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## Proceedings

# Are House Prices Endangering Financial Stability? If so, How Can We Counteract This?

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OESTERREICHISCHE NATIONALBANK  
EUROSYSTEM

# WORKSHOPS

Proceedings of OeNB Workshops

Are House Prices Endangering  
Financial Stability?  
If so, How Can We Counteract This?

October 9 and 10, 2014

The issues of the “Workshops – Proceedings of OeNB Workshops” comprise papers presented at the OeNB workshops at which national and international experts – including economists, researchers, politicians and journalists – discuss monetary and economic policy issues. One of the purposes of publishing theoretical and empirical studies in the Workshop series is to stimulate comments and suggestions prior to possible publication in academic journals.

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**Opinions expressed by the authors of studies do not necessarily reflect the  
official viewpoint of the OeNB.**

# Editorial

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*Martin Schneider*

*Karin Wagner*

*Oesterreichische Nationalbank*

The housing sector significantly shapes a country's long-term economic development, since it accounts for a considerable part of a country's welfare, wealth and GDP. House prices and housing wealth have risen sharply since the mid-1990s in the vast majority of European countries. In a number of countries, bursting house price bubbles have seriously damaged macroeconomic and financial stability. More recently, there have been strong house price increases in countries as Germany, Switzerland and Austria.

Against this background the Oesterreichische Nationalbank (OeNB) organized a workshop entitled *Are House Prices Endangering Financial Stability? If so, How Can We Counteract This?* on October 9 and 10, 2014. The workshop's objective was to discuss and assess the implications of most recent price increases in European housing markets. It aimed at bringing together international experts in the field for an exchange of views. The keynote speech was held by Professor John Muellbauer (University of Oxford). He shed light on the interactions between the housing sector, the mortgage sector and the real sector of the economy. The workshop consisted of four sessions, which covered a broad range of relevant topics.

1. *House Price Measurement: a Prerequisite for Assessing Upcoming Bubbles.* The focus of session 1 was on the measurement of house prices and whether associated problems restrain policymakers from a proper and timely assessment of a bubble?
2. *Which Factors Drive House Prices?* The following session consisted of presentations showing the heterogeneity of national residential property markets and the impact of structural factors on house price developments.
3. *How Can We Identify House Price Bubbles before They Occur?* This session dealt with the question of how to identify house price bubbles in advance.
4. *Which Instruments Are Available to Contain an Upcoming Bubble?* The last session completed the workshop with experiences of countries that faced a bubble in the past and where national policymakers and central banks have implemented measures to counteract these crises.

This workshop volume collects those papers that were provided by the authors after the workshop. All presentations and the workshop program are available on the OeNB website ([www.oenb.at/Geldpolitik/immobilienmarktanalyse/workshops-und-konferenzen.html](http://www.oenb.at/Geldpolitik/immobilienmarktanalyse/workshops-und-konferenzen.html)).

## **Session 1: House Price Measurement: a Prerequisite for Assessing Upcoming Bubbles**

Measuring house prices is a complex task. House price indices differ regarding methodology (e.g. weighting of subindices, method of enabling constant quality measures, valuation method) and coverage (e.g. regional coverage, type of property, new versus existing property). Different house price indices may deliver rivaling signals. Is there a potential for mismeasurement that could blur the assessment of an upcoming bubble?

Mick Silver (IMF) discussed various data sources and approaches to calculate residential property price indices. He stressed the relevance of commercial property prices. He also underlined the possibility to calculate more sophisticated approaches than simple hedonic models due to the increased availability of geospatial data. Michael Scholz (University Graz) presented a model incorporating geospatial data. Wolfgang Brunauer (Real(e)value) and Wolfgang Feilmayr (Vienna University of Technology) showed the indices calculated in cooperation with the OeNB. These include a spatial imputation index which is based on semiparametric models that take nonlinearity and spatial heterogeneity into account.

## **Session 2: Which Factors Drive House Prices?**

House prices are determined by a complex interplay of various demand and supply factors which tend to produce cyclical price movements. The differences in house price developments across countries may reflect country-specific factors such as demographic differences, institutional regulations or cyclical positions.

Christophe André (OECD) gave an overview of the latest housing cycle in selected OECD countries and discussed the implications of house price developments for financial stability. Christian Hott (Economic Advice) concluded that forecasting models relying on fundamentals miss partially the development of house prices. He concluded that the excess fluctuations of actual house prices can partly be explained by incorporating herding behavior and speculation into house price models.

### **Session 3: How Can We Identify House Price Bubbles before They Occur?**

The identification of house price bubbles in real time is an extremely difficult task. Besides pure statistical measures, methods based on the estimation of “fundamentally justified” prices are usually utilized to assess the existence of a bubble. The papers in this session address possible methods to identify house price bubbles in advance. Florian Kajuth (Deutsche Bundesbank) showed an assessment of house prices in Germany using an estimated stock flow model. Martin Schneider (OeNB) presented the OeNB’s Fundamentals Indicator for Residential Property Prices, which serves to assess deviations of house prices from fundamentally justified prices. Finally, Christian Dreger (DIW Berlin) introduced an early warning system for predicting house price bubbles based on three alternative approaches.

### **Session 4: Which Instruments Are Available to Contain an Upcoming Bubble?**

House price bubbles can pose a serious threat to financial stability, especially if they are accompanied by a strong increase of credit. Policy makers have a variety of instruments available to contain upcoming bubbles. The papers in the last session dealt with instruments available to contain upcoming bubbles. The authors presented experiences of countries whose authorities have already implemented such measures. Thomas Schepens (Nationale Bank van België) showed recent developments in the Belgian housing and mortgage market and the methods used by the Nationale Bank van België to monitor these markets. Srobona Mitra (IMF) discussed the results of six case studies of countries that have already implemented macroprudential measures.



# House Price Indexes: Why Measurement Matters

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## 1 Introduction

Macroeconomists and central banks need measures of residential property price inflation. They need to identify bubbles, the factors that drive them, instruments that contain them, and to analyze their relation to recessions. Timely, comparable, proper measurement is a prerequisite for all of this, driven by concomitant data.

There have been major advances in this area foremost of which are: (i) recently developed international standards on methodology, the Eurostat *et al.* (2103) *Handbook on Residential Property Price Indices*; (ii) an impressive array of data hubs dedicated to the dissemination of house price indices and related series including the IMF's Global Housing Watch and the Bank for International Settlements' (BIS) Residential Property Price Statistics; and (iii) encouragement in compiling and disseminating such measures: real estate price indexes are included as Recommendation 19 of the G-20 Data Gaps Initiative (DGI), and residential property price indexes prescribed within the list of IMF Financial Soundness Indicators (FSIs), in turn included in the IMF's Special Data Dissemination Standard (SDDS) Plus. In this presentation we identify the challenges countries face in the hard problem of measuring residential property (hereafter "house") price indexes (HPIs).<sup>2</sup>

In section 1 we consider some measurement issues making use of country illustrations. Section 2 examines, using a more formal approach to the empirical question as to whether measurement and coverage differences matter and the importance of measurement in modeling house price inflation. Section 3 turns to the similar, though very much harder, measurement area of commercial property price indexes (CPPIs).

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<sup>1</sup> The views expressed herein are those of the author and should not necessarily be attributed to the IMF, its Executive Board, or its management.

<sup>2</sup> We draw on Silver (2011, 2012, and 2013) and Silver and Graf (2014).

## 2 The Hard Problem of Properly Measuring HPIs

### 2.1 The Problem

HPIs are particularly prone to methodological differences, which can undermine both within-country and cross-country analysis. Critical to price index measurement is the need to compare transaction prices of representative goods and services, in successive periods, with like. However, there are no transaction prices every month/quarter on the same property. *HPIs have to be compiled from infrequent transactions on heterogeneous properties.* A higher proportion of more expensive houses sold in one quarter should not manifest itself as a measured price increase, and vice versa. There is a need in measurement to control for changes in the quality of houses sold, a non-trivial task.

The main methods of quality adjustment are hedonic regressions, repeat sales data only, and mix-adjustment by weighting detailed homogeneous strata, and the sales price appraisal ratio (SPAR), Eurostat et al. (2013). The method selected depends on the database available. The database needs to include details of salient price-determining characteristics for hedonic regressions, a relatively large sample of transactions for repeat sales, and good quality appraisal information for SPAR.

Second, the *data sources are generally secondary sources that are not tailor-made by the national statistical offices (NSIs)*, but collected by third parties, including the land registry/notaries, lenders, realtors (estate agents), and builders. The adequacy of these sources to a large extent depends on a country's institutional and financial arrangements for purchasing a house and vary between countries in terms of timeliness, coverage (type, vintage, and geographical), price (asking, completion, transaction), method of quality-mix adjustment (repeat sales, hedonic regression, SPAR, square meter) and reliability. In the short-medium run users are dependent on series that have grown up to publicize institutions, such as lenders and realtors, as well as to inform. Metadata may be far from satisfactory.

We stress that our concern here is with measuring HPIs for FSIs and macroeconomic analysis. However, for the purpose of national accounts and analyses based thereon, such as productivity, there is a need to both separate the price changes of land from structures and undertake a quality change on structures. This is far more complex since separate data on land and structures is not available when a transaction of a property takes place. Diewert and Shimizu (2013) tackle this difficult problem.

## 2.2 Country Illustrations

Chart 1: A Feast of UK HPIs

Annual quarterly % rate

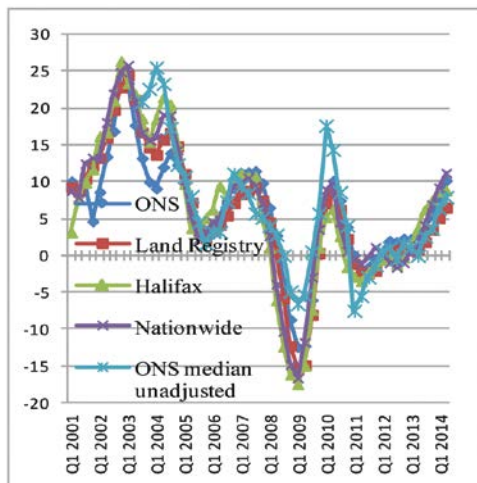
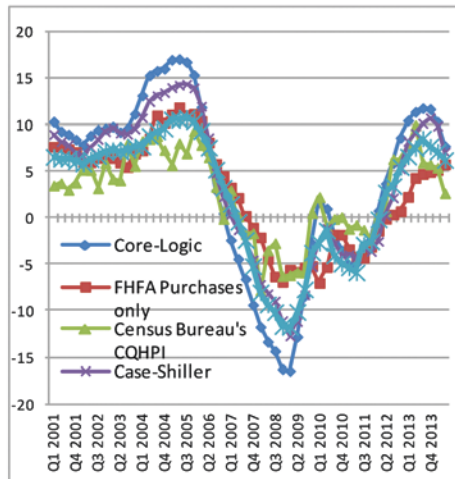


Chart 2: US Repeat Sales HPIs

Annual quarterly % rate



Source: Author's compilation.

Chart 1 shows a feast of HPIs available for the UK including the UK Office for National Statistics (ONS) (UK coverage, hedonic mix-adjusted, completion price); Nationwide and Halifax (both UK, hedonic, own mortgage approvals, mortgage offer price; Halifax weights); the England and Wales (E & W) Land Registry (E & W coverage, repeat sales, all transaction prices); and the ONS Median price index unadjusted for quality mix – given for comparison. Also available are the LSL Acadata E &W HPI (E&W, mix-adjusted with forecasts, all transaction prices) and a realtor, Rightmove (UK, asking prices, hedonic), among others. Measured inflation in 2008Q4 coming into the trough was – 8.7 (ONS) – 12.3 (Land registry) – 16.2 (Halifax) – 14.8 (Nationwide); and – 4.9 (ONS Median unadjusted (for quality mix change); methodology and data source matter.

In contrast for Brazil there is a famine of HPIs: Banco Central do Brasil “Measures the long term trend. It uses individual loan collateral appraisal data to construct series of median house values. These median house appraisals series are filtered using a HP filter. The FipeZap Index of over 100,000 (January 2012) monthly advertised prices of apartments; is a weighted (2000 Census shares in total income) average of median asking prices of 64 cells (16 regions and 4 bedroom sizes). Neither of these measure up to the concepts and standards of the RPPI Handbook.

Chart 2 shows the main HPIs available in the US; they include the: CoreLogic, Federal Housing Finance Agency (FHFA) purchases-only, Case-Shiller, and the FHFA expanded-data HPI, chart 2. These all use repeat sales for quality-mix adjustment. The FHFA expanded-data HPI includes, in addition to purchases-only transactions price information from Fannie Mae and Freddie Mac mortgages, transactions records for houses with mortgages endorsed by the Federal Housing Administration (FHA) and county recorder data. This change in source data coverage accounted for the 4.6 percentage point difference in 2008 Q4 between the annual quarterly HPI respective falls of 16.26 and 11.66 percent for the FHFA “All Purchases” and “Expanded-Data” FHFA HPIs. Coverage limited to particular types of mortgages matters.

Leventis (2008) decomposed into methodological and coverage differences the average difference between the FHFA (then Office of Federal Housing Enterprise Oversight (OFHEO)) and S&P/Case-Shiller HPIs for the four-quarter price changes over 2006Q3-2007Q3. Of the overall 4.27 percent average difference, FHFA’s use of a more muted down-weighting of larger differences in the lags between repeat sales, than use in Case-Shiller, accounted for an incremental 1.17 percent of the difference. The manner in which a method is applied matters.

### 2.2.1 Making Your Own Luck

There is no need to simply accept data sources with associated problems; you can make your own luck. France benefited from the combination of a research-based central statistical agency and a monopolistic network of notaries, 4,600 in 2009. Up to the end of the 1990s, only the “Notaires-INSEE” 1983 apartments’ index for the city of Paris was based on such data, though it was not quality-mix adjusted. There has since been a steady program of improvement as a result of close collaboration between the Notary associations and INSEE. Currently, for Paris and separately for the Provinces, there are hedonic quality-mix adjusted HPIs for apartments and houses by about 300 zones comparing transaction prices of fixed bundles of observed characteristics. The hedonic coefficients are now updated every 2 years – previously 5 years – band weights chain-linked (Gouriéroux and Laferrère, 2009).

## 2.3 More Formally: Does Measurement Matter?

HPI measurement differences may arise from: (i) the method of enabling constant quality measures for this average (repeat sales pricing, hedonic approach, mix-adjustment through stratification, sale price appraisal ratio (SPAR); (ii) type of prices (asking, transaction, appraisal); (iii) use of stocks or flows (transactions) for weights; (iv) use of values or quantities for weights; (v) use of fixed or chained weights; aggregation procedure; (vi) geographical coverage (capital city, urban etc.),

(vii) coverage by type of housing (single family house, apartment etc.) and (viii) vintage, new or existing property.

### 2.3.1 An Empirical Exercise

Silver (2012) collected 157 HPIs from 2005: Q1 to 2010: Q1 from 24 countries with, for each HPI, explanatory measurement and coverage variables (based on (i) to (vii) above; details are given in Annex 1 of Silver (2012)). The panel data had fixed time and fixed country effects; the estimated coefficients on the explanatory measurement variables were relaxed to be time- and subsequently country-varying.

The regressions had substantial explanatory power,  $\bar{R}^2$ , at about 0.45 in mid-2009, a result especially notable given only fixed effects, and measurement variables were included. Measurement mattered and, in particular,  $\bar{R}^2$  increased over the period of recession, when it really matters. On excluding the country- and time-fixed effects, the effect of the measurement variables alone, while diminished, accounted during the recession for about a quarter of the variation in house price inflation rate.

### 2.3.2 Does It Matter for Modelling?

Silver (2012) took (an earlier version of) the model in Igan and Loungani (2012) (hereafter IL) to illustrate the impact of measurement differences on such analytical models. Country house price inflation for Silver was estimated using (441 (21 countries by 21 quarterly changes) coefficients on country-time interaction dummy variables, from a pooled regression that included measurement variables, and time-varying country effects. Silver employed the same estimator (OLS with robust standard errors), variable list, and dynamics used by IL, but their model was estimated with measurement-adjusted and unadjusted HPIs on the left hand side.

Measurement – adjusted (Madj) estimates were found to improve on the unadjusted ones. Both stock price changes and long-term interest rates had no (statistically significant at a 5% level) affect on HPI changes both for the IL estimates and unadjusted estimates, but did so with the appropriate sign for the measurement-adjusted estimates.

Silver allowed parameters on measurement variables to vary across the 17 countries, for both measurement-adjusted and unadjusted HPIs. The individual results, for example for stock price changes and long-term interest rates, were for the large part – over 70% of the 272 estimates – statistically significant at a 5% level. The disparity between the estimated parameters arising from using measurement-adjusted and unadjusted HPIs, as well as the magnitude of their effects, was found to be quite marked in some countries, including Japan, Netherlands, Switzerland, the United Kingdom and the United States.

### 3 Commercial Property Price Indexes (CPPIs)

#### 3.1 Alternative Data Sources: Problems

The compilation of commercial property price indexes (CPPIs) is the elephant in the room. Commercial property can be highly heterogeneous and transactions infrequent, more so than for residential, thus complicating comparisons of average transaction prices for a fixed-quality bundle of properties over time. Kanutin (2013) and Silver (2013) highlight some of these limitations, especially for appraisal data. The focus of our work is on better ways of handling transaction data. Two illustrations of technical research work to improve measurement are given below.

#### 3.2 Sparse Data and Index Aggregation in a Regression Framework

CPPI country measurement practice, for the large part, benefits from a regression-based framework, as is the case with HPIs. The transaction-based CPPIs used in this US study were provided to the authors by Real Capital Analytics (RCA CPPI). The empirical work uses two panel data sets: RCA CPPIs from 2000: Q1 to 2012: Q4 for “apartments” broken down by 34 metros/markets areas, and similarly for “other properties.”

##### 3.2.1 How to Derive More Efficient Estimates Given Sparse Data

Silver and Graf (2013) (hereafter SG) considered the problem of sparse data and an increase in the efficiency of the estimator. SG used data on “counts” – number of transactions – in each quarter for each area/type of property, provided by RCA, and WLS to improve the efficiency of the estimates, in line with the literature on “errors in measurement” in the dependant variable – Hausman (2001). Such measurement errors result in OLS parameter estimates that are unbiased, but inefficient, with reduced precision and associated lower t-statistics. We found significant differences between OLS and WLS estimates during the recession.

##### 3.2.2 How to Aggregate in Regression Framework: Modeling Spatial Dependency

Index price changes in CPPIs are often measured as parameter estimates on a time dummy in a regression. This formulation for measuring aggregate price change can be subject to omitted variable bias if there are price spillovers across geographical areas. SG included a spatial autoregressive (SAR) term in the regression thus removing potential bias by incorporating spillover effects – a SAR model, Anselin

(2008). SG found the inclusion of a spatial term to significantly affect measured inflation. The OLS estimates were biased upwards against the SAR total (fixed) for apartments (core commercial) by, on average 1.78 (1.68) percentage, and in 2009: Q1 by 2.47 (2.48) percentage points. Moreover, they introduced weights into the hedonic aggregation by means of a novel approach.

## 4 Summary

For the hard problem for countries of properly measuring residential property price indexes countries generally have available to them secondary data sources, including land registries/notaries, lenders, realtors, buyers, and builders, each of which may have, albethey different, problems of coverage, pricing concept, timeliness, reliability and sufficiency for enabling quality-mix adjustment; harmonization is not a given. Looking at country illustrations we found that measurement matters, even for a given method, however we also showed an example of a country making its own luck and improving its HPIs by adopting a long-run strategies: the way forward.

A formal analysis showed that measurement mattered, and that it really matters when it matters, as we moved into, during and recovering from recession. It also mattered in modeling, but less so than may be envisaged.

The really hard area of price index measurement was for commercial property where transaction data can be very sparse and properties very heterogeneous. Valuation data and methodology for sparse transaction-based CPPIs both need further research and development. CPPI measurement using transaction data is quite technical; two problems looked at were of sparse data and aggregation within a regression framework.

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# What Does “Location, Location, Location” Mean in the Context of House Price Indexes

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## 1 Introduction

The interconnectedness of the housing market and the broader economy has been clearly demonstrated by the recent global financial crisis. It is important therefore that governments, central banks and market participants are able to monitor developments in housing markets.

In recent years there has been a proliferation of house price indexes (HPIs) (see Hill, 2013). But the sensitivity of house price indexes to the method of construction is a potential source of confusion (see Silver, 2012). Several difficulties are well recognized in the literature.<sup>1</sup> For example, dwellings are sold only sporadically. Furthermore, every house is different both in terms of its physical characteristics and its location. It is important that house price indexes take account of this heterogeneity. Otherwise they will confound price changes with differences in quality. Hedonic methods – which express house prices as a function of a vector of characteristics – are ideally suited for constructing quality-adjusted house price indexes.

The hedonic method can be implemented in different ways (see Hill, 2013). In this note, we emphasize the real estate professionals’ mantra: “location, location, location”, in the context of hedonic house price indexes. The discussion focuses primarily on recent developments where semi-parametric hedonic equations are estimated and afterwards combined with the imputation method and a Fisher price index formula (see Hill and Scholz, 2014).

## 2 How Can We Incorporate Location in HPIs?

One of the key determinants of house prices is location. It means that houses which are identical in their structural characteristics vary in value due to their location.

