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10. Housing Bubble and Government Regulation: Evidence from China

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ABSTRACT

Facing rampant real estate price surge, Chinese government imposed the home purchase restriction policy to dampen the speculation activity in major cities in 2010. Using a comprehensive dataset covering the real estate markets across various cities, we find that the policy triggered substantial decline in the property price and transaction volume. Cities having higher reliance on real estate sector for fiscal revenue and economic growth experienced greater drop in housing prices following the policy implementation. However, the policy had no measurable effects on the construction boom, hinting the limitation of the policy to correct the housing bubble. These evidences are robust to endogeneity concerns addressed by both two-step difference-in-difference approach and endogeneous treatment effects regressions.

Keywords: home purchase restriction policy, housing bubble, China, difference in difference, endogeneous treatment effects

JEL code: G12, G18, H83

1. Introduction

The Great Recession once again showed that real estate boom–bust episodes can have devastating consequences. Considerable evidences indicate that collapses of debt-laden housing bubble are the main cause of many financial crises (Reinhart and Rogoff, 2009). After investigating bubbles in housing and equity markets in 17 countries over the past 140 years, Jorda, Schularick and Taylor (2015) concluded that housing bubbles fueled by credit booms are the most dangerous and costly while equity bubbles that do not rely on debt are the least troublesome. This fact has triggered renewed attention on the necessity and effectiveness of public policy to contain real estate bubbles. Mian and Sufi (2009 & 2014) argue that monetary policies like low interest rate and easy credit caused the bubble and its bust.¹ Glaeser (2013) finds that housing bubbles often occurred when government intervention is minimal. Given that real estate market fluctuations could wreak havoc on financial and economic system, more and more economists and policymakers are now in favors of early interventions to curtail housing bubbles (Glaeser and Nathanson, 2014; IMF, 2011). An emerging literature has begun to investigate the effects of government interventions on the property market.² Examining 400 years of asset-price bubbles, Brunnermeier and Schnabel (2015) show that monetary policy and macroprudential measures that lean against inflating bubbles can and sometimes have helped deflate bubbles and mitigate the associated economic crises. However, we still know little about the

¹ In addition to Mian and Sufi (2009 & 2014), there is a rapidly growing literature examining the linkage between monetary policy, mortgage borrowing and housing price appreciation, including Jorda, Schularick and Taylor (2014), Del Negro and Otrok (2007), Goodhart and Hofmann (2008), Jarocinski and Smets (2008), Allen and Rogoff (2011), Glaeser, Gottlieb and Gyourko (2010), Williams (2011), Kuttner (2012), Adam and Woodford (2013), Leamer (2007), Taylor (2007), and Bernanke (2010).

² See Allen and Carletti (2011), Almeida et al., (2006), Crowe et al., (2013), Igan and Kang (2011), Kannan et al., (2012), and Wong et al., (2011) for the studies of government regulations on the real estate sector.

effectiveness and difficulties in implementing various policy tools, especially from an empirical perspective.

China provides a compelling setting to explore the role of government policies in reining in the housing bubble for several reasons. First, within less than two decades, Chinese real estate market has experienced skyrocketing price growth with occasional ups and downs. The drastic surge of prices attracts concerns on a possible housing bubble in China. MacDonald, Sobczak and Mussita (2012) show that property prices in China have increased at a compound annual growth rate (CAGR) of around 16% between 2005 and 2011, much higher than the 13% recorded in the U.S. housing market between 2000 and 2005. Following Himmelberg, Mayer, and Sinai (2005)'s approach, both studies by Wu, Gyourko and Deng (2012) and Ren, Xiong and Yuan (2012) find no conclusive evidence of the housing bubble in China, but they both raise great concerns over the over-valuation of housing prices. More recently, Fan, Gu, Xiong Zhou (hereafter FGXZ) (2015) show it is difficult to identify a bubble but they acknowledge that the rampant price run-up and speculations present a significant challenge to Chinese economy.

Second, despite its short history, the implication of Chinese housing market however cannot be underestimated. Real estate sector is one of the main drivers for Chinese economic growth. It accounts for roughly one-sixth of GDP growth, 25% of total fixed asset investment, 14% of total urban employment and around 20% of bank loans (IMF, 2014). Furthermore, the sector has strong linkage effects on both upstream and downstream industries. Many consider that Chinese housing market is too important to fail because local governments rely heavily on real estate-related income, land sales in particular as a source of fiscal revenue. As the second largest economy and the largest trading nation, a

sharp slowdown in the property sector may have a domino effect on the world economy. Ahuja and Myrovda (2012) predict that a 10% reduction in China's real estate investment would shave about 1% off China's real GDP within the first year and cause global output to decline by roughly 0.5% from the baseline.

Third, facing the rampant price surge and speculations, Chinese government has been actively intervening in the housing market through various policy tools, including the increase of minimum down payment ratio, cap on the loan-to-value ratio, higher mortgage rate for the second house, taxes on capital gains, and so on. When the effectiveness of these measures diminished, Chinese government resorted to the heavy-handed restriction on home purchase to curtail the speculation. This policy was first implemented in Beijing in May 2010 and then adopted by other 45 major cities. The main feature of this policy is that it allows those having local household registration (or *hukou*) or those with working records in their cities for certain consecutive years to purchase one or second homes. Different from the implementation of other cooling measures, HPR policy is decentralized and voluntary.³ This provides a rare opportunity to study such a unique macroprudential tool and its impact on the real estate sector.

Using a detailed city-level quarterly panel data for the years of 2008-2013, we systematically assess the effects of government intervention on the housing market in China. The data file we constructed covering various real estate indicators including housing price (or index), sales of new homes, investment and construction by the developers, and land sales price and revenue received by the local authorities in around

³ The central government only provides guidelines that the policy should be implemented in the first-tier cities and can be extended to the second- and even third-tier cities on a need basis, rather than mandated by all cities.

140 cities. To our knowledge, none of researchers have assembled a comparable city-level dataset on Chinese housing market.

The autonomous and heterogeneous adoption of the HPR policy in each city enables us to perform the empirical analysis with the two-step difference in difference (DID) approach developed by Donald and Lang (2007) and Greenstone and Hanna (2014). Under this approach, we treat the cities without adopting the HPR policy as a control group to draw the causal inference of the policy effect on the property market. Further, we perform a structural break test as a robustness check on the validity of the DID design.

In addition to the DID approach, we employ the endogenous treatment effects model to solve the endogeneity concerns arising from the non-random adoption of HPR policies. Under this identification strategy, the implementation of HPR policy is instrumented by the political connections of each city's top leader (party secretary) with the central government. This model not only captures the role of political factors in implementing HPR policy but also meets exclusion conditions.

We find that the HPR policy has a moderately negative impact on the official housing price index released by the National Bureau Statistics (NBS). Considering the potential manipulation concerns of NBS data,⁴ we alternatively investigate the policy impact on the hybrid housing price index recently composed by FGXZ (2015). Further, we resort to an alternative source -- transaction prices of secondary houses compiled by a nationwide private agent, the City House. We discover large decrease in the housing price following the HPR policy. The HPR policy causes a significant and sharp plunge in the transaction

⁴ As criticized by Ahuja, Cheung, Han, Porter, and Zhang (2010), Wu, Gyourko and Deng (2012), Wu, Deng and Liu (2014), and Fang, Gu, Xiong and Zhou (2015), NBS is likely to underestimate the housing price appreciation.

volume of new homes. This evidence is consistent with the policy motivation of curbing speculative demand in the property market. However, the policy does not address the problem of excessive supply. The growing trends of property investment and construction did not alter after the policy enforcement. These findings suggest that property developers largely ignore the intention of HPR policy in curbing property boom. Instead, they continue to increase investments in property market, which aggravate the oversupply of houses. Both the DID approach and endogenous treatment effects regressions yield robust results, confirming that our evidence is free from the endogeneity concerns.

More importantly, we investigate the varying effects of the HPR policy across different cities that exhibit dramatic heterogeneities in the fiscal reliance on land sales, economic dependence on real estate investment and pace of urban expansion. We find that cities having higher reliance on land sales, real estate investment and radical urban sprawl experience greater decline in housing prices and sales following the policy adoption. Further we show that these cities do not experience significant fall in property investment or construction. The latter finding suggests that HPR policy's effectiveness is limited due to local authorities' misaligned incentives and circumvention. With heavy reliance on real estate sectors, local governments are in the dilemma of correcting housing bubbles and maintaining economic growth via property investment. This indicates a lingering oversupply problem in the housing market.

Our research sheds new lights on how to design effective macroprudential measures to dampen the asset bubbles, the bust of which is catastrophic to the whole economic system. An efficient way to curb housing bubble could significantly improve well-being. The Chinese government has tried various cooling measures including purchase

restrictions. The HPR policy provides an ideal setting to understand Chinese housing market and the effectiveness of government policy in controlling the market mania. There are a growing number of governments in the world attempting to rein in housing price surge by restricting or even forbidding the purchases, especially on foreign buyers.⁵ Our study thereby provides a comparison of the efficacy of similar regulations across different markets.

This study also contributes to the literature of the political economy. We relate political connections to the implementation of HPR policy and associate the effectiveness of the policy to government incentives. Several papers on the Chinese cadre system have linked Chinese economic success with incentive system for its local leaders (Maskin, Qian and Xu, 2000; Li and Zhou, 2005). However, few researches have associated the enforcement of public policy with the political factors. This is of particular importance for a transitional economy like China where the regulatory institutions are weak while its unique political system grants the top city leaders with powers that far exceed their Western counterparts. The success of a public policy hence relies largely on the incentives of local governments in implementing the regulations.

The rest of paper is organized as follows. The next section summarizes the evolution of government policies toward residential property market and reviews the relevant literature. Section 3 presents the data source and summary statistics. Section 4 outlines the two-step DID approach and section 5 reports the main empirical results. Section 6 presents

⁵ For example, Singapore and Hong Kong governments have implemented several demand-managing measures to restrict the property purchase by foreign buyers, including higher down payment ratio, a higher rate of buyer stamp duty on property transactions, etc. Australian government has strengthened the restrictions on property buying by foreigners since 2010. Under those rules, temporary residents were allowed to buy established homes with approval from the foreign-investment regulator, but had to sell when their temporary visas expired.

the endogenous treatment effects model and its estimation results. Section 7 demonstrates the cross-sectional identification test results on the effect of HPR policy across cities. Section 8 concludes the paper.

2. Background: Chinese Government Regulations on Housing Market

Chinese government has interfered actively and significantly in the private housing market. Ahuja, Cheung, Han, Porter, and Zhang (2010) found that over the past decade, any misalignment in house prices would be corrected relatively quickly due to government intervention. FGXZ (2015) also pointed out that Chinese government through its heavy interventions played a more important role in affecting housing market than the counterparties in the rest of world.

Since the mid-1990s, Chinese government has made great efforts to promote housing finance and hence stimulate the growth of real estate sector, in order to support the housing reform and fight against the adverse economic impacts of 1997 Asian Financial Crisis. For example, between 1998 and 2002, the central government lowered the mortgage rate five times to encourage home purchases. By 2005, China has become the largest residential mortgage market in Asia, with an outstanding balance exceeding RMB two trillion (USD 300 billion), almost 89 times the 1997 balance (Deng and Liu 2009; Zhu 2006). Meanwhile, the government rolled out various policies favoring housing development, such as broadening the scope of development loans and allowing pre-sales. As a result, the annual housing investment increased by around six times from 1997 to 2005 (Ye and Wu, 2008).

The housing market started to experience a rapid boom starting in 2004. In response, the government implemented a series of policy tools to curtail speculative activities. For example, the minimum down payment ratio was raised to 40% in September 2007 and

mortgage rate set 10% higher than the benchmark rate. Personal income taxes were levied on corporate purchasing properties for individuals in 2008. These measures worked well for a short period, partially aided by the global financial crisis broken out in 2007.

In order to avoid the paramount threat of political instability triggered by the global financial crisis, the government reversed its housing policies in October 2008. This included a series of measures to support the housing market growth. Among them, the minimum mortgage rates were adjusted downwards to 70% of the benchmark rate and the down-payment ratio was lowered to 20%. Preferential policies were also introduced for first-time home buyers. Fueled by lax credit and easy monetary policy, the housing market regained momentum in mid-2009 and started a new round of price run-up and massive construction boom across the nation.⁶

In response to the continuing surge in housing prices, the government stepped up a campaign against the overheated property market in the early 2010. Besides the traditional policy tools, various less standard tightening measures, such as raising the down-payment ratio, prohibiting mortgage on the second home purchase, and imposing business tax and personal income taxes on housing transactions came in place. However, none of these measures can be compared to the most stringent policy instrument -- home purchase restriction adopted by various Chinese local municipalities. Taking Beijing as an example, the policy dictates that each family with Beijing *hukou* can own a maximum of two homes. Families without local *hukou* are not allowed to buy any unless they can provide documents to prove payment of taxes and social security contributions for five consecutive years in the past.

⁶ According to Smil (2013), between 2011 and 2013, China used 6.6 gigatonnes of cement, 1.1 gigatonnes more than what the US used between 1901 and 2000.

The goal of HPR policy is to curtail the speculative housing demand, although it does not touch the fundamentals driving the speculative demand, e.g., shortage of investment tools for Chinese residents.⁷ Such restrictions on home purchase substantially alter the demand in the housing market, which are often criticized by economists for unfairness, discrimination against migrants, and inefficiency.

Since the late 2013, an alarming economic slowdown emerged with residential property market receding. Housing prices started to decline in an increasing number of cities while the residential property inventories have increased sharply. Not affording to sit idle and watch the free fall of housing price, most municipal authorities abolished HPR policy in the mid-2014. Currently, the policy is only in force in four megacities of Beijing, Shanghai, Guangzhou and Shenzhen.

Not surprisingly, China's housing market has been the topics of many empirical investigations. Zhou (2005), for example, attempts to explain the underlying factors of the house price movement. Others focus on the price misalignment and the sustainability of China's housing boom (Economic Intelligence Unit 2011; Wu, Gyourko and Deng, 2012; Chivakul, 2015). Huang, Zhang and Lai (2014) investigate the relationship between Chinese stock and housing market, and others look at the association of housing price with land policy (Cai, Henderson, and Zhang, 2013; Du, Ma and An, 2010; Peng and Thibodeau, 2009). Fang, Gu and Zhou (2014) measure the corruption of home purchase in China. Although Chinese government has actively intervened in the real estate sector, especially

⁷ Real estate is the most preferred asset class for the Chinese thanks to the shortage of other investment options and a lack of property taxes. According to a Report "China—real estate: Good news in tough times" released by the Standard Chartered on 4 July 2013, residential property has made up more than 60% of household assets since 2008, dwarfing the 48 % in the UK, 32 % in Japan, and 26% in the US.

in light of US subprime mortgage crisis, very few studies have examined the effects of government cooling measures.

A few papers focus on the introduction and evolution of HPR policies, such as Wang and Murie (1999), Deng, Shen, and Wang (2011) and Zou (2014). The lack of systematic analysis of the heavy-handed government restriction on home purchase motivates our research. To our knowledge, there are only three papers examining the policy impact but they look at an individual market. Sun, Zheng, Geltner and Wang (2013) investigate the policy effect on Beijing's resale and rental market while Jia, Wang and Fan (2014) focus on the response of Guangzhou's real estate sector to the policy implementation. Using a counterfactual analysis, Du and Zhang (2015) evaluate the effects of HPR policy and trial property taxes on housing prices in Beijing, Shanghai and Chongqing. They find that the HPR policy lowers the annual growth rate of housing prices in Beijing by 7.69% while the trial property tax had no significant effects on the housing price in Shanghai. In this paper, we aim to bridge the gap by assembling a set of empirical analyses about the real estate market dynamics in relation to the HPR policy adopted by many Chinese local municipalities.

3. DATA AND SUMMARY STATISTICS

This section describes the data source, presents the summary statistics, and traces the evolution of the key property market indicators before and after the policy implementation.

3.1 Data

To perform the empirical analysis, we construct a city-level panel data file for the years of 2008-2013 at quarterly frequency from a number of sources, including the official source of NBS, a private data provider *Soufun*, a nationwide independent agent the City

House and the scholars of FGXZ (2015). Our main empirical analysis focuses on the 70 cities across 30 provinces. Their housing prices are regularly surveyed by the NBS.

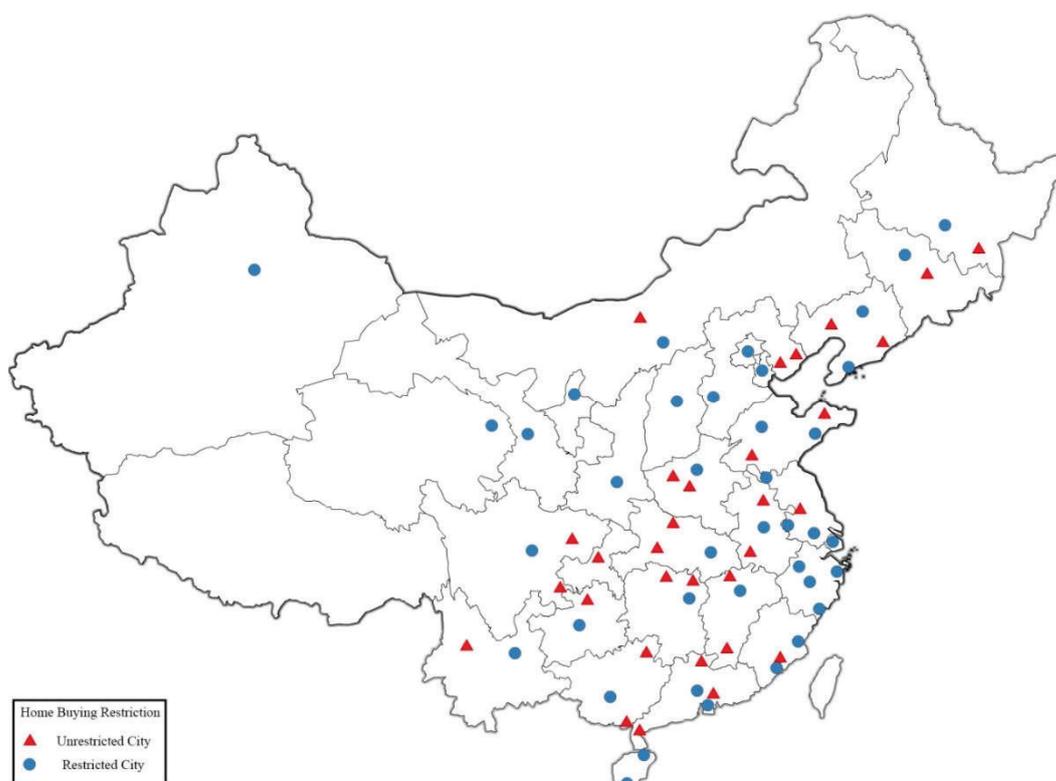
3.1.1 HPR Policy

The HPR policy was initiated by China's central government under the so-called "New National Ten Articles" and "New National Eight Articles" issued in April 2010 and January 2011 respectively.⁸ It was afterward implemented in 46 cities. Among the 70 cities that NBS regularly publishes their property price index, 39 of them adopted the policy. Figure 1 plots the location of these 70 cities and classify them into two groups of restricted and unrestricted cities.

Manually collecting the local version of "New National Ten Articles" and "New National Eight Articles", we assemble a comprehensive dataset that traces the policy changes. Appendix A summarizes the policy implementation status of all our sample cities. Beijing was the first city to enforce HPR policy in May 2010, followed by Shenzhen in September, Dalian, Fuzhou, Hangzhou, Xiamen, Guangzhou and Wenzhou in October, and Lanzhou and Zhengzhou in November and December respectively. In the spring of 2011, due to the requirements set by the "New National Eight Articles", the other 29 municipal governments launched the HPR policy in their cities.

⁸ The full name of "New Ten Clauses" is "Notice of the State Council on Resolutely Curbing the Soaring of Housing Prices in Some Cities" while the full name of "New National Eight Articles" is "Notice of the State Council on Further Problems Related to the Intervention of Real Estate Market".

Figure 1 Location of 70 major cities



We use four types of indicators to capture the dynamics of Chinese residential property market: (1) prices or price indices; (2) housing sales; (3) construction and investment by the real estate developers; and (4) land sales prices and revenue. Appendix B lists the definition, unit and sources of each variable.

3.1.2 Housing price

We obtain the housing price or price index data from several sources. Among them, NBS price indices including the price indices of newly constructed (*PINew.NBS*) and secondary residential property (*PISecond.NBS*) are the most widely used measures in analyzing Chinese real estate markets. The main advantage of this dataset is its wide coverage and long sample period. The starting date of NBS price indices could be traced back to July 2005. NBS reports the year-over-year or quarter-over-quarter house price

growth rate for individual cities. To track the price movement over time, we convert it into the indices with the second quarter of 2005 equal to 100.⁹

One drawback of NBS property price index is the underestimation of the housing price appreciation rate in China (Ahuja, Cheung, Han, Porter, and Zhang, 2010; Wu, Gyourko and Deng, 2012). We hence collect the sales prices of new houses (*Price.CREIS*) from the China Real Estate Index System (CREIS) developed by a private data provider *Soufun* and the transaction prices of secondary houses (*Price.Cityhouse*) from a nationwide independent agent the City House. These two datasets are less likely to have manipulation problem. We also adopt the City House's quarterly rental price to measure the dynamics of rental market.

An accurate housing price index should reflect evolution of prices of the same or similar houses over time. NBS price indices or sales price released by private sectors simply compare the mean or median sale prices per square meter. Without adjusting for property features, they represent not only the changes in the prices of similar homes, but also the changes in the quality and composition of transacted homes (FGXZ, 2015). However, there are few home sales data that could be used to compose the Case-Shiller type repeated sales housing price indices due to the short history of Chinese housing market. In US a hedonic price approach is often used to derive housing price indices that regresses sales prices on a set of variables characterizing housing units. This approach is not feasible for Chinese real estate market due to the dramatic unobserved time-varying characteristics caused by the rapid expansion of urban residential land parcels. To address these concerns, FGXZ (2015) employ a hybrid approach to construct a monthly housing price index using

⁹ The base period could be set as other periods, but the evolutions of the price index are the same and hence the empirical results would not be affected.

the sequential sales of new homes within same housing development projects in 120 cities for the years of 2003 to 2013. As a comparison, we also use this new housing price index (*PI.FGXZ*) to study the effects of HPR policy.

3.1.3 Housing transaction, investment and land sale

We gauge the transaction of residential property with three indicators of sales amount (*SaleAmount*), number of flats sold (*SaleUnit*), and floor space sold (*SaleFloor*) provided by NBS. They refer to the total amount, number of flats or floor area sold for buildings listed in the formal sales contract signed by both parties during the reporting period. They include both the sale of currently completed units and presale units offered by real estate developers. NBS only releases the transaction data for new homes.

We measure the activities of developers with four indicators of real estate investment (*Investment*), floor space started (*FloorStarted*), floor space under construction (*FloorUnderConstruction*) and floor space completed (*FloorComplete*) published by NBS and collected by CEIC database. According to the definition given by CEIC, *Investment* here refers to the investment by real estate development companies, commercialized building construction companies, and other real estate development units of various types of ownership in the construction of buildings. The land transaction is excluded. *FloorStarted* measure the entire floor space of the whole residential buildings newly started by real estate development enterprises during the reference period.¹⁰ *FloorUnderConstruction* refers to the total floor space of all residential buildings under construction by real estate enterprises during the reference period, including the “floor space starts” in current period, floor space of continued construction carried over from

¹⁰ All housing construction begun in previous periods or previously started, but restarted again because of some postponement or stoppage in earlier periods is excluded to avoid double counting.

previous periods, floor space stopped or postponed in the previous period but restarted for construction in the current period, floor space completed during the current year, and newly started floor space in current year but postponed. *FloorComplete* refers to housing construction that has been completed in accordance with the design and approval requirements and can be formally handed over to buyers for use.¹¹ We collect the land price (*LandPrice*) and land sales revenue (*LandRevenue*) data from the CREIS. The land price is calculated as the ratio of land transaction value to the area of construction land.

3.1.4 Control Variables

Housing price is usually pushed up disproportionately in the time of rapid economic growth because housing demand is often more elastic than housing supply and can remain strong (Economic Intelligence Unit, 2011; Chen, Guo and Wu, 2011). In this paper, demand for housing is proxy by disposable income per capita of urban residents and resident population of each city. Moreover, we use the developed area of city construction published by the CEIC database to reflect the elasticity of housing supply. The data for disposable income is obtained from the CEIC database.

We rely on *changzhu* population instead of *huji* population to measure the housing demand arising from population growth. The *huji* population refers to people who register with the police under the household registration system (*hukou*) but does not include residents living in the city without local *hukou*, whereas the *changzhu* population refers to the resident population that has stayed in the same area for more than 6 months and reflects the migration pattern. For a coastal city with decent manufacturing industry, *huji* population underestimates the real population since it often attracts numerous migrants as

¹¹ Chivakul et al (2015) provides a detailed description on China's residential real estate statistics, including the price, volume, investment, and inventory data.

residents. For an inland city that is the home of migrants, *huj*i population might overestimate its total residents. It is estimated there are currently 53.7% of population leaving in urban area although population with urban *hukou* only account for 36% of total population. Therefore, *changzhu* population instead of *huj*i population represents the real and potential demand for urban residential property. We collect the data of *changzhu* population from the yearbooks of each city.

