data to compute indices. The Eurostat CPPI report is more nuanced as there is less consensus on what type of data to use.

Theoretically, transaction data remain the gold standard for the construction of CPPIs, but in reality there is often not enough of it available. In addition to differences in data availability across countries, there are differences in data availability among segments of the commercial property market: Some types of commercial real estate are more traded than others (e.g. offices versus factories or urban versus rural areas) and also more homogeneous in type. Commercial transaction data tend to be incomplete as firms often do not want to disclose details or side deals that are part of the transaction.

A 2018 ESRB report on the vulnerabilities in the EU commercial real estate sector concludes that

macroprudential analysis and the monitoring of EU commercial real estate markets are severely hampered by the scarcity of accurate and comparable data. (ESRB, 2018, p. 4)

This sentiment was echoed by Peter Praet, then chief economist at the ECB, in a speech in 2019:

For commercial real estate markets, statistical gaps are more pervasive, with even the available price data not being of sufficient quality. A study by the ECB and Eurostat concluded that only nine EU countries have their own commercial property price statistics, six more obtain them from private sources, and 13 EU countries have no price data at all. Where commercial real estate statistics from official sources are available, they are not derived using a harmonised methodology. (Praet, 2019)

The question of what to do if transaction data are especially scarce seems to divide the academic community. Some experts (see, e.g. Silver, 2019) argue that in cases of insufficient transaction data, it is better to forgo the production of a CPPI for this part of the market than turn to alternative data sources—such as appraisals or real estate investment trusts (REITs)—or produce indices with limited statistical significance due to data scarcity. The (more implicitly stated) pragmatist view seems to be that, given private sector index providers have no such scruples, it is better to produce the best “possible” index (and attach warnings to it) than leave the field to private sector indices that are often black boxes with respect to data treatment and/or index design.

The CPPI report does not take sides on this issue but discusses three alternative data sources for index construction: appraisal data, tax assessment data, and stock market data (see chapters 6 and 7 of the Eurostat report). Appraisal and stock market data play important roles in the construction of private sector CPPIs and indicators. However, for EU agencies, the choice of data sources for CPPI

construction is more limited: Eurostat and the ESRB advise where possible using actual transaction data.

Guidance from work initiated by Eurostat advises that pricing data should be collected from actual transactions. Where these are not available and/or fully representative they may be approximated by appraisal or valuation data as long as these data reflect the current market price. (ESRB, 2017, p. 40)

Two alternative data sources are not discussed in the Eurostat report: (scraped) offer prices from real estate platforms and survey data. Offer prices, in particular, are attractive since they are widely available, contain detailed information on the listed properties, and can be obtained faster than transaction data, thus allowing an index to be calculated on time. However, offer prices will tend to be higher than actual transaction prices. Furthermore these markups (the gap between offer and transaction prices) tend to rise during market downturns and fall during booms (see Genesove and Mayer, 2001). The relationship between transaction and offer price indices over the real estate cycle warrants further investigation for both RPPIs and CPPIs.

The combination of different data sources is a promising new area for index compilers. For example, by linking transaction data with offer data (via GPS location or addresses) index compilers can get more complete information on the transacted properties. However, as platform providers often keep these locational details hidden, it might require some political intervention for NSIs to be able to efficiently link offer and transaction data.

4. HOW ARE CPPIs COMPUTED?

To construct CPPIs we need methods to adjust for quality differences in the sample of properties over time. In principle, most of the methods for constructing CPPIs are the same as for RPPIs. We provide a short overview of these methods in this section. The methods are described in more detail in the *Eurostat RPPI Handbook* and Eurostat CPPI report. Additional useful references include Diewert (2011), Hill (2013), Hill *et al.* (2018), and Silver (2019).

Although the theoretical foundations of CPPIs and RPPIs are essentially the same, the persistent lack of data and heterogeneity that characterize the commercial real estate market require special—and sometimes creative—solutions. Also, cultural and historical differences exist when it comes to which index method is preferred on each side of the Atlantic.

In the US the high turnover rate of properties and the historical influence of the Case-Shiller house price index (Case and Shiller, 1989) have made the repeat-sales method the most popular approach for constructing RPPIs and CPPIs.⁶ In Europe, hedonic methods are generally preferred, at least for RPPIs (see Hill *et al.*,

⁶The turnover rate for residential housing is defined by Dröes and Francke (2018) as the ratio of sold units to the total housing stock.