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<sup>1</sup> For a comprehensive overview of conceptual and practical issues related to the compilation of price indexes for residential properties see de Haan and Diewert (2013).

The structure of a house could be changed, the layout altered, but it cannot be moved. It is attached to its property as a part of its surrounding neighborhood. The explanatory power of the hedonic model can therefore be significantly improved by exploiting information on the location of each property. Desirable locations are, *inter alia*, top-rated school districts, close to recreation areas, shopping, public transportation, health care, work places or homes with views. On the other hand, it would be less desirable, for example, living close to industries, railroad tracks, freeways or in crime-ridden and economically depressed neighborhoods. Some of the aforementioned locational attributes, like distances or views, are easy to measure and to incorporate as dummy variables or distances to amenities in HPIs. But usually, the available data are not detailed enough to capture the location value precisely. For this reason more sophisticated approaches are needed. Nowadays, exact addresses of sold properties are available. Thus, exact coordinates, measured in longitudes and latitudes, can be used in non- and semi-parametric methods to proxy most of the missing locational information.

## **2.1 Dummy Variables**

Probably the simplest way of incorporating geospatial information in the hedonic model is to include postcode identifiers, dummy variables for regions, school districts or other neighborhood characteristics, etc. for each house. However, such an approach misses the final details of locational effects, particularly when the identified geographical zones are quite large. Furthermore, Hill and Scholz (2014) show that an HPI based on postcode or region dummies can be biased when the average locational quality of the houses sold within postcodes changes over time.

## **2.2 Distances to Amenities**

Given the availability of geospatial data, the distance of each house to prime spots such as the city center, recreation areas, the airport, nearest public transportation or hospital can be measured. These distances can be included as further characteristics in the hedonic model.

However, using such distances to amenities is problematic in hedonic models for a few reasons. First and most importantly, it makes only limited use of the available geospatial data, and hence leaves out a lot of potentially useful information. One example could be housing externalities which refer to the effects the characteristics of a house have on other residents and, potentially, businesses (see Rossi-Hansberg and Sarte, 2012) and vice versa. Second, for each distance one needs the correct specification of the functional form. The impact of distance to an amenity on price of a house may be quite complicated and not necessarily monotonic. For example, it may be desirable for a house to be neither too close nor too far away from the airport,

city center, etc. Third, geographic direction may matter as well as distance. For example, a house’s position relative to the flight path is at least as important as the actual distance from an airport. Fourth, a perhaps more informative alternative to distance to the city center is the commuting time (see Shimizu, 2014) as well as measures of urban transportation performance or of congestion.

## 2.3 Spatial-Autoregressive Models

Locational effects can be captured more effectively by a spatial autoregressive model. The main effect of explicitly modeling the spatial dependence in a hedonic equation is that it should help offset the locational omitted variables problem (see Hill, 2013). Thus, it accounts for housing externalities and other common factors shared by neighborhoods. A prominent example is the (first-order) autoregressive spatial model with (first-order) autoregressive errors, referred to as the SARAR(1,1) model (see Anselin 1988; Corrado and Fingleton 2012).

One problem with this approach is that when the model is estimated over a number of years of data the spatial weights matrix should be replaced by a spatiotemporal weights matrix. That is, the magnitude of the dependence between observations depends inversely on both their spatial and temporal separation.

Replacing a spatial weights matrix with a spatiotemporal weights matrix significantly increases the computational burden and complicates the derivation of price indexes (see Nappi-Choulet and Maury, 2009). One response to this problem is to use the adjacent-period (AP) version of the time-dummy method. In this case the temporal separation between observations never gets that large and hence it is more defensible to use a spatial weights matrix instead of the theoretically preferred spatiotemporal weights matrix (see Hill, Melser and Syed, 2009).

The main problem with spatial autoregressive models is that they impose a lot of prior structure on the spatial dependence.

## 2.4 Non- and Semi-Parametric Approaches

Non- and semi-parametric methods provide a different and potentially more flexible alternative for modeling spatial dependence. They can be used to construct a topographical surface describing how prices vary by location, *ceteris paribus*. For example, Hill and Scholz (2014) estimate with thin-plate regression splines the following *generalized additive model (GAM)*, which consist in period  $t$  of a parametric part defined over the physical characteristics  $Z$  and a fully flexible nonparametric part (an unknown function  $g_t$ ) defined on the geospatial data – the longitude  $z_{long}$  and latitude  $z_{lat}$  of each observed house in period  $t$ :

$$y = Z\beta_t + g_t(z_{lat}, z_{long}) + \varepsilon$$

where  $y$  is the vector of log prices.

Imputed prices for each house in each period can then be obtained by inserting its particular mix of characteristics (including the longitude and latitude) into the estimated hedonic model. Finally, the use of the Fisher price index formula gives the HPI.

Other estimation methods for similar problems are also available. For example, Kolbe et al. (2012) estimate their semi-parametric hedonic model with a two-step procedure. After splitting house prices into building and land components, the location value surface is estimated with adaptive weight smoothing. Other examples are Clapp et al. (2002) or McMillen and Redfearn (2010). However, most of the applied non- and semi-parametric approaches in estimating the hedonic model do not compute price indexes. Kagie and van Wezel (2007) estimate their hedonic model using a decision tree model called boosting, but without the use of geospatial data.

The main advantage of non- and semi-parametric methods is that they do not need to assume a functional form in the hedonic model (or in parts of it), and hence avoiding problems of misspecification of the functional form. Comparisons with pure parametric models almost invariably find that non- and semi-parametric models outperform the simple linear models in terms of goodness-of-fit measures or even when, for example, repeat-sales are used as a benchmark (see Hill and Scholz, 2014). Furthermore, these methods include geospatial data in an intuitive and natural way, while other often used approaches as the average characteristics method cannot include these kind of information at all.<sup>2</sup>

### 3 Practical Considerations

Another demonstration of the flexibility of non- and semi-parametric methods is the ability of dealing with missing characteristics. Hill and Scholz (2014) show the importance of including all available observations (even those missing some of the structural characteristics), otherwise a sample selection bias may occur. If, for example, the age, or number of floors of a house are unknown, but the dwelling is located in a more or less homogeneous neighborhood, then location is highly correlated with both of them. Thus, the estimation of a topographical surface will also capture such effects, even if some characteristics are missing.

The difference of the constructed HPI based on a fully parametric model using, for example, post code dummies as locational characteristics, and a HPI derived from a semi-parametric hedonic-GAM based on longitudes and latitudes, depends partly on how finely defined are the identifiable locational zones in a city. Hill and

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<sup>2</sup> It measures intuitively the change in the price of the average house over time. But averaging longitudes and latitudes does not make sense. For example, in the case of a city like Sydney built round a natural harbor the average location may be under water!

Scholz (2014) show that the use of broader geographical areas can induce a bias in the HPI. Using data from Sydney, Australia, from 2001-2011 they find a downward bias during the housing market boom in the first part of the observed period. This can be attributed to systematic changes over time within each zone in the locational quality of houses sold.

## 4 Concluding Remarks

Location is one of the driving factors in house prices. Hence location should likewise play a prominent role in the construction of house price indexes. The increasing availability of geospatial data has the potential therefore to significantly improve the accuracy of HPIs. However, a consensus has not yet emerged regarding the best way of using geospatial data. In our opinion, a hedonic model estimated using flexible non- and semi-parametric techniques used in combination with the hedonic imputation method are an attractive option in this regard.

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# Residential Property Price Indices for Austria<sup>1</sup>

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## Abstract

This paper describes two residential property price indices (RPPI) available in Austria. The first one is a classical hedonic property price index with chained dummy evaluation, available for Vienna since 1986. The second one is what we call a “spatial imputation index”. It has the advantage that is evaluable on arbitrary spatial scales above census tract level, and can take into account different perspectives for aggregation.

## Challenges and Methods for Index Construction

Real estate consists of a wide range of characteristics that make each object unique. Therefore, households implicitly select a set of values for each of the  $K$  (structural and locational) characteristics  $z = (z_1, z_2, \dots, z_K)$ . The price of the house or apartment is a function of the whole bundle of characteristics, or the hedonic price function  $P = P(z)$ , with functional relationships possibly varying over time and space. This implies the following challenges that have to be taken into account during the construction of a RPPI:

- **Comparability:** The index must take into account different quality levels (e.g. location, size, age, technical equipment) and make the results comparable across time periods.
- **Change of standards:** To construct a representative index, it is necessary to consider changes in quality standards over time and to rely on comparable characteristics. If price indices are evaluated for nonrepresentative characteristics, this may result in biased results.

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<sup>1</sup> Large parts of this paper are taken from Brunauer, Feilmayr and Wagner (2012).

- Time-varying effects: Even if the effects of price-determining characteristics change only gradually, in the long run they cannot be assumed to be fixed.
- Representativeness: During construction and aggregation of sub-indices, it is necessary to take into account the underlying population we want to describe.

The main methods to control for changes in property characteristics discussed in the literature are *stratification*, *repeat sales methods* and *hedonic regression methods* (for more details, see European Commission 2011, chapters 3 and 4).

In the following, we concentrate on hedonic regression models. In the literature, two subgroups of hedonic indices are discussed. The time dummy variable method, which models the property's price as a function of its characteristics and a set of time dummy variables, is most popular. The first index discussed in this paper is such a time dummy index. However, as data on all sample periods are pooled, the resulting indices may be subject to revisions. Furthermore, the results implicitly correspond to a transaction-weighting. To deal with these problems, hedonic imputation methods were developed. The second method presented here is a special type of such an imputation index.

## The Austrian RPPI

Both RPPI presented in this paper rely on quotation prices, which include price observations combined with “structural” (property-specific) variables. Approximately 10,000 observations are available each year from the internet platform AMETA-NET (EDI-ORG, Linz). “Locational” (location-specific) variables are used to adjust for spatial differences down to census tract level<sup>2</sup>. On the basis of the available data, indices are estimated for apartments and single family houses (SFH).

## Time Dummy Index

The time dummy index applies multiple linear regression models, where (log) price is explained by building attributes and district dummies. Overlapping models are estimated over a period of one year, with dummy-coded quarters, where the resulting time effects are chained over the last quarter of the previous model. In total, six separate models are estimated, split by object type and region:

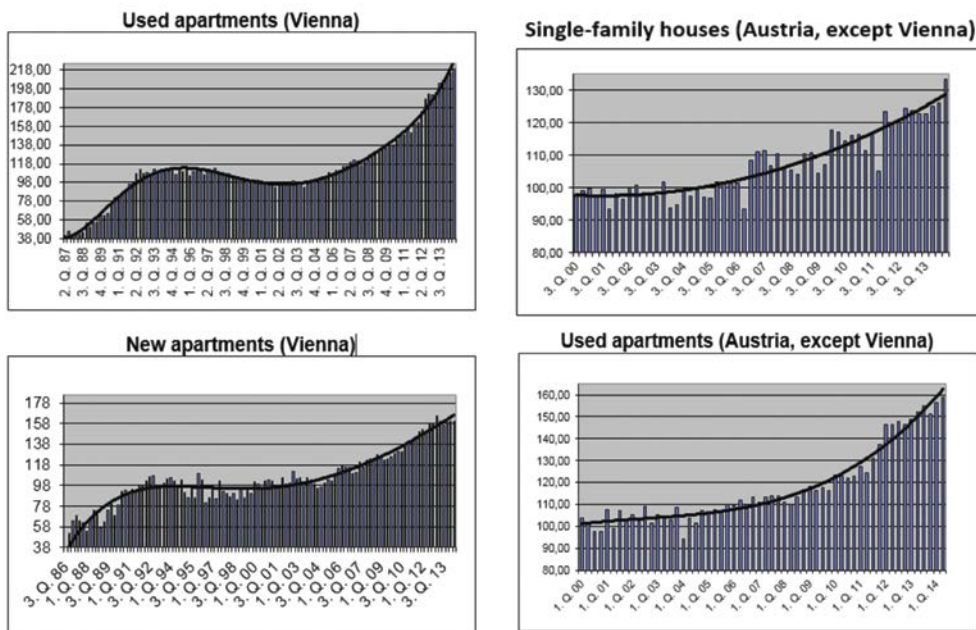
- “Vienna” and “Austria, except Vienna”
- SFH, apartments (new), apartments (used)
- The total effect is determined by a weighting scheme (see below)

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<sup>2</sup> In Austria, there are 8,748 census tracts in 2,379 municipalities, which form 121 districts across the 9 Austrian provinces.



Chart 1: Selected Results for Sub-Models of the Time Dummy Index<sup>1</sup>



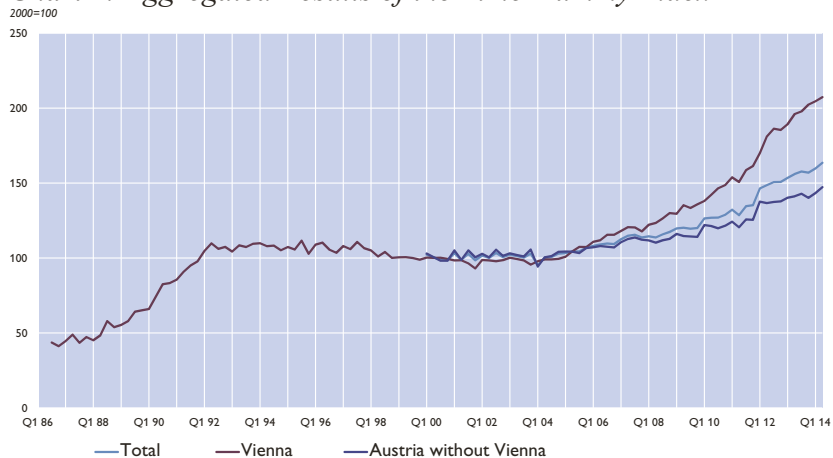
Source: Authors' calculations.

<sup>1</sup> Results available from <http://www.srf.tuwien.ac.at/feil/immobilienbewertung/Index214.pdf>.

The sub-indices are weighted by numbers of transactions from the land register (2008-2013).

Chart 2 shows the weighted results for “Vienna” and “Austria without Vienna” and the overall index development (“Total”).

Chart 2: Aggregated Results of the Time Dummy Index



Source: OeNB, Feilmayr, Department of Spatial Planning, Vienna University of Technology.

However, there are some drawbacks of this method: Due to model construction, the time dummy index faces the problem of “retrospective” variation of time effects. Furthermore, changes in quality levels are not explicitly considered in the model. And finally, as described above, the model implicitly incorporates a transaction perspective (or more precisely, a weighting by the number of quotation prices). Therefore, there is no inference for unobserved regions.

## Spatial Imputation Index

The second index described in this paper, the spatial imputation index, tries to overcome the shortcomings of the time dummy index. The basic principle of this index is to estimate hedonic models for rolling windows of two years, evaluating the results of these models over all census tracts in Austria for representative bundles of characteristics, and comparing the results of the current quarter to a base quarter.

Another issue in hedonic price modeling is the occurrence of nonlinear functional relationships and unexplained spatial heterogeneity, i.e. spatially varying relationships that cannot be explained by location-related variables. The time dummy index is based on classical linear models, which allow for nonlinearity in covariate effects only in a very restricted fashion (by integrating polynomial terms in the equation), again possibly resulting in functional misspecification. Furthermore, unexplained spatial variation is modeled by dummy effects. This approach yields very unstable results in districts where only few observations are recorded. Also, the time index is modeled according to the dummy approach, which results in very volatile effects if, in a certain time period, there are relatively few or outlying observations.

As linear models may seriously impair index construction, the new model uses a semiparametric approach, namely Generalized Additive Models (GAMs) as described in Wood (2006). GAMs model continuous covariates using penalized regression splines, which allow for nonlinearity in a regularized statistical framework. Distributional and structural assumptions, given covariates and parameters are based on Generalized Linear Models (GLMs),  $E(y_i|z_i, x_i) = h(\eta)^3$ . However, instead of a linear predictor, GAMs apply the additive predictor  $\eta_i = f_1(z_{i1}) + \dots + f_q(z_{iq}) + x_i' \gamma$ , where  $x_i' \gamma$  is the usual parametric part of the predictor,  $z_j$  is a continuous covariate, time scale or district index and  $f_j$  are (not necessarily continuous) functions of these covariates. The trade-off between data fidelity and smoothness is governed by model selection criteria, in our case the generalized cross-validation criterion (Wood, 2006). Unexplained spatial heterogeneity is modeled by random effects. Random effects penalize the lack of information in a district: The fewer obser-

<sup>3</sup> For the models applied here, we use the identity link, i.e. the linear predictor corresponds to the mean of the distribution function.

vations there are in one unit, the more they tend toward the “baseline” effect of the model, i.e. the level predicted by location-specific levels of covariates. Again, penalization is achieved by model selection criteria.

For the current version of the RPPI, the log of the property price is taken as the dependent variable. The effect of the age of the respective object, the specific living area and, in the case of family homes, also the plot area as well as locational covariates<sup>4</sup> are modeled as penalized regression splines, and unexplained spatial heterogeneity is modeled by district random effects<sup>5</sup>. The time trend is considered in five different ways:

1. In the *dummy approach*, quarterly time dummy effects are estimated like in the old model. However, as can be seen in charts 1 and 2, this leads to rather volatile estimation results, e.g. for condominiums in Q4 08 and for family homes in Q4 06.
2. The second version is a *smooth* trend estimation, where a nonlinear time trend is estimated using penalized regression splines. However, for both models, this approach seems to underestimate abrupt jumps.
3. The third version estimates a *random* time effect. As mentioned before, random effects models tend to weight the estimated parameters toward zero. Although this helps prevent large outliers, the effect is underestimated if the market truly tends up- or downward over time.
4. The fourth model combines a nonlinear time trend and random effects for modeling deviations from this trend, which is why it is called “*smooth-random*” model. This approach should account for abrupt deviations from a continuous baseline trend. Nevertheless, the results seem to be dominated by the nonlinear trend.
5. Finally, a model is estimated that integrates time effects in a hierarchical manner: The baseline time effect is estimated as a yearly effect, and deviations from that effect are captured by random effects on a quarterly basis, which is why this model is called “*year-random*” model. It seems to provide a robust trade-off between data fidelity and penalization, as the baseline effect is defined by a relatively large subsample while abrupt changes are also captured to some extent.

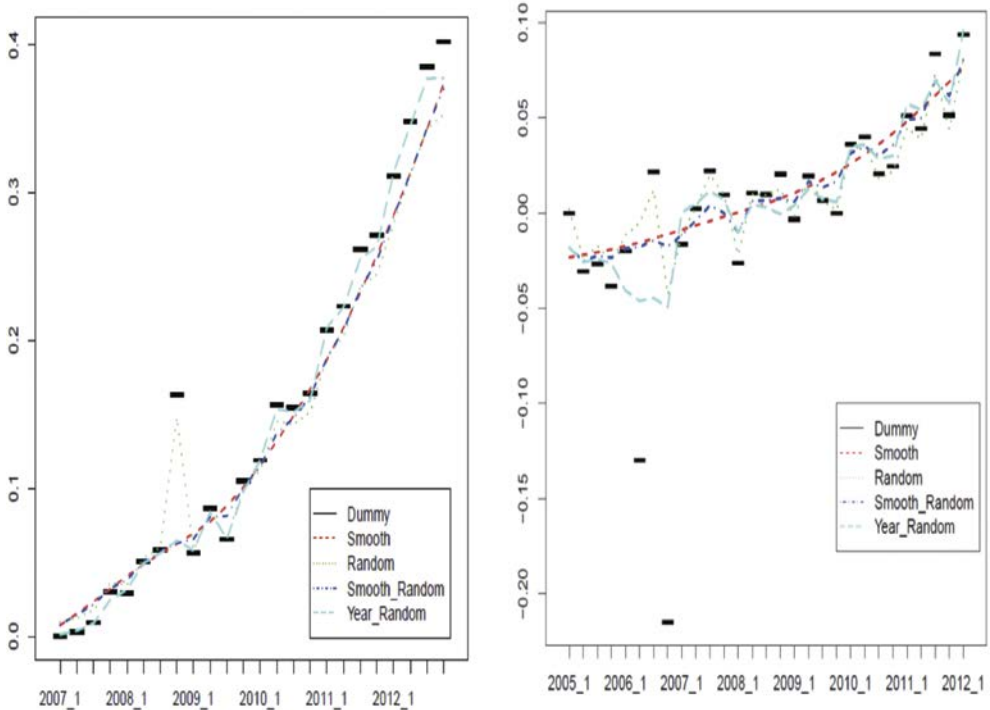
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<sup>4</sup> For the new RPPI, the log of the share of academics or high school graduates in the total population of a census tract is taken as a proxy for the social composition of the neighborhood. Furthermore, four variables enter the model at the municipality level: an index for the price of building land; the number of overnight stays (as a proxy for touristic activity in the municipality); a measure for accessibility (as a measure of centrality); and the growth of purchasing power from 2005 to 2009.

<sup>5</sup> There are 121 census districts in Austria.