3.2 Summary Statistics

We apply the seasonality adjustment to the series of property investment, floor space started and under construction, land sales revenue and disposable income that show evident seasonal fluctuations. Panel A of Table 1 lists the summary statistics of all variables for the full sample of 70 cities. The mean of property price index (*PINew.NBS* and *PISecond.NBS*) indicates that the housing price on average grows by around 35% since 2005, much lower than the appreciation rate estimated by MacDonald et al. (2012). The mean value of sales price published by the City House is around RMB 7,700 per square meter. In contrast to the high housing price, the average rental price is as low as around RMB 20 per square meter. The transaction volume averages 13,632 units of flats, 1.39 million square meters of floor space valuing for RMB 11,765 million per quarter.

There is a clear pattern of investment and construction boom in the housing market. For example, the quarterly investment by real estate developers averages RMB 12,144 million (slightly below USD 2,000 million) per city. Construction of residential property was growing at an extraordinarily high pace in the sample period. The summary statistics indicate that there is on average around 2 million square meters of floor space started and 22.3 million square meters of floor space under construction per city-quarter. With an

average land price of RMB 4,527 per square meter, the quarterly land sales revenue per city amounts to RMB 3.7 billion. Local governments, the ultimate owner and the only supplier of urban lands, are therefore one of the largest beneficiaries of the skyrocketing property market.

To assess the volatility of the housing market, we normalized standard deviation of each variable by its mean. Among all property market indicators, the investment, floor space started, sales amount, land price and land sales revenue exhibit highest level of volatility as their normalized standard deviation all exceed one.

Panel B of Table 1 presents the mean value of real estate market indicators around the time of policy implementation for adopting cities. Although HPR policy was launched to dampen the rampant housing price appreciation, the official price indicators -- *PINew.NBS* and *PISecund.NBS* declined respectively by only around 1 and 3 point four quarters after the policy implementation. However, the decline in the housing price released by the private agent (*price.Cityhouse*) is remarkable. It fell by RMB 364 four quarters after the policy adoption.

One year after the policy enforcement, the three measurements of new home sales including the *SaleAmount*, *SaleUnit* and *SaleFloor* plummeted by more than 40% relative to their peak value recorded at $\tau = -1$. The dramatic decline in these transaction volumes hints that most of home purchase before the policy adoption might be driven by the speculation purpose, instead of inelastic needs. Cities adopting the policy on average experienced a 60% drop in land sales revenue. On the contrary, the investment and construction of residential properties are unaffected by the policy. They continued their growing trend one year after the policy implementation. This finding suggests that HPR

policy does not tame the investment boom by real estate developers who will release future supply of residential housing in large magnitude.

Table 1 Summary statistics

This table presents the summary statistics of our key variables. Panel A shows the summary statistics of real estate market indicators of all cities. Panel B summarizes the statistics for the adopting cities around the time of policy implementation. Obs, observation; Std. Dev., standard deviation; Normalized Std. Dev. is calculated as the ratio of Std. Dev. to the mean; Min, minimum value; Max, maximum value. Please refer to Appendix A for the detailed description of each variable.

Panel A: Summary statistics for all cities									
Variable	Obs	Mean	Std. Dev.	Normalized Std. Dev.	Min	Max			
<i>PINew.NBS</i>	1680	138.05	20.21	0.15	90.99	226.49			
<i>PISecond.NBS</i>	1680	135.68	22.65	0.17	84.10	234.75			
<i>Price.Cityhouse</i>	1550	7730.66	5099.41	0.66	1943.00	37469.00			
<i>PI.FGXZ</i>	1050	1.33	0.31	0.23	0.78	2.74			
<i>Rental</i>	1585	19.99	9.27	0.46	5.50	65.05			
<i>SaleUnit</i>	992	13632.13	12249.75	0.90	571.00	73875.00			
<i>SaleFloor</i>	1015	1390.30	1213.42	0.87	55.50	8058.20			
<i>SaleAmount</i>	903	11764.59	13965.61	1.19	193.00	101534.00			
<i>Investment</i>	1680	12144.03	14448.50	1.19	115.43	93929.22			
<i>FloorStarted</i>	1680	2010.10	1906.28	0.95	0.00	16812.08			
<i>FloorUnderConstruction</i>	1680	22333.40	21648.64	0.97	234.50	192489.00			
<i>FloorCompleted</i>	1653	1176.69	1264.32	1.07	11.43	10561.56			
<i>LandPrice</i>	1471	4527.22	5239.26	1.16	4.43	60293.88			
<i>LandRevenue</i>	1471	3694.32	6672.21	1.81	0.05	80074.93			
Panel B: Mean value of real estate market indicators for the adopting cities around the policy implementation									
τ	-4	-3	-2	-1	0	1	2	3	4
<i>PINew.NBS</i>	138.28	139.81	141.22	143.29	145.14	146.07	145.86	144.98	144.15
<i>PISecond.NBS</i>	138.19	139.55	140.78	142.32	143.23	143.39	142.27	141.19	140.09
<i>Price.Cityhouse</i>	9124.90	9555.41	10174.77	10724.21	10977.28	10963.41	10772.95	10770.77	10613.13
<i>PI.FGXZ</i>	1.20	1.30	1.36	1.44	1.51	1.56	1.61	1.62	1.59
<i>Rental</i>	21.97	22.81	23.52	23.65	24.44	24.67	25.06	24.60	24.94
<i>SaleUnit</i>	14880.43	15055.57	17560.71	19765.07	14863.41	12865.93	12978.78	11456.18	10755.12
<i>SaleFloor</i>	1573.20	1607.76	1738.77	1974.80	1492.44	1278.42	1295.46	1130.67	1063.71
<i>SaleAmount</i>	13031.00	13925.27	16108.59	18109.85	14050.19	12876.00	13389.93	11455.48	10624.62
<i>Investment</i>	13648.27	15284.35	15508.42	16920.77	17545.47	18835.70	19823.24	20998.12	21600.04
<i>FloorStarted</i>	2290.80	2621.90	2912.14	2851.10	2848.54	3090.66	3166.57	2739.77	2943.89
<i>FloorUnderConstruction</i>	21655.61	24674.72	28041.27	28562.54	26595.68	30409.93	34059.92	34416.36	31753.29
<i>FloorCompleted</i>	1285.24	1412.78	1484.24	1576.86	1405.69	1491.51	1565.16	1852.15	1841.10
<i>LandPrice</i>	5705.37	6740.24	6723.63	6854.01	6696.27	6680.35	5242.33	5650.43	7035.17
<i>LandRevenue</i>	8273.31	6255.83	6058.68	8655.79	7055.47	5877.19	4238.21	3064.45	4023.23

4. EMPIRICAL STRATEGY

This section describes the two-step DID approach developed by Donald and Lang (2007), and applied by Greenstone and Hanna (2014) to study the casual effects of environmental regulations on pollution abatement across India. We employ it to assess the impact of HPR policy on Chinese residential property market.¹² This approach provides a convenient solution to the problem of intragroup correlation in the unobserved determinants of housing market movement. It is numerically equivalent to the GLS and FGLS approaches widely applied for a single-step DID approach. This two-step DID approach has a great advantage of avoiding the difficulty of collapsing the data into group-level.¹³ The first step is a typical event study-style equation:

$$Y_{it} = \alpha + \sum_{\tau} \sigma_{\tau} D_{\tau,it} + \mu_t + \gamma_i + \beta X_{it} + \epsilon_{it} \quad (1)$$

where Y_{it} is real estate market indicators in city i at quarter t . $D_{\tau,it}$ is a vector composed of a separate indicator for each of the quarters before and after the policy is enforced. τ is normalized to be zero in the quarter when the policy is implemented and ranges from -8 (8 quarters before a policy is adopted) to 8 (8 quarters after its adoption) so that we have enough city-by-quarter observations. τ is set to be zero for the nonadopting cities so as to facilitate the identification of time effects and the coefficients of β on the control variables. The city fixed effects, γ_i , control for all unobserved factors that are time-invariant and peculiar to each spatial unit and prevent the estimates of the treatment effects, σ_{τ} , from

¹² The two-step DID estimation of this paper is based on the stata code written by Jonathan Petkun and provided by Greenstone and Hanna (2014).

¹³ We also performed estimation with the single-stage approach for comparison. Results are available upon request. As a standard practice in DID approach, the standard errors from the one-stage approach are clustered at the city-level.

being biased upward by the possibly higher levels of real estate market indicators in the adopting cities, both before and after the policy implementation (Auffhammer and Kellogg, 2011). The inclusion of time effects μ_t which control for all city-invariant variables adjusts for the trends like nationwide legislation or policy changes. The control variables of developed area of city construction, disposable income per capita and resident population (X_{it}) are included to adjust for differential supply and demand factors across cities. The estimating equation is weighted by the GDP per capita to account for differences in precision due to city economic development level.

The parameters, σ_τ , our main estimates, gauge the mean value of various real estate market indicators in the quarters before and after the policy is enforced. The variation in the timing of HPR policy adoption across cities enables us to identify σ_τ and time fixed effects separately. A plot of σ_τ estimated from equation (1) against τ would allow us to visually investigate how the policy changes the real estate market. Additionally, these figures, which lend insights into whether the mean reversion appears in front of the policy's impact, would inform us the choice of the preferred second-step model.

In the second step, we quantitatively test the association of property market dynamics with HPR policy via three alternative models. We first estimate:

$$\hat{\sigma}_\tau = \pi_0 + \pi_1 1(Policy)_\tau + \epsilon_\tau \quad (2A)$$

where $1(Policy)_\tau$ indicates if the policy is in force (i.e., $\tau \geq 1$). π_1 tests whether there is a mean shift in one of the measurements of housing market after the policy adoption. An alternative specification is

$$\hat{\sigma}_\tau = \pi_0 + \pi_1 1(Policy)_\tau + \pi_2 \tau + \epsilon_\tau \quad (2B)$$

that includes a linear time trend, τ , to adjust for differential preexisting trends in the adopting cities.

Equation (2A) and (2B) test for the existence of mean shift in real estate market after the policy's implementation. However, the full impact of the policy may change over time as the individuals may find various niches to avoid the home purchase obstacles set by the government. We therefore estimate the third specification:

$$\hat{\sigma}_\tau = \pi_0 + \pi_1 1(Policy)_\tau + \pi_2 \tau + \pi_3 1((Policy)_\tau \times \tau) + \epsilon_\tau . \quad (2C)$$

From this specification, we report the impact of the policy four quarters after its enforcement as $\pi_1 + 4\pi_3$.¹⁴ For the second stage equations (2A)-(2C), the standard errors are heteroskedastic consistent. Moreover, the equations are weighted by the inverse of the standard error associated with the relevant σ_τ to account for differences in precision in the estimation of these parameters.

5. EMPIRICAL RESULTS

5.1 Event Study Graphical Evidence

We first present the event study graphs. The graphs not only visually depict the evolution of real estate market indicators around the time of HPR policy adoption but also help to identify the most appropriate version of equation (2). In Figure 1, each graph plots σ_τ estimated from equation (1) against τ . The quarter of the policy implementation, $\tau = 0$, is demarcated by a vertical dashed line in all figures. Additionally, all property market

¹⁴ We also test the policy effects eight quarters after the adoption. The results are similar and available upon request.

measurements are normalized to be zero at $\tau = -1$ and noted with the horizontal dashed line for easy comparison.

The figure shows that HPR policy was effective at reversing the upward trend of housing prices, transaction of new residential property and land sales revenue. Most price measurements fell to the lowest level six quarters after the policy adoption. For example, at the sixth quarter of the policy implementation, the NBS price index of newly constructed residential property (*PINew.NBS*, panel a) and secondary residential property (*PISecond.NBS*, panel b) declined slightly by 1.00 point and 2.09 point respectively. The housing price released by the City House (*price.Cityhouse*, panel c) fell considerably by RMB 468, the price released by the CREIS (panel d) decreased by RMB 167, and the price index calculated by FGXZ (2015) (panel e) dropped by 0.14 points. Rental price (panel f) remains stable within four quarters of policy enforcement, but gains strong growth momentum henceforth.

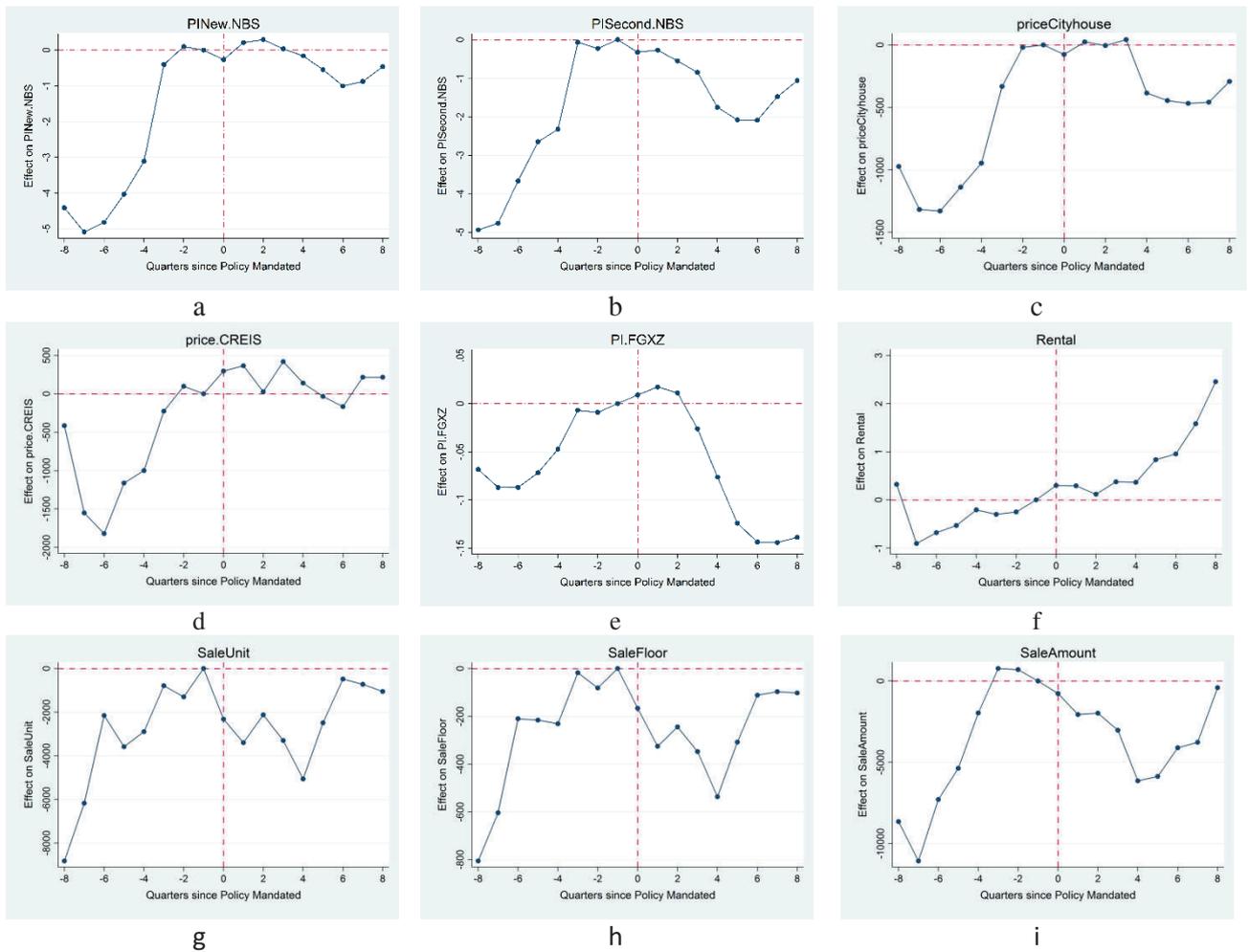
The policy's impacts on the new residential property transaction and land sales revenue are remarkable. Comparing with the quarter preceding the policy implementation, the floor space sold (*SaleFloor*, panel h) slumped by about 537 thousand square meters, the number of flat sold (*SaleUnit*, panel g) plummeted by 5,062 units and the sales amount (*SaleAmount*, panel i) precipitously dropped by RMB 6.43 billion at the fourth quarter of policy adoption. Land price and land sales revenue (panel n and o) plunged by RMB 4225 and RMB 5.40 billion at the fourth quarter of the policy enforcement.

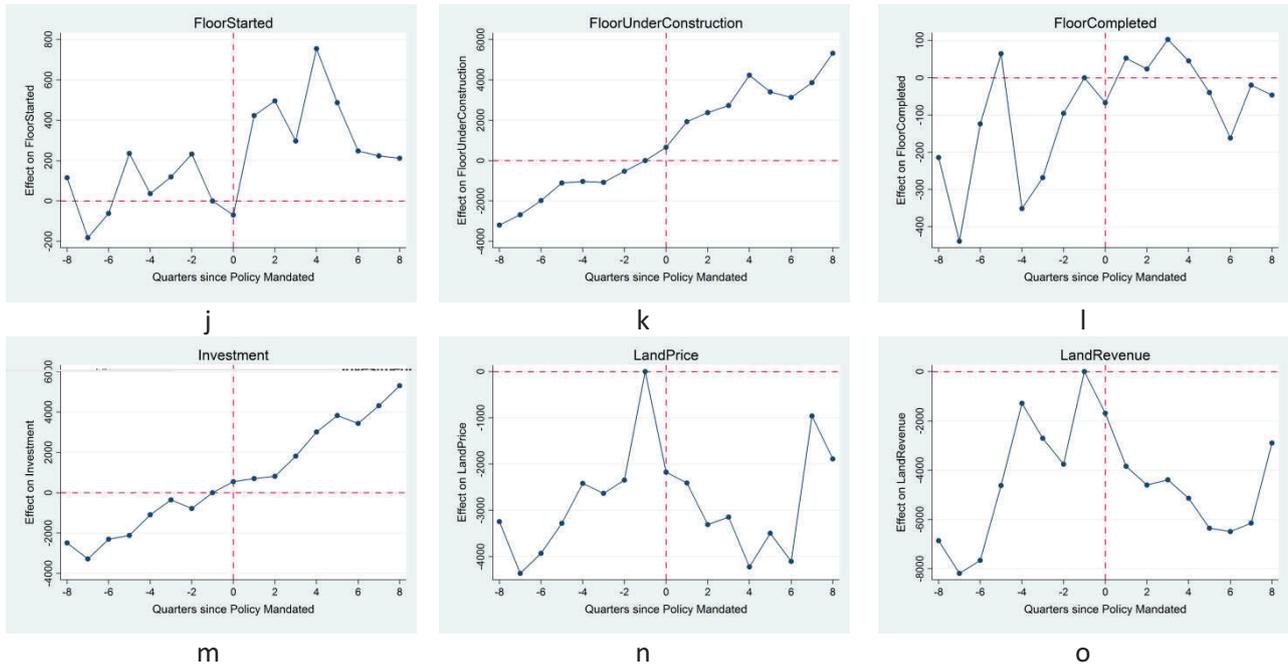
No sizable policy effect is witnessed for real estate investment and floor space under construction. On the contrary, their growth momentum remains strong in our sample period. This is because HPR policy is mainly designed to depress the speculation from demand

side. Moreover, local governments relying heavily on property investment for GDP growth do not have great incentives to suppress the property investment boom, although they are under the political pressure from the central government to control the housing price surge. Excess supply over demand in the housing market is an unavoidable consequence of misaligned incentives. A manifestation of this includes emergence of several ghost cities with empty houses.

Figure 1 Event Study of HPR Policy

The figures provide a graphic analysis of the effect of HPR policy on the housing market indicators by depicting the estimated σ_τ s from equation (1) against the event time τ . The quarter of the policy implementation, $\tau = 0$, is demarcated by a vertical dashed line in all figures. All property market measurements are normalized to equal zero at $\tau = -1$ and noted with the horizontal dashed line.





5.2 Quantitative Evidence

The oscillating trends for almost all real estate market indicators are observed in Figure 1. This suggests that the parallel trends assumption of the simple DID or mean shift model (i.e., equation (2A)) might be violated in many cases. This is particularly true for Chinese housing market where both prices and sales exhibited strong growing trends before the policy’s enactment. Therefore, equations (2B) and (2C) that accounts for differential trends are more likely to produce valid estimates.

Tables 2-4 report the policy effects estimated by the two-stage DID approach. Column (1) lists the estimate of π_1 from equation (2A), which tests how σ_τ on average changes after the policy was mandated. Column (2) presents the estimate of π_1 and π_2 from fitting the equation (2B), where π_1 tests for the policy effectiveness by accounting for the trend (π_2). Column (3) shows the results from equation (2C) that allow for a mean shift and trend break after the policy is in force. We also report the estimated effect of the policy four quarters after the implementation, which is equal to $\pi_1 + 4\pi_3$.

The regression results presented in Table 2 confirm the graphical analysis in the previous subsection that the HPR policy dampened the rampant housing price surge. The results estimated from the most comprehensive second-stage specification (equation (2C)) listed in column (3) indicate that four quarters after the policy was in force, the NBS property price index *PINew.NBS* and *PISecund.NBS* declined by 3.81 and 4.76 points respectively, or by 2.8% and 3.5% of sample mean. However, the fall in the price released by the City House is phenomenal, ebbing by RMB 882 or 11.43% of the sample mean four quarters after the policy is enforced. The price index estimated by FGXZ (2015) fell by 0.1 point or 7.5% of the mean value. No significant policy impact on the rental price is found a year after the policy is implemented.

Table 2 Trend Break Estimates of the Policy Effect on Housing Price and Rental Price

This table presents the regression results for the NBS property prices index, the price index calculated by FGXZ (2015) the housing price by the CREIS, the transaction and rental price released by the City House. Columns 1, 2 and 3 report the estimation results for the specifications of 2A, 2B and 2C, respectively. Robust standard errors are given in the parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
Panel A. <i>PINew.NBS</i>			
$\pi_1: l(\text{Policy})$	2.42*** (0.77)	0.03 (1.41)	0.06 (0.68)
$\pi_2: \text{Time Trend}$		0.28* (0.14)	0.85*** (0.11)
$\pi_3: l(\text{Policy}) \times \text{time trend}$			-0.97*** (0.14)
4-quarter effect = $\pi_1 + 4\pi_3$			-3.81***
p-value			[0.00]
Observations	17	17	17
Panel B. <i>PISecund.NBS</i>			
$\pi_1: l(\text{Policy})$	1.17 (0.73)	-0.80 (1.39)	-0.78 (0.53)
$\pi_2: \text{Time Trend}$		0.23 (0.14)	0.81*** (0.08)
$\pi_3: l(\text{Policy}) \times \text{time trend}$			-1.00*** (0.11)
4-quarter effect = $\pi_1 + 4\pi_3$			-4.76***
p-value			[0.00]
Observations	17	17	17

Panel C. price.Cityhouse			
$\pi_1: l(Policy)$	528.96** (201.41)	146.36 (399.92)	152.17 (228.44)
$\pi_2: Time Trend$		45.05 (40.78)	196.41*** (36.18)
$\pi_3: l(Policy) \times time trend$			-258.60*** (47.28)
4-quarter effect = $\pi_1 + 4\pi_3$			-882.20***
p-Value			[0.01]
Observations	17	17	17
Panel D. price.CREIS			
$\pi_1: l(Policy)$	923.28*** (250.85)	383.60 (491.53)	385.62 (417.32)
$\pi_2: Time Trend$		63.56 (50.13)	192.25** (66.26)
$\pi_3: l(Policy) \times time trend$			-219.07** (86.45)
4-quarter effect = $\pi_1 + 4\pi_3$			-490.60
p-Value			[0.11]
Observations	17	17	17
Panel E. PI.FGXZ			
$\pi_1: Policy$	-0.02 (0.03)	0.06 (0.05)	0.06** (0.02)
$\pi_2: Time Trend$		-0.01 (0.01)	0.01*** (0.00)
$\pi_3: Policy * Time Trend$			-0.04*** (0.00)
4-Quarter Effect = $\pi_1 + 4\pi_3$			-0.10***
P-Value			[0.00]
Observations	17	17	17
Panel F. Rental			
$\pi_1: l(Policy)$	1.13*** (0.30)	-0.21 (0.47)	-0.20 (0.40)
$\pi_2: Time Trend$		0.16*** (0.05)	0.03 (0.06)
$\pi_3: l(Policy) \times time trend$			0.21** (0.08)
4-quarter effect = $\pi_1 + 4\pi_3$			0.66
p-Value			[0.23]
Observations	17	17	17

Table 3 presents the estimation results for the new house sales and investment by the developers. The results derived from the equation (2C) with adjustments for differential

pretrends imply that the number of units sold, the floor space sold and the sales amount plummeted averagely by 7,510 units, 783.3 thousand square meters and RMB 12 billion respectively, at the magnitude of 55%, 56.3 % and 102 % compared to the whole sample mean four quarter after the policy adoption. This phenomenal fall in the sales volume hints that the policy enforcement is effective in dampen speculation by non-residents or policy-sensitive buyers. The plunge in both price and transaction volume is consistent with the findings reported by Sun et al. (2013) in their Beijing sample.

Similar to Figure 1, the regression results in Panel D of Table 3 reveal that there is little impact of the policy on real estate investment by property developers. The regression coefficient estimates for the four quarters' policy effect are positive (insignificant), indicating that property developers increased their investment regardless of the policy designed to cool the housing market. These findings are reinforced by the estimation results for the floor space started, under construction and completed presented in Panels A, B and C of Table 4. The overall evidence here suggests that HPR policy is ineffective in taming the massive property construction boom.