2018). One reason is that turnover rates are a lot lower in Europe. The Atlantic (2016) writes that during their lifetime Americans move on average three times as often as Europeans (based on data from the US Census Bureau and a survey within 16 European countries conducted by *Re/Max* Europe). Within Europe, the turnover rate also varies considerably across countries (Dröes and Francke, 2018). In addition to the low number of transactions relative to the housing stock, in some countries a high percentage of the transacted properties are new buildings that are automatically excluded from a repeat-sales index.⁷ For these reasons, the computation of harmonized repeat-sales RPPIs across Europe would be difficult.

4.1. Stratification

Simple stratification (without strata hedonic adjustment) is the fallback method for constructing price indices, when other index methods cannot be used. First, a number of reasonably homogeneous market segments (strata) are defined. Average prices are then calculated for that type of property. This average can consist of the mean or the median price of the strata cell. This measure is used as an approximation of the constant quality price of that particular market segment. Once the strata averages are calculated, regular index number theory can be used to aggregate these average cell prices into an overall index. This procedure is also sometimes referred to as the mix-adjustment method. The advantage of the stratification method is its simplicity. Its main drawback is its inexactness, as within-strata quality change is ignored.

4.2. Hedonic Regression Methods

Chapter 5 of the CPPI report distinguishes between two types of hedonic approaches based on whether the model is estimated separately each year (chained approach) or whether a single regression model is estimated on the entire historical database (pooled approach). Data scarcity is a bigger problem for the chained approach.

The pooled approach (the time-dummy method) estimates a model of the following form:

$$\ln p_{n,t} = \sum_{c=1}^C \beta_c z_{n,c} + \sum_{\tau=1}^T \delta_\tau d_{n,\tau} + \varepsilon_n$$

where $p_{n,t}$ is the price of property n sold in period t , $z_{n,c}$ is the level of characteristic c of property n , β_c is the shadow price of characteristic c , and $d_{n,\tau}$ is a time dummy. The price index is obtained by exponentiating the estimated coefficients δ_τ of each period.

The chained approach, by contrast, excludes the time-dummies when estimating the hedonic model. Instead, the estimated characteristic shadow prices, which

⁷For example in 2018, 53 percent (i.e. 385,900 of 726,600) of the transacted residential properties in Germany were newly constructed (own calculation with data from <https://www.ceicdata.com/en/germany/construction-completion/construction-completion-dwellingsandimmobilienmarktbericht-deutschland.info>).

are now different for each period, are used to price particular mixes of characteristics. Therefore, it is now possible to construct pseudo repeat sales. For example, suppose a property n sells in period t but not in period $t+1$. A price in period $t+1$ can be predicted for property n from the hedonic model of period $t+1$ as follows:

$$\ln \hat{p}_{n,t+1}(z_n) = \sum_{c=1}^C \hat{\beta}_{c,t+1} z_{n,c}.$$

In this way, prices can be predicted in period $t+1$ for all properties sold in period t . Similarly, for properties m sold in period $t+1$, prices in period t can be predicted from the hedonic model of period t as follows:

$$\ln \hat{p}_{m,t}(z_m) = \sum_{c=1}^C \hat{\beta}_{c,t} z_{m,c}.$$

Then standard price index formulas, such as Laspeyres, Fisher, and Törnqvist, can be used. These price indices between adjacent periods are then chained to obtain a time-series index.

When using the chained approach, a number of decisions need to be made, such as the choice of functional form (e.g. linear or semi-log) and whether to use single or double imputation. With single imputation, for each property sold in period t we compute the ratio $\hat{p}_{n,t+1}(z_{n,c})/p_{n,t+1}$, while with double imputation we compute the following: $\hat{p}_{n,t+1}(z_{n,c})/\hat{p}_{n,t}(z_{n,c})$. Double imputation has the advantage that it is more robust to omitted variables (see Silver and Heravi, 2001; de Haan, 2004; Hill and Melser, 2008).

Alternatively, a price could be predicted for a hypothetical average property in each period, and the price index is then given by the change in the price of these average properties. For example, we could compute the change in the predicted price of the average property in period t : $\hat{p}_{t+1}(\bar{z}_t)/\hat{p}_t(\bar{z}_t)$. This approach is typically referred to as the average characteristic method (see Hill, 2013).

One hedonic method that does not get enough attention in the CPPI report is the rolling time dummy (RTD) method (see Shimizu *et al.*, 2010b; O'Hanlon, 2011).⁸ RTD is a variant on the time-dummy method in which only a limited number of periods are included when the hedonic model is estimated. Then when a new period of data (e.g. $t+1$) becomes available, the window of periods included is moved forward one period, and the hedonic model is re-estimated. The new model is used only to link period $t+1$ to period t . Therefore again chaining is needed to construct the time-series price index. The RTD method has the advantage that it is very flexible. The index compiler can choose the appropriate window length. A longer window helps when data are scarce but reduces the ability of the index to respond to current trends in the market.