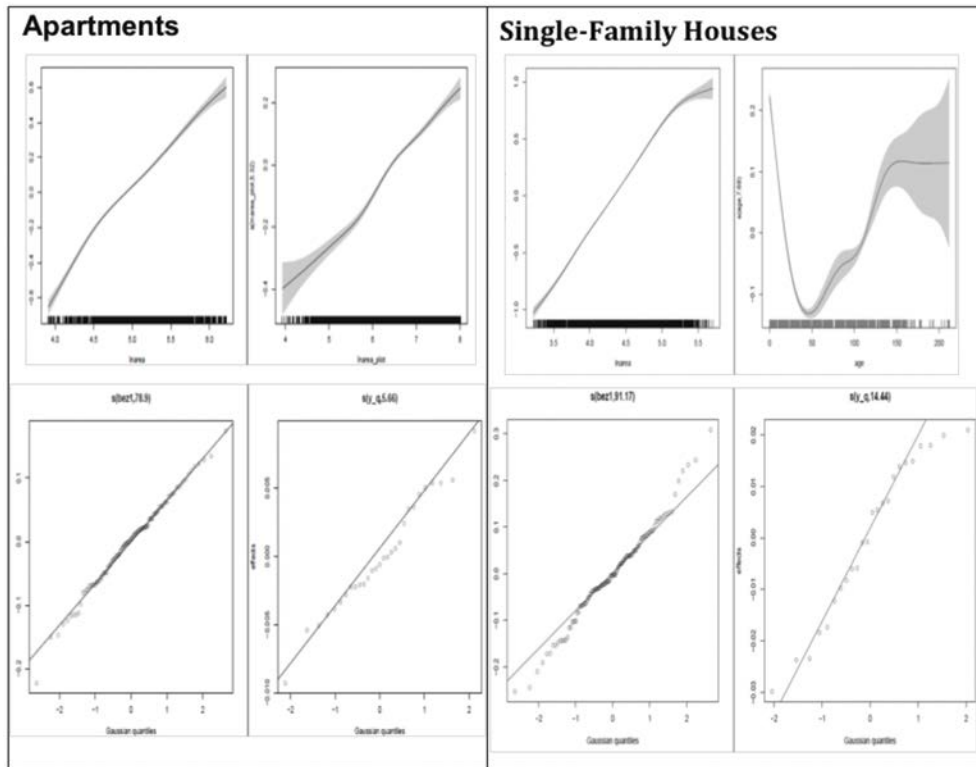
A comparison of these approaches is shown in chart 3. The subsequent chart 4 shows some nonlinear effects in the base model, where the central line is the estimated effect, and the grey areas correspond to 95% confidence intervals. In both cases, the explanatory variable is printed on the x-axis, while the y-axis can be approximately interpreted as the percentage effect on market values.

*Chart 3: Various Trend Models for Single Family Houses and Apartments*



Source: Authors' calculations.

Chart 4: Nonlinear Effects



Note: In clockwise order for SFH (left panels): Effect of  $\log(\text{floor area})$ ,  $\log(\text{plot area})$ , random effects for districts, random effects for quarters. Apartments (right): Effect of  $\log(\text{floor area})$ , building age, random effects for districts, random effects for quarters.

Using this methodological background, the following steps are taken to construct the spatial imputation index:

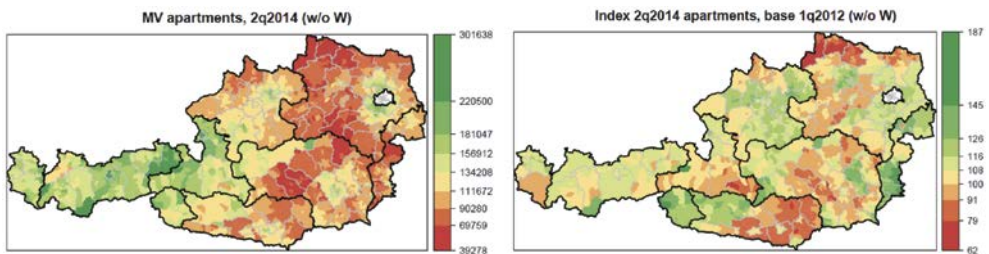
1. Definition of subsamples for model construction
  - a) Base model: 2007Q1–2012Q1 (apartments) and 2005Q1–2012Q1 (SFH), with base period 2012Q1
  - b) Comparison model: Moving window of two years, with comparison the latest available quarter
2. Determining “average characteristics“ for the last year until the base and comparison period, respectively
3. Regression model for base and comparison period
4. “Spatial imputation“:
  - a) Simulation of an „average characteristics“ object for each census tract in base and comparison period

- b) Leveraging on the similarities modeled by location covariates and the hierarchical structure for spatial heterogeneity
5. Index calculation on census tract level:
  - a) Laspeyres-Index: Determine average characteristics of base period, impute these effects on census tract level
  - b) Paasche-Index: Determine average characteristics of current period, impute these effects on census tract level
  - c) Fisher-Index: Geometric mean of Laspeyres and Paasche
6. Rescaling to 2007Q1 = 100 using dummy effects from base model
7. Weighting scheme:
  - a) For each submodel and state: Averaging over census tracts (except: SFH/Vienna, “inner“ districts)
  - b) Average over state/type index values weighted by share of state/type on total stock (based on Household Finance and Consumption Survey/HFCS 2010)

The approach described above has the advantages that space is taken into account by location covariates on census tract and municipality level (“observed” spatial heterogeneity) and a hierarchical structure of state and district (“unobserved” spatial heterogeneity). Furthermore, representativeness is obtained on the one hand by imputation in each census tract, with spatially varying census tract characteristics, and a weighted aggregation using shares of respective state in total building stock.

In the following charts, we evaluate the results on census tract level with base period 1Q2012<sup>6</sup>. For both apartments and SFH, the spatial indices are strongly heterogeneous.

*Chart 5: Results for Apartments on Census Tract Level for Austria Except Vienna*

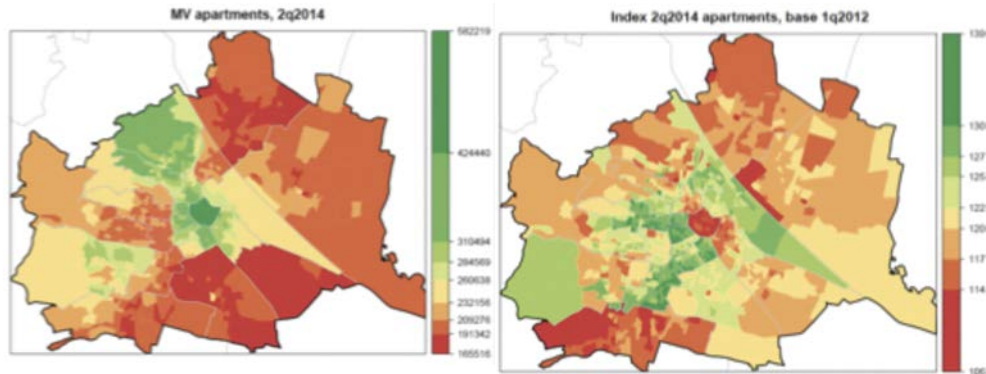


*Note: Upper left panel: market value in base period, lower panel: Fisher index, upper right panel: market value in comparison period, lower panel Fisher index.*

<sup>6</sup> Note that for the final index, the results are re-scaled to 1Q2007 as described above.

For apartments in Austria except Vienna, positive developments can be seen predominantly in urban and suburban regions as well as in the western parts of Austria with distinct tourism.

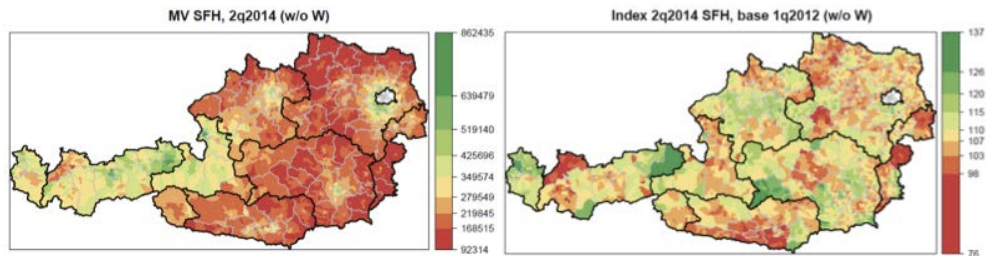
*Chart 6: Results for Apartments on Census Tract Level for Vienna*



*Note: Left panel: market value in current (comparison) period; right panel: Fisher index.*

For apartments in Vienna, we do not find any negative developments. The strongest positive developments can be found in the CBD and on the fringe of Vienna.

*Chart 7: Results for SFH on Census Tract Level for Austria except Vienna*

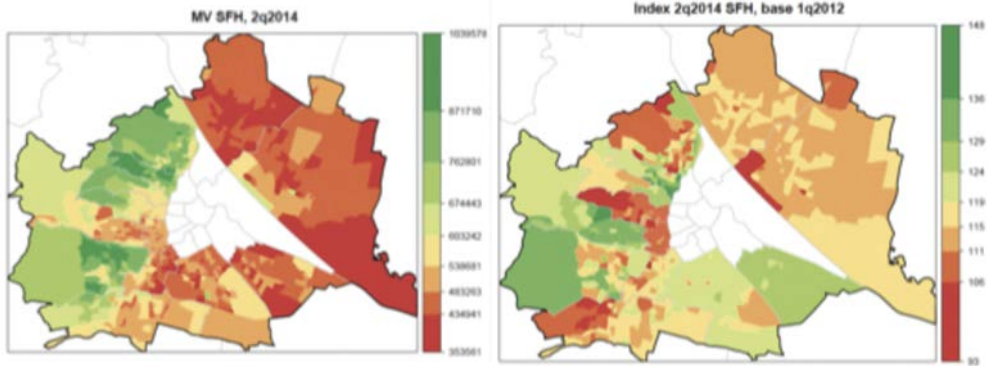


*Note: Left panel: market value in current (comparison) period; right panel: Fisher index.*

For SFH in Austria except Vienna, we find the strongest positive developments in the eastern part of Tyrol and the northern part of Vorarlberg. Also upper Austria and the very west of Styria show strong price increases. However, the latter is possibly due to statistical artifacts and still has to be examined in more detail.



*Chart 8: Results for Apartments on Census Tract Level for Vienna (Except Inner Districts)*



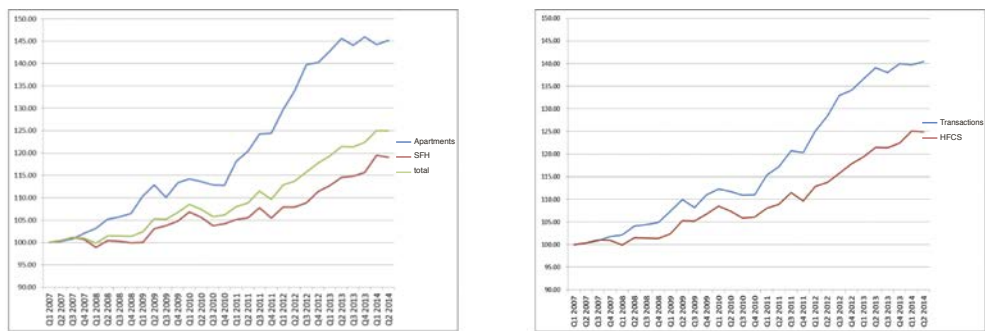
*Note: Left panel: market value in current (comparison) period; right panel: Fisher index.*

For SFH in Vienna, we exclude the inner districts from index construction as there is no market for SFH. Due to very small sample sizes the results for the single districts should be interpreted very carefully.

In a next step, the resulting index values on census tract level are aggregated on state level. The indices on state level are then weighted according to their share on total stock based on Household Finance and Consumption Survey/HFCS 2010.

The left panel of chart 9 shows the resulting index for apartments, SFH and the overall index. However, it is important to be aware of the effect of the weighting scheme: the right panel shows a comparison between the index resulting from the stock weighting scheme and an index resulting from transaction weights.

*Chart 9: Results for SFH and Apartments*



*Note: Left panel: Index development for apartments, SFH and the overall index based on stock weighting scheme (based on HFCS 2010); right panel: comparison between stock and transaction weights.*



## Conclusion

In this paper, we describe two indices available in Austria: The time dummy index, which is available for Vienna for the period since 1986 and for Austria except Vienna since 2000, and the spatial imputation index, available for the period since 2007. Both indices are updated quarterly and available from the OeNB's website.<sup>7</sup> While the spatial imputation index solves some problems that are obvious for the time dummy index, there is still much room for improvement concerning data, model and weighting scheme:

1. Data: The spatial imputation model is based on quotation/asking price data. Obtaining data sources that are not affected by weaknesses of asking price data would be preferable.
2. Model: The underlying model could be improved e.g. by spatially varying effects for object characteristics and by including location covariates measured in respective year (currently, locational covariates only provide a "cross-section" perspective, i.e. they do not vary over time). Additional covariates could be included measuring fundamental factors for demand (e.g. demographic development) and supply (e.g. available floor space).
3. Weighting scheme: Although the disaggregated index values overall give a plausible picture, there are some regions where statistical artifacts may occur. Furthermore, a more detailed weighting scheme seems appropriate, accounting for share of stock e.g. on district level.

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<sup>7</sup> [www.oenb.at/isaweb/report.do?lang=DE&report=6.6](http://www.oenb.at/isaweb/report.do?lang=DE&report=6.6).

# Housing Cycles: Stylised Facts and Policy Challenges

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1. Seven years after the start of the global financial crisis (GFC), housing markets are slowly recovering in most OECD countries, albeit at a different pace. Nevertheless, the current state of housing systems creates serious policy challenges. The very low policy rates, which are necessary to stabilise the economy after the GFC, risk fuelling new bubbles. Low interest rates are pushing up household debt in countries where access to credit is relatively easy, raising concern about long-term sustainability and vulnerability to hikes in interest rates, decreases in income and asset prices or higher unemployment. Beyond credit risk, which is usually moderate on mortgages, funding structures involving important maturity or currency mismatches can prove fragile in financial turbulences. Furthermore, indebted households facing rising interest payments or unexpected losses in revenue are bound to reduce consumption, impacting economic activity, employment and possibly the financial system through second round effects. Financial authorities are increasingly turning to macro-prudential instruments to mitigate such risks. While these instruments are promising, they are still largely untested in OECD countries. Careful implementation and monitoring will be necessary to prevent future housing crises with destabilising effects on the wider economy and the financial system.
2. The deep economic downturn has heightened stress on housing systems. Construction has dropped sharply in most OECD countries, including some where there is a structural shortage of dwellings. Constrained government finances tend to restrict support for affordable housing. Shortages and high cost of housing are not only causing social hardship, weighing on household finances and possibly reducing labour mobility, they also tend to exacerbate housing price volatility. A holistic approach to housing issues is needed to achieve at the same time financial stability and decent housing conditions for all. The two dimensions are interrelated, as structural features of housing markets influence their resilience to shocks coming from the economy or the financial system.

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<sup>1</sup> The views expressed in this paper are those of the author and do not necessarily reflect those of the OECD or its member countries.

## Housing Markets Are Recovering in Most OECD Countries

3. Table 1 provides a snapshot of the most recent real housing price orientations across the OECD. Apart from Japan, where land prices have been declining for over two decades, ongoing housing price declines are concentrated in the euro area, notably its southern periphery.<sup>2</sup> Weak macroeconomic conditions and financial sector fragilities are weighing on housing demand in these countries, worsening the downturn where housing bubbles have burst (e.g. Greece, Spain) and triggering price falls even where housing price increases had remained moderate during the expansion (e. g. Italy, Portugal).
4. After spectacular tumbles, housing prices seem to have bottomed out in Denmark and most OECD countries of Central and Eastern Europe. Some of the countries which had experienced a housing market collapse are now seeing a fairly strong rebound in prices. They include Estonia, Iceland, Ireland and the United States. In New Zealand and the United Kingdom, where the fall had been less severe, real prices are now close to their pre-crisis levels.

*Table 1: Current Housing Price Orientation in OECD Countries  
(as of September 2014)*

|                   |   |
|-------------------|---|
| Continued fall    | Greece (-42), Italy (-23), Spain (-38), Slovenia (-27)  |
| Moderate fall     | France (-6), Finland (-3), Japan (-9), Portugal (-10)   |
| Broadly stable    | Belgium (+3), Czech Republic (-11), Denmark (-27), Hungary (-34), Korea (-3), Luxembourg (+7), Mexico (-1), Netherlands (-24), Slovakia (-28) |
| Moderate increase | Austria (+22), Canada (+14), Germany (+18), Norway (+13), Sweden (+4), Switzerland (+26)  |
| Firm recovery     | Estonia (-34), United Kingdom (-9), Iceland (-27), Ireland (-44), New Zealand (+1), United States (-18)                                       |
| Rapid increase    | Australia (+8), Israel (+58)  |

*In parenthesis, percentage change in real housing prices relative to peak in 2006-08.*

*Source: OECD and national sources.*

5. In many countries, the global financial and economic crisis has not led to a sharp correction in housing prices. In countries with a solid financial system, low interest rates have supported prices, which are often high by historical standards. This is in particular the case of Australia, Canada and some Nordic countries. Prices are vulnerable to a normalisation of interest rates from their currently very low levels. Austria, Germany and Switzerland, which were not part of the global housing boom, now experience a steady expansion.

<sup>2</sup> Land prices are used as a proxy for Japan, as no long housing price series is available for the whole country.

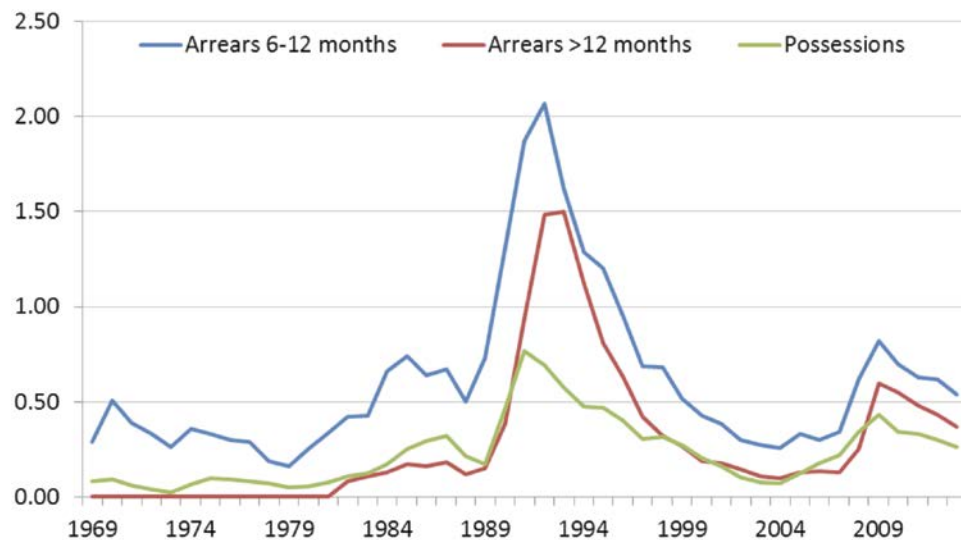
6. In the countries where a construction boom had created large over-supply, residential investment fell spectacularly. The fall has been even more spectacular in residential investment than in housing prices. But residential investment also contracted in countries where housing supply was already fairly tight, like the Netherlands and the United Kingdom, worsening structural housing shortages. Unsurprisingly, the pick-up in housing demand as mortgage market conditions improved in the United Kingdom was met by rapid price increases.

## **Mortgage Delinquencies Reflect Lending Practices and Economic Conditions**

7. In the run up to the GFC, mortgage lending increased spectacularly in most OECD countries. In many cases, the expansion was supported by overly optimistic expectations about future economic and housing price developments. The crisis resulted in rising arrears, although with large differences across countries. Foreclosures rose sharply in the United States, but much less in other countries, partly as a result of institutional differences, state interventions and lender forbearance. Variations in mortgage delinquencies across OECD countries reflect lending practices during the boom, institutional settings, housing price developments and the financial situation of indebted households. Defaults early into the crisis result mainly from lax underwriting standards, in particular “equity lending” where the ability to repay is contingent on rising housing prices (e.g. US subprime), or the prevalence of mortgages tied to volatile measures such as inflation (e.g. Iceland) or foreign currencies (e.g. Hungary, Iceland). As the crisis deepened, falling income and rising unemployment generated defaults in more countries (e.g. Italy, Portugal).
8. In many countries, the share of non-performing mortgages has only risen modestly. A general factor which has helped prevent larger increases in mortgage delinquencies is low interest rates. The transmission of lower policy rates to mortgages is especially strong in countries where variable rates are prevalent. The United Kingdom provides an illustration. During the downturn of the early 1990s, arrears and possessions increased markedly, as high interest rates pushed up the loan servicing burden. During the latest recession, low interest rates contained the increase in arrears, although a smaller increase in unemployment also contributed (chart 1).

*Chart 1: Arrears and Possessions in the United Kingdom*

% of outstanding mortgages



Source: Council of Mortgage Lenders.