Table 3 Trend Break Estimates of the Policy Effect on Housing Sales and Investment

This table presents the regression results for sale unit, sale floor and sale amount for new homes as well as investment by the developers. Columns 1, 2 and 3 report the estimation results for the specifications of 2A, 2B and 2C, respectively. Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
Panel A. SaleUnit			
$\pi_1: l(Policy)$	877.99 (1,111.68)	-4,329.06** (1,644.34)	-4,329.75*** (1,333.83)
$\pi_2: Time\ Trend$		613.15*** (167.64)	1,081.28*** (212.06)
$\pi_3: l(Policy) \times time\ trend$			-795.07** (276.36)
4-quarter effect = $\pi_1 + 4\pi_3$			-7510.0***
p -Value			[0.00]
Observations	17	17	17
Panel B. SaleFloor			
$\pi_1: l(Policy)$	20.04 (107.97)	-442.75** (170.65)	-449.40*** (137.68)
$\pi_2: Time\ Trend$		54.48*** (17.37)	104.60*** (22.17)
$\pi_3: l(Policy) \times time\ trend$			-83.49** (28.61)
4-quarter effect = $\pi_1 + 4\pi_3$			-783.3***
p -Value			[0.00]
Observations	17	17	17
Panel C. SaleAmount			
$\pi_1: l(Policy)$	972.43 (1,696.00)	-4,247.24 (3,116.36)	-4,244.03** (1,944.24)
$\pi_2: Time\ Trend$		614.65* (317.72)	1,750.73*** (309.01)
$\pi_3: l(Policy) \times time\ trend$			-1,930.47*** (402.80)
4-quarter effect = $\pi_1 + 4\pi_3$			-11965***
p -Value			[0.00]
Observations	17	17	17
Panel D. Investment			
$\pi_1: l(Policy)$	4,189.16*** (725.36)	-428.02 (478.88)	-432.95 (434.71)
$\pi_2: Time\ Trend$		543.20*** (48.80)	438.31*** (68.70)
$\pi_3: l(Policy) \times time\ trend$			179.55* (89.89)
4-quarter effect = $\pi_1 + 4\pi_3$			285.26
p -Value			[0.25]
Observations	17	17	17

The reduction in land price and sales revenue is strongly related with the policy. The results presented in Panels D and E of Table 4 suggest that the land price and land sales revenue slumped by RMB 3483 and RMB 7.8 billion four quarters after the policy was mandated. This implies that the top-down effort in curbing the housing prices surge via HPR policy could hardly be supported by the local authorities that rely excessively on the revenue from land sales to finance their spending and investment in infrastructure.

Table 4 Trend Break Estimates of the Policy Effect on Construction and Land Sales

This table presents the regression results for the floor space started, floor space under construction, land price and land sales revenue. Columns 1, 2 and 3 report the estimation results for the specifications of 2A, 2B and 2C, respectively. Robust standard errors are given in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
Panel A. FloorStarted			
$\pi_1: l(\text{Policy})$	279.12** (95.65)	196.87 (195.77)	196.02 (202.10)
$\pi_2: \text{Time Trend}$		9.68 (19.94)	18.98 (32.40)
$\pi_3: l(\text{Policy}) \times \text{time trend}$			-15.59 (41.96)
4-quarter effect = $\pi_1 + 4\pi_3$			133.68
p-Value			[0.62]
Observations	17	17	17
Panel B. FloorUnderConstruction			
$\pi_1: l(\text{Policy})$	4,519.11*** (602.06)	803.13 (491.48)	802.69 (509.59)
$\pi_2: \text{Time Trend}$		437.18*** (50.09)	427.82*** (80.54)
$\pi_3: l(\text{Policy}) \times \text{time trend}$			16.03 (105.37)
4-quarter effect = $\pi_1 + 4\pi_3$			866.79
p-Value			[0.36]
Observations	17	17	17
Panel C. FloorCompleted			
$\pi_1: l(\text{Policy})$	166.49** (63.87)	120.50 (131.57)	121.58 (126.17)
$\pi_2: \text{Time Trend}$		5.41 (13.41)	28.14 (19.94)
$\pi_3: l(\text{Policy}) \times \text{time trend}$			-38.91

			(26.09)
4-quarter effect = $\pi_1 + 4\pi_3$			-34.05
<i>p</i> -Value			[0.45]
Observations	17	17	17
Panel D. LandPrice			
π_1 : <i>l</i> (Policy)	-74.86	-1,941.72*	-1,931.48*
	(583.78)	(1,063.34)	(973.19)
π_2 : Time Trend		219.68*	446.40**
		(108.39)	(153.88)
π_3 : <i>l</i> (Policy) \times time trend			-387.93*
			(201.28)
4-quarter effect = $\pi_1 + 4\pi_3$			-3483.00**
<i>p</i> -Value			[0.02]
Observations	17	17	17
Panel E. LandRevenue			
π_1 : <i>l</i> (Policy)	-221.31	-2,483.84	-2,448.37
	(1,157.04)	(2,292.92)	(1,552.70)
π_2 : Time Trend		266.25	1,052.09***
		(233.72)	(245.51)
π_3 : <i>l</i> (Policy) \times time trend			-1,344.65***
			(321.15)
4-quarter effect = $\pi_1 + 4\pi_3$			-7826.00***
<i>p</i> -Value			[0.00]
Observations	17	17	17

5.3 Robustness Check

This section performs two robustness checks to verify the validity of two-step DID method, including the structural break test and different sample test.

5.3.1 Structural Break Test

This subsection employs the structural break test developed by Greenstone and Hanna (2014) to check the robustness of the two-stage DID design. The basic idea is to assess if there is a structural break in the policy parameters (i.e., π_1 and π_3) estimated from the second-stage specification of equation (2C) around the time of policy implementation. The test first identifies the time at which the largest change in parameters (proxied by the largest change in the *F*-statistics) occurs and then generates *p*-values to judge if the changes in

those parameters are different from zero. A significant break around the time of policy implementation, i.e. $\tau = 0$, or some quarters after $\tau = 0$ would prove the existence of a policy effect from the DID results. In contrast, failure to find a break or finding of a break significantly before the time of policy adoption implies the ineffectiveness of the policy.

Greenstone and Hanna (2014) use the Quandt likelihood ratio (QLR) statistic to select the maximum value of the F -statistics to test the existence of a break at an unknown date. We use the same method and report the results in both Figure 2 and Table 5. As shown in Figure 2, the structural breaks of NBS price index of newly constructed (*PINew.NBS*) and secondary residential house (*PISecund.NBS*) occur before the policy implementation while the QLR statistic identifies the significant breaks three quarters preceding the event. This finding implies the ineffectiveness of the policy in curbing the growth of housing price, which is also consistent with the small effect of HPR policy on official price index shown in the previous two subsections. However, the test on the price index calculated by FGXZ (2015) is very significant, implying the precipitous drop of housing price three quarters after the policy enforcement, i.e. $\tau = 3$. The evidence is consistent with FGXZ (2015) in the sense that their housing price index has better quality than NBS data.

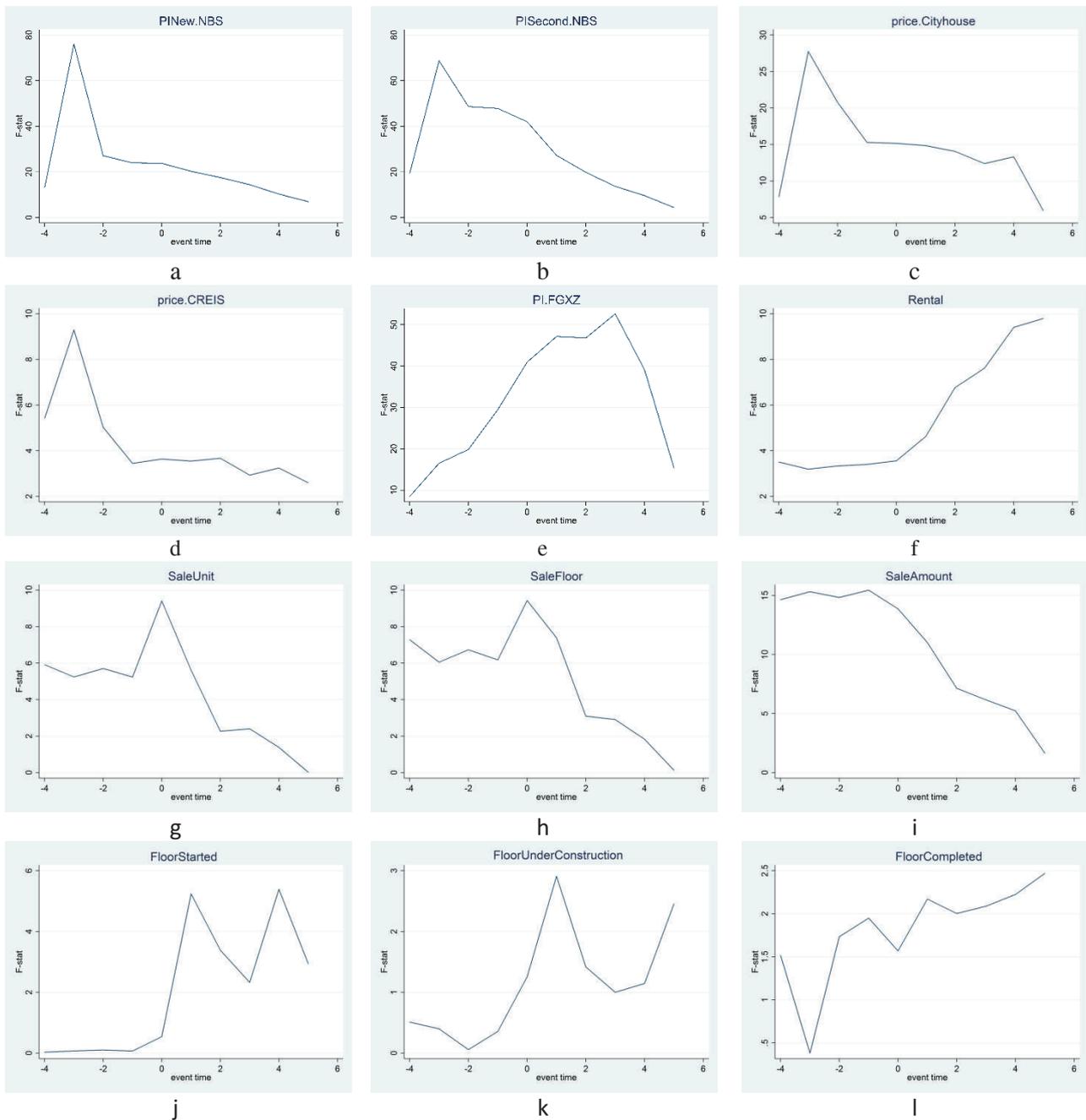
With respect to the transactions, Figure 2 evidently picks the occurrence of the biggest F -statistics around $\tau = 0$. Moreover, Table 5 reveals that the null hypothesis of no break at $\tau = -1$ can be significantly rejected for the sales amount. These findings further prove that the policy causes significant and sharp decline in the property transaction volume.

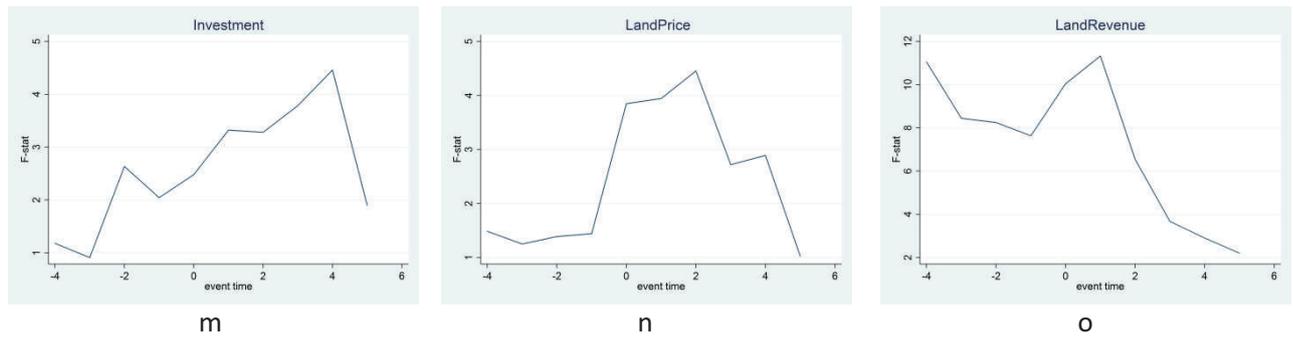
The structural break test results for the real estate investment, floor space started and construction are broadly supportive on the findings of the previous two subsections. The breaks representing by the largest F -statistics are found at $\tau = 3, 4$ and -4 respectively

where the null hypothesis of zero effect cannot be rejected, confirming that the policy do not change the construction boom, neither does it help address the potential oversupply of housing in the market.

Figure 2 F-statistics from QLR Test

The figure shows the structural break tests using Quandt likelihood ratio (QLR) statistic. The horizontal axis is the event time τ . The vertical axis is the F-statistics for the QLR tests.





The QRL test shown in Figure 2 for the land sales revenue evidently selects $\tau = 1$ as the event time with the most substantial break. Table 5 reinforces that the null hypothesis of no break at $\tau = 3$ can be rejected at high significance. This result further proves the decline of land sales revenue triggered by the HPR policy.

Table 5 Structural Break Analysis

Table 5 presents the results of structural break tests using the QLR test statistic and the corresponding quarter of the break in the data estimated from the specification of equation (2C). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

	Quarter of maximum F -statistics	QLR test statistic
<i>PINew.NBS</i>	-3	76.007***
<i>PISecond.NBS</i>	-3	68.713***
<i>Price.Cityhouse</i>	-3	27.751***
<i>Price.CREIS</i>	-3	9.294
<i>PI.FGXZ.</i>	3	52.614***
<i>Rental</i>	5	9.794
<i>SaleUnit</i>	0	9.405
<i>SaleFloor</i>	0	9.4297
<i>SaleAmount</i>	-1	15.456***
<i>Investment</i>	4	4.462
<i>FloorStarted</i>	4	5.387
<i>FloorUnderConstruction</i>	1	2.908
<i>FloorComplete</i>	5	2.469
<i>LandPrice</i>	2	4.453
<i>LandRevenue</i>	1	11.324**

5.3.2 Robust Test with Different Samples

The sample from NBS data on property price index report relatively few observations. We use other data sources and increase the sample to 139 cities (45 of them with the home

purchase restriction policy). All the robust tests with the enlarged sample are reported in the Appendix. Appendix C maps the location of these cities. Appendix D reports the two step-DID estimation results that are consistent with those for the sample of 70 cities. Several points need to be noted: first, the decrease in the housing prices or price index following the policy implementation is much larger than that for the 70 city samples. Second, the transaction measured by the sale amount, sales unit and floor space sold plummeted significantly after the policy is in force, although smaller in magnitude than that for the 70 city samples. Third, the HPR policy has no measurable impacts on the housing construction and investment. Forth, the land price and land sales revenue plunged sharply after the policy was enacted.

6. Political Connections and HPR Policy Implementation: An Endogenous Treatment Effects Regression

We further address the endogeneity problem of HPR policy. Since the implementation of HPR policy is not random, some unobservable factors may affect the policy implementation and housing price growth simultaneously.

We employ an endogenous treatment effects model¹⁵ to address the non-random adoption of HPR policy. Under this framework, we have an outcome equation and a treatment equation where the treatment is binary and the outcomes are continuous variables. The outcome equation describing the growth of housing price (y_j) can be expressed as:

$$y_j = X_j\theta + \delta T_j + \epsilon_j. \quad (3)$$

¹⁵ See Imbens (2004); Cameron & Trivedi (2005), chapter 2.7; Imbens & Wooldridge (2009); and Wooldridge (2010), chapter 21 for more detailed discussions of the treatment effects model.

where X_j is a set of observable covariates affecting the housing price movements, including the disposable income, residential population, and developed area of city construction. ϵ_j is an idiosyncratic error term. T_i is the treatment variable representing a city's policy implementation as follows:

$$T_i = \begin{cases} 1, & \text{if } W_j\gamma + u_j > 0 \\ 0, & \text{otherwise} \end{cases} \quad (4)$$

where W_j are the covariates used to model treatment assignment. The error terms ϵ_j and u_j are bivariate normal with mean zero and covariance matrix of

$$\begin{bmatrix} \sigma^2 & \rho\sigma \\ \rho\sigma & 1 \end{bmatrix} \quad (5)$$

where ρ measures the correlation between the treatment errors and the outcome errors. The covariates X_j and W_j are unrelated to the error terms; in other words, they are exogenous.

We instrument the assignment of treatment or implementation of HPR policy with local governors' political connection with the central government. In China, central and local governments have conflict of interest in the property sector (Li, Chiang and Choy, 2011). In the wake of US subprime mortgage crisis, Chinese central government wishes to curb the housing bubble and avoid potential financial risks, while local governments rely heavily on the real estate sector for GDP growth and fiscal revenue. As pointed out by de Mesquita, Smith, Siverson and Morrow (2003), the key objective for any government is political survival and the key condition for survival is to have ample financial resources under government control. In China, local governors with a strong political connection not only have higher probability of promotion but also can easily get fiscal resources (like transfer from the central government) to promote economic growth, rather than rely heavily on the real estate sector (Huang and Chen, 2012). Hence, to what degree local governments

would comply with the central government's objective to cool housing market depends on local authorities' political connection with the central government

Under China's current political system, the Communist Party is responsible for the formulation of policies and the government is responsible for its day-to-day execution. A city's party secretary the leader of the Communist Party in an administrative region, hence is the *de facto* highest political office of its area of jurisdiction and more senior than the mayor. He plays a critical role in the local policy making by selecting key government officials and assigning crucial tasks. Therefore, whether a city would implement HPR policy is mainly decided by its party secretary's willingness and political connection with the central government.

A city's party secretary is connected with central government via three forms: 1) being the member of Communist Party's Central Committee or National Party Congress; 2) being the member of the National People's Congress (NPC); or 3) having been worked for the central government before. Although the NPC is the top legislative organization in China, the Communist Party is the ultimate controller of power. The Central Committee, the highest committee-level authority within the CCP, is elected by the National Party Congress every five years. The present 18th Central Committee elected in 2012 has approximately 200 members; among those, 25 occupy a seat in the Political Bureau (*Politburo*), where the ultimate authority of the CCP rests. Below the Central Committee, there are approximately 200 alternate members to replace the committee members who have either died or been dismissed.

To reflect the features of the Chinese political system and estimate its influence on the HPR policy adoption, we follow Huang and Chen (2012) to construct a political connection

index for each city in the year of 2011 when the HPR policy was enforced by most cities. In the calculation, we assigned a value of 7 to municipal party secretaries who are *Politburo* members; a value of 5 to those who are Central Committee members or previously worked for the central government; a value of 4 to those who are Central Committee alternate members; a value of 3 to those who are the members of National Party Congress; a value of 2 to those who are the members of NPC; and a value of 1 to those not belong to any of these categories. We obtain the name list of the party secretaries for each city from Zecheng website and biographies of city party secretaries mainly from Baidu Encyclopedia.

A comprehensive study of the advancement of Central Committee members in China indicates that the promotion of local governors to the Central Committee is closely related to the factional ties to top leaders, but not to economic growth (Shih, Adolph and Liu, 2012). Moreover, the timing of appointments of the members of Central Committee and National Party Congress closely follows the central political cycle. Most of new appointment is made in the year prior to or in the same year as the beginning of a new *Politburo* term.¹⁶ This implies that the political connections of most cities' party secretaries in 2011 was decided in 2006 or 2007, long before the HPR policy was enforced. In addition, according to the Chinese cadre system, the assignment of central government officials to the positions at local jurisdictions is decided by the Organization Department that holds over personnel throughout every level of government and industry and uses the *nomenklatura* method to determine appointments.¹⁷ Therefore, the political connection index we constructed should satisfy the exclusion restriction requirement.

¹⁶ The three recent turnovers of Politburo took place in 2002, 2007 and 2012.

¹⁷ *Nomenklatura* is "list of names" in Soviet terminology.

Table 6 reports the endogenous treatment effects regression results estimated by the maximum likelihood approach. For the outcome equation, the dependent variable (y_j) is the percentage change of housing price from 2012 to 2013, the independent variable of our main interest is HPR policy. The coefficient on HPR policy measures the average treatment effect of the policy. We employ the percentage change of disposable income, developed area of city construction and residential population from 2012 to 2013 to control the demand and supply side factors that might affect the housing price movement. In the treatment equation, besides the political connection index, the percentage change of housing price from 2008 to 2009 is included to account for the concern that the rampant housing price surge prior to the policy adoption results in the enforcement of HPR policy. The likelihood-ratio (LR) tests for regression (2) and (3) presented in the bottom of panel A are statistically significant, indicating that we reject the null hypothesis of no correlation between the treatment errors and the outcome errors. This suggests that the adoption of the HPR policy is endogenous. In the treatment equation, the coefficient on the political connection is statistically significant, implying that cities with higher political connection with the central government are more likely to adopt HPR policy to curb the housing bubble. In the outcome equation, the coefficients on HPR policy or the average treatment effects (ATE) of the policy, are significantly negative, hinting the effectiveness of the HPR policy in dampening housing price growth. Taking regression (1) as an example, the housing price growth rate in the adopting cities is on average 0.12% lower than the nonadopting cities.

Table 6 HPR policy and housing price with endogeneity treatment effects regression

Panel A. Outcome equation				
	(1)	(2)	(3)	(4)
	% Δ PI.FGXZ.	% Δ Price.CREIS	% Δ PINew.NBS	% Δ Price.Cityhouse
HPR policy	-0.12*** (0.04)	-0.20*** (0.00)	-0.03*** (0.01)	0.04 (0.05)
% Δ disposable income	0.24 (0.22)	-0.29 (0.29)	0.01 (0.08)	-0.27 (0.17)
% Δ developed area of city construction	0.11 (0.08)	-0.05*** (0.01)	0.00 (0.03)	0.01 (0.06)
% Δ residential population	0.48 (0.87)	2.09** (1.02)	0.19 (0.31)	0.68 (0.67)
LR test of $\rho = 0$	1.265	12.73	7.079	=0.170
p-value	0.261	0.000	0.008	0.681
Observation	51	41	69	69
Panel B. Treatment equation: determinants of adopting HPR policy				
Political connection in 2011		0.174** (0.102)		
% Δ housing price before policy adoption		11.428* (6.964)		
Constant		-0.882** (0.441)		
AIC		91.7796		
BIC		98.498		
Log likelihood		-42.898		

Note: standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

7. CROSS-SECTIONAL TESTS OF POLICY EFFECTS

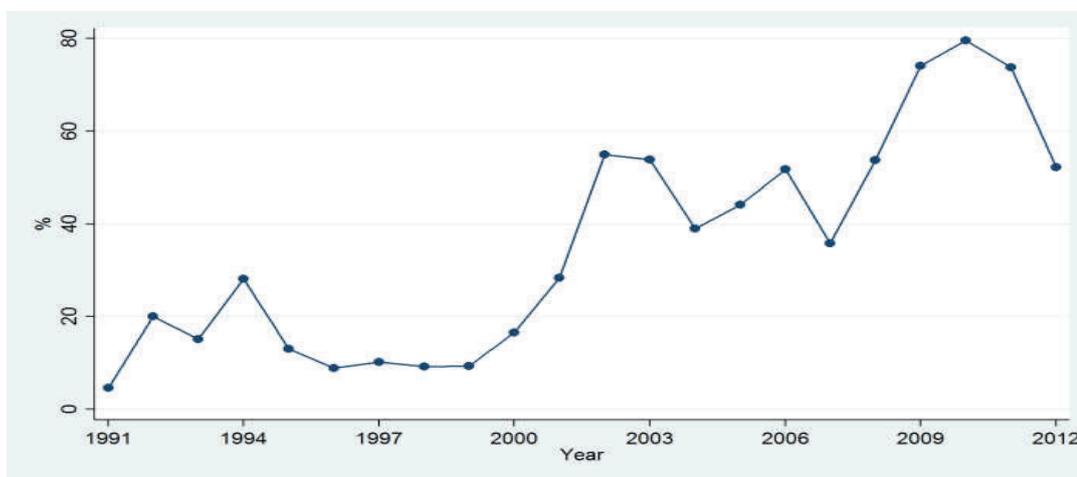
Since real estate market carries quite a few of local characteristics, the effect of HPR policy on different cities can vary greatly. In this section, we follow Greenstone and Hanna (2014)'s practice to compare the policy effects across cities. The main idea is to divide the sample cities into those with above and below the median value of a given proxy, estimate separate σ_{τ} s for these cities with equation (1), stacking the two sets of σ_{τ} s obtained from the estimation of equation (2C), and then test whether $\pi_1 + 4\pi_3$ is the same for the two sets of policy adopting cities. We divide cities into two groups according to three different measures: their reliance on land sales for fiscal revenue, dependence on real estate investments for economic growth, and pace of urban expansion.

A. Land Finance

Land and housing are important fiscal sources in many countries, but China’s land finance, or heavy and growing fiscal reliance on land sales revenue by the local authorities, carries several important characteristics that generate far-reaching impacts on the real estate market.

Figure 3 Ratio of Land Sales Revenue to Budgetary Revenue of Municipal Governments

The data for the years of 1989-2009 is from Barth et al. (2012) and the rest is calculated by the authors where the data of land sales revenue is obtained from China Land & Resources Yearbook (2011-2013) and the data of budgetary revenue is from CEIC.



Under the current intergovernmental fiscal relationship established in 1994, local governments currently receive half the nation’s fiscal revenue but are responsible for 80% of spending (The Economist, 2014). Facing heavy expenditure responsibilities, local governments depend heavily on off-budgetary sources such as profits from expropriating farmers’ land, revenue related to land sales and transactions, and so forth (Huang and Chen, 2012). As shown in Figure 3, the ratio of land sales to municipal government budgetary revenue¹⁸ increased from less than 1% in the early 1990s to around 80% in 2010. Among our 70 sample cities, the average ratio of land sales revenue to budgetary revenue for the

¹⁸ Budgetary revenue consists mainly of tax revenue and state-owned enterprise contributions.

years of 2001-2011 shows large variations across cities ranging from 11% to 117%. Cities having meager fiscal resources or tremendous needs for infrastructure investment exhibit higher degree of reliance on land finance.