In our opinion, the RTD method is particularly well suited to CPPIs, as it works well when data are scarce. We recommend it as the benchmark hedonic method in this context. Within the European Union, Croatia, Cyprus, France,

⁸In the CPPI report in chapter 5, the RTD method is referred to as the rolling window hedonic method.

Ireland, and Portugal all use the RTD method in their official RPPIs. France and Portugal have window lengths of two quarters, Cyprus and Croatia of four quarters, and Ireland of five quarters (see Hill *et al.*, 2018).

One additional issue for hedonic indices is the treatment of outliers. We can distinguish between two types of outliers: data entry errors and atypical properties. Both types can create problems in hedonic models such as distorting the shadow prices and worsening the fit for most of the properties. So it is important to carefully check for (and delete) outliers before estimating the hedonic models.

4.3. Repeat-Sales Methods

Repeat-sales indices (see Bailey *et al.*, 1963) control for quality differences by limiting the data set to properties that sold at least twice. Essentially the basic repeat-sales method is a special case of the time-dummy method, where the only characteristic included is a unique identifier for each property. More sophisticated versions of the repeat-sales method allow the weight given to each repeat sale to vary depending on the time interval between sales and replace the dummy-variable approach with a more structural model of time trends (see Francke, 2010).

Repeat-sales indices require less information than hedonic indices on the characteristics of the sold property (all that is needed is a marker for individual properties so that repeat sales can be identified). They may also be less vulnerable to omitted variables bias, particularly with regard to location which is especially important in a commercial setting.

To really compare “like with like” repeat-sales indices should also control and adjust for major renovations and for depreciation between sales. A recent paper by Wong *et al.* (2018) proposes a repeat-sales approach to estimate an age-adjusted repeat-sales index by decomposing property value into land and structure components. As depreciation is more relevant to the structure than land, the property’s depreciation rate should then depend on the relative value shares of land and structure.

Repeat-sales indices delete transactions for which there are no repeat sales in the data set. Throwing away data, when it is scarce to begin with, is problematic. This could introduce sample-selection bias into the index, as properties that are sold more than once tend to differ from those that are sold only once (see Munneke and Slade, 2000; Gatzlaff and Haurin, 1997).⁹ Comparisons between repeat-sales and hedonic RPPIs (using the same data source) tend to show that repeat-sales indices lag behind hedonic indices (see, e.g. Shimizu *et al.*, 2010a,b).¹⁰

A possible way to throw less data away (and also to limit the selection bias) is the “matched sample estimation” method, a hybrid of hedonic regression and the repeat-sales method. In it, the potential sample selection bias and loss of data

⁹This literature generally finds that properties that are sold more frequently have higher price changes than less frequently sold properties. Francke (2018) additionally finds a tendency for the holding period (the time gap between repeat sales) and return on real estate to be negatively correlated.

¹⁰The most severe lag was found by Shimizu *et al.* (2010a) for the Tokyo apartment market in the early 2000s: there a repeat-sales index lagged by up to 2 years the predicted market turning point. However, a similar comparison over the same time period using American housing data (Los Angeles and San Diego) found that a repeat-sales index did not always lag behind a hedonic index (see Dorsey *et al.*, 2010).

due to including only properties that sold multiple times is reduced by constructing artificially matched pairs of properties that sold at different points in time (McMillen, 2012). For an application of a propensity-score matching approach to the Singapore commercial real estate market, see Deng *et al.* (2014).

4.4. *Appraisal-Based Indices and Indicators*

Chapter 6 of the Eurostat CPPI report deals with appraisal-based price indices and defines them as indices constructed by regressing actual transaction prices on appraisal values (and other characteristics). Thus, at a minimum, this method needs both appraisals and sales prices on the same properties. The Sales Price Appraisal Ratio (SPAR) method, which is a simple version of an appraisal-based index, is used by Denmark, the Netherlands, and Sweden to compute their RPPIs (see Hill *et al.*, 2018).

The Eurostat report draws a distinction between appraisal-based valuation indicators and appraisal-based indices. An appraisal method is only an index if it uses actual transaction data in addition to appraisals. However, the online private investor community does not seem to follow this distinction: there the term “appraisal-based index” generally means what the Eurostat CPPI publication would call an “appraisal-based indicator.”