## Non-Performing Loans to Construction and Real Estate Developers Weigh Heavily in Some Countries

9. In most downturns associated with tumbling housing prices, financial institution losses related to commercial property mortgages and loans to developers are much higher than those on residential mortgages. In countries where construction was booming before the crisis, notably Ireland and Spain, non-performing loans have weighed heavily on the banking sector and public finances, as governments stepped in to rescue distressed financial institutions. In Ireland, the government set up in late 2009 the National Asset Management Agency (NAMA), a state bank restructuring agency, which acquired 11,500 property development-related loans, with a nominal value of EUR 72.3 billion (46% of GDP) at an average haircut of 58%. Subsequent capital injections added to the gross direct fiscal cost of the banking crisis, which has been estimated at over 40% of GDP (OECD, 2011). Spain launched SAREB (Sociedad de Gestión de Activos Procedentes de la Reestructuración Bancaria) in July 2012 to remove distressed real estate assets from the balance sheets of troubled financial institutions. SAREB, which is owned for 55% by the private sector and for 45% by the government

(through the FROB, Fondo de Reestructuración Bancaria) received nearly 200,000 assets for an amount of EUR 50.7 billion euros (about 5% of GDP), of which 80% are financial assets and 20% property. Although NAMA and SAREB are likely to recoup part of the losses over time, final fiscal costs are bound to be high.

## What Is Driving the Housing Cycle?

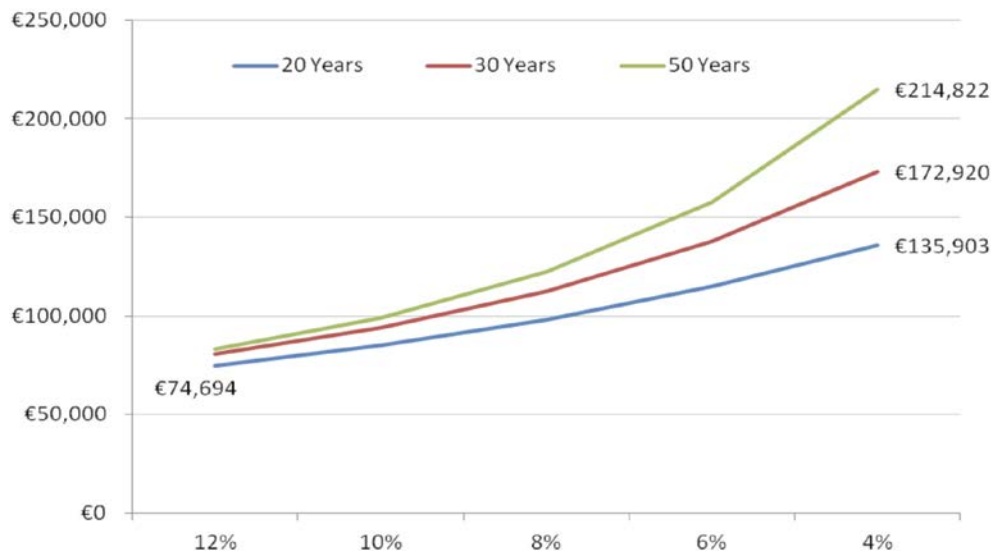
10. Cyclicalitv is a well-known feature of housing markets. Demand for housing is strongly influenced by business and financial cycles. The inertia of supply resulting from construction lags and backward-looking expectations generate hog-type cycles. Over the past two decades, interest rates, which are among the main drivers of housing prices, have declined markedly across the OECD. As inflation receded, nominal interest rates declined even more than real rates. Lower nominal rates ease borrowing constraints, as repayments become less frontloaded (Engelhardt, 1996). The creation of the euro area in 1999 led to a convergence towards German interest rates, which contributed to fuelling housing booms in peripheral countries.
11. The impact of lower interest rates was compounded by financial innovation, which took a variety of forms. To give a few examples seen in various countries, the maturity of loans lengthened, the share of adjustable-rate mortgages increased, caps on loan-to-value ratios were raised and deferred amortisation loans became more common. It is worth noting that the impact of financial innovations may vary with interest rates in a non-linear way. For example, the impact of lengthening the loan duration on borrowing capacity increases, all else equal, as interest rates decline (chart 2). A loan-to-value cap would increase the deposit required for larger loans, limiting the borrowing capacity of many, especially first-time buyers. However, during the boom, limits on loan-to-value ratios were often relaxed. This simple example illustrates how low interest rates and different types of financial innovations can combine to increase borrowing capacity significantly.<sup>3</sup>

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<sup>3</sup> For an evaluation of the impact of credit conditions on price-to-rent ratios in the United States, see Duca et al. (2011).

*Chart 2: Borrowing Capacity for Various Interest Rates and Maturities*

Capital corresponding to a EUR 10,000 annuity



Source: Author's calculations.

- While lower interest rates and easing of credit conditions can be seen as largely global drivers of the housing cycle, dwelling prices are also affected by a number of local factors, including on the demand side developments in household real disposable income, unemployment, demographics, taxation, housing price expectations and foreign demand, and on the supply side the profitability of construction, housing and land price expectations, planning and zoning regulations and infrastructure.

## Housing Market Dynamics: a Stylised Representation

- Housing markets are characterised by delays in supply responses and backward-looking expectations. The model of the hog cycle, or cobweb model, offers a fairly good stylised description of housing market dynamics. Chart 3 and 4 illustrate housing price and quantity dynamics in the case of respectively low and high supply elasticities. In both cases, prices jump (from P<sub>0</sub> to P<sub>1</sub>) as a result of a demand shock – which could result, for example, from a loosening of credit conditions – as supply is fixed in the short term. In the next period, quantities adjust in response to higher prices. At this point (P<sub>1</sub>, Q<sub>1</sub>), both prices and quantities overshoot their equilibrium level, but by a much wider margin

Chart 3: Housing Market Dynamics: Low Supply Elasticity

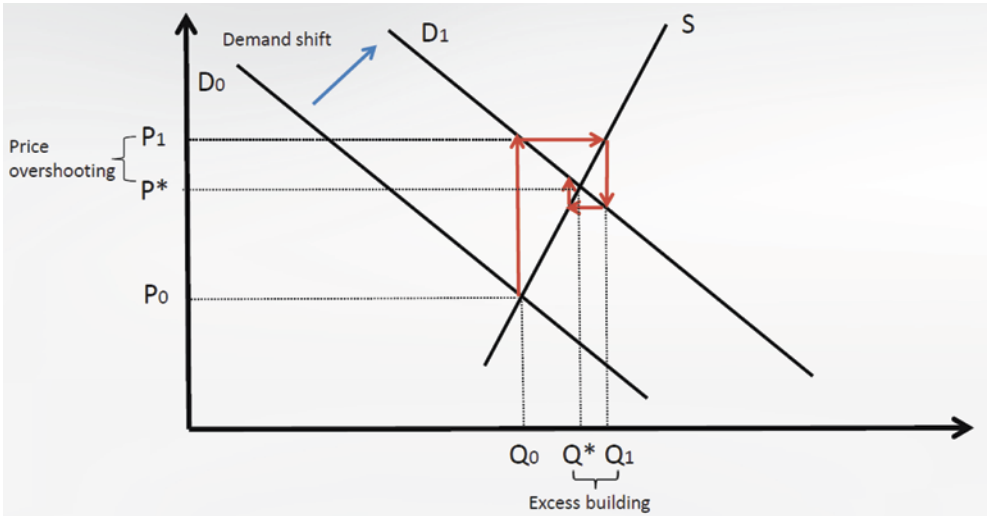
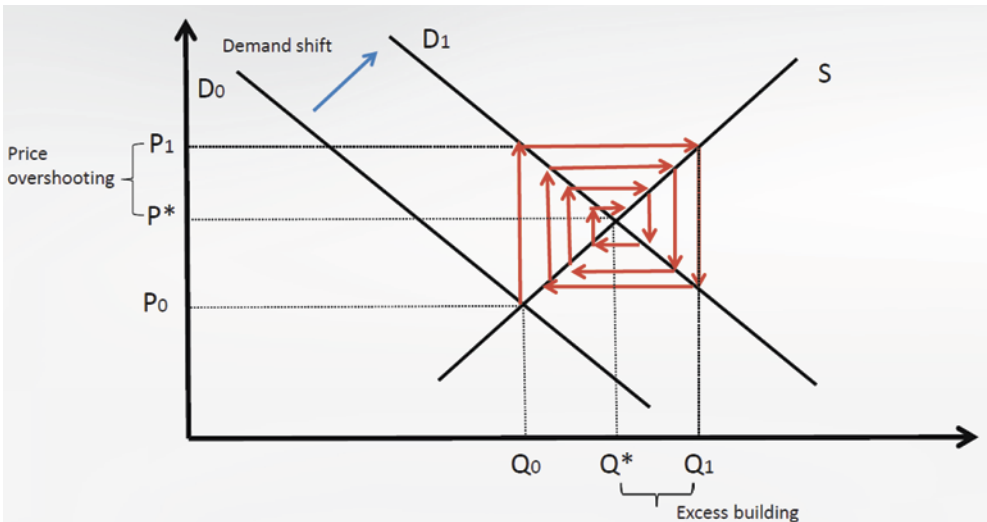


Chart 4: Housing Market Dynamics: High Supply Elasticity





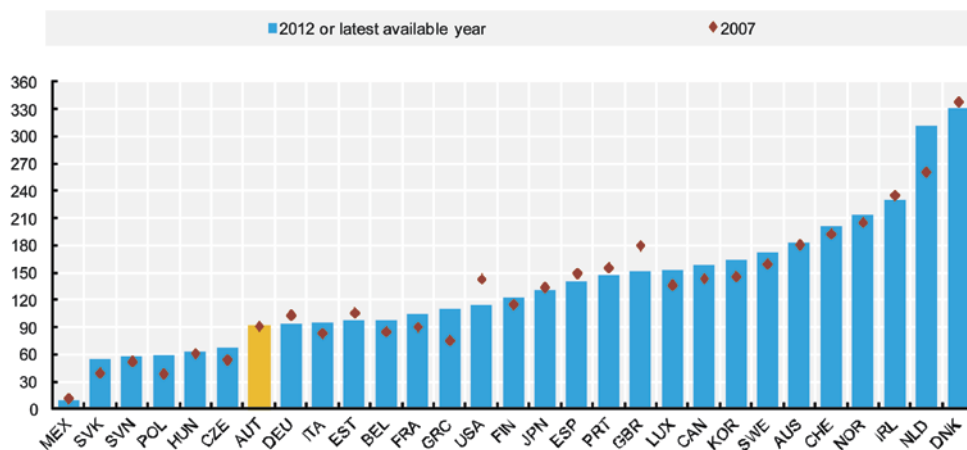
when supply is more elastic. While this example is very simplistic, it broadly illustrates developments over the latest cycle in countries where supply is tight (e.g. the United Kingdom), where prices eventually stabilised at a high level, and in countries which experienced building booms followed by a collapse in prices and construction (e.g. Ireland and Spain). The model explains fairly well how demand shocks can lead to instability when supply elasticity is high. This is of particular relevance from a financial stability point of view, as loans to developers have often been a source of significant losses for financial institutions. However, high supply elasticity results in a lower equilibrium price ( $P^*$ ) and hence better affordability in the long run.

## Policy Challenges

14. In many countries, housing prices remain high by historical standards relative to income. With a few exceptions, gross household debt has continued to increase faster than disposable income since the GFC and is mainly used to finance housing (chart 5). A high level of gross household debt is not in itself an indicator of financial risk, in particular because vulnerabilities depend both on the amount of assets and on the distribution of liabilities and assets across households. However, high debt may entail risks for households, the financial system and the wider economy. Credit risk on mortgages is generally moderate, although risky lending can generate substantial losses, as with US subprime mortgages and foreign currency loans in Hungary and Iceland. Micro-prudential regulators should remain vigilant about underwriting quality. Credit losses often follow a sharp deterioration in income and employment or an increase in interest rates. Maturity and currency mismatch in the funding of mortgages may create additional risks, as evidenced by the failure of several mortgage lenders using such funding structures during the GFC. Rapid debt expansion can create macroeconomic risk. The probability of recession increases as household debt rises above its trend and recessions associated with high debt tend to be deeper and more protracted than those where debt is lower (Sutherland et al., 2012). Macro-prudential tools, such as caps on loan-to-value ratios or risk weights on mortgages are the most promising instruments to prevent housing bubbles. However, they are largely untested in OECD countries and designing effective macro-prudential policy is one of the main challenges currently facing policymakers. Although monetary policy may be used in some cases to slow household debt accumulation, it is a very crude instrument for this purpose.

### Chart 5: Gross Household Debt

as a percentage of net disposable income



Source: OECD National Accounts Statistics.

- Finally, housing challenges do not end with financial stability. Ensuring access to decent housing for all is also essential. Moreover, the stability of housing markets is not independent from their structural features, which are affected by a wide range of policies, including taxation, land-use planning, infrastructure, welfare, social housing and rental market regulations. Hence policymakers should adopt a holistic approach to housing issues.

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# Fundamental and Non-Fundamental Explanations for House Price Fluctuations

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*Christian Hott*  
*Economic Advice*

## 1 Unexplained Real Estate Crises

Several countries were affected by a real estate crisis in recent years. In many cases strongly falling house prices resulted in increasing default rates among home owners, solvency threatening losses at banks and one of the most devastating financial and economic crises in history.

This crisis was preceded by a long episode of strongly increasing house prices. While there were some economists that warned against the buildup of imbalances on the housing market and the risk of a real estate crisis, most investors, banks and politicians seemed to have believed that prices will continue to increase forever. Yet, real estate crises are not something new. The last wave of real estate crises was around 1990 when some Nordic countries but also in countries like the UK, Japan and Switzerland experienced strong price declines on the housing market.

How can we explain these price fluctuations? Similar to the 1990 crisis, the price increase that resulted in the recent crisis was accompanied by favorable economic conditions with high growth rates as well as relatively low interest rates. When prices declined, there was a very weak economic development. This would indicate that the price development can be explained by an endogenous interaction with fundamental factors like GDP and interest rates.

In order to evaluate, which part of the house price development can be explained by fundamentals, we develop a model of fundamental house prices. We then calibrate fundamental prices for ten different OECD countries and compare them to actual prices. The results indicate the prices fluctuate much more than fundamentally justified.

As prices fluctuate more than fundamentally justified there have to be non-fundamental effects which drive these excess fluctuations. We will therefore deviate from the standard rational agent model by incorporating herding behavior and speculation into the house-price model. We will then calibrate the modified models and examine the improvement of the fit to actual prices.

## 2 Fundamental Explanation for House Price Fluctuations

### 2.1 A Model of Fundamental House Price

Our model of fundamental house prices is built on Hott and Monnin (2008). This model takes into account that a house can be seen as an asset which price should reflect a risk-return tradeoff but also as a good which price should reflect the utility gain from owning it.

The asset view of a house price is given by a simple asset pricing model where the fundamental house price ( $P$ ) is assumed to be equal to the sum of future discounted fundamental imputed rents ( $H$ ). The discount factor is given by the sum of the mortgage rate ( $m$ ) and the risk premium  $\rho$ .

$$P_t^* = E_t \left[ \sum_{i=0}^{\infty} \frac{H_{t+i}}{\prod_{j=0}^i (1 + \rho + m_{t+j})} \right] \quad (1)$$

Hence, the fundamental house price depends positively on the fundamental imputed rent and its future growth rate and negatively on the risk premium as well as present and future mortgage rates.

The determination of the fundamental imputed rents brings in the utility view. We assume that  $H$  is the clearing price (i.e. rent) on the housing market. The supply in one period is given by the discounted ( $\delta$ ) housing stock ( $S$ ) of the previous period plus the construction of new houses ( $B$ ). The demand side is driven by a variation of a Cobb-Douglas utility function and leads to an aggregated demand equal to a constant fraction  $\alpha$  of aggregated income ( $Y$ ) which is spend on housing plus an autonomous demand per household multiplied by the number of households ( $N$ ).

$$H_t = \alpha \frac{Y_t}{S_t - \hat{d}N_t} = \alpha \frac{Y_t}{(1-\delta)^t S_0 + \sum_{j=1}^t (1-\delta)^{j-1} B_{t-j} - \hat{d}N_t} \quad (2)$$

As we can see, the fundamental imputed rent and therefore also the fundamental house price, depend positively on aggregated income as well as the number of households and negatively on construction activities.

### 2.2 Calibration of the Fundamental House Price

In order to see to which degree our fundamental house price model can explain actual house price developments, we calibrate the model for ten different OECD

countries: Australia (AUS), Switzerland (CH), Spain (ES), France (FR), Ireland (IE), Japan (JAP), the Netherlands (NL), Sweden (SE), the UK, and the US.

Based on equation (1) and (2) we need data on mortgage rates (sources: BIS and OECD), GDP (as a proxy for aggregated income, sources: IMF and OECD), population (as a proxy for the number of households, source: IMF), and construction (sources: Datastream, OECD and SNB). For the calibration we need also the development of actual house prices (sources: BIS and S&P Case-Shiller National Home Price Values for the US) and actual rents (source: OECD). In addition, as we are interested in the real development, we need data on CPI (source: IMF).

One problem is that according to (1), we not only need the past development of the imputed rents and mortgage rates, but also their future development up to infinity. For simplicity and since we are mainly interested in the overall development of the prices, we assume that imputed rents will increase at a constant rate which is equal to the country specific average growth rate in the past. For the mortgage rate we assume that it stays constant at its country specific historical average.

Besides the development of the different variables, we need to have adequate values for the different parameters. As in Hott (2012), we chose the parameter values by taking established values from the literature and, where this is not applicable, by using them to adjust the development of the theoretical prices and rents to their actual developments.

Based on studies by Harding et al. (2007), Himmelberg et al. (2005), Pain and Westaway (1997), and Poterba (1992) we assume that the discount factor  $\delta$  is 2 percent and that the risk premium  $\rho$  is 5 percent.

The initial housing stock, the utility parameter  $\alpha$  and the autonomous demand are relevant for the fundamental imputed rent. As actual rents are expressed as an index value, we need an additional parameter which adjusts the level of the theoretical rents to that of the rent index. We multiply this adjustment parameter with  $\alpha$  which has also only an influence on the level of house prices (and not their development) and get the new parameter  $\alpha l$ . We choose the different parameter values by minimizing the mean squared difference between the logs of theoretical and actual rents.

Using the calibrated fundamental imputed rents, we can now calibrate the fundamental house prices. As with rents, we have to adjust the level of the theoretical prices to that of the house price index. We choose this adjustment parameter by minimizing the mean squared difference between theoretical and actual house prices. For the calibration of these fundamental prices we assume that there are no distortions and that households have perfect foresight.

The results of the calibration are displayed in Chart 1. As we can see, although the overall trend of the fundamental and actual prices is comparable, there are substantial deviation of the actual prices from their fundamental value from time to

time. On average, prices deviate about 25 percent from their fundamental value. The reason for this is that actual prices fluctuate much stronger than fundamentals would justify. On average, the variance of the actual price increases is about ten times higher than that of fundamental prices.

### 3 Non-Fundamental Reasons for Excess Price Fluctuations

As we have seen, house prices fluctuate much stronger than fundamentally justified. Shiller (1981, p. 434) gets similar results for stock prices and argues:

*“The failure of the efficient markets model is thus so dramatic that it would seem impossible to attribute the failure to such things as data errors, price index problems, or changes in tax laws.”*

In this chapter we will evaluate in how far herding behavior and speculation can explain the excess price fluctuations.

#### 3.1 Herding Behavior

Following Hott (2012), herding behavior can be included into our basic house price model by using the main elements of Lux (1995).

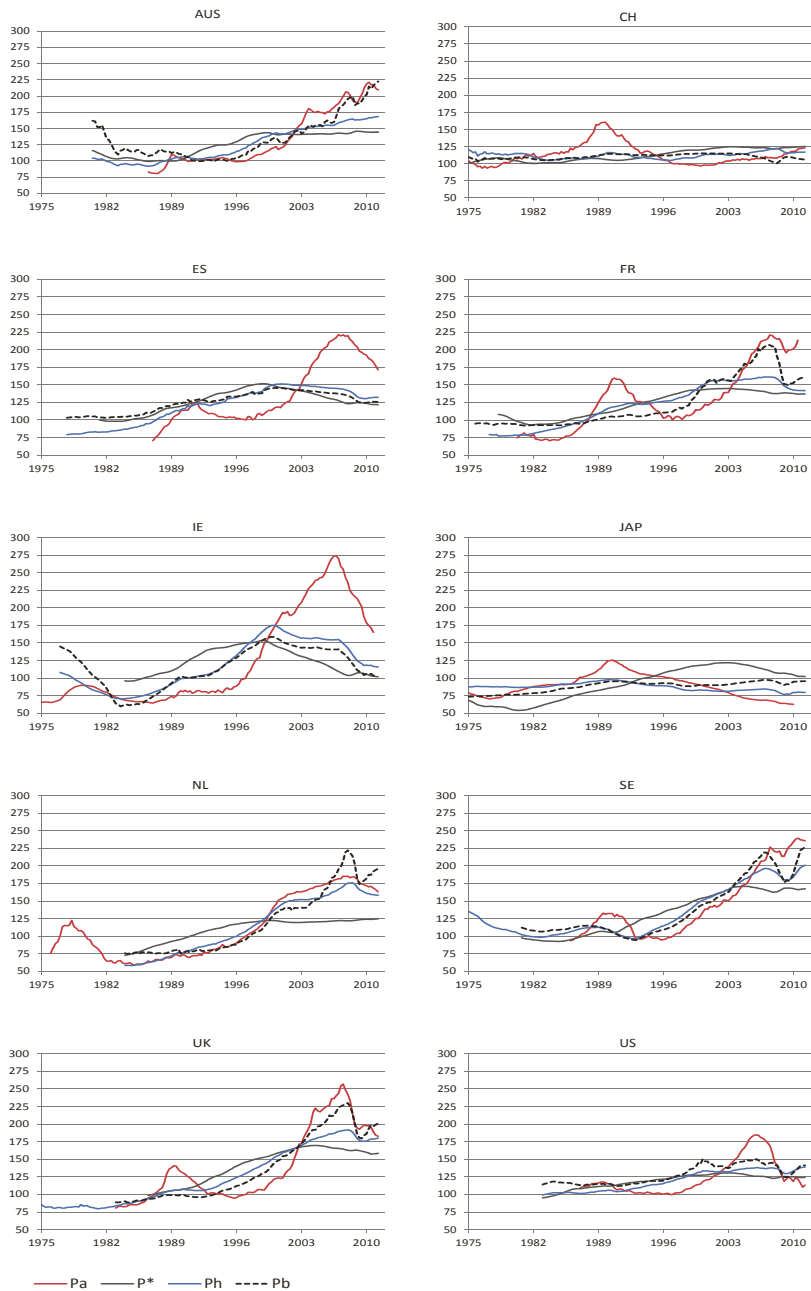
In the fundamental model we have assumed that the risk premium is constant. In this section we adjust this by assuming that the risk premium depends on the mood of households. If households get more optimistic, they demand a lower risk premium and they demand a higher risk premium if they get more pessimistic.