Besides, land finance builds up a territory-based coalition between local governments and real estate developers both of whom cash in their political power and expand their wealth in a reciprocal way through the increasing intensification of land use (Fu, 2014). For example, by investing in the urban infrastructure with the land sales revenue, local authorities could prop up the sales of real estate and facilitate the flow of capital and goods, consistent with enlarged 'tax base' of the city (Logan and Molotch, 2007).

However, tremendous negative externalities and social costs have arisen due to land finance, including soaring housing prices, forcible land seizures in cities, rural land expropriation, unrests related to land and housing problems (Lin, 2009) and debt-laden local fiscal system (Tsui, 2011). In terms of the impacts on real estate market, although the immense land sales revenue spurs the local authorities to increase the supply of land for urban residential purposes (Chen et al., 2011), it also inflates housing prices by imposing substantial yet mandatory costs on real estate development (Fu, 2014).

B. Real Estate Investment dependence

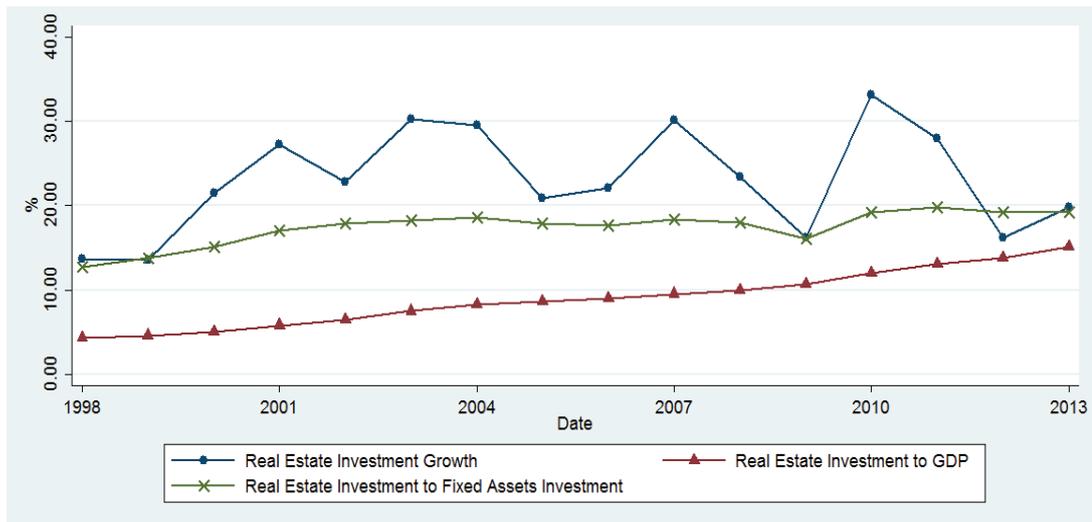
A considerable volume of literature has investigated the dynamic interaction between real estate investment and economic growth (for example, Braid, 2001; Brito and Perreira, 2002; Coulson and Kim, 2000; Liu et al. 2002). However, the role of real estate investment in Chinese economy is an issue merits special scrutiny.

China's more than a decade of spectacular economic growth, much of it in double digits, is mainly achieved by the gigantic investment whose share in the total economic

activity is as high as around 50% in 2012.¹⁹ As shown in Figure 4, being the most significant contributor to the GDP growth, the real estate investment has grown at an average annual pace of 23% for the last 15 years. Given its extensive industrial linkage, real estate investment is of particular importance to create job opportunities and hence stave off social unrest for China whose workforce swelled by about 145 million from 1990 to 2008 (The Economist, 2012). Real estate-related industries, in particular, construction, steel, cement, copper and glass industries are key job providers for low skilled workers in China.

Figure 4 The Importance of Real Estate Investment in the Economy

The figure depicts the percentage of real estate investment to GDP, real estate growth rate and real estate investment to national fixed asset investment. The data is obtained from CEIC.



Moreover, under China’s current political systems, achieving high economic growth is the main promotion criterion for local authorities. Driven by this target, local governments fostered reckless real estate investment across the nation, especially after

¹⁹ According to China Statistical Yearbook 2013, the capital formation rate, which is computed as the share of gross capital formation in the GDP by expenditure approach, amounts to 47.8% in 2012.

2008 when housing is chosen as a key part of the economic rescue plan to fight against the global financial crisis. However, such spectacular building boom would be unsustainable as the housing market matures, population ages, urbanization slows down, and the rate of return of investment declines (Bai, Hsieh and Qian, 2006). Empty buildings and ghost towns have testified to the oversupply of housing and massive misallocation of resources in China.

Overinvestment in housing is more acute in smaller cities, where new drivers of growth are often lacking. To measure the importance of real estate investment to local economy, we calculate the average ratio of real estate investment to fixed asset investment as well as to GDP for the years of 2005-2013. The latter ratio varies substantially from 4% to 50% among our 70 sample cities, with Sanya topping in the dependence of property investment.

C. Urban sprawl

China's property boom is accompanied by the country's impressive and unprecedented urbanization process whose speed has been much faster than that in Western countries during their industrial transformations. It took China only 30 years to climb from 20% of urbanization to today's 54% while the equivalent journey took 100 years in Britain and 60 years in America (The Economist, 2014).

Some believe that the urbanization and internal migration is one of the most important forces to purport Chinese property boom (Economic Intelligence Unit, 2011). However, a very special feature of Chinese urbanization process is that the growth of urban area has outstripped the growth of urban residents. On average, the built-up areas across the country have recently been growing by 8% a year whereas their populations have been rising by

only 5% (The Economist, 2014)²⁰. As a result, for the years of 2000-2011, the urban built-up areas grow by 76.4% while the urban population only increases by 50.5% (Southern Weekly, 2014)²¹. The gap is far wider in inland cities with urban areas growing three times faster than their populations. In those cities where the urban area is expanding too fast, the stock of new housing is also soaring and hence would have a serious problem of structural oversupply. The ratio of urban land area in 2010 to that in 1980 released by the Beijing City Lab (BCL)²² indicates that the population density in around a quarter of cities is declining as the growth of urban population lags behind the growth of urban area.

7.2 Quantitative Evidence

Table 7 reports the test results of how the HPR policy effect four quarters after implementation varies in cities with above (relative to below) the median measures of land finance reliance, real estate investment dependence and urban expansion.

Table 7 Differences in Policy Effects across Cities

This table reports the results of how the HPR policy effect four quarters after implementation varies in cities with above (relative to below) the median measures of land finance reliance, real estate investment dependence and urban expansion.

	Land finance reliance (1)	Real Estate Investment/ fixed asset investment (2)	Real Estate Investment/GDP (3)	Urban Expansion (4)
Panel 1. PINew.NBS				
Difference in four quarter effect	-2.58	-4.4***	-2.3	-6.5***
p-value	[0.11]	[0.00]	[0.21]	[0.00]
Observations	34	34	34	33
Panel 2. PISecund.NBS				
Difference in four quarter effect	-2.56**	-4.26***	-3.84***	-4.15***
p-value	[0.05]	[0.00]	[0.00]	[0.00]
Observations	34	34	34	33
Panel 3. price.Cityhouse				

²⁰ The rampant urban sprawl is actually the result of local governments' ability to seize rural land at will. Moreover, local bureaucrats have a predilection for vast areas of concrete because massive buildings help to boost local officials' egos and brand their cities.

²¹ Available at <http://www.infzm.com/content/106082>

²² The data is released at the website <http://www.beijingcitylab.com/>. Beijing City Lab infers urban land for all Chinese cities at the prefectural level and above in 1980 and 2010 from remotely sensed images. The ratio between urban land area in 2010 and that in 1980 is used to approximate the degree of urban expansion in individual cities.

Difference in four quarter effect	-1153.00**	157.62	139.72	-885.7*
p-value	[0.03]	[0.70]	[0.93]	[0.01]
Observations	33	34	33	34
Panel 4. price.CREIS				
Difference in four quarter effect	1421.8	-99.62	1553.4	-752.00
p-value	[.11]	[10]	[0.19]	[0.15]
Observations	33	33	34	34
Panel 5. PI.FGXZ				
Difference in four quarter effect	0.02	-0.04	0.07	-0.03
p-value	[0.61]	[0.33]	[0.16]	[0.22]
Observations	34	34	34	34
Panel 6. Rental				
Difference in four quarter effect	-1.96**	2.20**	-0.32	-0.28
p-value	[0.03]	[0.01]	[0.72]	[0.72]
Observations	34	34	34	33
Panel 7. SaleUnit				
Difference in four quarter effect	4519.10	68.14	-7000.00**	2415.30
p-value	[0.22]	[0.99]	[0.05]	[0.39]
Observations	34	33	34	33
Panel 8.SaleFloor				
Difference in four quarter effect	352.76	64.22	-703.70**	-35.44
p-value	[0.31]	[0.68]	[0.05]	[0.93]
Observations	34	33	34	33
Panel 8.SaleAmount				
Difference in four quarter effect	4905.10	315.25	-5166.00	-2215.00
p-value	[0.28]	[0.94]	[0.41]	[0.89]
Observations	33	34	33	33
Panel 8.Investment				
Difference in four quarter effect	1947.0*	-387.60	-259.70	-907.90
p-value	[0.09]	[0.10]	[0.82]	[0.13]
Observations	34	34	34	33
Panel 9.FloorStarted				
Difference in four quarter effect	-68.21	-469.10	-390.60	-201.30
p-value	[0.89]	[0.59]	[0.80]	[0.76]
Observations	33	33	34	33
Panel 10. FloorUnderConstruction				
Difference in four quarter effect	810.54	1921.80	-64.64	1465.80
p-value	[0.47]	[0.07]	[0.39]	[0.27]
Observations	34	34	34	33
Panel 9.FloorCompleted				
Difference in four quarter effect	-127.60	527.91	125.48	-258.1
p-value	[0.68]	[0.14]	[0.69]	[0.57]
Observations	34	33	34	33
Panel 11.LandPrice				
Difference in four quarter effect	1458.30	-1650.00	1085.20	-3082.00
p-value	[0.58]	[0.48]	[0.70]	[0.16]
Difference in eight quarter effect	1700.20	-2615.00	1226.70	-4177.00
p-value	[0.66]	[0.46]	[0.62]	[0.13]
Observations	34	34	34	34
Panel 12.LandRevenue				
Difference in four quarter effect	1741.80	-2675.00	-1530.00	205.91
p-value	[0.60]	[0.45]	[0.62]	[0.90]
Observations	33	34	34	34

The results for the three price indicators, i.e. *PINew.NBS*, *PISecond.NBS* and *Price.Cityhouse* are significantly negative, implying that the cities with land finance reliance, real estate investment dependence and urban expansion pace above the median value experience larger decline in the housing price. Moreover, panel 7 and 8 indicates that cities who have higher ratio of real estate investment to GDP observe more drops in housing sales. These findings indicate that housing market is more fragile in these cities. An external demand shock like the implementation of HPR policy would trigger larger corrections in them. No significant differences in investment and construction of real estate are found between two groups of cities, hinting the overheated property boom all over the nation.

8. CONCLUSION

Due to the skyrocketing housing prices across the nation and the failure of traditional macroprudential policies to contain speculation in the property market, Chinese central government encourages local authorities to impose HPR policy to curb real estate speculation and stabilize housing prices. Among our sample of 70 cities, 39 local authorities adopted HPR policy starting from 2010. With a comprehensive real estate market data, this research systematically investigates the impacts of Chinese HPR policy on the property markets. To address endogeneity problems and infer casual relation, we employ two empirical strategies including the two-step DID approach and endogenous treatment effects regression. We find that HPR policy leads to significant changes in the housing market.

HPR policy has negative impact on property price as well as remarkable effect in reducing transaction volume. The policy seems to be effective in dampening housing demand. However, the policy failed to restrain the nationwide property construction boom. Investment by property developers actually increased after the implementation of the policy. The cross sectional tests show that the HPR policy has more pronounced effect on housing prices for cities with heavy reliance on real estate, while these cities continue greater property investment and construction boom than those with less dependence on housing market.

Our findings cast serious doubts on the overall effectiveness of HPR in China. Such a policy seems to work temporarily well to stabilize housing prices and repress housing transaction volumes, but it does not correct a potential housing market excess supply. We first time provide empirical study that cities experience great investment or construction boom. This pattern is more pronounced in cities with high dependence on housing market for GDP growth and fiscal revenue. These evidences are consistent with government's misalignment of incentives and circumvention of the HPR policy.

From the policy perspective, our research suggests that the policies designed to contain the housing bubbles by choking demand may have limited effects. The housing problem in China needs to address some fundamental issues, e.g., lack of investment vehicles, the over-dependence of economic growth on real estate investment and the heavy fiscal reliance of local governments on land sales. The housing problem continues to present a fundamental risk to the Chinese and global economic stability. Governments should consider new ways of imposing transaction costs on speculators of both home purchasers and real estate developers.

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Appendix A Variable descriptions

Variable	Definition	Unit	Source
PINew.NBS	Property price index: newly constructed residential property	2005Q2=100	NBS, CEIC
PISecond.NBS	Property price index: secondary residential property	2005Q2=100	NBS, CEIC
Price.Cityhouse	Price of secondary residential property	RMB per square meter	City House
PI.FGXZ	Property price index estimated by FGXZ (2015)	2009Q1=1	FGXZ(2015)
Rental	Rental Price of residential property	RMB per square meter	City House
SaleUnit	Number of flats sold: newly constructed residential property	Unit	CREIS, CEIC
SaleFloor	Floor space sold: newly constructed residential property	thousand square meters	CREIS, CEIC
SaleAmount	Sales amount of newly constructed residential property	RMB million	CREIS, CEIC
Investment	Investment on new residential property seasonality adjusted	RMB million	NBS, CEIC
Floorstarted	Floor space started	thousand square meters	CREIS, CEIC
Floorconstruction	Floor space under construction	thousand square meters	CREIS, CEIC
LandPrice	Land Price	RMB per square meter	CREIS
LandRevenue	Land Sales Revenue	RMB million	CREIS
Population	Resident Population	thousand person	CREIS, city and provincial yearbook
DPI	Disposable Income per Capita Seasonality Adjusted	RMB	NBS, CEIC
GDPPC	GDP per capita	RMB	NBS, CEIC

Appendix B Implementation of home purchase restriction policies across 70 cities

No.	Name	Starting date	Ending date	Policy implementation	No.	Name	Starting date	Ending date	Policy implementation
1	Beijing	01-05-2010		YES	36	Tangshan			NO
2	Tianjin	01-03-2011	01-08-2014	YES	37	Qingdao			NO
3	Shijiazhuang	21-02-2011	26-09-2014	YES	38	Baotou			NO
4	Taiyuan	19-02-2011	04-08-2014	YES	39	Dandong			NO
5	Hohhot	31-03-2011	24-06-2014	YES	40	Jinzhou			NO
6	Shenyang	25-02-2011	10-06-2014	YES	41	Jilin			NO
7	Dalian	19-11-2010	03-09-2014	YES	42	Mudanjiang			NO
8	Changchun	28-01-2011	19-07-2014	YES	43	Wuxi	20-02-2011	30-08-2014	YES
9	Harbin	28-02-2011	16-08-2014	YES	44	Yangzhou			NO
10	Shanghai	01-02-2011		YES	45	Xuzhou	01-05-2011	01-08-2014	YES
11	Nanjing	19-02-2011	21-09-2014	YES	46	Wenzhou	14-03-2011	30-07-2014	YES
12	Hangzhou	01-03-2011	29-08-2014	YES	47	Jinhua	31-03-2011	01-08-2014	YES
13	Ningbo	22-02-2011	30-07-2014	YES	48	Bengbu			NO
14	Hefei	31-03-2011	02-08-2014	YES	49	Anqing			NO
15	Fuzhou	10-10-2010	01-08-2014	YES	50	Quanzhou			NO
16	Xiamen	01-10-2010	01-07-2014	YES	51	Jiujiang			NO
17	Nanchang	01-02-2011	12-08-2014	YES	52	Ganzhou			NO
18	Jinan	21-01-2011	10-07-2014	YES	53	Yantai			NO
19	Qingdao	31-01-2011	01-08-2014	YES	54	Jining			NO
20	Zhengzhou	31-12-2010	09-08-2014	YES	55	Luoyang			NO
21	Wuhan	14-01-2011	24-09-2014	YES	56	Pingdingshan			NO
22	Changsha	04-03-2011	06-08-2014	YES	57	Yichang			NO
23	Guangzhou	15-10-2010		YES	58	Xiangyang			NO
24	Shenzhen	30-09-2010		YES	59	Yueyang			NO
25	Nanning	01-03-2011	01-10-2014	YES	60	Changde			NO
26	Haikou	28-02-2011	22-07-2014	YES	61	Huizhou			NO
27	Chongqing			NO	62	Zhanjiang			NO
28	Chengdu	15-02-2011	22-07-2014	YES	63	Shaoguan			NO
29	Guiyang	20-02-2011	01-09-2014	YES	64	Guilin			NO
30	Kunming	18-01-2011	11-08-2014	YES	65	Beihai			NO
31	Xian	25-02-2011	01-09-2014	YES	66	Sanya	03-03-2011	07-10-2014	YES
32	Lanzhou	05-11-2010	03-09-2014	YES	67	Luzhou			NO
33	Xining	25-02-2011	10-09-2014	YES	68	Nanchong			NO
34	Yinchuan	22-02-2011	22-08-2014	YES	69	Zunyi			NO
35	Urumqi	28-02-2011	01-08-2014	YES	70	Dali			NO

Appendix C Location of 139 cities



Appendix D Trend Break Estimates of the Policy Effect in 139 cities

Table A1 Trend Break Estimates of the Policy Effect on Housing Price and Rental Price of 139 cities

This table presents the regression results for the NBS property prices index, as well as the transaction and rental price released by the City House. Columns 1, 2 and 3 report the estimation results for the specifications of 2A, 2B and 2C, respectively. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
Panel A. price.Cityhouse			
$\pi_1: I(Policy)$	512.77** (195.19)	-54.75 (362.57)	-66.97 (141.70)
$\pi_2: Time\ Trend$		66.88* (36.96)	222.34*** (22.71)
$\pi_3: I(Policy) \times time\ trend$			-261.06*** (29.43)
4-quarter effect = $\pi_1 + 4\pi_3$			-1111.00***
p-Value			[0.00]
Observations	17	17	17
Panel B. price.CREIS			
$\pi_1: I(Policy)$	547.15*** (183.71)	-7.32 (339.74)	-4.26 (244.71)
$\pi_2: Time\ Trend$		65.27* (34.64)	176.33*** (38.79)
$\pi_3: I(Policy) \times time\ trend$			-189.44*** (50.66)
4-quarter effect = $\pi_1 + 4\pi_3$			-762.00**
p-Value			[0.03]
Observations	17	17	17
Panel C. price.FGXZ.			
$\pi_1: I(Policy)$	0.02 (0.02)	0.03 (0.05)	0.03 (0.02)
$\pi_2: Time\ Trend$		-0.00 (0.01)	0.02*** (0.00)
$\pi_3: I(Policy) \times time\ trend$			-0.04*** (0.00)
4-quarter effect = $\pi_1 + 4\pi_3$			-0.11***
p-Value			[0.00]
Observations	17	17	17
Panel D. Rental			
$\pi_1: I(Policy)$	1.05*** (0.28)	-0.36 (0.38)	-0.35 (0.35)
$\pi_2: Time\ Trend$		0.17*** (0.04)	0.08 (0.06)
$\pi_3: I(Policy) \times time\ trend$			0.14* (0.07)
4-quarter effect = $\pi_1 + 4\pi_3$			0.20
p-Value			[0.68]
Observations	17	17	17

Table A2 Trend Break Estimates of the Policy Effect on Housing Sales of 139 cities

This table presents the regression results for sale unit, sale floor and sale amount for new homes as well as investment by the developers. Columns 1, 2 and 3 report the estimation results for the specifications of 2A, 2B and 2C, respectively. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
Panel A. SaleUnit			
$\pi_1: l(Policy)$	-229.09 (1,005.16)	-4,806.34*** (1,519.64)	-4,822.35*** (1,526.90)
$\pi_2: Time\ Trend$		538.82*** (154.79)	714.82** (244.61)
$\pi_3: l(Policy) \times time\ trend$			-295.41 (316.91)
4-quarter effect = $\pi_1 + 4\pi_3$			-6003.00***
p-Value			[0.01]
Observations	17	17	17
Panel B. SaleFloor			
$\pi_1: l(Policy)$	-69.12 (101.16)	-489.68*** (163.45)	-491.34** (166.17)
$\pi_2: Time\ Trend$		49.51** (16.65)	64.77** (26.68)
$\pi_3: l(Policy) \times time\ trend$			-25.54 (34.51)
4-quarter effect = $\pi_1 + 4\pi_3$			-593.40**
p-Value			[0.02]
Observations	17	17	17
Panel C. SaleAmount			
$\pi_1: l(Policy)$	-672.42 (1,098.17)	-4,948.22** (1,851.27)	-4,943.47*** (1,608.65)
$\pi_2: Time\ Trend$		503.24** (188.69)	963.91*** (255.30)
$\pi_3: l(Policy) \times time\ trend$			-784.07** (333.07)
4-quarter effect = $\pi_1 + 4\pi_3$			-8079.00***
p-Value			[0.00]
Observations	17	17	17

Table A3 Trend Break Estimates of the Policy Effect on Construction and Investment by the Developers of 139 cities

This table presents the regression results for the floor space started, floor space under construction, land price and land sales revenue. Columns 1, 2 and 3 report the estimation results for the specifications of 2A, 2B and 2C, respectively. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
Panel A. FloorStarted			
$\pi_1: l(Policy)$	215.66** (96.20)	46.15 (192.48)	47.58 (176.81)
$\pi_2: Time\ Trend$		19.93 (19.61)	60.46** (27.96)
$\pi_3: l(Policy) \times time\ trend$			-69.27* (36.55)
4-quarter effect = $\pi_1 + 4\pi_3$			-229.4
p-Value			[0.16]
Observations	17	17	17
Panel B. FloorUnderConstruction			
$\pi_1: l(Policy)$	4,046.98*** (909.21)	-272.80 (1,314.37)	-260.73 (1,331.37)
$\pi_2: Time\ Trend$		509.52*** (134.05)	376.65 (213.86)
$\pi_3: l(Policy) \times time\ trend$			222.59 (276.81)
4-quarter effect = $\pi_1 + 4\pi_3$			629.63
p-Value			[0.72]
Observations	17	17	17
Panel C. Investment			
$\pi_1: l(Policy)$	4,010.63*** (703.82)	-431.07 (475.60)	-418.99 (350.14)
$\pi_2: Time\ Trend$		523.40*** (48.48)	368.31*** (56.11)
$\pi_3: l(Policy) \times time\ trend$			260.49*** (72.72)
4-quarter effect = $\pi_1 + 4\pi_3$			622.96
p-Value			[0.03]
Observations	17	17	17

Table A4 Trend Break Estimates of the Policy Effect on Land Sales of 139 cities

This table presents the regression results for the floor space started, floor space under construction, land price and land sales revenue. Columns 1, 2 and 3 report the estimation results for the specifications of 2A, 2B and 2C, respectively. Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Panel A. LandPrice			
$\pi_1: l(Policy)$	375.19 (438.66)	-1,366.17* (728.01)	-1,372.96* (734.39)
$\pi_2: Time Trend$		205.19** (74.21)	284.42** (117.77)
$\pi_3: l(Policy) \times time trend$			-132.93 (152.56)
4-quarter effect = $\pi_1 + 4\pi_3$			-1904.00*
p -Value			[0.11]
Observations	17	17	17
Panel B. LandSalePieces			
$\pi_1: l(Policy)$	-9.62*** (0.92)	-7.34*** (1.77)	-7.34*** (1.81)
$\pi_2: Time Trend$		-0.27 (0.18)	-0.14 (0.29)
$\pi_3: l(Policy) \times time trend$			-0.22 (0.37)
4-quarter effect = $\pi_1 + 4\pi_3$			-8.23***
p -Value			[0.02]
Observations	17	17	17
Panel C. LandRevenue			
$\pi_1: l(Policy)$	-832.75 (883.42)	-3,136.94* (1,678.29)	-3,175.55** (1,419.61)
$\pi_2: Time Trend$		271.51 (171.08)	721.98*** (227.66)
$\pi_3: l(Policy) \times time trend$			-755.82** (294.90)
4-quarter effect = $\pi_1 + 4\pi_3$			-6198.00***
p -Value			[0.01]
Observations	17	17	17

11. Reasoning Behind Choices: Rationality and Social Norms in Housing Market Behaviour

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Abstract

The main objective of this paper is to draw attention to the influence of social norms on housing market behaviour. The research is based on in-depth qualitative study of first-time buyers in the Czech Republic. We found systemic deviations from economically rational behaviour (as defined by mainstream housing economic theory) that stem from influence of dominant housing social norm about ‘right’ housing tenure. We show how influence of social norm constrains financial, pragmatic, utility- or investment-based considerations of Czech home-buyers. Sociology can thus significantly contribute to recent econometric research about sources of housing market instability.

Key words: housing market – social norms – housing systems – house prices

Introduction

As real estate property is heterogeneous and property transactions occur infrequently, the available information on the housing market is limited (Evans 1995). The excess price volatility (called often bubbles) observed in the housing market signals that the available information is insufficient to adjust prices. Property prices tend to be positively autocorrelated and, as a result, the efficiency of the housing market has been questioned (Malpezzi 2005; Wheaton 1999).