One of the drawbacks of appraisal-based indices is that they are restricted to property groups that are regularly and consistently appraised (chapter 6, CPPI report). Appraisals are done by professionals with knowledge of the local market. Repeated interaction between local appraisers will tend to create consistency in valuation within local markets. But customs of how to perform these appraisals can differ between regions and will differ across countries. These differences in customs can hamper interregional or international comparisons.

Another drawback is that appraisers are implicitly backward looking: They produce valuations that fit with their experience; they extrapolate from past transactions. The implication of this backward focus is that indices will tend to lag behind true market developments—and this lag can be substantial (see Cole *et al.*, 1986; Fisher *et al.*, 2007; Geltner, 2015; Diewert and Shimizu, 2017; Silver, 2019). This becomes a particular problem when appraisal-based CPPIs are used to try and detect market turning points.

More troubling is that conflicts of interest can also arise. This point is made forcefully by Eriksen *et al.* (2019):

Appraisers were ... more likely to bias appraised values for the properties associated with loan officers and real estate brokers they worked with more frequently. These findings offer insights into how appraisers confirmed ever increasing prices leading in to the housing market crash and subsequent Great Recession. (Eriksen *et al.*, 2019, p. 132)

In response to evidence of appraisal bias and alleged collusion in appraisal values, then New York Attorney General Andrew Cuomo sued eAppraiseIT, an appraisal management company working with mortgage lender Washington Mutual, for pushing its appraisers to provide

appraisal values in support of inflated contract prices. (Eriksen *et al.*, 2019, p. 133)

The implication is that appraisal-based indices and indicators cannot be relied on by central banks for monetary policy and maintaining financial stability. Nor can they be relied on by banks for evaluating the risk of their real estate portfolios (see Nakamura, 2010).

4.5. *Investment Return Indicators*

Investment return indicators (IRIs) are discussed in chapter 7 of the CPPI report. IRIs are not proper indices as they do not reflect changes in actual prices but rather the change in valuation of property within the portfolio.

Two broad groups of IRIs exist: appraisal-based IRIs and stock-market-based IRIs. Stock-market-based IRIs measure the liquid market values of traded financial assets. Such indices can be produced where a large enough and mature enough real estate investment trust (REIT) sector exists within the stock market. REITs are publicly traded firms that are confined in their operations to own and operate/manage commercial investment properties and that pay out most of their earnings as dividends.

Stock-market IRIs (or REIT-based indicators) have advantages: They are easy to understand, are cheap to compute, are available at high frequency (e.g. daily), and have no data availability problems. The main advantage of REIT-based indicators, however, is that they do not lag and therefore lead other property price indices (Fisher *et al.*, 2007).

On the flip side, there are also a number disadvantages associated with IRIs:

- They are more volatile than other CPPIs and indicators (Fisher *et al.*, 1994).
- They suffer from composition bias, as only a small subgroup of commercial property is publicly traded.
- They represent the current stock-market valuation of a property, but not its transaction value on the real estate market (Silver, 2019).
- And they suffer from a tendency to overestimate returns.¹¹

More research is needed on how CPPIs and REIT-based indicators behave when tracking the same underlying data pool. For example, a differentiation into prime and other locations within an area could provide the opportunity to compare the co-movements of prime-location CPPI indices with REIT-based indicators.

5. EXISTING CPPIs IN THE US

Chapter 10 of the CPPI report provides a nice overview of existing CPPIs around the world. Here we focus specifically on CPPIs for the US market.

¹¹Chapter 6 of the CPPI report provides a good explanation of how this last tendency is linked to the way renovation costs are treated in REIT-based indices.

There are three main transaction-based indices in the US: the CoStar, RCA, and NCREIF indices. The CoStar and RCA CPPIs use a repeat-sales approach, while the NCREIF index uses the SPAR method. As was noted in Section 4.4, this entails comparing current actual transaction prices with appraised values on the same properties from earlier periods.

The BIS publishes CPPIs currently for 16 countries (including the US) and the Euro area. These indices can be downloaded from https://www.bis.org/statistics/pp_commercial.htm. This website is a useful resource. However, it could be even more useful if more detail on the sources of these indices was provided. After some investigation we established that the US CPPI listed on the BIS website splices together indices from different sources. However, from 1996 it is just the CoStar index.¹² The IMF also publishes a CPPI for the US, which can be downloaded at <https://fred.stlouisfed.org/series/COMREPUSQ159N>. Again, source information on the index is lacking. After some investigation we established that this index is also derived from the CoStar index.