Further we assume that the mood of the households is affected by the returns on the housing market. If there is an excess return, households get more optimistic and they get more pessimistic if the return is too low. The return, however, depends on the investment decision of the households

This introduces an endogenous price dynamic: If there is a positive shock which results in a excess return, households get more optimistic. The more optimist households demand a lower risk premium and are therefore willing to pay higher prices. This in turn leads to an increase in prices and again to an excess return. The process is reversed when the return from the imputed rent gets too low to be compensated by the price increase. Now households get more pessimistic and prices fall.

This herding house price with endogenous risk premiums can be calibrated in the same way as the fundamental price. Only now we also have to find optimal parameter values for the speed of mood adjustment. The results of the calibration are displayed in Chart 1.

*Chart 1: Actual, Fundamental, Herding and Speculative Real House Prices*



Sources: BIS, S&P Case-Shiller National Home Price Values for the US, IMF, and author's calculations.

### 3.2 Speculative Bubble

When it comes to over- or undervaluations of assets speculative behavior is often named as a possible reason. Under speculation the investment decision is at least partially influenced by expected changes of the corresponding asset price. This could lead to a situation where a price increases only because investors believe that the price will increase in the next period, because they expect that the price will further increase in the period after that and so on.

This idea is formalized by Froot and Obstfeld (1991). The authors look at a pricing model where the price depends on the dividend, the price in the next period and a discount rate. Similar to our house price model, in this setting forward iteration leads to a price that is equal to the sum of all discounted future dividends. Froot and Obstfeld, however, show that this present value solution is only a particular solution. The general solution is that the price is equal to the present value of future dividends plus a (rational) bubble term that has to fulfill several requirements. Now the authors assume that this bubble term only depends on fundamentals. Hence, the dynamic of the bubble is entirely driven by the dynamic of fundamentals. If we transform this idea into our house price model we get:

$$P_t^b = \frac{H_t}{(\rho + \bar{m} - w)} + zH_t^\lambda \quad (3)$$

where  $\lambda = (\rho + m) / w$  and  $z$  is an arbitrary constant.

Again, this speculative bubble house price can be calibrated in the same way as the fundamental price. Only now we also have to find optimal country specific parameter values for  $z$ . The results of the calibration are displayed in chart 1.

### 3.3 Comparison of Approaches

The performance of the herding behavior and speculative bubble approach is displayed in table 1. As we can see, both approaches substantially improve the fit to actual prices. For some countries, herding behavior can better explain the development of actual prices and for other countries it is the speculative bubble approach. On average, however, the improvement of the fit is very similar.



*Table 1: Comparison of the Different Approaches*

|                           |                   | AUS | CH  | ES  | FR  | IE  | JAP | NL   | SE  | UK  | US  |
|---------------------------|-------------------|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|
| <b>Improvement of fit</b> |                   |     |     |     |     |     |     |      |     |     |     |
| <i>herding behavior</i>   | 1-(MSE Ph/MSE P*) | 59% | 35% | 37% | 40% | 67% | 82% | 93%  | 57% | 53% | 31% |
| <i>speculative bubble</i> | 1-(MSE Pb/MSE P*) | 74% | 41% | 20% | 40% | 52% | 71% | 90%  | 67% | 69% | 28% |
| <b>Fluctuations</b>       |                   |     |     |     |     |     |     |      |     |     |     |
| <i>herding behavior</i>   | VAR wPh/ VAR wPa  | 10% | 18% | 15% | 12% | 38% | 17% | 49%  | 35% | 8%  | 8%  |
| <i>speculative bubble</i> | VAR wPb/ VAR wPa  | 56% | 15% | 9%  | 11% | 12% | 16% | 172% | 86% | 28% | 33% |

Source: Author's calculations.

## 4 Conclusions

House prices fluctuate more than fundamentally justified. This finding might not be surprising but has several implications that call for an explanation for this excess fluctuations. First, forecasting models that rely on fundamentals miss part of the development. Second, and probably more important, the excess price fluctuations can have serious consequences for financial and economic stability of a country. A better understanding of the reasons of these fluctuations is a first step to be able to prevent them.

We argue that a deviation from standard rational agent models is necessary to explain house price fluctuations. Agents overreact to current fundamentals as well as past returns and they are influenced by their sentiment. Although the performance of the approaches differs across countries and time, speculation and herding can explain a part of the excess fluctuations of actual house prices.

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# An Assessment of Current House Price Developments in Germany<sup>1</sup>

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## 1 Introduction

House prices in Germany did not experience a noticeable boom before the economic and financial crisis nor did they fall dramatically in the wake of it. Rather, with the onset of the recovery in 2010 residential property prices started to increase. According to available house price indicators (chart 1) urban agglomerations in Germany saw rather strong price increases over recent years, while the whole country average indicates relatively moderate house price rises. Against this background it is of interest to investigate whether the recent house price increases are signals of an incipient overheating of the German housing market, in particular in large urban areas.

Standard valuation measures based on aggregate time series, such as real house prices, the price-rent ratio or the price-income ratio, usually take the long-run mean as a reference value. Due to extended cycles on housing markets empirical averages are relatively sensitive to the length of the sample. The longest house price series for Germany goes back to 1975. It covers apartments in the largest cities in Western Germany and can neither be taken as representative for Germany as a whole, nor for other market segments. A broader measure is available from 1991 and refers to single-family houses and apartments in 125 German cities.<sup>3</sup> The relatively short samples limit the reliability of the time-series mean as a reference value. In particu-

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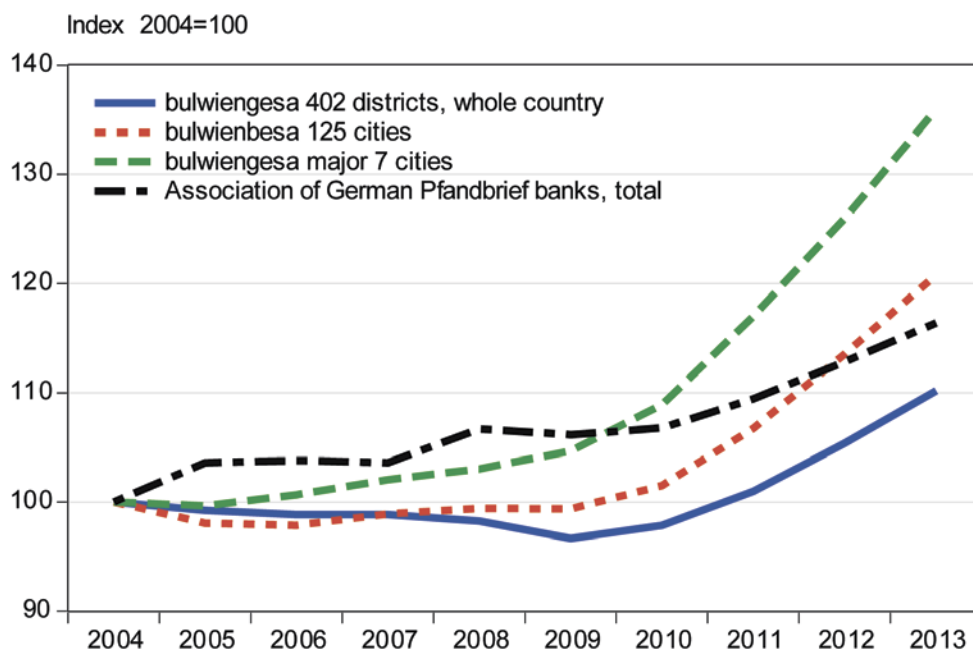
<sup>1</sup> Based on an updated and revised version of Kajuth, Knetsch and Pinkwart (2013). The views expressed represent the authors' personal opinions and not necessarily those of the Deutsche Bundesbank or its staff.

<sup>2</sup> Economics Department, Macroeconomic Analysis and Projections Division.

<sup>3</sup> Data representative for the whole of Germany is available only from 2004. In the sample period before 1991, only large cities in Western Germany are covered.

lar, the protracted period of decline of real residential property prices since the mid-1990s casts doubt on the view that house prices only recently completed a full cycle since the beginning of the 1990s.<sup>4</sup>

*Chart 1: Nominal House Price Indicators for Germany*



Source: Bundesbank calculations based on data provided by bulwiengesa; Association of German Pfandbrief Banks.

As an alternative to pure time-series approaches we draw on the information from a panel dataset with a high degree of cross-sectional variation, which helps to overcome some limitations of time series data, to estimate an equilibrium house price equation.

For an assessment of recent house price developments in Germany, we take as a reference value the fundamental house price, which is determined by fundamental socioeconomic factors and macroeconomic variables at levels free of unsustainable elements. Deviations of actual house prices from their fundamental level thus consist not only of unexplained parts but also of transitory and one-time factors.

<sup>4</sup> The price-rent and price-income ratios exhibit a similar pattern. For a detailed discussion of the standard measures applied to the evaluation of house prices in Germany, and their limitations, see Deutsche Bundesbank (2013).

## **2 Empirical Model**

### **2.1 Panel Model Specification**

The panel dataset covers house prices (in euro) for existing apartments and existing single-family houses provided by a private property valuation firm, bulwiengesa, in all 402 administrative districts of Germany at annual frequency for the years 2004 to 2013, and for a subset of 93 towns and cities for the years 1996 to 2013. The unique feature of the dataset is that it contains prices in euros, which allows comparing the level of house prices across regions.

The empirical specification of house prices in our paper is derived from a theoretical stock-flow model, which accounts for the interaction of house prices with residential investment and allows for sluggish stock and price adjustments (DiPasquale and Wheaton, 1992; McCarthy and Peach, 2002; Steiner, 2010).

Real house prices per square metre are modelled to depend on the number of housing units per resident, real disposable income per capita, the population aged between 30 and 55 as a ratio of total population, the population density, the unemployment rate (in % of population), the mortgage interest rate and growth expectations of aggregate real GDP per capita.

### **2.2 Estimation Results**

To make use of the cross-section information in a panel model while accounting for potential endogeneity of some regressors we use an instrumental variables estimator based on a random-effects setup, which allows to address the correlation of some of the explanatory variables with the unobserved district-specific effect (Hausman and Taylor, 1981).

Our results, based on separate equations for apartments and single-family houses, show significant effects of the explanatory variables that are in line with economic intuition. For a given level of demand, the house price level is lower in districts with a higher supply of housing in form of the housing stock at the beginning of the period. A higher disposable income per capita, a larger share of middle-aged population, more densely populated areas and more favourable growth expectations put pressure on house prices, while higher mortgage rates are associated with lower house prices. However, the effect of the unemployment rate cannot be determined with sufficient statistical precision in the estimation.

## **3 Assessing Aggregate House Prices**

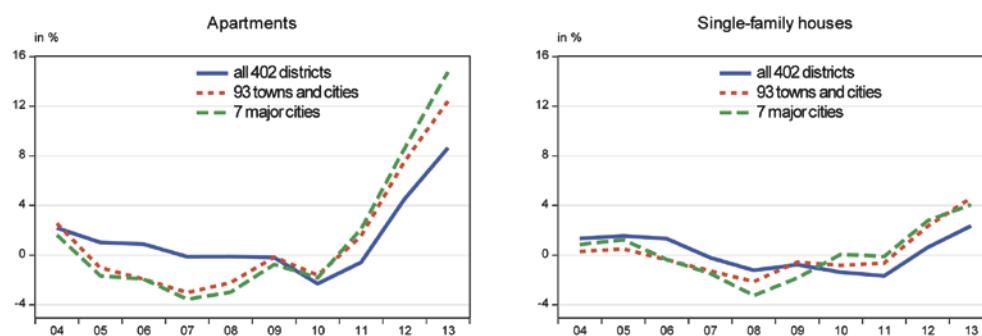
Our approach is designed to assess house prices for the whole country or other sub-aggregates such as urban areas or large cities. This is particularly relevant since house price developments have recently differed substantially across regions.

The panel estimates can be used to assess residential property prices at aggregate levels. Under the condition that the explanatory variables exclusively reflect permanent movements, the fitted values for house prices at district level can be taken as a measure for the fundamental house price at district level.<sup>5</sup> Assuming that the estimated equation on the district level represents the true underlying relationship with parameters valid for all regional entities, a model for the fundamental prices of houses at different levels of aggregation can be constructed.

In order to gauge the degree of over- or undervaluation in German house prices at different aggregation levels, the deviation of actual house prices from their estimated fundamental price is computed for different regional sub-aggregates using population weights.

Based on the variance of the district-specific estimation errors we can also provide approximate confidence intervals for the estimated aggregate residual, which also allows for spatial correlation among the residuals.

*Chart 2: Residential Property Price Misalignments*



Source: Authors' calculations.

Note: Deviations of residential property prices in % of estimated fundamental value conditional on an unchanged mortgage rate from 2009 onwards.

The results suggest that, currently, apartment prices significantly exceed their fundamental levels (chart 2). Their deviation is largest in the group of major cities and smaller for a whole-country average. A similar pattern holds for single-family houses with the size of house price misalignments being generally smaller than for apartments and often not significant. For Germany as a whole, apartment prices show a moderate overvaluation, whereas single-family house prices appear to be approximately in line with the level suggested by the model.

<sup>5</sup> In particular, this condition is critical for interest rates. See the discussion in section 4.

Available data on residential property prices and their determinants for 93 towns and cities from 1996 to 2013 allows the regression model to fit house prices with a view to a longer term average. This is important as the sample in our baseline model covers the period 2004 to 2013, which excludes the previous period of a protracted decline in real house prices. Results based on the extended estimation sample show house price misalignments at the sample end of a similar degree to those derived using the shorter sample.

The declining GDP growth expectations since the beginning of the last decade play an important role by accounting for some of the downward trend in real house prices. Since around 2006 GDP growth expectations have on average been more or less stable at a relatively low level. These additional results serve as a cross-check against the claim that, during the period 2004 to 2013, the housing market as a whole, was characterised by persistent undervaluation.

## 4 The Role of Interest Rates

The reference value, against which actual house price developments are compared, is defined as the level of house prices that is supported by economic fundamentals, which are free from unsustainable elements. It is debatable whether the currently unusually low mortgage rates on the German housing market should fully affect the fundamental house price. One could argue that the current low interest rate environment is to a large extent due to factors associated with the management of the financial and sovereign debt crisis. In the assessment of aggregate house prices, the transitory component of the interest rate changes since 2009 is taken as influencing actual but not fundamental house prices. We calculate the hypothetical level of house prices, had interest rates remained at their level from before 2010, on the basis of the estimated house price equation and conditional on the estimated coefficient on interest rates. In particular, we set the interest rate to its value in 2009 for the following years.

The effect of actual interest rates on the deviations of aggregate house prices from their fundamental value can be evaluated. Note that the interest rate effect is identical for all regional sub-aggregates because it is assumed that the mortgage rate does not vary across districts and that its coefficient is the same for all districts.

According to the results, the decline in interest rates since 2010 has stimulated apartment prices by approximately 5% up to 2013 compared to a scenario with unchanged interest rates. Prices of single-family houses are higher by around 0,75%.

The results also imply that the estimated overvaluations of residential property in Germany are partly attributable to the extraordinarily low interest rates. In particular, the overvaluation of apartments by 10% to 20% in urban regions appears to be due to the low level of mortgage rates by approximately 5 percentage points.

## 5 Conclusion

The main goal of the paper is to examine to what extent the recent price increases on the German housing market are attributable to developments in macroeconomic factors, or whether there is any significant misalignment. Based on a stock-flow model for the housing market we derive an equation for equilibrium house prices, which relates residential property prices to explanatory macroeconomic variables. To estimate the equation we make use of a regional panel dataset comprising price data for single-family houses and apartments in all 402 districts in Germany and district-specific explanatory variables.

District-specific regression residuals are interpreted as deviations of house prices from their fundamental levels. By aggregating the residuals across all districts we conclude that, for Germany as a whole, there are no signs of a significant or sizeable misalignment of single-family house prices. Apartment prices seem to be overvalued significantly at the sample end in 2013 on a whole-country average. In German cities, apartments appear to be markedly overvalued.

Our assessment of residential property prices is subject to an important caveat. Estimates based on a large regional dataset require the assumption that the sample mean of the price observations equals the true unconditional average of house prices. Given the substantive role played by growth expectations without cross-sectional variation, however, the assumption of zero (time-series) residual means cannot be evaluated without further information from outside the chosen framework. However, using an extended sample period for a subset of cities indicates that residential property prices were not sizeably and persistently undervalued before the recent upswing on the German housing market. Rather, the long decline in real residential property prices from the mid-1990s to around 2006 is associated with decline in the long-term growth expectations of real GDP per capita.

Finally, the results are conditional on the role interest rates play in the determination of fundamental house prices. To the extent that the exceptionally low interest rates are out of line with a fundamental equilibrium of the German housing market, they should not affect the fundamental price of residential property. Rather, results based on a scenario analysis show that the increasing misalignments in the recent years are partly due to the decline of interest rates to historically low levels.

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# **An Assessment of Recent Increases of House Prices in Austria through the Lens of Fundamentals**

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## **1 Introduction**

The housing sector is one of the most important sectors of an economy. Since residential property is the most important component of households' wealth, house prices affect household's consumption and investment decision via wealth effects. The construction sector impacts on the overall business cycle and on employment trends. As real estate is often used as collateral for loans, changes in house prices affect households' debt and their ability to repay loans and, as a result, also have an impact on the banking sector. The housing sector of a country has therefore far-reaching implications for the overall economy and for financial stability.

An increasing number of central banks are monitoring developments of real markets on a regular base. The European Central Bank publishes a misalignment indicator for residential property markets in a number of euro area countries in its Financial Stability Review (ECB, 2011). It is based on four different measures (house price-to-rent ratio, house price-to-income ratio, a demand equation approach and an asset pricing approach). The Deutsche Bundesbank publishes regular analysis of the German residential property market since 2009. In October 2013, the Deutsche Bundesbank found overvaluations of house prices of up to 20% in attractive cities (Bundesbank, 2013). The Schweizerische Nationalbank (SNB) is involved in a new macroprudential framework. The SNB's duty is to analyze risks to the banking sector, including the monitoring of real estate and mortgage markets.

Given the recent surge in house prices in Austria and above all in Vienna, fears of an emerging real estate price bubble in Austria evoked. The Oesterreichische Nationalbank (OeNB) has therefore developed a fundamentals indicator for residential property prices, which serves to assess deviations of house prices from fundamentally justified prices (Schneider, 2013). This indicator tracks developments in the residential property market and serves as an alert mechanism, helping to identify adverse developments in good time.

This paper gives an overview of the construction of the indicator and the empirical results for Austria and Vienna. In addition, the indicator is implemented for a number of euro area countries where sufficient data are available.

## **2 The Indicator**

The fundamentals indicator for residential property prices combines seven subindicators that monitor a variety of data related to households, investors and systemic factors (real residential property prices and affordability, price-to-rent ratio, price-to-build ratio, ability to repay loans, housing investment-to-GDP ratio, interest rate risk). Representing the aggregate result of these seven subindicators, the fundamentals indicator for residential property prices reflects the percentage by which residential property prices deviate from the prices of the underlying fundamentals.

### **2.1 Real Residential Property Prices**

Real residential property prices are obtained by dividing residential property prices by the consumer prices. This ratio represents the price of housing relative to a basket of consumer goods. Long-term studies using international data have found that real property prices (corrected for consumer price inflation) are stationary in the long run. Here, the length of the observation period is crucial, and in this context, “long term” implies centuries, since there may even be periods of several decades during which real property prices are nonstationary. Therefore, a marked hike in real prices may be an indicator of overheating, while the predictive power for short-term corrections is low.