The issue of housing market inefficiency became especially important after it was found that excess volatility of housing prices in OECD countries is increasing in time (Claessens et al. 2011; Bracke 2011). Traditional housing economics explains market inefficiency as due to the specific features of the housing market, such as the spatial fixity of housing, high transaction costs, housing supply restrictions and price inelasticity, mortgage regulations or other state interventions (Maclennan 1982). Malpezzi (2005) stresses the investment aspect of housing purchases, which attracts professional short-term speculators ('hot money') and accelerates any boom in housing prices. The application of behavioural economics in housing studies extended speculative motivations to general house-buyers (Case, Schiller 1988; Schiller 2000, 2008). According to behavioural economics, the fact that people extrapolate past experience (price increase) as the best predictor of the future (Nofsinger 2012) and do not base their price expectations on an analysis of fundamental trends results in a 'rationality bias' and, consequently, market inefficiency.

Over time it became clear that incorporating psychology into the study of housing-market processes made by behavioural economics is very fruitful. A number of behavioural economists proved that 'irrational' price expectations indeed exist and confirmed that such expectations had an influence on the excess volatility of housing prices observed after 2000 (see, for example, Case et al. 2011 and Sinai 2012 for US; Tsai 2013 for Taiwan). Case et al. (2011) wrote that Americans had turned into a 'nation of speculators'; a phenomenon explained in Schiller's *Irrational Exuberance* (2000) in terms of behavioural economics, such as the money illusion, false intuition and storytelling. In recent studies, self-fulfilling beliefs, irrational expectations and sentiments concerning expected future price trends have been considered to be the main sources of housing market inefficiency and excess price volatility (e.g., Schiller 2000, Kashiwagi 2014, Hui and Wang 2014, Kuang 2014, Kouwenberg and Zwinkles 2014, to name just a few of them).

However, econometricians were trying to incorporate both traditional economic sources of inefficiency and irrational backward-looking expectations about future housing price trends into their market models well before onset of the last global financial crisis, yet even this improvement of econometric house price models proved insufficient to reliably warn against the threat of instability and price swings (for an example see Girouard et al. 2006). Moreover, it has never been shown that in all the countries that experienced housing market inefficiency during the last unprecedented boom, buyers are primarily motivated to buy housing on the basis of expectations about the profit to be made from housing price appreciation.

In this paper we intend to show that through the study of social norms sociology may also significantly contribute to the knowledge of the actual foundations of the formation of housing demand and disequilibrium in the housing market, similar to the contribution of psychology through behavioural economics in the past. We show that social norms have a significant influence on the decision to buy housing and this influence constrains financial,

pragmatic, utility- or investment-based considerations that are studied in traditional or behavioural economics. The recent normative aspect of house-buying behaviour – present in sociological studies but overlooked by econometric research – adds to systemic deviations from economic rationality in the process of purchasing owner-occupied housing and this additional ‘rationality bias’ may potentially contribute to explanation of housing market inefficiency.

To the best of our knowledge, no previous sociological studies have surveyed the impact of social norms on the actual decisions of housing-market agents. The influence of emotions and affection on house-buying decisions during the peak boom phase in the housing market has only been empirically demonstrated (Munro and Smith 2008), but this specific phenomenon, which only appears at a particular point in market development and among a certain section of buyers, has limited power to explain inherent market inefficiency. We apply a novel conceptual research framework that was inspired by the successful application of psychology to economics (via behavioural economics). This concept is not fully in line with concepts recently applied by studies in economic sociology but it may represent an alternative bridge between sociology and mainstream economics. In other words, we do not intend to substitute mainstream economic theory by a new theory of market structure (as offered, for example, by New Economic Sociology) but uncover facts overlooked in their model applications. The main contribution of this paper is thus to show that sociological studies of the behaviour of housing-market agents may effectively help mainstream housing economics and econometrics in its search for warning mechanisms of future housing market and financial instability.

The remainder of this paper is structured as follows. Section 2 reviews the literature and describes the theoretical foundations of the study. Section 3 briefly describes the context of our research and section 4 its methodology. The findings are presented in section 5 and these are discussed together with wider policy implications in section 6.

Theoretical background

Sociology has been tackling the question of the nature of rational action/decision since its beginnings (e.g. M. Weber, V. Pareto) and continues to do so in the present. The question of what is or is not a rational decision has been the subject of perennial dispute, one that divides also mainstream economists and sociologists. However, in order to conceptualise the alternative and, we hope, novel contribution that sociology can make to mainstream economics, we - similarly to what psychologists did through behavioural economics (Tversky & Kahneman 1983) - clearly distinguish *economically rational* justifications from other forms of justification of market behaviour called *heuristics*; despite the fact that the latter may also be perceived as rational justification in economic sociology (such as, bounded rational justification). In other words, we acknowledge significant merit to econometric modelling of housing markets and use sociological theory and methods to contribute to housing economic research instead of setting alternative economic theoretical explanations. We use above-mentioned distinction of forms of justification only as a formal methodological way of enabling sociology to effectively contribute to housing econometrics and suspend any normative implications that this conceptual framing may have.

Let's define an *economically rational* behaviour as the kind of behaviour described in the standard individual-agent utility-maximising models of classic economic theory. Economically rational decision means the pragmatic, informed and analytical comparison of utilities, characteristics, benefits and costs of alternatives, limited by budget constraint. The dominant approach in housing economics, based on economically rational consumer choice theory and the present value concept, assumes that renting and owning the same bundle of housing services (i.e. a similar level of housing consumption and security) are economic substitutes (Smith et al. 1988, Muth & Goodman 1989, DiPasquale & Wheaton 1996, Meen 2002). Let's assume that one and the same flat with identical housing services and security can be purchased or rented. According to economic theory, an economically rational housing consumer should base his/her tenure considerations in this case on a comparison of rent (net of utilities, service costs, tax) and the user costs of homeownership, and will select the cheaper of those two alternatives (all other housing attributes are similar). The user costs of homeownership are defined by interest and depreciation costs, and, if relevant, less the expected house price appreciation. Economic theory thus perceives rental and owner-occupied housing as 'communicating vessels' – a change in conditions (prices) in one necessarily entails changes in the other. This is called a 'substitution effect' and it represents an important balancing mechanism of the housing market. The formal details are provided in Appendix 1.

The housing services and tenure security that are in practice offered by rental and owner-occupied housing are not however identical (Boehm 1982, Andersen 2011). Today, the level of tenure security in the rental housing sector is weaker than the security enjoyed by homeowners, in particular in terms of the duration of occupancy and the means available to tenants to protect themselves against unjustified rent increases. In many countries it is difficult to rent a family home, and the only way to reside in a family home is to buy one. The transaction costs of moving are substantially different for each of the two housing tenures. That is why references are often made to the link between housing tenure and migration choices (for an overview of this issue, see, for example, Lux & Sunega 2012): people who plan to move frequently are more likely to look for rental housing. State intervention is another factor that weakens the substitution: governments can use regulations and subsidies to prioritise one type of housing tenure over another. Poorly regulated investment markets may

lead market actors to prefer to invest in residential real estate as a way of securing income in old age.

However, a pragmatic and informed comparison of utilities that results in one form of housing tenure being favoured (preferred) over another does not negate the existence of the economic rationality and substitution effect – substitution continues to exist, though it is biased by transaction costs, state interventions, and the specific legislative context. Should these conditions change, the nature of the substitution would also change. When economic rationality is applied, the dynamics of tenure choice reflect changes in pragmatic comparison of utilities, benefits and costs at any given point in time.

Let's assume, however, that economic rationality is constrained by an informal social norm about what constitutes the 'right' form of housing tenure. The influence of this social norm may mean that in the process of making a decision between rental and owner-occupied housing, engaging in any pragmatic comparison of the benefits of the two alternatives may be rendered irrelevant beforehand. If selection of one of two theoretical substitutes is normatively predetermined and not based on an informed and pragmatic comparison of characteristics, qualities, utilities and costs, it creates a 'rationality bias' (from perspective of economic rationality) and the substitution effect is negated.

There is a considerable amount of sociological research, dating as far back as the 1980s, demonstrating that there indeed exists a social norm that deems homeownership is superior to renting, despite the comparable security of the two forms of tenure. Observations from various sociological studies (Boehm 1982, Krumm 1984, Coolen et al. 2002, Clark & Dieleman 1996, Clark et al. 2003, Bazyl 2009) gave birth to the concept of a 'housing career' and, in stratification studies, to the concept of 'housing class', both of which consider housing tenures hierarchically on a normative 'housing ladder'. Homeownership, and specifically ownership of a detached house, in many cultures figures at the top end of the ladder (see, for example, for US Saunders 1990; Clark & Dieleman 1996; Taylor 1999; Shlay 2006; for Australia Bourassa 1995; for Belgium De Decker & Geurts 2003; for UK Lauster 2010, Flint & Rowlands 2003; for Finland Ruonavaara 1996; for Japan Hirayama 2010).

A long but inconclusive sociological discussion took place about whether a normative housing ladder, and the position of homeownership at its top end, is an expression of a natural human preference or need (Saunders 1990) or whether this norm is imposed by elites (Lauster 2010) or some other visible (Kemeny 1978, 1981; Gabriel, Rosenthal 2005) or less visible power (Gurney 1999a, Doling & Ford 2003). Saunders (1990) views the desire for homeownership as deriving from the natural need for 'ontological security' and as a solution to the problem of alienation in capitalist society. By contrast, Lauster (2010) sees the sources of the norm in the incentives of the privileged to distinguish themselves from the marginalised members of society. Gurney (1999a) favours instead Foucault's concept of the omnipotent and invisible 'disciplinary' power, in the exercise of which homeowners figure as both objects and subjects; and he stresses the crucial role played by metaphor in the social construction of reality (Gurney 1999b). Doling & Ford (2003) highlight a less visible source of power arising out of recent globalisation, which puts constraints on public welfare spending: due to the globalisation of economic processes and budget cuts public welfare is being replaced by individual asset (housing)-based welfare.

Setting aside the fact that it is impossible to empirically rule out the plausibility of any of these theoretical concepts (see, for example, Mandic & Clapham 1996), these studies use data

only from surveys or qualitative studies of existing homeowners and not data on people who are actually making tenure choices – for example, young first-time buyers. The reason is straightforward: these studies seek to explain existing tenure inequalities rather than individual market and tenure decisions. Most of them only marginally touch on the economic aspects of home-buying.

Adherence to a norm may be a socially legitimate justification of the current situation of people who already own homes, but the question remains whether people, when they are actually making a decision that may lead to the biggest investment in their life, really do ignore the substitution effect? In other words, is the economically grounded substitutability of owning and renting ignored in actual tenure choice and, if it is, is this due to influence of a social norm? From this theoretical perspective, more important than the ‘ontology’ of the social norm is the comparison of economically rational and normative behaviour in the actual home-buying.

Market actors may adhere to a norm either unconsciously or on the basis of socially rational, conscious and strategic grounds. The first case is illustrated well by Bourdieu's sociological concept of *doxa*, i.e. tacit knowledge taken as given (Bourdieu 1993). Bourdieu defines *doxa* as ‘undisputed, pre-reflexive, naive, native compliance with the fundamental presuppositions of the field’ (Bourdieu 1993, p. 68; Everett 2002). *Doxa* is a practically oriented form of knowledge that is learned during socialisation and once learned it remains tacit and in most situations is taken for granted. It makes it possible for people to align their activities with their position in society and to acquire ‘a sense of one’s place’. In the field (such as the housing market), a *doxa* is sustained by the straight-reasoning (orthodox) majority, which controls the application and preservation of common knowledge by suppressing any ‘improper’ reasoning (heterodoxy; Bourdieu 1977, pp. 168–169). A *doxa* tends to be stable in time; and only a concerted effort on the part of prominent actors in the field can change it (Zelizer 1983).

Bourdieu’s concept of *doxa* does not suggest that actors are acting under the dictates of a given norm and that their actions are therefore purely mechanical; rather it is that the social norm constrains the behaviour of actors in the same way as it does their limited cognitive ability. As mentioned above, suggesting that economic rationality in tenure choice may be constrained by the influence of a social norm does not mean that rationality in the pursuit of social aims is not possible (Lindenberg 2001, Hertwig & Herzog 2009). A possible conceptualisation of social rationality can be achieved with the help of Erving Goffman’s concept of face-saving behaviour (Goffman 1967: 12). According to Goffman, a ‘face’ assigns a positive social value to the individual claiming it. If an individual behaves consistently, he may claim a face for himself. The fear of damage to or loss of face, which implies a lower social status, gives rise to various face-protecting and face-repairing strategies (Goffman 1967). It is worth noting that an effective face-protection strategy is to adhere to a commonly shared attitude or social norm (Krueger et al. 2008). Goffman’s theory closely relates to the concepts of reputation/respect (Kewell 2007) and social self-image (Sirgy et al. 2005).

To sum up our argument, we suggest that home-buying decisions are most often socially conditioned and that this conditioning manifests itself in two ways: unconscious adherence to a socially legitimate knowledge of the field (hereafter, housing social norm) and a strategic emphasis on presenting one’s good image (social rationality). Our main hypothesis is that adherence to a housing social norm and the socially rational behaviour this norm generates together have a significant influence on the decisions to buy owner-occupied housing. Home-buying decisions are complex; they include both economic and social motives and there is no

way to rank them. However, the influence of a social norm suspends the economically rational considerations stressed by mainstream economics and the speculative motives stressed by behavioural economics. Consequently, if the influence of a social norm on home-buying decisions is common and systemic, as we assume in our hypothesis, then sociology may be able to effectively assist recent economic studies in their search for the ‘rationality bias’ in market agents’ behaviour, which may help to explain housing market inefficiency and instability during econometric modelling of housing markets.

Context of the research

Our analysis focuses on the Czech Republic, where (1) there has been considerable growth in owner-occupied housing during the last three decades, caused by the privatisation of municipal housing; but where (2) housing tenure structure is not so markedly skewed in the direction of owner-occupied housing and a substantial part of the housing stock is rented; and where (3) rents have been deregulated and therefore rents are not distorted by state intervention. In 1991, the homeownership rate in the Czech Republic was 38%, co-op housing formed 19% and public rental 39% of the housing stock; private renting was almost non-existent. By 2011, the homeownership rate had risen to 56%, and co-op housing formed 9%, public rental 8% and private rental housing 14% of the housing stock.

The initial increase in private renting occurred in the early stages of the post-communist transition when apartment buildings that had been expropriated in the past by the communist regime were restituted to their owners or the owners' heirs (see details in Lux & Mikeszová 2012). In 1993 caps on rent were lifted from newly vacated flats (new tenancies), and soon after a large number of small landlords emerged in the market. The share of private rental housing out of the total housing stock consequently grew much faster than in advanced countries, going from almost zero in 1990 to 7% in 1993 (as a result of property restitution) and to 14% in 2011. Eventually a few institutional investors emerged in the Czech housing market; two of them became major private landlords in the local market.

The vast majority of rental tenancies recorded in the 2011 census were legal tenancies, i.e. based on a formal lease signed between landlord and tenant. The private rental market was stabilised by a rapid expansion of the housing stock and the deregulation of rents after 2007. While the average apartment price between 2000 and 2008 increased by almost 200%, the increase in average market rent in the same period was much more gradual – it grew by 64% (Lux & Sunega 2010). The value of the price-to-rent ratio increased; for example, in Prague, the national capital, it rose from 13.7 to 26.0. In 2008, in most regional capitals the average rent was below the level of the average user costs of homeownership (not including price appreciation). The market quickly changed from being supply-driven to demand-driven.

Methodology

The housing social norm (HSN), in accordance with the theory outlined above, is a value-loaded hierarchical ranking of housing tenures unconsciously adhered to or strategically adhered to by market actors; since it is perceived as taken-for-granted it does not need any empirical or analytical justification.

According to *Housing Attitudes Survey 2013*, a survey of the preferences and attitudes of the Czech adult population towards housing on a sample of 3,003 respondents,¹ 83% of adult Czechs agree with the statement 'living in your own home is *always* better than being a tenant, but not everyone can afford their own home' (53% agreed strongly with this statement). The survey also asked respondents to indicate what spontaneous associations they

¹ The survey was designed as a quota survey representative of the total Czech population: quotas included gender, age, education, size of the municipality, region and housing tenure.

make with owner-occupied and rental housing.² For owner-occupied housing the most common associations mentioned were ‘*well-being, peace, background*’, ‘*security*’, ‘*home*’; less frequent associations were ‘*my property, wealth*’, ‘*worries, work*’ and ‘*investment, mortgage*’. Respondents most often associated rental housing with ‘*troubles, insecurity, dissatisfaction*’, ‘*rent, fees*’ and less often also with ‘*security, comfort*’, ‘*problems, noise*’ and ‘*dependence and restrictions*’.

Respondents were also offered 13 loaded associations in two similar batteries of terms and were asked to choose the three that most come to mind when they think of owner-occupied housing (first battery) and the three that come to mind when they think of rental housing (second battery): the associations were *flexibility, no worries, freedom, insecurity, throwing money out the window, home, self-fulfilment, background, security, obligation, being tied down, troubles, investment*. For owner-occupied housing, value-positive or value-neutral associations were those most often selected: *home* (46% of respondents selected it at least once), *security* (43%), *background* (42%), *investment* (36%), *freedom* (26%), and *self-fulfilment* (22%). Conversely, value-negative associations were selected far less often: *troubles* (14%), *obligation* (12 %) and *being tied down* (8%). For rental housing, the associations that respondents selected most often were value-negative: *insecurity* (61% selected it at least once), *throwing money out the window* (46%) and *troubles* (33%). Value-positive associations were selected less often: *flexibility* (27%), *no worries* (25%) and *freedom* (16%). To illustrate, only 5% chose the term *home* from the selection of associations for rental housing.

A subsequent Principal Component Analysis for both batteries of associations³ confirmed the existence of a dominant black-and-white mental image of tenures that predetermines one type of housing tenure to be seen as value-superior to the other type of housing tenure: people who associate owner-occupied housing with ‘*home/security/background*’ significantly more often associate rental housing with ‘*insecurity/throwing money out the window/troubles*’.

Our main task is to find out whether this dominant mental image is (1) known and (2) adhered to or strategically adhered to by actual house-buyers. For this purpose we studied how recent homebuyers justify their tenure choice. Based on our conceptual and theoretical framing of research, here economically rational justifications must have been clearly distinguished from heuristics following from adherence to or strategic adherence to the dominant mental image (HSN). Economic rationality means the pragmatic, informed, analytical and economically (statistically, mathematically) ‘relevant’ comparison of utilities, benefits and costs of alternative tenures, including the ‘relevant’ comparison of the costs of renting and owning. Adherence to or strategic adherence to HSN means the application of (from an economically rational perspective) simplified and associative heuristics, referring, sooner or later, to taken-for-granted dominant mental image (HSN).

As indicated in the second section, such heuristics could also include economic motives (such as investment or financial motives) and, given the high level of uncertainty in the housing market, it may be viewed as rational or as bounded rational in economic sociology (i.e. it is based on a belief in the experiences of relatives, friends, the most common media stories,

² The question was: ‘Could you give us one word that automatically comes to your mind when you hear the term owner-occupied housing, that is, living in one’s own home [or rental housing]?’ The purpose of this question was to determine the respondents’ main spontaneous associations with individual types of housing tenure.

³ The results of this analysis are not presented here owing to spatial constraints, but the authors are able to provide them upon request.

blogs, and expert statements). Our intention is certainly not to blame any respondent as behaving irrationally. However, considering our conceptual framework, if the respondents' decision is poorly grounded in knowledge of the facts and is overwhelmingly based on beliefs, values, emotions, other people's opinions and recommendations instead of his or her own pragmatic analysis, and at the same time the respondent makes a clear reference to HSN during the interview, we will interpret his/her justifications as heuristics.

We created a sample of 57 respondents from two big Czech cities, Brno and Ostrava,⁴ who were planning to buy their first flat, and invited them to take part in a mini-panel study, which involved interviewing them on two separate occasions: before and after they purchased a flat. The respondents also filled in several questionnaires and took part in joint focus groups. The purpose of the interviews and the focus groups was to find out whether the decision to buy housing is grounded in knowledge and the results of a deliberate economically rational analysis or whether it is instead based on heuristics relating to the housing social norm.⁵ Sample recruitment was relatively difficult and a range of methods were employed (snowballing, real-estate agency assistance, and advertising with real-estate servers or among university alumni). Because of the size and structure of the sample the findings cannot be generalised to the whole population of first-time buyers. In order to test our main hypothesis, we incorporated two specific methodological approaches (M1-2) in our research design for first interview and focus group:

M1: We asked respondents not only to tell us their own personal story but also to give us their 'expert' advice. Presenting respondents with a hypothetical situation allowed them to step outside their own complex situation and put themselves in the role of an independent expert. Respondents offered expert advice in two fields:

M1A: *Estimating the housing tenure of a third person.* In the focus groups, the respondents were presented with statements excerpted from the individual interviews conducted solely with homeowners living in one Prague neighbourhood as part of our earlier study. Participants in the focus groups were asked to individually determine whether the excerpt from the interview was the statement of a home-owner or a tenant; the excerpts were deliberately devoid of any leading information or context, and for the most part did not refer to housing but to the family life of the respondent. The focus-group respondents were also asked to underline the main lexical items that helped them to decide whether it was a home-owner or a tenant who was speaking. The results were discussed in a group (for details of this method, see Hájek and Dlouhá 2014).

M1B: *Tenure advice for the interviewer.* In the first individual interview with the respondent, the interviewer (a young single woman) asked the respondent for advice on whether she should buy or rent a flat in the city the respondent resides in.

⁴ We conducted our research in two cities to control partially for differences in the wider context. The capital city of Prague was avoided as it is a big international city and its housing market is therefore specific; Brno is the second-largest city in the country and Ostrava the third-largest. In both cities, housing prices at the time of research were just taking off after a period of contraction, but in Brno the preceding decline in housing prices had been negligible, while Ostrava had experienced a sharp contraction after a period of sharp growth.

⁵ The average age of respondents was 31.2 years; 80% of respondents had completed university education and 8% were still studying at university; 81% were childless, 69% were living with a partner (but only 22% were married); 82% of the respondents were already economically active, either as an employee or with their own business (59% of the respondents were women and 41% were men).

M2: At the beginning of both the first interview and the focus groups we allowed respondents to express spontaneously their motives for buying their home, and then challenged them with two types of questioning:

M2A: *Verification questioning* was conducted during the first individual interviews in an effort to verify whether the pragmatic and economically rational reasons (utility, costs, benefits, investment gains) respondents spontaneously gave for buying a home were grounded in their knowledge or in their own analysis (calculations); we posed questions such as ‘how do you know that this is true?’ (i.e. ‘what kind of information did you collect, or computations and verifications did you make, before you made this conclusion?’). We explained the purpose of the questioning to the respondents as based on our need to know exactly how they made their decisions.

M2B: *Laddering questioning* was conducted during the focus groups in order to determine the core (underlying) reasons for home-buying. For this purpose we applied the means-end chain (Gutman 1982) that has already been applied in housing studies by Coolen and Hoekstra (2001). We posed questions such as ‘why is this reason for home-buying so important for you?’, and continued to ask this until we came to the core reason (value), the reason that was so obvious that it did not need to be further justified (the respondents stopped answering or started to laugh). The methodological details are in Coolen and Hoekstra (2001).

The qualitative study took two years. All the interviews and focus groups were audio-recorded and transcribed for further analysis. We applied a qualitative heuristic analysis to first interviews with 31 randomly selected respondents. In order to get a better understanding of ‘investment’ motives, we also applied a two-stage qualitative segmented coding of interviews (using MaxQDA), inspired by the work of Strauss and Corbin (1998), on a sample of 36 first and second interviews with 18 randomly selected respondents. The advantage of using MaxQDA is that it helps systematise the coding process and the subsequent data retrievals and analyses (Bazeley 2012, Junker 2012, White et al. 2012).⁶

⁶ The first stage of coding involved open coding, the aim of which was to identify all the themes, topics and meanings expressed by our informants. In our case, the first stage of coding resulted in 97 primary codes across 2,678 segments. The second stage of the coding process consisted of axial coding, i.e. structuring and clustering the codes (and coded data) in order to unravel the basic thematic structure behind the data and to identify the key themes related to tenure choice preferences. This resulted in two clusters of 184 segments of data (statements) expressing the HSN, which were further analysed in a qualitative content analysis (Mayring 2000).

Main findings

At the beginning, we tested the knowledge of a dominant between-tenure mental image among actual home-buyers: indirectly, through their expert estimation of the housing tenures of third persons, based on the fragments of information they obtained from the interview excerpts (using the MIA method described in the methodological section). The respondents' estimates were discussed in the focus groups. We will focus only on the excerpts about which there was almost a consensus among participants about the type of housing tenure the speaker was identified with; the excerpts are presented in Appendix 2.

Almost all the participants in the focus groups (87%) reached the conclusion that Excerpt 1 was from an interview with the owner of a family home; the parts of the excerpts underlined by participants as the basis for their decision were the following: 'as parents we wished this for her' (the most frequently underlined statement), 'we signed her up for a lot of groups', 'I have this feeling of contentment', 'she came back from England with her class'. In the ensuing discussion they explained their decisions, saying that the statements seemed like they were made by a speaker they described as follows: '[they're] family-like, no worries' (fg 1),⁷ 'they're able to provide for everything' (fg 2), 'I got the impression that they're a really happy and wealthy family' (fg 3), 'I imagined this kind of American family, the daughter comes home from England, out runs the golden retriever and they hug' (fg 3), 'a spoiled little girl with wealthy parents in a little family home' (fg 4), 'they have no other worries, just their daughter' (fg 5).

There was also a strong consensus about Excerpt 2, where 84% of participants indicated the speaker was a homeowner. The statement underlined most often this time was 'my husband didn't want me to work', and in the discussion the participants stated that 'the guy had money' (fg 1), 'I got the impression they had money' (fg 1), 'there's no negative view of their housing here' (fg 3), 'it sounds to be like comfortable old age' (fg 3), 'her husband earned a lot of money and she just looked after the kids' (fg 4).