In addition to its CPPI computed using the SPAR method discussed earlier—referred to as the NCREIF Transaction Based Index (NTBI)—NCREIF computes a pure appraisal index—the NCREIF Property Index (NPI). Greenstreet Advisors and MSCI also produce appraisal-based indicators. According to the strict definitions in the CPPI manual, while the NTBI is an index, the NPI, Greenstreet, and MSCI series are indicators and not indices. The Greenstreet indicator is mentioned only on passing in chapter 10 of the CPPI report, since its underlying methodology is not publicly available. The MSCI/PREA US Property Fund Index is a rebranded version of the IPD US index discussed in chapter 10 of the CPPI report. This indicator has been rebranded as a result of the takeover of IPD by MSCI.

One final indicator not discussed in chapter 10 of the CPPI report is the SIOR Index. This is a sentiment index based on a survey of experts. This topic of survey-based indicators could be investigated further by researchers in the field.

An unfortunate feature of CPPIs is that they often lack transparency, in terms of both the source data and underlying methodology. In some cases even the index itself is proprietary. For example, one should pay to download the NCREIF indices. In the US context, RCA is probably the most transparent, sometimes providing researchers with access to the source data (see, e.g. Silver and Graf, 2014). It would really help the CPPI literature move forward if more index providers would follow the lead of RCA.

6. FUTURE DIRECTIONS

6.1. *Improving Data*

One potential avenue (not discussed in the CPPI report) would be for European NSIs to get better data access on property transactions through a mandate from the European Parliament, for example, by requiring a minimum standard for the description of transacted properties at the point of transaction.

¹²We thank Robert Szemere of the BIS for providing us with this information.

A second avenue missing from the CPPI report is to make greater use of offer data. Given the increasing availability of such data through online listing platforms they should be given more attention henceforth. This can be done in two ways: First by linking transaction data with offer data by matching addresses or GPS locations (or property IDs if they were mandated), and second by producing property price indicators directly with these offer data.

Evidence from the residential sector suggests that the spread between asking and transaction prices is lower during housing booms than during busts (see, e.g. Genesove and Mayer, 2001). Also, it is likely that this spread will depend on a variety of other factors (e.g. local norms about markups). Therefore, further investigations of the relationship between transaction and offer data are needed.

6.2. *Machine Learning Methods*

Machine learning (ML) methods are generally better at valuation (now-casting) than parametric hedonic methods (see, e.g. Varian, 2014). For this reason automated valuation models are almost exclusively based on ML algorithms and not on hedonic theory. While the use of such algorithms disrupts the link of valuations to economic micro-foundations, it can generate better valuations in markets with heterogeneous goods. ML methods could therefore prove useful for constructing CPPIs. Therefore this topic warrants more attention.

6.3. *For Which Sectors Are CPPIs Feasible?*

Silver (2019) presents methods to derive appropriate price indices when data are sparse, but also argues that

the honest and professional stance is to focus on markets segments, such as offices and retail, where sample sizes are sufficiently large and there is not undue heterogeneity; this is in line with the statistical theory on confidence intervals on index numbers. (Silver, 2019, p. 3)

The counterargument is that the private sector will provide indicators for submarkets with less data anyway if there is demand. At least if done by NSIs (and in a systematic way) there is some quality control and transparency.

6.4. *Liquidity-Adjusted Indices*

Commercial real estate is highly illiquid. In particular, asking prices are sticky in a downturn, due to loss aversion and anchoring by sellers (see van Dijk *et al.*, 2018). When assessing the current market value of a portfolio, it is the market clearing price of a commercial property that matters. In a normal market this is the same as the observed market price. But in a downturn, this price could be a lot lower than the observed price of similar transacted properties.

For portfolio valuation and risk hedging it is important to consider the price at which one could actually liquidate an asset at any given time. Since market clearing prices are not directly observed, the construction of such hypothetical prices

requires the use of quite sophisticated econometric methods as well as the validity of a number of assumptions. Not all index compilers are keen to go there.

The estimation of liquidity-adjusted real estate indices has been explored by Fisher *et al.* (2003), and by van Dijk *et al.* (2018). These authors find that liquidity-adjusted indices tend to lead standard transaction-based indices, which could be particularly useful for central banks for monitoring financial stability. Given the potential importance of its applications, the construction of CPPIs based on market clearing prices is a topic that warrants further research.

7. CONCLUSION

There is a pressing need for more reliable CPPIs. The Eurostat CPPI report of 2017 is an important contribution in this regard. However, much work still needs to be done improving data sources and methods.

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