### **2.2 Affordability**

Affordability is an important measure for assessing residential property prices. The simplest measure of affordability – the ratio of residential property prices to household income – has important shortcomings. When it comes to purchases of big-ticket items such as real estate, however, the level of interest rates also plays a crucial role, since it determines the maximum affordable mortgage payment based on a given household income. To account for both, income level and interest rates, a “hypothetical borrowing volume” (see Schneider, 2013 for details on the calculation), which defines the maximum affordable mortgage volume for a given household income and interest rate. Affordability is defined as the ratio of hypothetical borrowing volume to property prices. That ratio reflects the affordability of properties more accurately than analyses based on household income alone, such as are

often found in empirical studies. The inverted affordability is included in the composite indicator.

### **2.3 Price-to-Rent Ratio**

The price-to-rent ratio represents the relative cost of home-ownership versus renting. In the long term, the ratio should be stationary, since rising relative prices for residential properties make renting a more attractive option, in turn leading to reduced demand for home ownership.

### **2.4 Residential Property Prices to Construction Costs**

Construction costs are an important supply-side cost factor, an element that contributes to explaining the development of residential property prices in the long term. The association between construction costs and property prices is measured by Tobin's  $q$ , a company performance indicator calculated by dividing the market value of a company by its replacement cost. If the resulting coefficient is greater than 1, a company's stock is considered overvalued. Applied to properties, the cost factor is calculated as the property price divided by the construction costs. Since property prices and construction costs are available only in index form, the extent of overvaluation or undervaluation cannot be stated with absolute certainty; rather, only the change may be interpreted. An inherent limitation in this concept is that it fails to consider land prices, a decisive factor in urban agglomerations.

### **2.5 Loan-Bearing Capacity**

This indicator measures households' ability to repay home loans by relating the hypothetical borrowing volume to the aggregate amount of home loans actually granted to them by Austrian banks. An increase in this indicator implies that higher income or lower interest rates place households in a better position to meet the repayment obligations for their outstanding loans, thereby reducing banks' exposure to systemic risk. The inverted loan-bearing capacity is included in the composite indicator.

### **2.6 Housing Investment-to-GDP Ratio**

The ratio of housing investment to GDP, the housing construction rate in short, represents the supply side. A building sector that accounts for a disproportionately high percentage of GDP implies a state of overheating, which can be interpreted as a sign of a housing bubble. Conversely, rising property prices stimulate construction, which should dampen price spikes in the medium term. Nationwide, the

housing construction rate peaked out in the mid-1990s and has been declining ever since. In Vienna, that trend is even more pronounced than in the rest of Austria.

## **2.7 Interest Rate Risk**

The role interest rates play in the evaluation of bubbles is unclear. Interest rates are a fundamental factor in real estate markets: Low interest rate levels drive improved housing affordability and thus appear to fundamentally justify higher property prices. From the macroeconomic perspective, however, interest rates are an endogenous factor. Central banks set interest rates according to the prevailing macroeconomic environment, a practice that prompts concern about whether current interest rates actually suit the macroeconomic environment. If they are too low, there is an additional risk of a subsequent interest rate rise, which leads to a slump in affordability wherever variable-interest loans (the most common type in Austria) are involved. The question of whether interest rates are suited to the macroeconomic environment can be answered by using the “Taylor rule,” which provides a simple description of a central bank’s behavior: The appropriate interest rate depends on the equilibrium real interest rate, the target inflation rate, the output gap (percentage deviation of actual output from potential output) and the gap between the actual inflation rate and the target inflation rate.

To ensure comparability with other subindicators, a hypothetical borrowing volume (see above) is calculated at different interest rates (i.e., the three-month interest rate and the Taylor interest rate). The subindicator represents the ratio of the two resulting hypothetical borrowing volumes.

## **3 Trend Adjustment and Weighting**

Based on the subindicators discussed in the foregoing sections, the fundamental residential property price indicator was calculated in two steps.

### **3.1 Trend Adjustment**

The percentage of deviation from a historical average was calculated for each subindicator with mean values adopted for most indicators (real property prices, affordability, property prices versus construction costs, property prices versus rentals, interest rate risk). A linear trend was applied to the housing construction rate since – as with all other components of domestic demand – it shows a downward trend spurred by steadily increasing internationalization. To account for the distortion caused by foreign currency bullet loans, a smooth HP trend was used for the loan-bearing capacity. Affordability and loan-bearing capacity were inverted to

enable comparability with the other subindicators (a positive value indicates overvaluation).

## 3.2 Weighting

The indicator is determined by calculating a weighted sum of the subindicators. The required weighting factors were determined by applying a principal components analysis. This approach has the advantage to take the correlation between the subindicators into account. The number of factors used was selected to permit explanation of the highest possible fraction of variance in the dataset using the smallest possible number of factors.

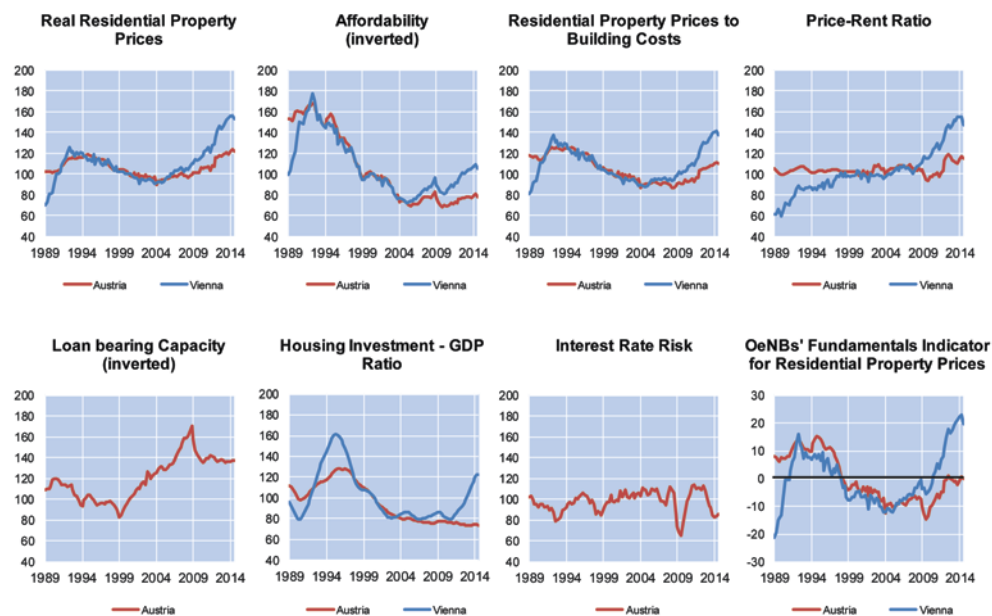
## 4 Results of the Indicator

### 4.1 Results for Austria and Vienna

Chart 1 shows the detailed results of the fundamentals indicator for residential property prices including its subindicators for Vienna and Austria. For Vienna, the indicator reflects a pattern of overvaluation, which currently (third quarter of 2014) stands at 20% (right chart in second row). Five out of seven subindicators point to an overvaluation of house prices in Vienna, since they are above their long-term averages. This holds especially for real house prices and the price-rent ratio, which are more than 50% above their means. Only affordability and the interest risk are currently below their long-term averages and thus have a dampening effect on overvaluation. That conclusion coincides with recent findings by the Deutsche Bundesbank (2013), which identified overvaluations of 5% to 10% in urban housing markets and up to 20% in attractive major cities.

For Austria as a whole, the indicator shows that residential property prices are in line with fundamentals and even correspond exactly to these in the third quarter of 2014, having remained practically unchanged against the second quarter.

*Chart 1: Detailed Results of the Fundamentals Indicator for Residential Property Prices for Austria and Vienna*

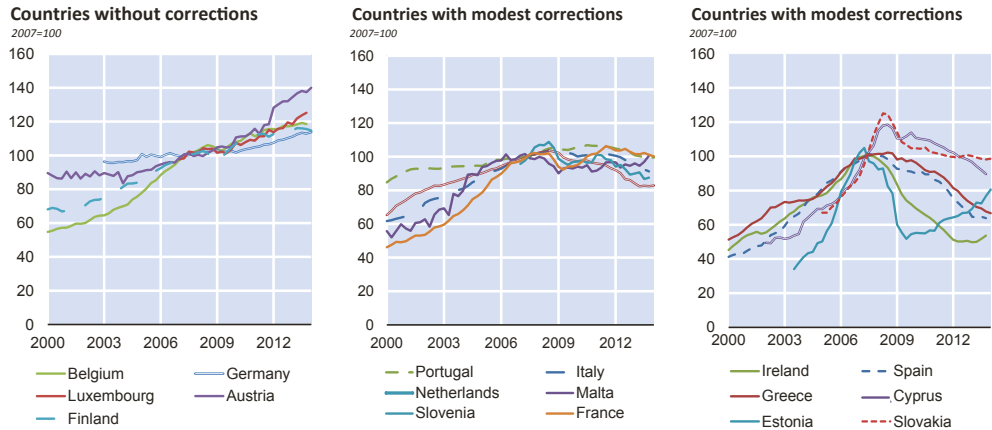


Source: Author's calculations.

## 4.2 Results for Selected Euro Area Countries

Chart 2 shows the development of house prices for 17 euro area countries. The countries are grouped into three groups. The first group consists of five countries where no house price correction occurred (Austria, Belgium, Finland, Luxembourg and Germany). The second group consists of six countries with modest corrections (France, Italy, Malta, Netherlands, Portugal and Slovenia). The countries of the third group (Cyprus, Estonia, Greece, Ireland, Spain and Slovakia) have experienced strong corrections of house prices. While it can easily be seen that countries in group three have seen unsound developments, the situation is not clear for countries in the first two groups. Simple eyeballing does not help much in assessing house price developments.

*Chart 2: House Price Developments in Euro Area Countries*

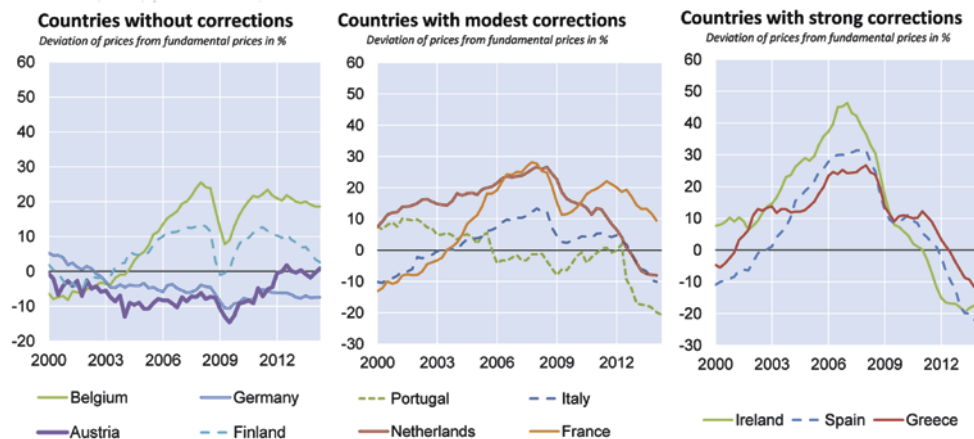


Source: ECB (Statistical Data Warehouse).

Chart 3 shows the results of the Fundamentals Indicator for Residential Property Prices for those euro area countries, where sufficient data are available. It demonstrates the ability of the indicator to distinguish between sound and unsound developments. From the group of countries without correction Belgium stands out with the highest degree of overvaluation of house prices. In Austria and Finland prices are in line with fundamentals, whilst in Germany house prices seem to be undervalued. From the group with countries with modest corrections, France seems to be the only country where prices are overvalued, although the degree of overvaluation is declining. In the other three countries (Italy, Netherlands and Portugal), house prices are below fundamentals. In Greece, Ireland and Spain (which saw strong corrections), prices are currently clearly below fundamentals.



*Chart 3: Fundamentals Indicator for Residential Property Prices for Euro Area Countries*



Source: Author's calculations.

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# An Early Warning System to Predict House Price Bubbles

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## **Abstract**

Financial shocks can exert huge negative impacts on real economic activity. Hence, there is a high payoff on timely and correct warnings on speculative components in house prices. A preemptive policy reaction can help to limit the buildup of financial imbalances and the risks of a bust in the future. In this article, an early warning system for the timely detection of house price bubbles is developed. Different empirical methods are applied to ensure the robustness of results.

*JEL: C25, C33, E32, E37*

*Keywords: House prices; early warning system; speculative price bubbles*

## **1 Introduction**

The striking role played by housing markets in the recent financial crisis has demonstrated that shocks arising in the housing sector can exert huge effects on real economic activity, especially through the consumption and residential investment channels. Falling house prices might depress private consumption, especially in countries where mortgage markets are highly deregulated. Since they affect the profitability of investments, they could also cause a decline in construction activities. In Anglo-Saxon countries, Spain, and some of the new EU Member States, house prices increased at spectacular rates in the period before the financial crisis. This development was primarily driven by speculation and herding behavior. Since the macroeconomic fundamentals were more stable, they did not play a decisive role.

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The bursting of speculative price bubbles triggered massive production losses and raised serious doubts about the sustainability of growth in these states. In other countries like Germany, house prices did not accelerate at all, despite the same monetary environment. To the extent that the evolution of house prices is unequal across countries, they may constitute a source of business cycle divergence and can limit the prospects of the common monetary policy in the euro area.

In this paper, an early warning toolkit for the timely detection of house price bubbles is constructed. The analysis is based on past episodes of speculative house price bubbles. The early warning system is based on a two-step procedure. First, a bubble chronology is derived on a country-by-country basis, as the timing of bubbles is heterogenous across economies. The chronology is then used to calibrate forecasting methods for the timely detection of bubbles. Different approaches are applied to assess the robustness of the results.

The rest of the paper is organized as follows: In the next section the main transmission channels of house prices to the real economy are reviewed. Section 3 presents the strategy to develop the bubble chronology. Section 4 holds the forecasting methods to detect speculative bubbles in the housing market. Measures of forecasting accuracy are discussed in Section 5. Finally, section 6 concludes.

## **2 House Prices and the Real Economy**

Real house prices can affect private consumption through a housing wealth and a collateral effect, see Case et al. (2005) and Dreger and Reimers (2012). An increase in housing wealth will raise consumption due to its impact on expected lifetime income. Consumption expenditures can be shifted upwards without violating budget constraints. However, the effects of housing wealth are not obvious. A permanent increase in house prices has positive effects for homeowners, but there are also negative effects on tenants who have to pay higher rents, and on prospective first-time buyers who have to save more for future house purchase, see Poterba (2000) and Goodhart and Hofmann (2008). In addition, an increase in the value of owner-occupied housing does not automatically foster the ability of a household to consume more of other goods and services unless that household is willing to realize the higher value by moving into a less expensive flat. Many households are not expected to do that, including those who intend to leave their homes as bequests. A positive impact of house prices implies that the winners win more than losers lose. This is more likely to happen if potential homeowners interpret a house price acceleration as an evidence of future capital gains that can be earned if they step into the housing market.

Besides the effect on wealth, there is also a collateral effect of house prices, since houses are widely used as a security for loans (Muellbauer, 2008). Collateral effects improve the response of aggregate demand to house price shocks. In general,

households tend to borrow or lend in order to smooth consumption over time. If liquidity constraints exist, access to credit will be restricted. In periods of rising house prices, the value of the collateral the household can offer to banks is higher and banks become less reluctant to provide loans. Because of deregulation in mortgage markets, it has become easier and cheaper for consumers to borrow against housing collateral to finance extra consumption. This effect is higher in more deregulated financial markets, since financial innovation has increased the availability of funds for credit-constrained agents.

Furthermore, housing markets have an impact on the transmission of monetary policy. In countries with more flexible mortgage rates and higher loan-to-value ratios, i.e., the ratios between the mortgage amount and the value of the property, the response of private consumption and residential investment to monetary policy shocks can be amplified (Calza et al., 2009). But the relationship is not unidirectional, as housing wealth also affects money demand, see Dreger and Wolters (2009). There is evidence that idiosyncratic house price developments have been a major source of divergence in competitiveness and the formation of external imbalances within the euro area, as accelerating house prices give rise to a boom in private consumption and import demand (Aizenman and Jinjark, 2009). House price dynamics influence the performance of the financial system through their impact on the profitability and soundness of financial institutions.

The institutional conditions in housing and mortgage markets are substantially different across the euro area member states (ECB 2009). In the development of real house prices and their spillovers to the real economy, these structural features play a crucial role. For example, Almeida et al. (2006) reported evidence that the sensitivity of house prices and mortgage borrowing to income shocks tends to be higher in countries with higher loan-to-value ratios. Carroll et al. (2006) stressed that the long-run responsiveness of consumption to permanent changes in housing wealth is higher for countries with a market-based than for countries with a bank-based financial system. According to Calza et al. (2009), strong impacts of real house prices on consumption can be detected especially in countries that have large and responsive mortgage markets. A high degree of mortgage market completeness, i.e., the extent to which the market is able to offer a variety of products and to serve a broad range of potential borrowers is also important. The most crucial element is the extent to which the markets provide opportunities for housing equity withdrawal, that is the magnitude to which the household sector can extract liquidity from the housing market. The response of real house prices to economic conditions as well as their impact on private consumption and residential investment tends to be larger if favorable tax treatment of mortgage interest encourages the leveraging of housing equity.

### 3 Obtaining a Bubble Chronology

Bubbles are not directly observable. Therefore, the analysis has to separate house prices driven by fundamental factors and the role of speculative attacks. Unfortunately, a widely accepted chronology does not exist. To proceed, the separation is performed on the basis of the historical house price evolution. Empirical methods should distinguish between the two effects to extract the speculative component. For robustness, the chronology is based on filter and structural models. Speculative bubbles are periods, when house prices exceed their fundamental values, the latter being defined on the basis of the fundamental economic development. Not each positive deviation from the fundamental values can be interpreted as a bubble, since deviations might be too short and minor. Thus, this structural chronology should be confirmed by periods, where prices are above their trend.

Specifically, the real house prices ( $hp$ ) are regressed on fundamental factors, such as real per capita GDP that captures disposable income ( $y$ ); urbanization rates ( $urb$ ), i.e., the share of urban population in the total population; and real interest rates ( $rir$ ), as a proxy for financing costs. While higher income and lower real interest rates lead to an increase in house prices, urbanization will have negative effects, as high urbanization implies that less people would migrate from rural to the urban areas. This leads to a structural regression model

$$h_{it} = \beta_{i0} + \beta_{i1}y_{it} + \beta_{i2}urb_{it} + \beta_{i3}rir_{it} + \varepsilon_{it} \quad (1)$$

where  $i$  indicates the country,  $t$  is time, and  $\varepsilon$  is the error term. The regression is estimated for each country individually. This accounts for the fact that bubbles are rare events that occur unequally across countries. House prices expected conditional on the fundamental development are the fitted values of the regression model. The positive deviations of the actual values from the fundamentals are treated as bubble candidates. To reduce volatility, the deviations are smoothed using spline regression techniques. By and large, the country regressions reveal meaningful results, i.e., the variables are correctly signed.

In addition, the deviations of actual prices from their long-run trend are considered, where the latter is obtained by the Hodrick-Prescott filter. Potential bubbles require that these deviations (cycle) exceed a certain threshold, i.e.

$$cycle_{it} = hp_{it} - trend_{it} > \gamma\sigma_i \quad (2)$$

The threshold is expressed as a multiple ( $\gamma$ ) of the standard deviation of the *cycle* variable. The fundamental and filter approaches are considered jointly to produce the bubble chronology. In particular, a speculative bubble is identified if the deviation from the fundamentals is positive and larger than 0.5 times the standard deviation of

the residuals taken from the regression (1). Moreover, these bubbles should at least partially coincide with periods suggested by the filter approach. The parameter  $\gamma$  is chosen to maximize the concordance between the two approaches.

## 4 Predicting Speculative House Price Bubbles

Forecasting is based on a signal and logit models. Variables for predicting bubbles include, for example, nominal and real short-run interest rates, money growth, house price-to-income and house price-to-rent ratios, the investment rate, GDP growth, and private lending.

In the signal approach, each variable is smoothed by the Hodrick-Prescott filter on a country-by-country basis. To remove differences in the fluctuations across countries, the smoothed series are standardized using country-specific standard deviations. Then, the series are stacked into a panel. Fourth, a grid of potential thresholds is defined, ranging between 0.2 and 3 with a step width of 0.2. A signal is extracted if a variable exceeds the threshold. For each threshold, the accuracy of detecting bubbles is calculated by adding the ratio of correctly identified bubbles to all bubbles and the ratio of correctly identified non bubbles to all non-bubbles. Both ingredients constitute the accuracy measure

$$z_j^\tau = \frac{a}{a+c} + \frac{b}{b+d} \quad (3)$$

The index  $j$  denotes the particular variable considered,  $\tau$  is the threshold value and  $a, b, c, d$  are defined according to the table

|           | Bubble | No bubble |
|-----------|--------|-----------|
| Signal    | $a$    | $b$       |
| No signal | $c$    | $d$       |

The accuracy function (3) is maximized over the threshold grid. For the optimal threshold, the signal is equal to 1, when the variable exceeds the threshold, and 0 otherwise. A combined indicator is derived by summing the signals for the different variables. Individual signals are weighted according to their squared accuracy coefficients. Hence, variables with a better forecasting fit receive a higher weight.