Conversely, in the case of Excerpt 3, almost all the participants in the discussion (95%) concluded that the speaker was a tenant; the statements underlined were: 'I don't plan far into the future' (the statement underlined by far the most often), 'a new stimulus', 'a feeling of freedom', 'I make my own choices'. In the ensuing discussion they argued that this was a person who 'throws on a backpack and goes off somewhere for a year' (fg 1), 'doesn't worry about his/her future' (fg 1), 'doesn't feel the need to settle down' (fg 3), 'is independent' (fg 3), 'won't tie him/herself down in some property' (fg 4), 'lives for the day' (fg 5), 'is afraid and is unwilling to commit to anything' (fg 6).

There was also a strong consensus among participants about Excerpt 4: 78% of participants identified the speaker as a tenant and the statements underlined most often were: 'I don't know where I belong, where to head to' (the statement underlined most often), 'I'm not sure what's right and what isn't', or 'fight to survive'. Participants in the discussion imagined the respondent as a person who 'is unsure of him/herself' (fg 3), s/he 'doesn't have a clear future, doesn't have a place, a thing, to fall back on' (fg 4), s/he 'hasn't decided what s/he actually wants' (fg 5), s/he 'would like to settle down, but simply isn't able to make it happen' (fg 5), s/he's 'depressed' (fg 6), his/her 'life is in disarray' (fg 6), s/he's 'in a crisis' (fg 7).

⁷ Fg means 'focus group'. Fg 1 means focus group one. In total, there were 7 focus groups.

The discussions of the excerpts, including those not mentioned here, revealed that homeownership is associated with wealth, family life, security, a planned future, comfort, a positive outlook on life; rental housing, by contrast, is associated with financial difficulties, temporality, flexibility, divorce, frustration, mental instability, negativism, organisational inability, failure in life, an adventurous life, and a life free of commitments (even family ones). The results of the group discussion showed that first-time buyers were well aware of the normative mental images associated with the two housing tenures; although the excerpts were taken from interviews with homeowners, the dominant mental image predetermines that certain statements and life situations are ascribed to one or the other housing tenure.

The first support for our hypothesis that housing tenures in most cases are not compared on an economically rational basis was provided by the reactions of the respondents when they were asked to give the interviewer expert advice (using the M1B approach described in methodological section). At the end of the first interview the interviewer asked the respondent for advice on whether she herself should buy a flat at price x or rent the same flat for rent y in the respondent's town; x and y corresponded to the average buying price/rent of a small flat in the given town, and the purchase was to be covered by a mortgage with a 100% loan-to-value ratio. Although economically rational decision is not only about simple cost comparison of alternative tenures, for simplicity the request focused on this important decision element.

In conclusion, only one of the 57 respondents in their expert advice 'correctly' compared the user costs of ownership and rent. Nine respondents (16%) made any actual calculation, and the majority of them calculated the monthly (annual) mortgage payment and compared that sum to net rent; in their comparisons, however, they used the total and not just the interest portion of the mortgage repayment in the calculation. And not a single respondent considered the expected trend in housing prices (the investment motive). Conversely, 82% of the respondents made no financial comparison; 30% of the respondents said that the choice depended only on how long the interviewer planned to reside in the town; 5% that it depended on what kind of flat it was; 17% recommended renting because a person should have some savings before buying property (a 100% loan-to-value is too risky); and 46% held the typical view that if the interviewer could afford it (had a stable job and income) then it's always better to buy own housing. For the majority, therefore, the decision is just a factor of the expected length of time a person plans to reside in a place, the amount and stability of a person's income, and how much savings a person has. While these are important pragmatic arguments, investment gains or financial costs are omitted from comparison; and in case of long-term family housing the only point of discussion is whether homeownership is or is not affordable.

The results of a qualitative heuristic analysis of main reasons for buying their own home, using first interviews with 15 randomly selected first-time buyers from the City of Brno and 16 randomly selected first-time buyers from the City of Ostrava, confirmed that for the vast majority of respondents the influence of a housing social norm on their decision to buy housing is strong. This norm deems owner-occupied housing as the only way of establishing a secure home and that for those who do not expect to be moving frequently owner-occupied housing is under every circumstance better than rental housing.

These respondents often gave what at first glance seem like economically rational arguments for buying housing, such as greater tenure security, lower costs, more freedom to furnish their home as they wish, and greater savings security than what other forms of investment offer. However, the verification questioning (M2A approach described in the methodological

section) revealed that these arguments are not grounded in knowledge and are unsupported by facts. Our research showed that these respondents had little knowledge of what the Civil Code says about tenant rights and lease termination, they were uninformed about possible ways for securing a long-term protected tenancy, they had no information about other forms of investment (savings) and they made no attempt to find a landlord who would accept their right to modify the interior of a flat according to their own preferences. These respondents typically did not make any real comparison of the financial costs attached to the different housing tenures, and when they mentioned financial motives and were asked to specify them, their calculations were entirely ‘incorrect’. In most cases, they explicitly rejected the investment motivation (the expectation of capital gain) for purchasing a flat.

All these respondents spontaneously referred to the taken-for-granted HSN equating notions of security and a home with owner-occupied housing (see Excerpts 1 in Appendix 3). For some of them, buying housing is a sign that they are adult and reflects the need to ‘move up’ on the HSN-determined housing ladder (Excerpts 2 in Appendix 3). Some were even aware of the influence of the HSN, but their decision remained unchanged (Excerpts 3 in Appendix 3). In sum, the decision to buy housing was always explained by a full set of motives, and economic reasons were often mentioned early among the respondents’ justifications for buying. However, when we applied our strict conceptual framing, the reasoning behind the economic motives of these respondents remained heuristics (references to clichés used by reference groups or the media); and this was further confirmed by their reference to HSN, as the excerpts presented in the Appendix 3 demonstrate. Economically rational justifications for home-buying decision were found only among a minority of young first-time buyers in the sample; the respondents in this group differed from those in the other group in that they tended to be younger (up to the age of 30) and had received less financial assistance from their family for purchasing housing. Evidence of strong economic rationality was also observed among all the respondents when choosing which flat to buy (comparing attributes of the flats, prices, mortgage rates, budget constraint), but it was much weaker in the actual decision to buy a home.

Using MaxQDA software a more complex content analysis was made of the 36 first and second interviews (with 18 randomly selected respondents). It revealed that the HSN (*doxa*) revolved around two key themes – *investment* and *security*. However, in the interviews ‘investment’ was in most cases observed to mean something different from the meaning it has in standard economic theory and practice. The doxic knowledge revealed in this analysis shows that ownership of a good in itself represents an investment; and there is no need for any other potential financial gain (Table 2). Moreover, the investment motive is strongly related to the motive of security; the two motives overlap and complement each other (Table 3).

Table 2: The structure of doxic knowledge across the identified 184 relevant segments

Code – investment	No. of segments
Investment	103
- (into) ownership	78
- (for potential) profit	25

Source: A qualitative survey among first-time buyers, 36 randomly selected interviews.

Note: A segment is a section of a text (transcribed interview) consisting of one or more sentences relating to a particular meaning or theme. Segments relating to the same theme are grouped under the same code.

Table 3: Frequencies of analysed segments and their distribution in the codes related to the doxic statements about the acquisition of property

Code System	Pavlina	Vera	Sabina	Tobias	Albert	Nikolas	Robert	Denisa	Simon	Libor	Marcela	Diana	Vilma	Hubert	Lubor	Jolana	Prokop	Nina
DOXA																		
Investment - Ownership	2	6	6	3	7	3	4	3	3	5	3	11	2	5	1	6	4	4
Profit					10	4	1					2		1	4	1	1	1
Security	6	9	1	4	5	6	5	1	3	3	2	8	5	4	10	1	5	3

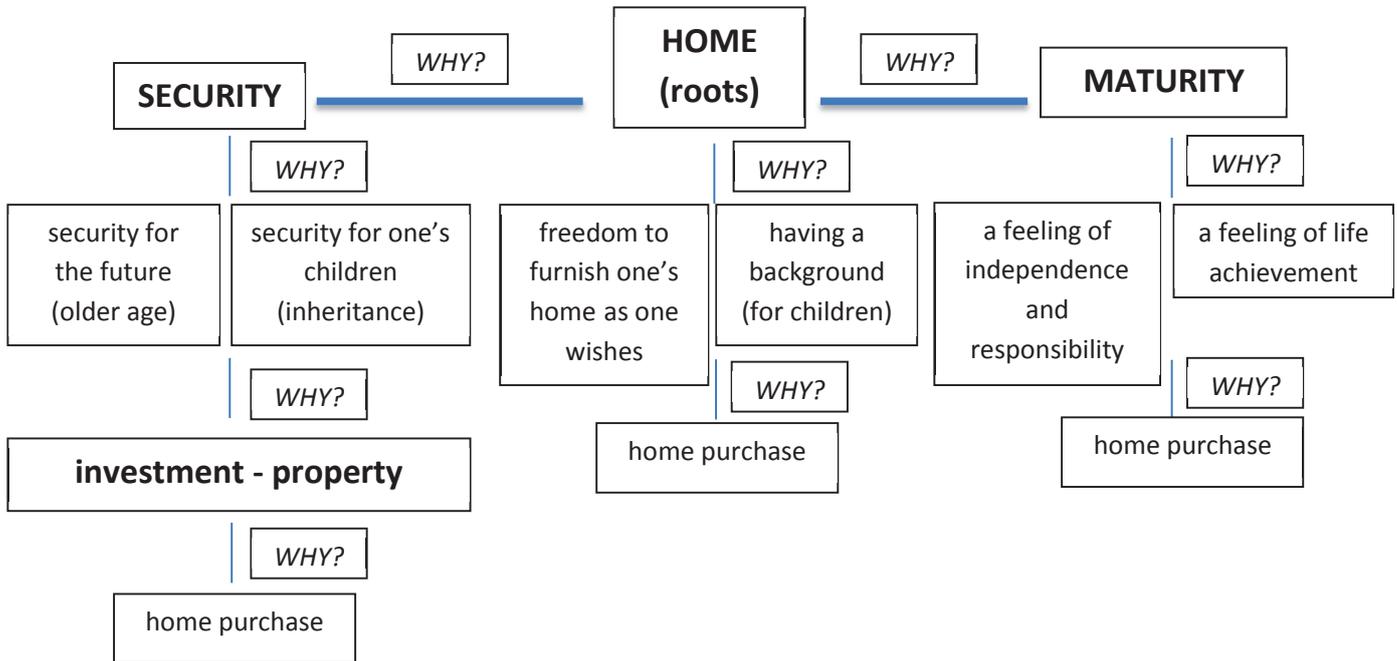
Source: A qualitative survey among first-time buyers, 36 randomly selected interviews

Note: The table shows the frequencies of segments in selected interviews (columns are respondents). A segment is a section of a text (transcribed interview) consisting of one or more sentences relating to a particular meaning or theme.

Owning one's own home provides long-term security in that people have something they can do what they wish with in the future and with which they can solve any potential financial problems. The feeling that comes with having one's own property is thus transformed into a feeling of being secure into the future, which is another strong meaning attached to ownership. As one respondent put it: 'I still have the feeling that to own something small is a kind of certainty' (Denisa). Owning property thus translates into a sense of security for the future. Security is a notion that relates to the future, and property is associated with the future because it is something that can eventually be passed on to heirs. It is seen as an investment in oneself, one's family and in the security of the future of both. To own a flat means 'it is our property. It is ours. Renting means having nothing. That makes it simple' (Sabina). Thus, to buy a flat means to 'be in my own and free to do whatever I want' (Robert). As one informant put it, 'to have my own [flat] and have it according to myself [...] is priceless, you cannot have it in tenancy' (Jolana).

Scheme 1 provides a more comprehensive description of the typical heuristics used by those respondents who were found to adhere or strategically adhere to the HSN, along with a list of core reasons behind the complex heuristics that were identified by the M2B methodological approach during focus groups: these core reasons are *security*, *home* and *maturity*. While the heuristics surrounding *home* and *maturity* directly relate to the HSN, laddering questioning showed the mean position occupied by *investment-property* in the heuristics surrounding *security*.

Scheme 1: The typical means-end chain for the heuristics used to justify purchasing a home



We acknowledge that *doxa* is culturally determined and time- and context-sensitive. In a different context where tenancy rights are better specified and enforced and where people have a higher degree of legal consciousness, the findings might be different. History of specific housing policy and state interventions to property rights during communism (Lux and Sunega 2010), and rapid changes during transition to market economy, certainly influenced the recent content of *doxa*. However, cultural sensitivity of findings, though important, will be better analysed through the future comparative research. We should also acknowledge that macro (quantitative) tenure choice research usual finds that the relative cost of owning and renting has an impact on tenure choice behaviour in many countries. The discrepancy with our findings may be again explained by cultural sensitivity of results; and possibly also by different perspectives offered by quantitative (macro) and qualitative (micro) research.

When we consider the core reasons for purchasing a home as specific objectives that individuals want to achieve through their actions (security, home, maturity), it becomes clear that all of the objectives, once achieved, also serve a face-protection function. Therefore, although we can't prove it, we would surmise that it was not just doxic knowledge in the field that led respondents to stress the reasons for buying a flat; it was also that they regarded them as strategic (socially rational) objectives in relation to their social status. With respect to the core reason of *security*, homeownership is a means of maintaining personal dignity/status in old age, when other sources of such status (a job, intellectual ability, physical appearance) are less available. The core reason of *maturity* has a face-saving function for individuals against potential damage to face that could occur were there to be doubts about how a person is progressing along the life course and whether the person is where s/he should be. Among the respondents in the qualitative part of the research 26% agreed with the statement 'if a person doesn't want to look like a loser in the eyes of others, he/she must own a home'. When we consider how many obvious reasons there are to disagree with such a generalising statement, this is a relatively high figure.

Based on empirical findings we can therefore conclude that our main hypothesis was actually confirmed. Home-buying is in Czech context substantially driven by the housing social norm and for most of the young and well-educated first-time buyers in our sample it is only weakly based on real knowledge or economically rational arguments. Unfortunately, it is impossible to clearly differentiate between when people are adhering to this norm unconsciously and when they are doing so for strategic reasons. In the end, however, this does not matter, as in both cases their market behaviour is guided by this norm. Consequently, it is likely that the market dynamics (including volatility of house prices) in the Czech Republic and possibly also in other cultures largely reflect the dynamics of the given normative social context.

Conclusion

In our qualitative research we used a new theoretical framework and specific methodological approaches to examine whether sociology can contribute to recent discussions in economics about the sources of housing market inefficiency and instability. We surveyed people exactly at the time they were deciding to buy a home, i.e. to make one of the biggest investment decisions in their life. We clearly distinguished economically rational arguments from those that are considered as ‘irrational’ (heuristic) in economic theory. We found (1) systemic deviations from economically rational behaviour assumed by mainstream economics that (2) stem from the influence of a dominant housing social norm (*doxa*) about the ‘right’ form of housing tenure (3) rather than from irrational expectations about future housing returns, as behavioural economics assumes.

Consequently, in certain home-buying markets and cultures, the assumption of economic theory that ownership and renting are substitutes does not hold and the principle that renting and owning are ‘communicating vessels’ is negated. By studying social norms sociology can thus significantly contribute to knowledge about the actual foundations of the formation of housing demand and, implicitly, disequilibrium in the housing market; a contribution akin to what psychology did in the past through behavioural economics. Future research should focus on how best to operationalise the housing social norm’s influence on market behaviour in order to improve econometric market (house price) models and increase their reliability in assessing systemic risks.

The fact that people engage in ‘economically irrational’ behaviour based on adherence to a housing social norm or in socially rational ‘speculation’ on this norm has various important implications. For example, we can assume that if the substitution effect between rental and owner-occupied housing is weak or no longer exists, then the demand for owner-occupied housing becomes more income-elastic: a demand shock will drive up housing prices to the maximum budget constraint of a marginal buyer in the market irrespective of the trend in rent. This process has been described by Hoekstra and Vakili-Zad (2011) as the ‘Spanish paradox’: in Spain, despite the high vacancy rate and the growing disparity between rent and user costs, housing prices rose for a long time. In case of low price-elasticity of supply, which is indeed characteristic for housing markets, high income elasticity will translate into higher price volatility. And excess price volatility has negative effects on the economy, consumption and the welfare of individual households.

Moreover, if the substitution effect ceases to apply, it has clear impact on housing system: tenants will consist mainly of low-income, lower-class households, or households renting housing as just a temporary solution to their needs. The turnover in tenants increases the costs of landlords (for repairs and search costs) and changes in structure of tenants raise their risks. Higher costs and risks have the effect of increasing rent levels and standard comparison of price and rent levels may not offer sufficient warning of increasing housing market instability. Recently discussed macroprudential regulations aimed to mitigate systemic financial risks may thus be more relevant in societies with high influence of social norm than in societies with more balanced housing system.

Another implication concerns so-called housing-price stickiness during bust periods. It has been found that during periods of price correction housing prices do not adjust as quickly as assumed by theory and the explanation that has been given for this is that sellers anchor their reservation price in the original historical acquisition price. In other words, sellers are not

willing to sell a house at a price lower than what they paid for it. However, price stickiness can equally be explained as sellers engaging in socially rational speculation based on the housing social norm. Sellers can effectively rely on the fact that once prices stop falling, buyers will start to buy, irrespective of the actual level of rents, i.e. even at prices unjustified by rent levels. Consequently, they set their reservation price above the housing's fundamental value.

Moreover, drawing on their experiences professional investors adapt their strategies towards minimising losses, but social norms change very slowly and may remain insensitive to financial losses, even if they are considerable. As a result, the residential real-estate market may experience long-term systemic risks because under the influence of a strong social norm general home buyers do not learn sufficient lessons from their past decisions. However, there is a need for further economic research on these broader market implications.

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Appendix

Appendix 1: Tenure decisions in economic theory

In economic theory, the fundamental value of an asset (house price) is measured by the present-value of expected future income flows (rents). The equilibrium price-to-rent ratio is derived from a standard Lucas-type asset pricing model. A rational agent demanding housing services compares the costs of owning with the costs of renting and chooses the cheaper option. The nominal user costs of homeownership (UC) can be expressed as follows:

$$(1) \quad UC = P * [i_t + \delta], \text{ where}$$

- P - price of a dwelling
 i_t - interest (mortgage) rate in time t ;
 δ - depreciation rate.

The user costs of homeownership are determined by the interest (mortgage) rate (which serves also as opportunity costs for buyer's savings that could be otherwise invested) and depreciation (which includes also potential management fees); if property taxes are included in the rent, then equation (1) is extended to include the property tax rate. An adjustment of the interest rate $[(1-\theta).i]$, where θ denotes the marginal income tax rate] may be added to reflect the tax subsidy for the mortgager if applicable. A rational consumer choosing between two tenure substitutes compares the UC and the annual nominal net rent (R):

- $R > UC$ the consumer would opt for homeownership;
 $R < UC$ the consumer would opt for tenancy;
 $R = UC$ the consumer would be indifferent about tenure choice.

The substitution effect in demand is consistent with the substitution effect in housing supply. If, for now, we ignore the yield from capital appreciation, the expected net present value (NPV) from residential investments for private landlords is equal to the future discounted income stream from rent:

$$(2) \quad NPV = \frac{R_1 - D_1}{1+i} + \frac{R_2 - D_2}{(1+i)^2} + \dots + \frac{R_n - D_n}{(1+i)^n}, \text{ where}$$

- R_1, R_2, \dots, R_n - cash flow (rental income) in years $1, 2, \dots, n$;
 D_1, D_2, \dots, D_n - costs of depreciation and management
 i - interest (discount) rate.

When depreciation is removed, market equilibrium is expressed as:

$$R = Pi \quad - \text{demand}$$

$$P = \frac{R}{i} \quad - \text{supply for } n > 30 \text{ and stable } R$$

And the equilibrium price (P_t^*) of a dwelling in time t is equal to:

$$(3) \quad P_t^* = \frac{R_t}{i_t}.$$

However, owner-occupied housing is also an investment good and many investors in rental housing properties (such as buy-to-let investors) include the expected capital gain in their calculations. Consequently, both investors in rental housing and homeowners have some expectations concerning future price inflation. Equations (1) and (2) are extended as follows:

$$(4) \quad \text{for demand: } UC = P * [i_t + \delta - \frac{g^e}{g_t}],$$

where g^e/g_t is the expected annual housing-price appreciation rate, and

$$(5) \quad \text{for supply: } NPV = -I_0 + \frac{R_1 - D_1}{1+i} + \frac{R_2 - D_2}{(1+i)^2} + \dots + \frac{R_n - D_n}{(1+i)^n} + \frac{I_n}{(1+i)^n}, \text{ where}$$

I_0 - value of investment (house price) in year 0;

I_n - expected value of investment (house price) in year n .

In recent economic studies, self-fulfilling beliefs, irrational expectations and sentiments concerning expected future price trends have been considered to be the main sources of housing market inefficiency and excess price volatility (e.g., Schiller 2000, Kashiwagi 2014, Hui and Wang 2014, Kuang 2014, Kouwenberg and Zwinkles 2014, to name just a few of them). Therefore, economists include a different proxy for such expectations such as lagged housing-price growth, sentiment or confidence indices.

Appendix 2: Excerpts used in focus groups

Excerpt No. 1

I have a good relationship with my daughter, when she had that phase ‘don’t take my picture’, ‘don’t touch me’, now that’s over, she comes to cuddle with me, mummy ... I feel good about it, we signed her up for a lot of groups, she took up the piano, she does floorball, but she hopefully doesn’t smoke, doesn’t do drugs. And when she comes to chat, and she’s in a good mood, then I feel content. She came back from England with her class, she was overjoyed, I have the feeling that as parents we could grant her that and she appreciates it and it’s mutual.

Excerpt No. 2

But I, my former husband didn’t want me to work, quote unquote to have a career, and it really bugged me, and so there over the way, where those chestnut trees are, I managed to get some cleaning. So I was doing cleaning and I’d walk over on foot and when there was some free time I’d take my daughter around in the Trabant to English classes, scouting, drawing, and so on.

Excerpt No. 3

I’m open to any new stimulus that comes along, so I try to lead my life on a path that is open, I don’t plan far into the future, I do things deliberately, but when something works out, or sometimes even when it doesn’t, then I try to mark out a new direction, that gives me the feeling that I’m making the choice myself. It’s this feeling of freedom.

Excerpt No. 4

A person always has to make plans, where to go next, to think about every step, I'm not sure what's right, what isn't. Whether what's at home is right or if there's something better waiting elsewhere, your biological clock is ticking, you can hear it all around you. Plus today it's a struggle for me to get by, financial things and lots of changes in the family and especially professionally. And the biggest role is played by age, the area where you live...No, I don't know what to do with myself, I've reached a crossroads, I don't know where I belong, where to head to.

Appendix 3: Excerpts from interviews with first-time buyers

Excerpts 1

'...owner-occupied housing, there are probably no disadvantages...because the feeling that something is mine, no one can just give that to you...even if I were to lose money...it's historically established. There's nothing we could do to change that in just one generation.' (Jolana)

'...many people I know tend to have their own little castle...I'd definitely recommend ownership... at any rate, in my view, it's better to invest in owning something because otherwise you're throwing money out the window...and in the end you have nothing.' (Zuzana)

'...I own something, I'm secure, I have something that has some value... I can do what I like...as soon as I have enough money to build that, I'll build, I'm not going to worry much about how the prices are high now because I don't know what will happen in a year, they could go up, they could go down...' (Ignác)

'... this nice feeling that I can touch something and say to myself, this is mine, or this belongs to me and my girlfriend, that is a great feeling and it means a lot to me...' (Hubert)

'the money we put into it, we can see it somewhere, it's not going to some landlord, or municipality, or someone, while all the while we've got nothing...for us, housing was a big priority in life overall...it's different when, say, you go to the park, that's not yours...From my housing I simply want the security that that housing will be there, that I can rely on it, for me that's just so important in life.' (Magda)

'...by its nature I think that ownership is always better because no matter what happens that flat is always yours.' (Viktor)

'...it's always better to buy...if you've got enough money it's good to buy even a small flat, but your own...we want to buy our own [housing], to have something that will be definitively ours...so, like in the book, we said to ourselves that, once we're there, then that's the Villekulla villa, and at that friend's flat [where the respondents live now], that's the deserted island that Pippi went to visit, so we can introduce the kids to that in a way.' (Pavĺína)

'... if I put [money] in real estate, you can't ever go wrong there...that's something that's yours.' (Eliška)

'I'd always choose to own a home if I got a loan...I have a few bricks that are mine, not like some pieces of paper [a metaphor for money], if some bomb goes off or there's an earthquake, all the money's lost.' (Amélie)

'I don't like long-term leases, I really don't, but short-term, when it's so you're able to save up, I'm willing to do that...since high school I've been planning that I want to own my own home...I just like the security, that's it's mine, and that it's all up to me, that it's in my hands.' (Sylva)

'It's our property. It's ours. Otherwise we have nothing. So it's just obvious.' (Sabina)

Excerpts 2

‘As soon as we finished our studies we decided that we’d stand on our own two feet...so then we jumped in head first because if we wanted to make it happen then it was necessary to take immediate and dramatic action...mainly we wanted to prove to ourselves that we could build something, own something, have a home, that’s the foundation, to have something of your own.’ (Šimon)

‘...I’m going on 30 and I don’t yet own anything and haven’t accomplished anything. I don’t have a family, I don’t have children, I’ve got nothing I’ve built or created...so I had the feeling that I’d have something of my own, that it would be a move forward, that I’d accomplish something, there was something I was able to do...but given that it was just so spontaneous and maybe a decision made not entirely on any true or tested grounds, I just decided I’d buy.’ (Jitka)

‘...I look at this flat as part of this growth...quote unquote I built a home, planted a tree, and produced a son...I think that I’m ready for that because I’ve reached a certain age...I want to invest in my future.’ (Robert)

Excerpts 3

‘...it means a lot to me that it’s mine, owning my home is really important to me...I think that in the next generation the view of owning is changing generally...but we grew up with a certain hierarchy of values that was based on ownership rather than on utilization... maybe we got it from our parents, even I was influenced by my grandmother and grandfather who owned their own fields.’ (Hynek)

‘When I was single, then it didn’t matter, I didn’t worry about it. But now we’ve been a couple for a while and we’d like to settle down and I feel that these things go together...you just reach that age. At 32 it was time to stop being a youngster and to start being responsible...here I guess it’s upbringing or tradition...of course even I have to admit that there’s something there that forces a person to say that it’s probably better to own. Even though I can’t myself properly define what it is exactly, why that’s the way it is.’ (Libor)

‘...now, if I were renting, that would be better for me...I say, if I didn’t have children, then I wouldn’t worry about it, but because I have a child and she only has me, I have to think about it...it’s something that will always be there for her, if something [happened], that’s the way I looked at it.’ (Sandra)

‘I wouldn’t rent. It seems to me that if a person is able to put the money together, even if they have to go into debt, then it’s better to get your own housing...Maybe it’s just something that’s in a person’s head. It strikes me that it’s completely irrational. It’s better when it belongs to you than when it belongs to someone else...Maybe what bothered me most was the feeling that someone’s trying to make money off me.’ (Andrea)

‘I’m not entirely convinced that it’s rational, because in the end there’s the costs of maintaining a flat and also various other ones so in the end it doesn’t financially pay off...Maybe emotions play a role in this, that need to feel anchored...maybe really the arguments in favour were heavily based on emotions...maybe almost this kind of impetuosity a bit, this feeling a bit that if not now then never...I think that in a way even for us it might be a really bad step.’ (Tobiáš)

12. The degree, impact and differences in house price index measurement

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I. 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.¹ Timely, comparable, proper measurement is a prerequisite for all of this, driven by concomitant data.