As an alternative to the signal approach, conditional panel logit and probit models with country fixed effects are estimated to predict the probability of the occurrence of bubbles. Logit and probit models can be formulated as

$$Pr(R_{it}=1 | X_{it}) = F(X_{it}\beta + \varepsilon_{it}) \quad (4)$$

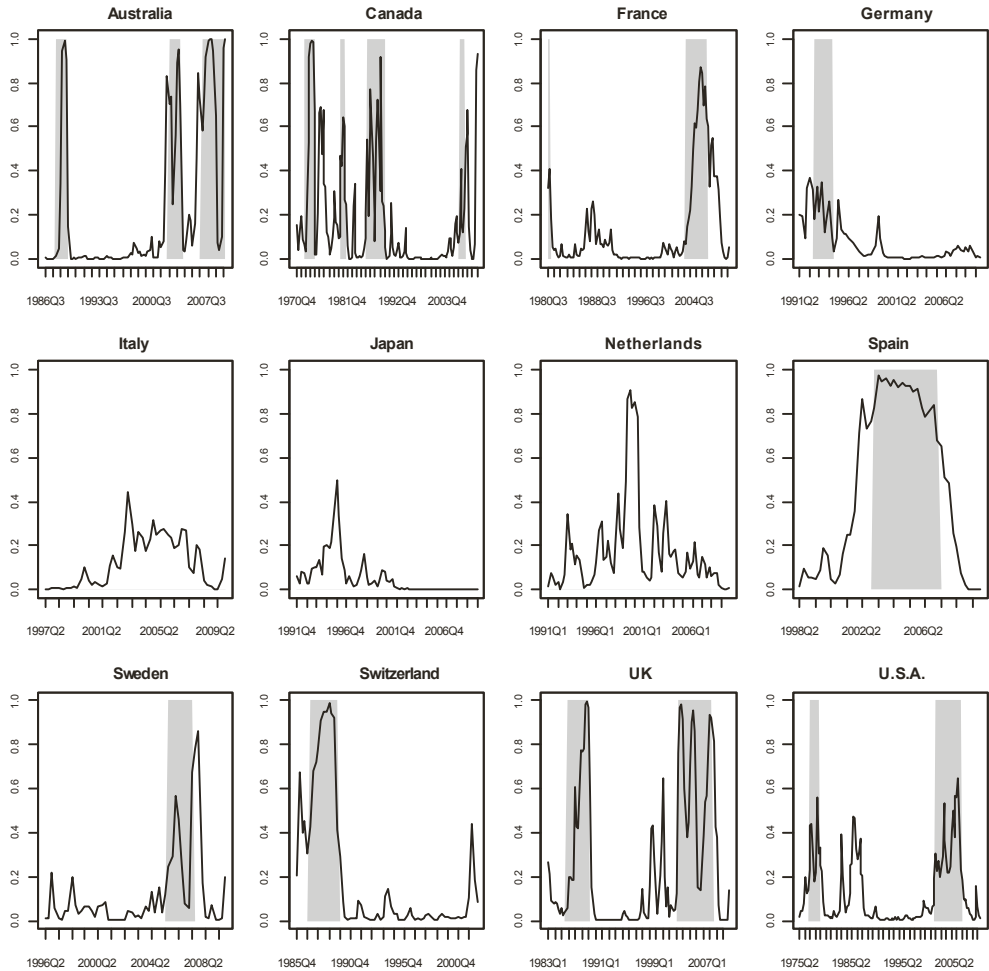
where  $R$  is a binary variable equal to 1, if there is a bubble, and to 0 otherwise, otherwise;  $\Pr()$  is the conditional probability of the bubble, the matrix  $X$  is the set of relevant variables and  $F()$  is the cumulative probability function, either in the logit or standard normal form. The relevance of variables is evaluated according to their statistical significance (t-values). Table 1 reveals the weighting of different variables in the signal and logit approach in a sample of OECD countries. For example, the house price-to-income ratio receives a high weight in the logit model, but not in the signal approach. Credit growth is similarly weighted. For illustrative purposes, Figure 1 shows the results of the logit approach. The probabilities for excessive price developments are quite high in times of bubbles and low otherwise. Overall, the model is able to capture the historic development, at least to some extent.

*Table 1: Weights of Variables in the Prediction of House Price Bubbles*

| Weights                   | Signal | Logit |
|---------------------------|--------|-------|
| Short term interest rates | 15.0   |       |
| Real exchange rate        | 6.9    | 7.1   |
| Rent                      | 5.0    |       |
| House prices / income     | 7.6    | 21.7  |
| House prices / rent       | 8.1    | 7.2   |
| Investment ratio          | 7.9    | 7.2   |
| Credit growth             | 19.5   | 20.9  |
| GDP growth                | 6.5    | 7.2   |
| Liquidity (based on M3)   | 19.7   | 14.4  |
| Public finances           | 3.8    | 7.0   |
| Financial regulation      |        | 7.3   |

*Note: Unbalanced panel data for 12 OECD countries (Australia, Canada, France, Germany, Italy, Japan, Netherlands, Spain, Sweden, Switzerland, UK, US), 1970–2009. Weights according to quadratic accuracy for signal approach, see equation (3) and log odds ratio in the logit model.*

*Chart 1: Logit Detection of Speculative Bubbles in Housing Markets*



*Note: Shaded areas are bubble periods according to the bubble chronology developed in section 3, and the lines show the estimated probabilities taken from the logit model. Evaluating the Predictive Accuracy of Early Warning Systems.*



## 5 Evaluating the Predictive Accuracy of Early Warning Systems

The accuracy of the alternative prediction approaches presented above can be evaluated using goodness of fit measures, such as Quadratic Probability Score (QPS)

$$QPS_j = \frac{1}{T} \sum_{i=1}^T (R_{it} - P_{it}^j) \tag{5}$$

where  $R$  is the binary variable (=0 for no bubble, =1 for bubble) and  $P$  is the probability for a bubble according to the  $j$ -th forecasting method. In case of a perfect foresight, the  $QPS$  is equal to 0. Thus, lower values of  $QPS$  indicate better forecasting performance. According to the  $QPS$  of the different models

| QPS             | In sample | Out of sample |
|-----------------|-----------|---------------|
| Signal approach | 0.278     | 0.292         |
| Progit model    | 0.081     | 0.139         |
| Logit model     | 0.081     | 0.134         |

the logit and probit models outperform the signal approach. This result holds both within the observation period (in sample) and for annual forecasts obtained in an out-of-sample exercise with perfect foresight of the regressors.

## 6 Conclusions

The results point to the fact that the emergence of house price bubbles is a rather complex process. Observing credit and liquidity is not sufficient for a reliable detection of speculative bubbles. These variables represent only 35% (logit) and 55% (signal) of the forecast of overall indicator (table 1). Other variables should be monitored as well. Our findings suggest that early warning systems are important tools to be used by policymakers in their attempts to timely detect the house price bubbles and attenuate their devastating effects on the domestic and world economy. Specifically, the detection through the probit and logit approach is recommended. Furthermore, the signalling approach could be useful to assess the robustness of the bubble evidence.

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# The Belgian Mortgage Market: Recent Developments and Prudential Measures

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## 1 Introduction

The presentation at the workshop was based on two articles that appeared in the Financial Stability Review 2014 of the Nationale Bank van België (NBB). The articles, which are summarised in the sections below, are:

- “The Belgian mortgage market: recent developments and prudential measures”<sup>1</sup> and
- “Evaluating early warning indicators for real estate related risks”<sup>2</sup>.

## 2 The Belgian Mortgage Market: Recent Developments and Prudential Measures

The first article that appeared in the NBB’s Financial Stability Review 2014 discusses recent developments in the Belgian mortgage market and presents the three prudential measures that the NBB took at the end of 2013 to bolster the resilience of the market and of those credit institutions with the largest exposures to Belgian mortgage loans.

As in many other countries, the Belgian residential property and mortgage market was characterised by strong growth of both housing prices and mortgage loans outstanding in the period up to 2007. Since then, experiences have varied significantly between countries. In Belgium, a marginal correction of housing prices and a temporary slowdown in mortgage loan growth in 2009 were followed by new increases in housing prices and mortgage debt, before both moderated again in the course of 2013 and 2014.

A large number of factors appear to have contributed to the dynamic growth of house prices in Belgium in the past 15 years, ranging from macroeconomic and

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<sup>2</sup> Authors: Stijn Ferrari and Mara Pirovano.

demographic factors to key changes in the tax regime for mortgage loans and a trend towards higher rates of down payment. Crude and simple measures of housing price valuation nevertheless suggested that housing became less affordable for households with a limited amount of own funds for a down payment. For these households, the developments may thus have been associated with a need for increasingly large mortgage loans, contributing to upward pressures on debt service levels and/or longer loan maturities.

Against this background, the NBB introduced an ad-hoc reporting scheme in 2011 for 16 credit institutions on Belgian mortgage loans granted and held. This survey now collects information on outstanding totals and new business – whereby banks are asked to break down their outstanding stock and new annual production volumes for various mortgage loan characteristics – and data on the corresponding minimum capital requirements and underlying parameters.

The first extensive survey – commented on in an article in the NBB's Financial Stability Review 2012 – showed a trend towards longer loan maturities and a relatively high (although quite stable) share of loan-to-value ratios of more than 80% (including ratios higher than 100%) in new production, confirming that banks' credit standards had not been tightened in a countercyclical way to slow exuberant growth or to anticipate potentially less favourable market conditions. On the basis of this information, the 2012 article argued that a sizeable group of borrowers in recent vintages may have stretched their loan maturities, mortgage loan sizes and/or debt service ratios to levels that could entail a higher risk of future credit losses for banks, as compared to earlier vintages. The main conclusion of the article was therefore that more vigilance was required from banks and authorities alike to ensure the continuous application of sufficiently conservative credit standards and adequate risk-pricing in all new mortgage loans. It also called for a tightening of credit standards, where necessary, in order to maintain the current high asset quality of Belgian mortgage loan portfolios.

As a follow-up to this policy message, the NBB conducted new stock-taking exercises, devoting particular attention to assessments of the way in which the potential risks associated with mortgage loans were taken into account in calculating the minimum capital requirements for credit risk under the Pillar 1 rules. This fact-finding exercise focused mainly on the banks relying on internal risk models to compute the minimum regulatory capital buffers required for these exposures, as these calculations result in risk weights (10%, on average) that are significantly lower than those applied under the Basel II standardised approach (35%).

The risk weights calculated with these internal ratings-based (IRB) models for Belgian mortgages are not only considerably lower than those determined by the standardised approach for calculating the minimum capital requirements for credit risk, but they also vary widely between institutions. More detailed analysis has confirmed that these differences between institutions are largely attributable to

variations in the risk profile – and, particularly, the relative importance of the riskier sub-segments – of different banks’ mortgage loan portfolios in Belgium. It showed the heterogeneity of banks’ credit standards and the importance of these standards in explaining the number of subsequent defaults in the portfolios. In particular, banks that generally tended to have less conservative credit standards (loans granted to more risky borrowers, with higher debt service ratios) were found to be the ones with the relatively higher default rates. The study also showed that differences in individual banks’ IRB risk weights and parameters for Belgian mortgage loans seemed to be broadly consistent with the ranking of bank portfolios’ (relative) risk profiles.

Another main conclusion of the fact-finding exercise was that these IRB risk weights for Belgian mortgages are generally relatively low and, on average, lower than in other countries. Data collected by the European Banking Authority has shown that the average IRB risk weight for mortgage loans in Belgium was one of the lowest in all the sample countries, with Sweden having the lowest weights. However, the Swedish authorities have enacted a measure in the course of 2013 aimed at putting a 15% floor on this risk weight and recently announced plans to raise the floor further to 25%. Belgium’s neighbours report average risk weights of over 10 % (up to 18%). Echoing the developments in Sweden, Norway and Switzerland have also recently taken measures aimed at raising the average risk weight of IRB banks for domestic mortgage loans (up to 35%, as in the standardised approach).

Although the aggregate credit quality indicators for households do not so far point to any deterioration in default rates on recent mortgage loan vintages, the NBB and international institutions such as the European Central Bank (ECB), the European Systemic Risk Board (ESRB), the Organisation for Economic Co-operation and Development (OECD) and the International Monetary Fund (IMF) have drawn attention to potential risks associated with the Belgian housing and mortgage market, partly on the basis of criteria measuring the over or undervaluation of property prices. If conditions in the Belgian housing market were to become less buoyant than they have been over the past 15 years, the riskier loan segments of the outstanding stock of mortgages could be the source of higher-than-expected credit losses for banks. In spite of the recent tightening of some credit standards for new mortgage loans, a sizeable group of borrowers may in recent years indeed have stretched their mortgage loan maturities, loan sizes and/or debt service ratios to levels that could entail a higher risk of future credit losses for banks than in the past. Here, it should be noted that the internal risk models are calibrated on historical credit loss data, so that these low risk weights can to some extent be explained by the absence of a major crisis on the Belgian housing market in the past and by the generally buoyant market conditions over the past 15 years. Risk weights calculated on the basis of IRB models could thus be too low for losses that may emerge in less

favourable market circumstances and from the materialisation of risks embedded in certain sub-segments of banks' Belgian mortgage loan portfolios.

In this context, and in view of the relatively large share of domestic mortgage loans in the balance sheets of Belgian credit institutions, the NBB considered it justified to take some prudential measures aimed at strengthening the banks' resilience and reducing the concentration risk.

The first measure that was taken in the last quarter of 2013 was macroprudential in nature and provided for a flat-rate increase of 5 percentage points in the risk weights calculated by the banks themselves, but only for banks calculating their minimum regulatory capital requirements for Belgian mortgage loans according to an IRB model. That measure took effect with the Royal Decree of 8 December 2013. This add-on did not apply to banks using the aforementioned standardised approach to calculate their capital requirements. In practice, if a bank using the IRB approach calculates an internal risk weight of 10% for Belgian mortgage loans, this measure requires the minimum capital requirements to be calculated on the basis of a 15% risk weight. The average risk weight of the IRB banks effectively increased from around 10% at the end of 2012 to about 15% at the end of 2013, as a result of the introduction of the add-on. The relatively moderate size of the add-on seemed appropriate in view of both Belgian banks' generally rather conservative policies on mortgage lending in the past and the historically low level of losses on such loans. However, given the cyclical character of this measure, the NBB will keep a close eye on market developments for the purpose of a continuous assessment of the appropriate level of that add-on.

The other two measures adopted by the NBB at the end of 2013 were microprudential in nature.

One involved launching a horizontal assessment of the IRB models on the basis of the results of the back-testing to be conducted by the institutions, followed by any necessary adjustments to those approaches. The goal of this measure is to address potential weaknesses of the risk parameters used in the IRB approach. To this end, the NBB will evaluate the adequacy of the calibration of the probability-of-default (PD) and loss-given-default (LGD) models used in the regulatory capital calculation within the IRB approach. Banks with unsatisfactory calibrations will be required to adapt their Pillar 1 models.

The other microprudential measure consisted in requesting credit institutions to carry out a self-assessment of the degree to which each bank conforms to the EBA's Opinion on Good Practices for Responsible Mortgage Lending and the EBA's Opinion on Good Practices for the Treatment of Borrowers in Mortgage Payment Difficulties. These self-assessments by banks of the degree of conservatism of their credit standards for residential mortgage loans will be analysed by the NBB and, if weaknesses are identified, banks will be asked to develop an action plan to redress identified weaknesses. This measure applies to all 16 banks.

Through these three prudential measures, the NBB aims to bolster the resilience of the market, and of those credit institutions with the largest exposures to Belgian mortgage loans, against potentially higher-than-expected credit losses on Belgian mortgage loans if conditions in the Belgian housing market were to become less buoyant than they have been over the past 15 years. The measures also aim to underscore once again the importance of maintaining sound credit standards at origination in mortgage lending, as these play an important role in the development of imbalances in residential property markets. As experience in several other countries has shown, such imbalances could then lead to severe macroeconomic (and social) outcomes and losses for banks, in the event of a bubble bursting.

### **3 Evaluating Early Warning Indicators for Real Estate Related Risks**

The second article that appeared in the NBB's Financial Stability Review (FSR) 2014 presents a novel graphical methodology for identifying leading indicators of real estate-related banking crises using information on 15 EU Member States.

Adverse developments in the real estate sector can be an important source of systemic risk and financial instability. Addressing systemic concerns in the real estate sector is therefore one of the priorities on European authorities' macro-prudential agenda.

The European Systemic Risk Board (ESRB) strongly encourages countries to develop sound macroprudential policy strategies to frame actions aimed at dampening systemic risk in real estate markets. Such strategies involve linking the ultimate objectives of macro-prudential policy to instruments (for example, risk weights for real estate exposures, and limits to loan-to-value and debt service-to-income ratios) and indicators. The operationalisation of such instruments requires the identification of sound leading indicators and associated thresholds, which could serve as a basis for guided discretion in the activation of macroprudential instruments.

Accounting for the uncertainty surrounding the estimates of cross-country average levels of the indicator, the methodology presented in the FSR article provides a graphical tool for assessing the predictive power of an indicator for real estate-related banking crises. The framework also enables identification of thresholds that determine zones that correspond to different intensities of the signal issued by each indicator for a given prediction horizon. As such, the framework can be applied as a monitoring tool for systemic risks stemming from the real estate sector.

The article highlights the relevance of the results for systemic risks emanating from the Belgian property markets. In particular, signals related to increasing levels of household indebtedness, in combination with a potential overvaluation of housing

prices, suggest the need for a close monitoring of developments in the Belgian real estate market and Belgian banks' mortgage loan portfolios.

The methodology described in this article serves as input into the NBB's general framework for monitoring housing and mortgage market developments. However, signals obtained from early warning indicators and thresholds should not serve as automatic triggers for policy action. Uncertainty about threshold levels, country-specific factors driving developments in housing and mortgage markets, and heterogeneity in the risk profile of individual loans warrant caution in the policy application of such frameworks. Rather, they should be considered as input into the first stages of the systemic risk assessment process, indicating the potential need for a further in-depth assessment and monitoring of possible risk sources and triggers.



# Implementing LTV-DTI – Through the Magnifying Glass<sup>1</sup>

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## 1 Introduction

Macroprudential policy is now widely considered to be useful in mitigating systemic risks, including from housing booms. Yet, there are many blind spots in our understanding of how exactly it works. The paper (Jácome and Mitra, forthcoming) on which this presentation is based on, in some sense brings us back to the basics on one particular set of policy tools – the loan-to-value (LTV) and debt-service-to-income (DTI) – and tries to understand how exactly it can be implemented in countries. We are using six case-studies for the look through the magnifying glass.

We know from a survey conducted by the Fund in 2013, The Global Macroprudential Policy Instruments (GMPI) survey, that about 50% of the advanced economies and more than 50% of the emerging economies had LTVs (chart 1).<sup>2</sup> DTIs are much less in use, and are often supplemented by LTVs. But countries do not necessarily *change* the LTVs and DTIs in a macroprudential sense – lowering or tightening the limits for emerging risks and loosening them when risks are about to materialize. Only some countries have varied it over risks and that’s what this paper is about.

The main question is: how exactly do these limits work when these are changed over risks? In fact, there are many missing pieces, almost like pieces of a jigsaw puzzle. We can think of five such pieces. For instance, which indicators *trigger* a tightening of the instruments? What are the *levels* of LTV/DTIs and by how much are they adjusted? Which institutions are responsible for the tools in practice? How are the limits *applied, enforced and communicated* to the public? What are the typical interactions with monetary and fiscal policies? How can one prevent regulatory arbitrage? And, finally, are LTV/DTIs *effective* and what kind of models can be used to evaluate their effectiveness on an ongoing basis?

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<sup>1</sup> The views expressed in this note are the author’s and do not necessarily reflect those of the International Monetary Fund or any other central bank.

<sup>2</sup> GMPI covers 132 countries, over 17 policy instruments.

This paper contributes by filling in some of the gaps. Given the enormity of the tasks, we came up with a project that made our lives simpler. We collaborated with six central banks that have been active LTV/DTI users in the macroprudential sense and coordinated case studies done by a group of people. The Central banks of Brazil, Hong Kong, Korea, Malaysia, Poland and Romania participated in this project. This paper drew lessons from the six case studies, which will be published as working papers shortly.

In what follows, I will first go through the triggers for activating the LTV/DTI tightening, the levels and the changes in the ratios, how these are enforced and communicated, which institutions are responsible and finally, whether these are effective. I will end with a set of 10 lessons that we draw from the studies and where more work is needed.

## 2 Triggers for Activating Policy Tightening

If we look at cross-country studies, for instance panel-logit models that mapped macroeconomic data to the probability of a banking crisis, credit growth and house price growth together form very powerful signals. The rainbow chart in chart 2 is a slice from a 3D diagram that mapped house price growth and credit growth to the probability of a systemic banking crisis. The warmer the colors, the higher is the probability of a banking crisis. Typically, in this particular rendition of the model, house price growth by itself was not a source of banking crisis, unless credit growth was involved; hence, the dark blue space at the 3 percentage point credit growth mark.<sup>3</sup>

However, when we hold our magnifying glass at the time series evidence for each of the six countries, we find that they usually cast a much wider net over and above credit and house prices. They look separately at the property sector, banks, nonbanks, households, speculative activities and other qualitative information that would show that the financial institutions are taking risk. In fact, they creatively combine micro information with macrodata to see if systemic risks are rising, with a strong eye on whether there could be debt-servicing difficulties in the future. Various vintages of NPLs are observed – for different disposable incomes, foreign-currency loans, loan tenors, LTVs etc. In fact, high LTV loans with long loan tenors send an alert signal in some countries. Furthermore, rapid mortgage loan growth with rising number of multiple mortgage loans sends an alert for rise in speculative activities.