This working paper draws on a number of publications including Silver (2011, 2015, 2016a and b). In section II we outline the problem: one of measuring constant quality price change for infrequently traded heterogeneous properties. The problem is further complicated by the fact that price data are typically from secondary sources including land registries (notaries), lenders, and realtors (estate agents) and not always fit for the purpose. Section III summarizes some results as to the importance of measurement and section IV turns to the use of hedonic regression estimates for estimating changes in constant quality average price change for residential property. The focus of the section is on the use of hedonic regressions and the paper foreshadows some results forthcoming in Silver (2016b).

¹ For salient papers see the recent Conference by Deutsche Bundesbank, the German Research Foundation (DFG) and the International Monetary Fund on “Housing Markets and the Macroeconomy: Challenges for Monetary Policy and Financial Stability” at:
http://www.bundesbank.de/Redaktion/EN/Termine/Research_centre/2014/2014_06_05_eltville.html

II. RESIDENTIAL PROPERTY PRICE INDEXES: THE HARD MEASUREMENT PROBLEM

A. The problem

Critical to price index measurement is the need to compare in successive periods the transaction prices of like-with-like representative goods and services. Price index measurement for consumer, producer, and export and import price indexes (CPI, PPI and XMPPIs) largely rely on the *matched-models method*. The detailed specification of one or more representative brand is selected as a high-volume seller in an outlet, for example a single 330 ml. can of regular *Coca Cola*, and its price recorded. The outlet is then revisited in subsequent months and the price of the self-same item recorded and a geometric averages of its price and those of similar such specifications in other outlets form the building blocks of a CPI. There may be problems of temporarily missing prices, quality change, say size of can or sold as a bundled part of an offer if bought in bulk, but essentially the price of like is compared with like every month.² House price indexes (HPIs)³ are much harder to measure.

First, 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 (lower) proportion of more expensive houses sold in one quarter should not manifest itself as a measured price increase (decrease). 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 (i) hedonic regressions; (ii) use of repeat sales data only; (iii) mix-adjustment by weighting detailed relatively homogeneous strata; and (iv) sales price appraisal ratio (SPAR) method.⁴

² International manuals on all of these indexes can be found at under “Manuals and Guides/Real Sector” at: <http://www.imf.org/external/data.htm#guide>. This site includes the *CPI Manual: International Labour Office et al. (2004)*.

³ Also referred to as residential property price indexes (RPPIs), both being a generic term that includes apartments (flats).

⁴ Details of all these methods are given in Eurostat et al. (2013); see also Hill (2013) for a survey of hedonic methods for residential property price indexes; Silver and Heravi (2007) and Diewert, Heravi, and Silver (2008) on hedonic methods; Diewert and Shimizu (2013b) and Shimizu et al. (2010) for an application to Tokyo; and Shiller (1991, 1993, and 2014) on repeat-sales methodology.

We stress that our concern here is with measuring HPIs for Financial Soundness Indicators (FSI)s and macroeconomic analysis where the transaction price, that includes structures and land, is of interest. However, for the purpose of national accounts and analysis based thereon, such as productivity, there is a need to both separate the price changes of land from structures and undertake adjustments to price changes due to any quality change on the structures, including depreciation. This is far more complex since separate data on land and structures is not available when a transaction of a property takes place. Diewert, de Haan, and Hendriks (2011) and Diewert and Shimizu (2013a) tackle this difficult problem.

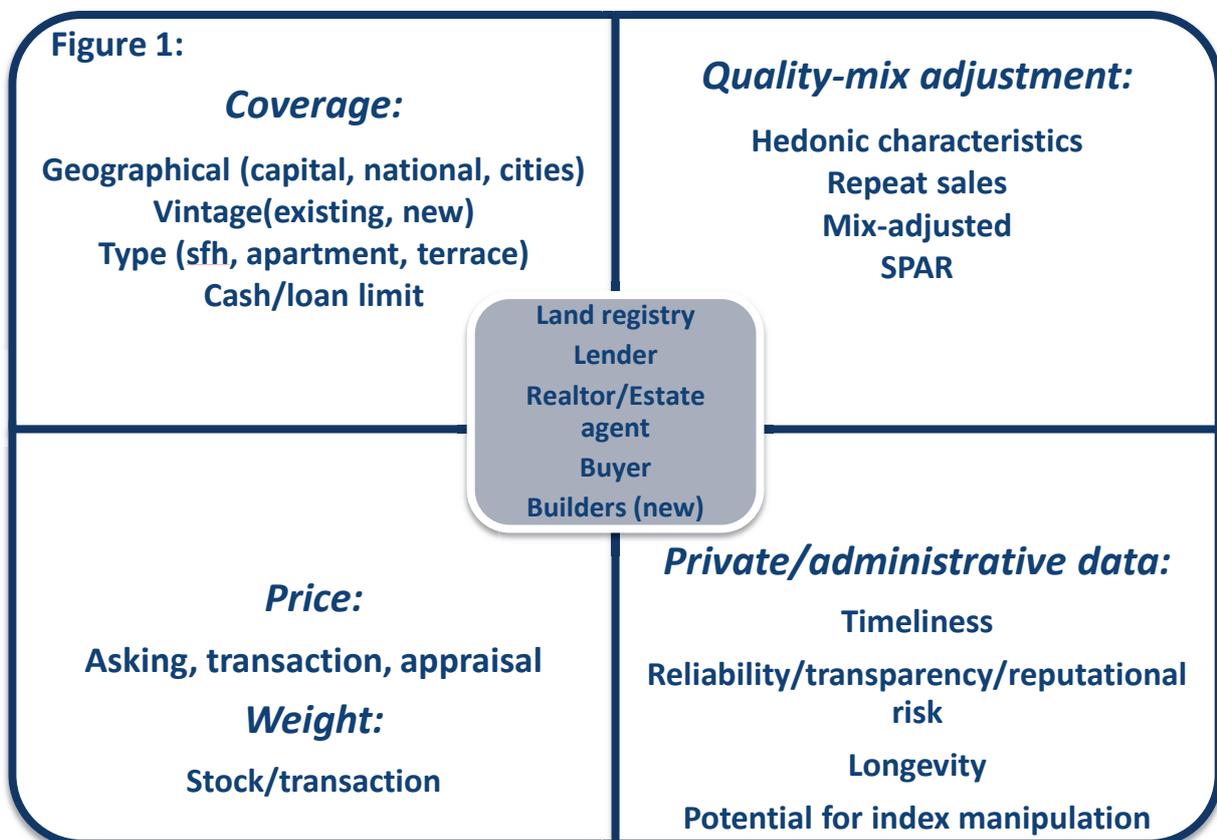
Figure 1 shows alternative data sources in its center and coverage, methods for adjusting for quality mix, nature of the price, and reliability in the four quadrants. Land registry data, for example, may have an excellent coverage of transaction prices, but have relatively few quality characteristics for an effective use of hedonic regressions, not be timely, and have a poor reputation. Lender data may have a biased coverage to certain regions, types of loans, exclude cash sales, have “completion” (of loan) price that may differ from transaction price, but have data on characteristics for hedonic quality adjustment. Realtor (estate agent) data may have good coverage, aside from new houses, data on characteristics for hedonic quality adjustment, but use asking prices rather than transaction prices.

The importance of distinguishing between asking and transaction prices will vary between countries as the length of time between asking and transaction varies with the institutional arrangements for buying and selling a house and the economic cycle of a country.

Silver (2011 and 2015) provide some country illustrations of the trade-offs adopted in practice and the longer term need for countries to “make your own luck”: that is for countries not to simply accept data sources with associated problems, but proactively develop the data and methods. This need in part arises from the unusually difficult measurement problems—and variety of methods adopted—in estimating constant quality HPIs and vagrancies of the data source, particularly in relation to coverage. We summarize some results from a more formal analysis below.

III. MORE FORMALLY: AN EMPIRICAL EXERCISE AS TO WHY MEASUREMENT MATTERS

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; (v) geographical coverage (capital city, urban etc.), (vii) coverage by type of housing (single family house, apartment etc.); and (viii) vintage, new or existing property.



Silver (2015) collected 157 HPIs from 2005:Q1 to 2010:Q1 from 24 countries with, for each HPI, explanatory measurement and coverage variables (details are given in Annex 1 of Silver (2015)).⁵ The explanatory measurement variables were:

Based on coverage:

- **Vintage** (benchmarked on *both* new and existing dwellings).
New (newly constructed dwelling)=1 (0 otherwise); **Xsting** (existing dwelling) =1(0 otherwise).
- **Geographical coverage** (benchmarked on *national* coverage).
Capital (major) city=1 (0 otherwise); **Big cities**=1 (0 otherwise); **Urban** areas=1 (0 otherwise); **Notcapital**=1 (0 otherwise); **Rural**=1 (0 otherwise).
- **Type of dwelling** (benchmarked on *both* apartments and single-family homes).
Apartment=1 (0 otherwise); Single family home (**Sfh**)=1 (0 otherwise).

Based on method:

- **Quality-mix adjustment** (benchmarked on *price per dwelling*, no adjustment).
Hedonic regression-based=1 (0 otherwise); **Repeat** sales=1 (0 otherwise); **SPAR**=1 (0 otherwise); **MixAdjust**=1 (0 otherwise); **SqMeter**=1 (0 otherwise)
- **Type of price** (benchmarked on *transaction price*).
Asking price =1 (0 otherwise); Tax/mortgage **Appraisal** price=1 (0 otherwise).
- **Weights: as a flow of sales transactions or stock** (benchmarked on *sales*=0).
Wstock=1 (0 otherwise).
- **Weights: quantity or value or other shares** (benchmarked on *value*=0).
Wquantity=1 (0 otherwise); **Wsqmeter**=1(0 otherwise); **Wpopulation**=1(0 otherwise); **Wprice** in base-period =1(0 otherwise).
- **Weights: fixed or chained/regularly-updated or unweighted** (benchmarked on *fixed*=0).

The above panel data had fixed-time and fixed-country effects; the estimated coefficients on the explanatory measurement variables were first held fixed and then relaxed to be time varying. Subsequently, the explanatory variables were interacted with the country dummies. First, Table 1 shows that given only measurement-related variables are included, the regressions have substantial explanatory power, \bar{R}^2 , at about 0.45 in mid-2009. The result is especially notable given only fixed effects, and measurement variables were included with neither hedonic variables nor structural explanatory variables to explain house price inflation

⁵ Information on the characteristics of the house price indexes was based on the methodological notes attached to the source data, survey papers, and, often, extensive email correspondence with the providing institutions. The HPIs were from: national (official and private) sources and the BIS Residential Property Price database, <http://www.bis.org/statistics/pp.htm>.

by means of supply and demand (and financing) of a country's housing market as in, for example, Muellbauer and Murphy (2008).⁶ From the results of Table 2, column 2, measurement matters and, in particular, \bar{R}^2 increases over the period of recession, when it really matters.

Second, Table 1 also shows the explanatory power of the model is not exclusively driven by the fixed **time** and **cou** effects. On excluding the country- and time-fixed effects, Table 2 column 4, the effect of the measurement variables alone, while diminished, accounted during the recession for about a quarter of the variation in house-price inflation rates.

Third, regarding the question: given that measurement matters, what matters most, coverage variables or methodological variables? Table 1, columns 5 and 6 find that dropping either set leaves the other with substantial explanatory power, though “method” is for the large part slightly more important than “coverage.”⁷

Having shown that measurement issues matter when comparing HPIs, and that they matter particularly during the recession—when they do—we turn to a consideration of the impact of these findings on some macroeconomic analytical work.

A. The impact of measurement on modelling?

There is naturally much concern in the literature with the duration of housing cycles (Bracke (2011) and the relationship between (real) house price booms and banking busts including Igan and Loungani (2012), Crowe et al. (2011); and Claessens *et al.* (2010), though see

⁶ The paper finds the main drivers of house prices to include income, the housing stock, demography, credit availability, interest rates, and lagged appreciation.

⁷ There is likely to be some intercorrelations between the variable sets. For example, in the United States, the repeat-purchase method is used to hold constant the quality mix of transactions for existing houses, but for new houses sold only once, the hedonic method is used, since new houses (coverage) will generally have only one transaction (method). More generally, Land Registry data based on transaction prices often has a large coverage, but limited characteristic variables, arguing against the use of hedonic regressions, while the opposite applies to realtor data based on asking prices.

Leamer (2007). Empirical work is often based on a sample of countries⁸ and includes analysis of the cross-country coincidence of real house price index changes, the magnitude, duration, and characteristics of house price cycles, and cross-country relationship between HPI changes and those of other macroeconomic and household financial variables. Implicit in such analysis is the assumption that the measurement-related differences in house price indexes between countries are not of a nature/sufficient magnitude to adversely affect the results. We take (an earlier version of) the model in Igan and Loungani (2012) (hereafter IL) to illustrate the impact of measurement differences on such analytical work. We stress that their estimates and ours are not directly comparable. Their estimates are from a regression using (unbalanced) pooled quarterly HPIs from 17 countries over 1970Q1 to 2010Q1. This contrasts with ours in a shorter period of 2005:Q1 to 2010Q1 and use of a panel data set of about 150 HPI series over a similar, but extended, set of 21 countries. We estimate country house price inflation using 441 (21 countries by 21 quarterly changes) coefficients on country-time interaction dummy variables, from a pooled regression that includes measurement variables, and time-varying country effects. However, we employ the same estimator (OLS with robust standard errors), variable list, and dynamics used by IL. We adopt their model but estimated with our measurement-adjusted or standardized HPIs—the residuals from the regression of HPIs on measurement variables—and unadjusted HPIs on the left hand side.

Table 2, column 1 provides from the results by IL from their pooled regression—further details and rationale for their model are given in IL. Quite similar results are found from our analysis given in columns 2 and 3 of Table 2 with the expected signs on the estimated coefficients. Given the quite major differences in the data sets used here and by IL, this study gives further credence to their work. Affordability is not statistically significant at a 5 percent level, but becomes so (columns 4 and 5) when its square is dropped.⁹

⁸ Work has also been undertaken for states within countries, for example Igan and Kang (2011) for Korea and the United States.

⁹ Excluded from Table 4 are the country effects (available for the authors) required by our model given that more than one series is used for each country. F-tests on the redundancy of these country effects found the null
(continued)

The measurement-adjusted (Madj) estimates in columns 2 and 4 improve on the unadjusted ones in columns 3 and 5. Table 2 shows both stock price changes and long-term interest rates have no (statistically significant at a 5 percent level) affect on HPI changes both for the IL estimates (column 1) and unadjusted estimates (columns 3 and 5), but do so with the appropriate sign for the measurement-adjusted estimates (columns 2 and 4).¹⁰ For some cases, parameter estimates for Madj price-changes have larger falls and smaller increases than their unadjusted counterparts. For example, Madj and unadjusted house price inflation are estimated to *fall* by 8.5 and 7.7 percent respectively as (lagged) affordability increases by 1 percent, to *increase* by 0.40 and 0.52 percent respectively as the change in income per capita increases by 1 percent, and to *increase* by 0.156 and 0.186 percent respectively as the change in credit increases by 1 percent.

Having established the measurement problems, and that measurement matters, we turn to a particular technique of constant quality price index number measurement, hedonic regressions.

hypothesis of no such effects to be rejected at a 1 percent level ($F=3.735$ and 2.887 respectively for the measurement-adjusted and unadjusted estimates).

¹⁰ The coefficient for stock prices in column (4) denoted as statistically significant at a 10 percent level was in fact a borderline p -value of 0.1056. We used a (White) period heteroscedasticity adjustment to the standard errors. Had diagonal or cross-sectional one been applied the p -value would have been 0.017 and 0.069 respectively, compared with p -values of 0.2076 and 0.1884 for the unadjusted estimates.

IV. THE USE OF HEDONIC REGRESSIONS TO ESTIMATE CONSTANT QUALITY HPIs

The aim of this section is to outline findings in Silver (2016b) that further develop a best practice hedonic methodology grounded in both the practical considerations and methodological rigor required for such an important statistic.

The preferred and major methodology employed for ensuring constant-quality price change is the use of hedonic regressions. The hedonic approach identifies properties as tied bundles of characteristics. The characteristics are the price-determining ones, including size, number of bedrooms, location and so forth, and the sense in which they are “tied” is that there is no single price for each characteristic. The market price is for the bundle as a whole. A hedonic regression is a regression of property prices on characteristics thus providing estimates of the (marginal) value of each characteristic. This provides the means by which we can “unbundle” the overall price and attribute marginal values to the individual characteristics. Moreover, for example, an estimated hedonic regression equation or period 1 allows us to predict period 1 prices for (constant-quality) period 0 housing characteristics a say period 1 price of period 0 characteristics—the numerator of the ratio, thus providing the basis for a constant(period 0) quality price index. This paper tackles the important question as to how, given estimated hedonic regressions, how do we compile property price indexes?

The methodology is consistent with the outline and proposals in de Haan and Diewert (2013) that form the international standards in this area, the *Handbook on RPPIs*,¹¹ but consolidates and develops them.

The *Handbook on Residential Property Price Indices (RPPIs)* (Eurostat *et al.*, 2013) provides international guidelines on RPPI measurement and chapter 5 contains three hedonic approaches—the hedonic time dummy approach, characteristics approach, and imputation approach—and many alternative forms for each approach. This follows previous literature in this area including Triplett (2006), Silver and Heravi (2007), de Haan and Diewert (2013), and Hill (2013). Silver (2016b) addresses three problems

¹¹ http://epp.eurostat.ec.europa.eu/portal/page/portal/hicp/methodology/hps/rppi_handbook.

- Problem of choice between methods –consolidate and demonstrate equivalences
- Problem of introducing weights at property-level, and defining target superlative index with associated, and measurement problems of dual imputations.
- Problem of appropriate formulas for thin markets.

A. Problem of choice between methods –consolidate and demonstrate equivalences

The imputations and characteristics approaches both have an intuition: the former as a ratio of average constant price changes of matched properties, and the latter as a ratio of prices of a constant-quality basket of characteristics. We show in Silver (2016b) that the characteristics and imputations approaches yield the same answer under the credible conditions of using a linear and log-linear functional form as long as arithmetic means are taken of characteristics for the characteristics, and that under reasonable conditions, the time dummy (adjacent period) hedonic regression approach can closely approximate an indirect formulation of the characteristics/imputation approach. These are important findings insofar as a hedonic formulation gains credibility—on what might be considered as an axiomatic ground—if it results from approaches with quite different intuitions.

B. Weights

We have made no mention of an essential element of index number construction: the weighting of price changes.¹² Simple formulas from an imputation or a characteristics approach have implicit weighting structures. If one form has an implicit superior weighting, other things being equal, it is preferred. As noted by Griliches (1971, page 326): “There is no good argument except simplicity for the one-vote-per-model approach to regression analysis.”

We distinguish between two levels of aggregation: the lower and higher levels. Property price transactions are stratified by say location and type to form more homogeneous clusters

¹² Diewert (2005) and Rao (2005) consider weighting issues within a regression framework. The approach here is to use explicit weights external to the regression.

of properties, say apartments in the downtown area of a capital city.¹³ At the lower or elementary level constant-quality price indexes are estimated for each stratum. The national or some higher-level index is compiled as a weighted average of the constant-quality price changes of the individual strata indexes.¹⁴

The higher-level weights can be relative values of transactions or stocks of properties for each stratum. This choice depends on the purpose of the property price index and availability of adequate data on the stock of properties. Fenwick (2013) outlines issues relevant to such a choice, the concern here being with the incorporation of weights, implicitly or explicitly, into the lower level measured constant-quality property price index.

The concern in this section is with the weights for lower level aggregation—the individual property prices. There is a literature on elementary price index number formulas based on the needs of consumer, producer and trade price indexes. While some of these results have a bearing on the analysis here. The matched prices are predicted constant-quality prices for individual properties. Given a hedonic regression is run in periods 0 and t over all properties transacted in that period, then the counterfactual period t predicted price of a property i with k characteristics z_i^0 sold in period 0 can be estimated as $\hat{p}_{i|z_i^0}^t$. Thus if a detached property with 4 bedrooms in a particular postcode, 3 bathrooms, a floor area of 3,000 square feet, and so forth, is sold in period 0 for 750,000, we can use a hedonic regression estimated in period t to answer a question as to the estimated price of a property with the same characteristics sold in period t . By comparing the average price in period 0 with the average predicted price in period t of properties with the same period 0 characteristics, we have a measure of constant

¹³ It is well established in sampling theory (Cochran 1977) and its application to price indexes (Dalèn and Ohlsson, 1995, and Dorfman *et al.* 2006) that stratification can lead to large reductions in sampling error. There are trade-offs. A finer classification results in more similar houses—that is, each stratum has more homogeneous properties—and better estimates of quality-mix change. However, the resulting sample size of transactions in each stratum will be relatively small and estimates of the constant-quality price change inefficient—have relatively wide confidence intervals. A relatively coarse stratum classification will lead to efficient estimates of constant-quality price indexes, but ones based on a restriction assumption that the coefficients for quality attributes across the many strata now included, are the same.

¹⁴ The author is currently working on weighting systems at the higher level.

quality price change. This is the hedonic imputation approach. There is no problem outlining the problem just in this form because of the equivalences established in section A. Consider a simple ratio of arithmetic means or prosperities sold in period 0 from the imputation approach—a hedonic imputation Dutot index. The numerator is their predicted prices in period t , by its nature counterfactual and predicted, and the denominator the actual prices in period 0:

$$(1) \dots P_{HID}^{0t} = \frac{\frac{1}{N^0} \sum_{i \in N^0} \hat{p}_{iz_i^0}^t}{\frac{1}{N^0} \sum_{i \in N^0} p_i^0} = \frac{\sum_{i \in N^0} \left(\frac{\hat{p}_{iz_i^0}^t}{\hat{p}_{iz_i^0}^0} \right) \hat{p}_{iz_i^0}^0}{\sum_{i \in N^0} \hat{p}_{iz_i^0}^0}$$

since for OLS: $\frac{1}{N^0} \sum_{i \in N^0} p_i^0 = \frac{1}{N^0} \sum_{i \in N^0} \hat{p}_{iz_i^0}^0$

We use **dual imputation** methods in the last term of equation (1) to avoid any omitted variable bias in the specification impacting on the measure. For example, if the hedonic regression did not properly capture larger houses in an up-market location, the numerator would be downward bias but denominator not subject to a bias. We use predicted prices in both instances since the *average* of predicted prices is equal to the *average* of actual prices for an OLS estimator.

The implicit weight given to each property’s price change is, as shown by equation (1), its relative predicted price in the reference period, which in turn is equal to its expenditure share, since each property has a transaction quantity of one.

If geometric means are compared the index is an equally-weighted Jevons index:

$$(2) \dots P_{HIJ}^{0t} = \frac{\prod_{i \in N^0} \left(\hat{p}_{iz_i^0}^t \right)^{\frac{1}{N^0}}}{\prod_{i \in N^0} \left(\hat{p}_{iz_i^0}^0 \right)^{\frac{1}{N^0}}} = \prod_{i \in N^0} \left[\frac{\hat{p}_{iz_i^0}^t}{\hat{p}_{iz_i^0}^0} \right]^{\frac{1}{N^0}}$$

where the sample is only of the period 0 properties sold and equal weights are implicitly attached to each price change.