Let me add that faced with the imminent materialization of downside risks – be it a recession or a banking crisis – policymakers also have certain triggers that

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<sup>3</sup> Also see Kang, 2014, for a range of indicators that can be used for triggering LTV and DTIs.

would make them loosen policy. But, we have not seen an explicit discussion of why policy was loosened in the six countries.

### **3 Levels of LTVs and DTIs**

There are no magic numbers for the LTV and DTI limits and changes were mostly discretionary. In chart 3, we see different loan growth situations where the LTVs or DTIs were tightened. For some, it was done multiple times. For others, it was done together with other prudential policies and fiscal measures. LTVs varied between 60 % and 85 % but by loan types. For instance, it was lower for unhedged fx loans, much lower for commercial properties, long maturities, speculation prone areas, mortgage holders with overseas income etc. Changes were frequent because the authorities wanted to get around regulatory arbitrage, and we will talk about this a bit later.

### **4 Enforcement and Communication**

Most countries applied it immediately, right after the announcement. They were often accompanied by higher risk weights, reserve requirements or some fiscal tools, such as stamp duties that impacted housing transactions directly. There were some protection for first time home buyers such as exemptions of the tighter LTVs, or separate government schemes that helped first time buyers meet the tighter LTV requirements. Interestingly, there was not much communication with the stakeholders before the measures were announced. However, communication strategy is key in explaining the regulation.

### **5 Institutions and Regulatory Arbitrage**

Now the role of institutions, who does what. The six countries have different structures of decision making, and we admit that no one size fits all. But there are some basic principles (Nier et al, 2011; IMF, 2013). For instance, central banks should play a key role and it is best not to have a fragmented system of multiple agencies. In the six countries, mostly central banks monitor systemic risks whereas a diverse set of institutions take decisions on policy tools. And from what we have seen, the macroprudential decisions are not necessarily coordinated with monetary policy.

In most of the countries the institutional arrangement for decisions on LTV and DTI ratios were already in place several years ago. But a common feature is that the central bank is the key institution in charge of monitoring systemic risks – including developments in the housing market. In addition, in most countries the central bank is responsible for executing and enforcing macroprudential policies, such as LTV and DTI ratios

Whatever the institutional structures could be, policy leakages and regulatory arbitrage are inevitable. Best would be to expect it and prepare in advance including by cooperating with other authorities. The experiences of the six countries could give us some guidance on what type of leakages to expect and how to tackle these leakages. These leakages occurred through nonregulated entities, modification of the loan standards, direct crossborder lending and through foreign bank branches.

## 6 Effectiveness

Past work with macrodata showed that the measures were effective in curbing both credit growth and real house price growth (chart 4).<sup>4</sup>

However, when we looked through our magnifying glass at the six countries' experiences, we got a much more nuanced picture. The countries used various methods to do their effectiveness study creatively combining micro- with macrodata. They looked at the effectiveness of the measures on credit growth, mortgage growth, growth in real house prices, speculative mortgages, debt-servicing capabilities of the households (by looking at microdata on NPL vintages for different LTV limits on new loans). The measures were effective in reducing loan-growth and improving debt-servicing performances of the borrowers. In Hong Kong, for instance, stamp duties were better at lowering house price appreciations. Targeting the tools towards the loan segment most at risk, like speculative properties (as in Korea), worked better than aiming at overall mortgage loans.

## 7 Main Lessons

In conclusion, I would like to say that we have learnt some valuable lessons in trying to solve the jigsaw puzzle; I think we can say that we have got closer but there are still black spots and gaps.

### 7.1 Monitoring Systemic Risk – Going Beyond Credit and House Prices

Countries monitor a wide range of indicators, including those for the debtors, speculative activities and other qualitative indicators on risk-taking. Creative use of indicators based on macroeconomic, supervisory, credit bureaus, and financial

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<sup>4</sup> See for instance, Lim et al. (2011) and Arregui et al. (2013a) for cross-country evidence, and see Igan and Kang (2011) on Korea, Krznar and Morsink (2014) on Canada, Ahuja and Nabar (2011) and He (2014) on Hong Kong SAR, and Crowe and others (2011) for the U.S. and the references therein.

institution is key to effective monitoring. In order to do this, the macroprudential authority need access to all types of data sources.

Be on alert when:

- High LTV loans with long maturities are growing fast
- Mortgage loans and the number of borrowers with multiple mortgages are increasing fast
- Overall NPLs are decreasing due to rapid credit growth but NPLs on particular loan vintages – based on LTV, foreign-currency, income, loan tenors – are increasing.

## 7.2 Using the Tools

There are no magic numbers, but most countries limit LTVs to 60–85%, and DTIs to 30–45%. Although there is evidence of countercyclical changes in policy, the decisions for the changes were mostly discretionary.

NPLs by LTV-specific or DTI-specific loan vintages are very important variables for the calibration process. In particular, combinations of high-LTV loans with longer loan tenors were associated with higher NPL-ratios.

The LTV/DTI measures were often complemented by other prudential and fiscal measures to ensure effectiveness.

## 7.3 Taking Decisions

It is best to announce and impose the measures immediately, without discussing with stakeholders in advance; however, the policy needs to be communicated well to the public. The case studies found that reducing the time between announcement and implementation limits regulatory arbitrage.

In most countries, Central Banks monitor systemic risk but a diverse set of institutions take decisions on macroprudential policy. However, for the specific exercises for the case studies, the central banks had access to a range of data.

It is best to expect leakages, plan in advance, and cooperate with other agencies. Some instances of leakages are highlighted in the paper along with policies to curb them.

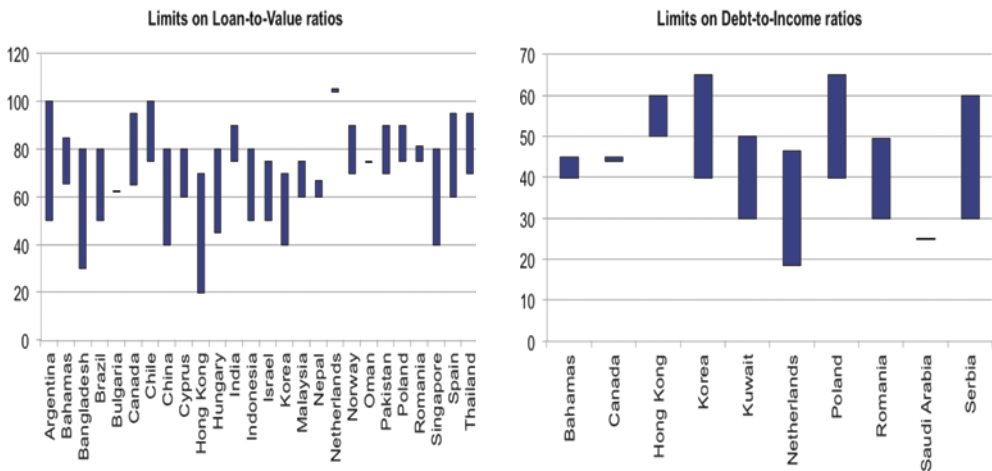
## 7.4 Evaluating Effectiveness

The measures seem to have been effective in reducing loan-growth and improving debt-servicing performances of the borrowers (the banks' credit quality improved). Thus the measures helped improve resilience of the financial sector against downside risks. However, the measures were, in general, not effective in curbing house price growth, except in one case. Capital flows in the real-estate market and direct

lending by foreign banks hindered the effectiveness of the measures. Targeted measures – those aimed at the group of mortgage loans most at risk – worked better.

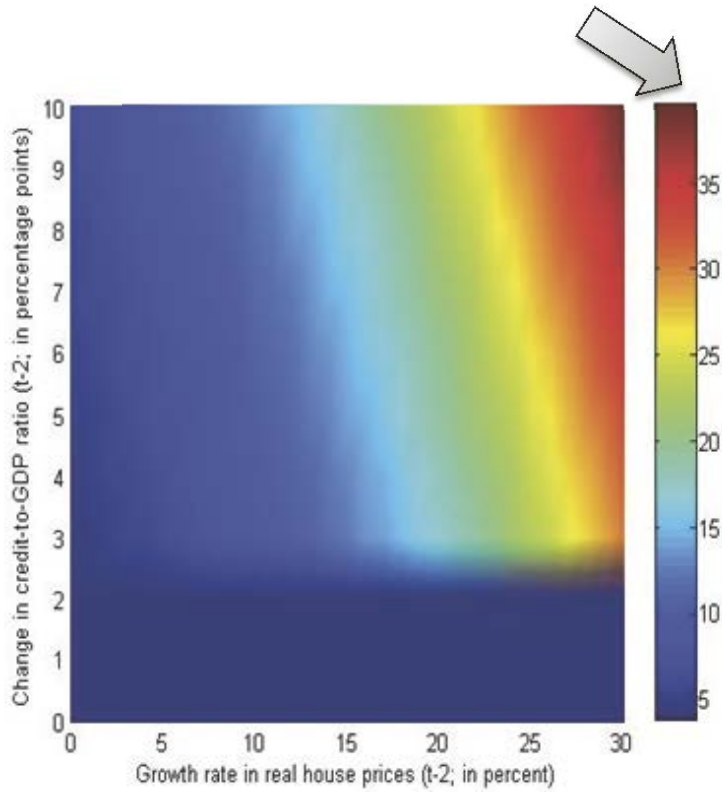
Large gaps remain in the following areas where further research and experience is needed. First, even though all the six countries changed LTV/DTIs in a discretionary fashion, further work could look at whether there are benefits to being more rules-based when deciding on how much to tighten or loosen policies. Second, the exact transmission channels through which the LTV/DTIs work in practice need further analysis, together with how these tools interact with other policies. Third, further work is needed on how to make macroprudential policies more effective in situations where there are surges in capital flows and strong and persistent demand for housing from cross-border sources. Finally, we need to tackle the trade-off between the benefits of social policies aimed at home-ownership versus the high economic costs of crisis from sub-prime lending.

Chart 1a/b: Range of Limits on LTV and DTI in 2013



Source: Global Macroprudential Policy Indicators database; IMF staff calculations.

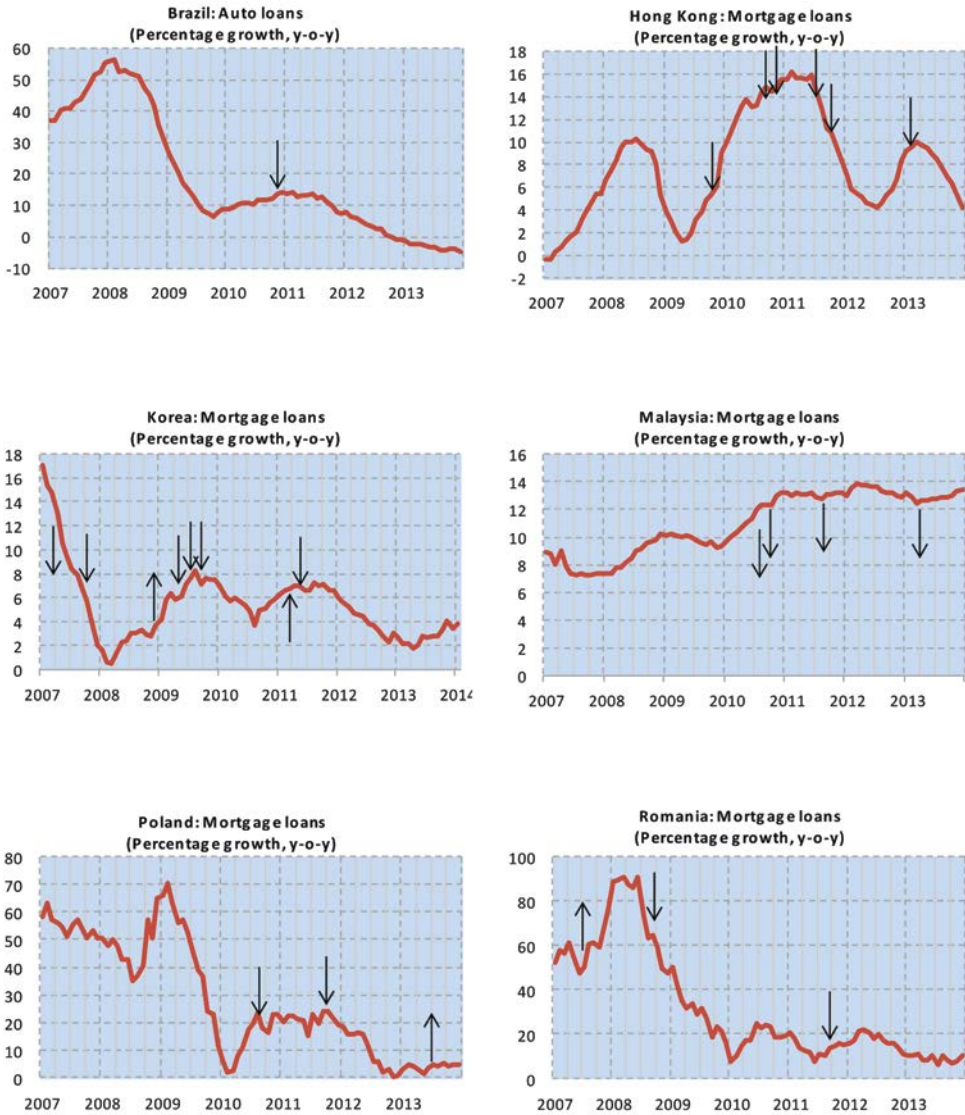
Chart 2: Probability of Crisis: Credit and House Price Growth



Source: Arregui, Benes, Krznar, Mitra and Santos (Evaluating Net Benefits of Macroprudential Policy: A Cookbook, IMF WP, 2013).



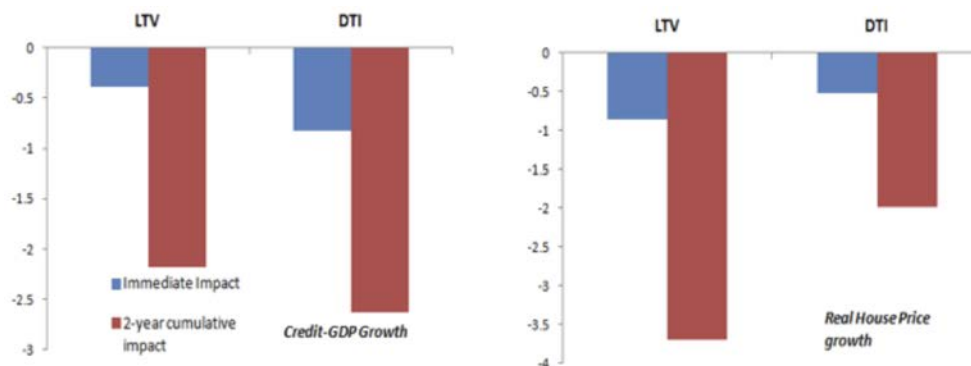
*Chart 3: Credit Growth and Changes in LTV and DTI Ratios*  
 (↓ = tightening, 2007–2013)



Source: Central banks from the countries in the sample.



*Chart 4: Effect of LTV and DTI on Credit and House Price Growth*



Source: Arregui et al. (2013).

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| No. 17 Limited Fiscal Space in CESEE:<br>Needs and Options for Post-Crisis Reform<br>68 <sup>th</sup> East Jour Fixe of the Oesterreichische Nationalbank<br><i>Vienna, 28 February 2011</i> | 11/2009          |
| No. 18 Bretton Woods @ 70:<br>Regaining Control of the International Monetary System<br><i>Vienna, 28 February, 27–28, 2014</i>  | 10/2014          |

# Periodical Publications of the Oesterreichische Nationalbank

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See [www.oenb.at](http://www.oenb.at) for further details.

## **Geschäftsbericht (Nachhaltigkeitsbericht) Annual Report (Sustainability Report)**

*German | annually*

*English | annually*

This report informs readers about the Eurosystem's monetary policy and underlying economic conditions as well as about the OeNB's role in maintaining price stability and financial stability. It also provides a brief account of the key activities of the OeNB's core business areas. The OeNB's financial statements are an integral part of the report.

<http://www.oenb.at/en/Publications/Oesterreichische-Nationalbank/Annual-Report.html>

## **Konjunktur aktuell**

*German | seven times a year*

This online publication provides a concise assessment of current cyclical and financial developments in the global economy, the euro area, Central, Eastern and Southeastern European countries, and in Austria. The quarterly releases (March, June, September and December) also include short analyses of economic and monetary policy issues.

<http://www.oenb.at/Publikationen/Volkswirtschaft/Konjunktur-aktuell.html>

## **Monetary Policy & the Economy**

*English | quarterly*

This publication assesses cyclical developments in Austria and presents the OeNB's regular macroeconomic forecasts for the Austrian economy. It contains economic analyses and studies with a particular relevance for central banking and summarizes findings from macroeconomic workshops and conferences organized by the OeNB.

<http://www.oenb.at/en/Publications/Economics/Monetary-Policy-and-the-Economy.html>

## **Fakten zu Österreich und seinen Banken Facts on Austria and Its Banks**

*German | twice a year*

*English | twice a year*

This online publication provides a snapshot of the Austrian economy based on a range of structural data and indicators for the real economy and the banking sector. Comparative international measures enable readers to put the information into perspective.

<http://www.oenb.at/en/Publications/Financial-Market/Facts-on-Austria-and-Its-Banks.html>

### **Financial Stability Report**

*English | twice a year*

The Reports section of this publication analyzes and assesses the stability of the Austrian financial system as well as developments that are relevant for financial stability in Austria and at the international level. The Special Topics section provides analyses and studies on specific financial stability-related issues.

<http://www.oenb.at/en/Publications/Financial-Market/Financial-Stability-Report.html>

### **Focus on European Economic Integration**

*English | quarterly*

This publication presents economic analyses and outlooks as well as analytical studies on macroeconomic and macrofinancial issues with a regional focus on Central, Eastern and Southeastern Europe.

<http://www.oenb.at/en/Publications/Economics/Focus-on-European-Economic-Integration.html>

### **Statistiken – Daten & Analysen**

*German | quarterly*

This publication contains analyses of the balance sheets of Austrian financial institutions, flow-of-funds statistics as well as external statistics (English summaries are provided). A set of 14 tables (also available on the OeNB's website) provides information about key financial and macroeconomic indicators.

<http://www.oenb.at/Publikationen/Statistik/Statistiken – Daten-und-Analysen.html>

### **Statistiken – Daten & Analysen: Sonderhefte**

*German | irregularly*

### **Statistiken – Daten & Analysen: Special Issues**

*English | irregularly*

In addition to the regular issues of the quarterly statistical series “Statistiken – Daten & Analysen,” the OeNB publishes a number of special issues on selected statistics topics (e.g. sector accounts, foreign direct investment and trade in services).

<http://www.oenb.at/en/Publications/Statistics/Special-Issues.html>

### **Research Update**

*English | quarterly*

This online newsletter informs international readers about selected research findings and activities of the OeNB's Economic Analysis and Research Department. It offers information about current publications, research priorities, events, conferences, lectures and workshops. Subscribe to the newsletter at:

<http://www.oenb.at/en/Publications/Economics/Research-Update.html>

### **CESEE Research Update**

*English | quarterly*

This online newsletter informs readers about research priorities, publications as well as past and upcoming events with a regional focus on Central, Eastern and Southeastern Europe. Subscribe to the newsletter at:

<http://www.oenb.at/en/Publications/Economics/CESEE-Research-Update.html>

**OeNB Workshops Proceedings***German, English / irregularly*

This series, launched in 2004, documents contributions to OeNB workshops with Austrian and international experts (policymakers, industry experts, academics and media representatives) on monetary and economic policymaking-related topics.

<http://www.oenb.at/en/Publications/Economics/Proceedings-of-OeNB-Workshops.html>

**Working Papers***English / irregularly*

This online series provides a platform for discussing and disseminating economic papers and research findings. All contributions are subject to international peer review.

<http://www.oenb.at/en/Publications/Economics/Working-Papers.html>

**Proceedings of the Economics Conference***English / annually*

The OeNB's annual Economics Conference provides an international platform where central bankers, economic policymakers, financial market agents as well as scholars and academics exchange views and information on monetary, economic and financial policy issues. The proceedings serve to document the conference contributions.

<http://www.oenb.at/en/Publications/Economics/Economics-Conference.html>

**Proceedings of the Conference on European Economic Integration***English / annually*

The OeNB's annual Conference on European Economic Integration (CEEI) deals with current issues with a particular relevance for central banking in the context of convergence in Central, Eastern and Southeastern Europe as well as the EU enlargement and integration process. For an overview see:

<http://www.oenb.at/en/Publications/Economics/Conference-on-European-Economic-Integration-CEEI.html>

The proceedings have been published with Edward Elgar Publishers, Cheltenham/UK, Northampton/MA, since the CEEI 2001.

[www.e-elgar.com](http://www.e-elgar.com)

**Publications on Banking Supervisory Issues***German, English / irregularly*

Current publications are available for download; paper copies may be ordered free of charge.

See [www.oenb.at](http://www.oenb.at) for further details.

<http://www.oenb.at/en/Publications/Financial-Market/Publications-of-Banking-Supervision.html>