We can improve on this by introducing weights to each matched price comparison and further developing the index into a quasi-superlative form by using reference and current period weights:

$$(3) \dots P_{HIQT}^{0t} = \prod_{i \in N^0} \left(\frac{p_{i|z_i^0}^t}{\hat{p}_{i|z_i^0}^0} \right)^{w_i^\tau} = \frac{\prod_{i \in N^0} (p_{i|z_i^0}^t)^{w_i^\tau}}{\prod_{i \in N^0} (\hat{p}_{i|z_i^0}^0)^{w_i^\tau}} = \exp \left(\sum_{i \in N^0} w_i^\tau \ln \left(\frac{p_{i|z_i^0}^t}{\hat{p}_{i|z_i^0}^0} \right) \right) = \exp \left(\sum_{i \in N^0} w_i^\tau \ln \left(p_{i|z_i^0}^t - \hat{p}_{i|z_i^0}^0 \right) \right)$$

where $w_i^\tau = \frac{1}{2} \left(\frac{p_{i|z_i^0}^t}{\sum_{i \in N^0} \hat{p}_{i|z_i^0}^t} + \frac{p_{i|z_i^0}^0}{\sum_{i \in N^0} \hat{p}_{i|z_i^0}^0} \right)$ which is a quasi-hedonic formulation of a Törnqvist index

(Feenstra, 1995, Ioannidis and Silver 1999, Diewert 2003, and Balk, 2008). A Törnqvist index has excellent properties in economic theory as a superlative index (Diewert, 2003 and 2004). It is “quasi” in the sense that it does not make use of period t transactions. Yet there is a sample selectivity issue. Equation (3) is based on period 0 transactions only. A quasi-hedonic Törnqvist index based on period t transactions is given by:

$$(4) \dots P_{HIQT}^{0t} = \prod_{i \in N^t} \left(\frac{p_{i|z_i^t}^t}{\hat{p}_{i|z_i^t}^0} \right)^{w_i^\tau} = \frac{\prod_{i \in N^t} (p_{i|z_i^t}^t)^{w_i^\tau}}{\prod_{i \in N^t} (\hat{p}_{i|z_i^t}^0)^{w_i^\tau}} = \exp \left(\sum_{i \in N^t} w_i^\tau \ln \left(\frac{p_{i|z_i^t}^t}{\hat{p}_{i|z_i^t}^0} \right) \right) = \exp \left(\sum_{i \in N^t} w_i^\tau \ln \left(p_{i|z_i^t}^t - \hat{p}_{i|z_i^t}^0 \right) \right)$$

Equations (3) and (4) each have a **sample selectivity bias** in only considering period (0) and period (t) properties respectively. Yet we need to combine the above formulas. Two obvious approaches are to give a weight to each period that is related to the transaction values in each period, or to give equal weight.

We follow the principles in Triplett and McDonald (1977), Diewert (2002), Silver and Heravi (2005)¹⁵ and de Haan (2010) and first use period 0 and period t transaction value weights. Some additional notation is required.

¹⁵ The paper acknowledges the contribution from Erwin Diewert (University of British Columbia) who helpfully provided rigorous derivations of the results in a previous working version of this paper.

Let $S(0 \cap t)$ be the set of properties that are present in both periods 0 and t , $S(0-t)$ is the set of properties that are present in period 0 but not period t , and $S(t-0)$ is the set of properties that are present in period t but not period 0. The weights for each term are the relative transaction values of these sets of data, that is, where V is the total value of transaction prices (or stocks) for $S(0 \cap t)$, $S(0-t)$ and $S(t-0)$, that is $V = \sum_{i \in S(t-0) \cup S(0-t) \cup S(0 \cap t)} v_i$; $v_{0-t} = \sum_{i \in 0-t} v_i$, $v_{t-0} = \sum_{i \in t-0} v_i$; and $v_{0 \cap t} = \sum_{i \in 0 \cap t} v_i$ and w_i^τ is an arithmetic mean of the weight (relative stock value or transaction (price) value) given to each property in periods 0 and t , that is $w_i^\tau = \frac{1}{2}(w_i^0 + w_i^t)$:

$$\begin{aligned}
 (5) \dots P_{HIT}^{0t} &= \prod_{i \in S(0-t)} \left(\frac{\hat{p}_{i|z_i^0}^t}{p_{i|z_i^0}^0} \right)^{w_i^\tau \times v_{0-t}/V} \times \prod_{i \in S(t-0)} \left(\frac{p_{i|z_i^t}^t}{\hat{p}_{i|z_i^t}^0} \right)^{w_i^\tau \times v_{t-0}/V} \times \prod_{i \in S(0 \cap t)} \left(\frac{p_{i|z_i^t}^t}{p_{i|z_i^t}^0} \right)^{w_i^\tau \times v_{0 \cap t}/V} \\
 &= \frac{v_{0-t}}{V} \prod_{i \in S(0-t)} \left(\frac{p_{i|z_i^t}^t}{\hat{p}_{i|z_i^t}^0} \right)^{w_i^0} \times \frac{v_{t-0}}{V} \prod_{i \in S(t-0)} \left(\frac{p_{i|z_i^t}^t}{\hat{p}_{i|z_i^t}^0} \right)^{w_i^0} \times \frac{v_{0 \cap t}}{V} \prod_{i \in S(0 \cap t)} \left(\frac{p_{i|z_i^t}^t}{p_{i|z_i^t}^0} \right)^{w_i^0} \\
 &= \exp\left(\frac{v_{0-t}}{V} \sum_{i \in S(0-t)} w_i^\tau (\ln \hat{p}_{i|z_i^0}^t - \ln p_{i|z_i^0}^0) \right) + \exp\left(\frac{v_{t-0}}{V} \sum_{i \in S(t-0)} w_i^\tau (\ln p_{i|z_i^t}^t - \ln \hat{p}_{i|z_i^t}^0) \right) + \\
 &\exp\left(\frac{v_{0 \cap t}}{V} \sum_{i \in S(0 \cap t)} w_i^\tau (\ln p_{i|z_i^t}^t - \ln p_{i|z_i^t}^0) \right)
 \end{aligned}$$

The first term on the right hand side of equation (5) is the change in price due to unmatched models existing in period t , but not in 0. The next term is the price change due to unmatched models existing in period 0 but not in t , and the final term is the price change due to the matched model contribution to the overall index. The first expression in equation (5), the period t sample selection; the last two expressions are not captured in this

Paasche-type formulation. If the second term, $\exp\left(\sum_{i \in S(0-t)} w_i^\tau (\ln p_{i|z_i^t}^t - \ln \hat{p}_{i|z_i^t}^0) \right)$, is larger than the first, then the hedonic Paasche price index is too low. Consider an “old” properties sold in period 0, but not t . If their mean (period t) constant-quality price change is larger than the mean price change of “new” properties sold in period t , but not in 0, then

there will be a downwards bias in an index that just uses as its sample the first term in equation (5)—Triplett and McDonald (1977) have a similar interpretation). While Silver and Heravi (2005) consider the direction of a similar such bias for consumer goods in terms of price strategies for models of items at the end and start of their life cycle, no such consideration applies here. Old and new properties refer to those transacted in each period and there is no such story to tell about the likely bias for property price indexes.¹⁶ Indeed the any discrepancy ne period's transaction may be taken to be a random sample of the other with, on aggregate, no bias.

It is also apparent from equation (5) that the magnitude of any bias will be tempered or otherwise by an increase in the relative transaction values in period 0 compared with period t , that is v_{t-0} , against v_{0-t} . In this instance cyclical movements, as an economy goes into (and comes out of) recessions, are likely to have a major affect on the magnitude of v_{0-t} as against v_{t-0} , though it nature will depend on the extent to which rebasing (re-estimating the hedonic function) coincides with the different stages of the recession. A, for example, downswing peak-to-trough comparison would give an increased weight to v_{0-t} as against v_{t-0} . An upswing would diminish bias as v_{t-0} is given increased weight against v_{0-t} .

Compilers using equation (5) might well undertake retrospective empirical work to identify the nature and magnitude of any such bias.

The third term is based on a price comparison of the actual prices of the sample of properties sold in both periods. This should be a minimal set of properties since first, data filters are normally employed that remove transaction prices that are resold quickly after purchase,¹⁷ or have major price increases. Those re-sales of the same property within a few years may also be minimal in that a well formulated index, as discussed below, will have a

¹⁶ As one comes goes into and comes out of recessions the sample of properties sold in period (period t) may have different characteristics than that sold in period 0. Yet it is still not clear that the (counterfactual) constant-quality price change of these new properties will differ in a unidirectional way, on aggregate, than the old properties. In practice this issue would be best answered empirically for each country using retrospective data.

¹⁷ The concern here, at least for repeat sales indexes, is to remove properties that are bought to renovate and sold quickly after. Such price changes are “not constant-quality changes as required for repeat sales but may be renovated in a manner that the structural changes are not captured by hedonic regressions.

relatively frequent periodic rebasing, that is estimation of the hedonic function for a new reference year t be spliced onto the existing index. Nonetheless, the term is included in case, as for example with apartments in Tokyo (Shimizu et al., 2010), there is an active turnover in properties. For practical purposes our hedonic Tornqvist price index is given by:¹⁸

$$\begin{aligned}
 (6) \dots P_{HIT}^{0t} &= \exp\left(\frac{v_{0-t}}{v_{0-t} + v_{t-0}} \sum_{i \in S(0-t)} w_i^\tau \left(\ln \hat{p}_{i|z_i^0}^t - \ln p_{i|z_i^0}^0\right)\right) + \\
 &\quad \exp\left(\frac{v_{t-0}}{v_{0-t} + v_{t-0}} \sum_{i \in S(t-0)} w_i^\tau \left(\ln p_{i|z_i^t}^t - \ln \hat{p}_{i|z_i^t}^0\right)\right) \\
 &= \frac{v_{0-t}}{v_{0-t} + v_{t-0}} \prod_{i \in S(0-t)} \left(\frac{\hat{p}_{i|z_i^0}^t}{p_{i|z_i^0}^0}\right)^{w_i^\tau} \times \frac{v_{t-0}}{v_{0-t} + v_{t-0}} \prod_{i \in S(t-0)} \left(\frac{p_{i|z_i^t}^t}{\hat{p}_{i|z_i^t}^0}\right)^{w_i^\tau}
 \end{aligned}$$

An alternative is to give equal weight to each period (see Rambaldi and Fletcher, 2014). In the form of a superlative hedonic Fisher index we have:

$$(7) \dots P_{HIF}^{0t} \sqrt{\sum_{i \in S(0-t)} \left(\frac{\hat{p}_{i|z_i^0}^t}{\hat{p}_{i|z_i^0}^0}\right) w_i^\tau \times \left[\sum_{i \in S(t-0)} \left(\frac{\hat{p}_{i|z_i^0}^0}{\hat{p}_{i|z_i^0}^t}\right) w_i^\tau\right]^{-1}}$$

Silver (2016b) undertakes a more extensive analysis of these issues.

C. Practical problem of appropriate hedonic formulas for thin markets.

Practical problems are considered arising out of a concern with thin markets, that is sparse transaction price data.¹⁹ Controlling for the effect of heterogeneity in a price index requires,

¹⁸ A caveat to this would be that if periods 0 and t are relatively close, the property is best deleted from the data since there is a reasonable chance that it is of a quite different (poorer) quality in period 0 than other period 0 properties, and much better quality in period t , having been bought with the aim of rebuilding/refurbishing to be sold-on.

¹⁹ There are other approaches to the problem of “thin” markets including (i) estimating a temporally aggregated price index for example, moving from a quarterly to a semiannual or annual index, Geltner (1993) and Bohari and Geltner (2012); (ii) use of a time-series methodology, such as the Kalman Filter, including Goetzmann (1992), Schwann (1998), Schwabb 1998, Schulz and Werwartz (2004), Francke and De Vos (2004), Francke (2008), and Rambaldi and Fletcher (2014); (iii) the inclusion of other related series as explanatory variables in thin markets, Baroni et al. (2007) and Schulz and Werwartz (2004), Thorsnes, P., & Reifel, J. W. (2007); and

(continued)

for heterogeneous properties, (i) an extensive hedonic specification and care with estimation that is ill-served by sparse data; (ii) hedonic price comparisons are grounded in a reference period that is relatively exhaustive of the property mix that arises in subsequent periods; (iii) avoid the estimation of hedonic regression equations in each current period as this may lead to large standard errors on the predicted values, upon which the hedonic methodology relies; and (iv) more regularly link the index with “rebased” re-estimated hedonic regressions. The concern of the proposed methods are for parsimony of estimation, that is to not rely on estimates in successive periods and to use a reference period designed better suited to the needs of sparse data (see Silver 2016b for details of what here is a brief outline).

Proposals for this practical problem are that:

- i. *That a current-period t-type formulation be used since the hedonic regression need only be estimated for period 0*

If a constant current period quality formulation is used for either of the approaches considered above, the hedonic regression need only be estimated for period 0, that is, for an arithmetic mean:

$$(8) \dots \frac{\frac{1}{N^t} \sum_{i \in N^t} p_{i|z_i^t}^t}{\frac{1}{N^t} \sum_{i \in N^t} \hat{p}_{i|z_i^t}^0} = \frac{\frac{1}{N^t} \sum_{i \in N^t} \hat{p}_{i|z_i^t}^t}{\frac{1}{N^t} \sum_{i \in N^t} \hat{p}_{i|z_i^t}^0}$$

The measure is of constant current period t characteristics, z_i^t , but only requires a hedonic regression for period 0. Limiting the regression estimation to the reference period is a major advantage given the critical role that hedonic estimates play in real estate property price indexes and the concomitant problems of data, specification, and estimation for hedonic estimation. Constant reference period quality hedonic indexes from the direct and indirect characteristics, and imputation approaches require that the regression equation has to be estimated for each subsequent period t , and for the time dummy approach, the estimated

(iv) Silver and Graf (2014) consider an improvement to the efficiency of the estimator using data on sample sizes.

hedonic regression has to include both period 0 and period t data (de Haan and Diewert (2013) and Silver (2016b)). Having to only estimate a hedonic regression for period 0 is a very attractive feature. Hedonic regressions are subject to the vagrancies of specification and estimation procedures. One such specification issue is omitted variable bias, especially with regard to location, that due to data limitations may be outside of the control of the agency responsible for the measure. A measure based on a well-grounded regression, especially one based on an extended reference period as outlined in (ii) below, better grounds the index.

A concern with both (geometric) Laspeyres- and Paasche- indexes is that they are both subject to substitution bias. They form bounds on a superlative index, such as the Fisher index that has good approximation properties to a theoretical index that does not have any substitution bias. A chained Paasche is further advocated that while requiring a hedonic regression equation is estimated on a periodic basis, will be closer to a theoretical index than its fixed base counterpart.

- ii. That an extended-current period formulation be used since *sparse data is less problematic*

Second, a major problem in HPIs and, especially CPPI, estimation is that of sparse data on heterogeneous properties. There may not be an adequate number of observations and/or variation in the characteristics of the sample of properties transacted in period 0 to enable reliable and pertinent estimates to be made of the coefficients of price-determining characteristics that define properties sold in period t . For example, there may a relatively large, recently-built retail property in a prime location (say postcode) sold in period t , but only a limited number of retail properties sold in period 0 all of which are much smaller, older, and located in poorer areas. The problem of sparse data prevents reliable estimates of the predicted price from a period 0 regression of the period t characteristics.²⁰ The current

²⁰ More formally, the width (standard error) of a prediction interval from a regression of y on x , for a given value of say $x = x'$, depends not only on the fit of the regression—the larger the sample size and dispersion of the explanatory variables, the smaller the interval— but also on the distance the given value of x' is from the sample mean \bar{x} . The prediction will be better for values of x' closer to \bar{x} (Maddala, 2009).

(continued)

period formulation goes some way to solving the problem of sparse data simply because we can define the reference period 0, for example, for a quarterly series 2016Q1, 2016Q2 etc., to be an extended period of say a year with the index referenced as 2015=100.0 and centered mid-2015. As such, the period 0 regression will be more likely to better encompass the characteristics of period t properties. It is worth noting that the current-direct hedonic characteristics and imputation indexes and the indirect counterparts all have this feature.

iii. *That an indirect approach be used*

The indirect approach takes the change in prices, as in equation (9), and divides this by the change in quality-mix, equation (10), to derive a measure of the change in constant quality price change, equation (11), that is:

$$(9) \dots \frac{\frac{1}{N^t} \sum_{i \in N^t} p_i^t}{\frac{1}{N^0} \sum_{i \in N^0} p_i^0} = \frac{\frac{1}{N^t} \sum_{i \in N^t} \hat{p}_{i|z_i^t}^t}{\frac{1}{N^0} \sum_{i \in N^0} \hat{p}_{i|z_i^0}^0} \text{ is the change in average prices}$$

$$(10) \dots \frac{\frac{1}{N^t} \sum_{i \in N^t} \hat{p}_{i|z_i^0}^0}{\frac{1}{N^0} \sum_{i \in N^0} \hat{p}_{i|z_i^0}^0} \text{ is the change in the quality-characteristics}$$

Since $\sum_{i \in N^t} p_i^t = \sum_{i \in N^t} \hat{p}_i^t$ for OLS, equation (9) *divided* by equation (10) *equals*:

$$(11) \dots \frac{\left[\frac{\frac{1}{N^t} \sum_{i \in N^t} \hat{p}_{i|z_i^t}^t}{\frac{1}{N^0} \sum_{i \in N^0} \hat{p}_{i|z_i^0}^0} \right]}{\left[\frac{\frac{1}{N^t} \sum_{i \in N^t} \hat{p}_{i|z_i^0}^0}{\frac{1}{N^0} \sum_{i \in N^0} \hat{p}_{i|z_i^0}^0} \right]} = \frac{\frac{1}{N^t} \sum_{i \in N^t} \hat{p}_{i|z_i^t}^t}{\frac{1}{N^t} \sum_{i \in N^t} \hat{p}_{i|z_i^0}^0}$$

is the constant (period t)-quality price index.

Silver (2016b) outlines issues surrounding the use of equation (11) and its adaptation for the geometric means. It is a very doable index that is suitable for thin markets with an obvious intuition. It can be directly compared with the superlative hedonic formulas outlined in section IIIB.

V. SUMMARY

For the hard problem of properly measuring HPIs countries generally have available to them secondary data sources, including land registries/notaries, lenders, realtors, buyers, and builders. Further, transactions of properties are infrequent and properties are heterogeneous. 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.

We also outlined some results to be provided in Silver (2016b) on methods of using hedonic regression estimates for constant-quality price change. De Haan and Diewert (2013) outline the three main approaches for which there are myriad forms including different forms of weights, sample selection, imputations, aggregators, direct and indirect methods and no straightforward guidelines. We demonstrate equivalencies for quite straightforward formulations to narrow down the choice, derive a superlative formulation of these hedonic indexes, and then propose an intuitive method suitable for thin markets that is less subject to sparse data and the vagrancies of the periodic estimation of hedonic regressions.

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Table 1, Fit of measurement variables in moving window regression					
	RbarSq including:				
	Time; Country;	Country;		Measurement.	
	Measurement	Measurement	Measurement	Coverage	Methodology
05 Q1	0.322	0.211	0.102	0.015	0.079
05 Q2	0.253	0.242	0.120	0.016	0.099
05 Q3	0.282	0.273	0.126	0.023	0.099
05 Q4	0.330	0.324	0.148	0.083	0.114
06 Q1	0.365	0.358	0.120	0.025	0.100
06 Q2	0.416	0.409	0.103	0.004	0.090
06 Q3	0.347	0.343	0.085	0.003	0.081
06 Q4	0.286	0.282	0.070	0.003	0.069
07 Q1	0.266	0.265	0.077	0.009	0.075
07 Q2	0.182	0.177	0.100	0.051	0.095
07 Q3	0.181	0.175	0.110	0.066	0.093
07 Q4	0.193	0.193	0.110	0.074	0.081
08 Q1	0.264	0.254	0.153	0.101	0.116
08 Q2	0.303	0.281	0.195	0.129	0.146
08 Q3	0.343	0.324	0.234	0.128	0.194
08 Q4	0.358	0.342	0.216	0.114	0.164
09 Q1	0.405	0.369	0.228	0.118	0.174
09 Q2	0.445	0.408	0.267	0.158	0.211
09 Q3	0.456	0.444	0.257	0.137	0.194
09 Q4	0.401	0.397	0.175	0.068	0.087
10 Q1*	0.413	0.415	0.099	0.020	0.051

Figures are for 5-quarters' moving (by one quarter) window regressions appropriately centered. Figures for 2009:Q4 and for 2010:Q1 are based on regressions over 2009Q2-2010:Q1 and 2009Q4-2010:Q1 respectively.

*The RbarSq are very similar for 2010Q1 for the first two columns, with and without the time dummies. The degrees of freedom adjustment is responsible for the latter exceeding the former.

Table 2, Pooled regression results for house price indexes

Dependent variable	House price index, log quarter-on-quarter change:				
	Igan and Loungani (2012) (1)	Measurement-adjusted estimates (2)	Unadjusted Estimates (3)	Excluding: Affordability-lag squared	
				Measurement-adjusted estimates (4)	Unadjusted estimates (5)
Affordability, lagged	-0.0517*** (0.0158)	-0.291* (0.1772)	-0.174 (0.1201)	-0.085** (0.037)	-0.077*** (0.0271)
Income per capita, change	0.431*** (0.0684)	0.392** (0.1516)	0.519*** (0.0917)	0.395*** (0.142)	0.520*** (0.0919)
Working-age pop, change	0.999*** (0.1970)	0.735* 0.3941	0.494** (0.2354)	0.754* (0.411)	0.503** (0.2438)
Stock prices, change	0.0044* (0.0026)	-0.017** (0.0086)	-0.007 (0.0071)	-0.016* (0.010)	-0.00604 (0.0077)
Credit, change	0.0190*** (0.0053)	0.165*** (0.0268)	0.191*** (0.0253)	0.156*** (0.031)	0.186*** (0.0273)
Short-term interest rate	-0.0009** (0.0004)	-0.010** (0.0046)	-0.006** (0.0025)	-0.010** (0.005)	-0.006** (0.0025)
Long-term interest rate	-0.0006 (0.0004)	0.000001*** 0.0000	0.000 (0.0000)	0.000006*** (0.0000)	0.000002 (0.0000)
Affordability, lag, squared	-0.0019* (0.0012)	-0.014 (0.0121)	-0.007 (0.0085)		
Construction costs, change	0.129*** (0.0366)	0.320* (0.1671)	0.312* (0.1709)	0.285* (0.172)	0.295* (0.1738)
Constant	-0.243*** (0.044)	-1.267** (0.6384)	-0.838** (0.4232)	-0.43** (0.247)	-0.504*** (0.1796)
No. Obs.	1,297	357	357	357	357
No. of periods	1970Q1-2010Q1	2005Q1-2010Q1	2005Q1-2010Q1	2005Q1-2010Q1	2005Q1-2010Q1
No. countries	17	17	17	17	17
Redundant country effect: χ^2		48.94 (0.0000)	60.72 (0.0000)	46.6 (0.0001)	59.10 (0.0000)
R-squared	0.18	0.29	0.54	0.29	0.54

13. FHB Agricultural Land Price Index

Gyula Nagy



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Eltinga is a university based institution, that provides up-to-date analyses of the Hungarian real estate market.

FHB Mortgage Bank was established as a specialised financial institution in 1997 with its main focus on mortgage lending. FHB Mortgage Bank Plc is listed on the Budapest Stock Exchange.

The views and conclusions in this paper are those of the authors and do not necessarily represent the views of FHB Mortgage Bank.

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Abstract

The FHB Agricultural Land Price Index was first published in 2010. It measures the nominal and real (deflated by CPI) price increase of the Hungarian agricultural land prices. The Agricultural Land Price Index was computed on the basis of transaction data received from the Stamp Duty Office ((later the National Tax Office). The data processed covers the period between 2000 and the first half of 2015. The value of the index is normalised with the average for the year 2000, i.e. the average index value in 2000 is 100 .

In order to ensure that the Index reflects real market trends, the FHB Land Price Index analysis only includes transactions that have been confirmed by FHB's property surveyors. The purpose of the data filtering is to measure the changes in prices of lands that are actually utilised; i.e. data that may refer to speculative investments when the land is bought only in the hope that it will later be upgraded to be municipal territory were excluded from the analysis.

Similarly to FHB House Price Index, FHB Agricultural Land Price Index was also prepared by hedonic method. Lands sold in different periods have different characteristics, thus the evolution of average prices are affected by the composition of the lands sold. By managing the composition effect, the hedonic method helped us to detect the real changes in prices. The most important factors that have been taken into account are the size, the location and the utilisation of land.

Keywords: Agriculture – Aggregate Supply and Demand, Farmland prices, Land ownership

JEL Codes: Q11, Q15, Q24

1) Introduction

General information about the FHB Index.

The FHB House Price Index was first introduced in 2009 and is published quarterly since the first appearance. The FHB Agricultural Land Price Index was first published at the end of 2010 and is published on a yearly basis.

Updates to the FHB House Price Prognosis and the FHB Agricultural Land Price Index are published regularly. The methodology behind the model rests on three pillars:

- I. On the basis of international and local experience, we have identified relations between selected Hungarian macroeconomic indicators, money-market and credit market indices, transactional data of the housing/agricultural land market and housing/land prices.
- II. The FHB Banking Group has been one of the major actors among Hungarian mortgage market financiers for over a decade. Our operations cover the entire country, and we have access to information from the most significant real estate appraisers, which is complemented by FHB Real Estate Ltd's own professional experience. Our forecasts, therefore, include processed and verified local assessments as well.
- III. Our database, which covers the entire country and the methodological development of the FHB Index make FHB able to provide help to the financial sector to fulfil the collateral monitoring and revaluation obligations under the Decree No 575/2013/EU (CRR). Our services have already been ordered by a number of major Hungarian financial institutions. The banks will also need to comply with the strict regulations in the future, it is, therefore useful to apply a procedure that conforms to international standards and can also be supported by documented methodology if required by authorities.

2. Agricultural land price movements 2000 – 2014

The record price growth on the agricultural land market was observed in 2013. The rise in 2014 was the second highest in the past 14 years, but could not surpass the record growth of 2013.

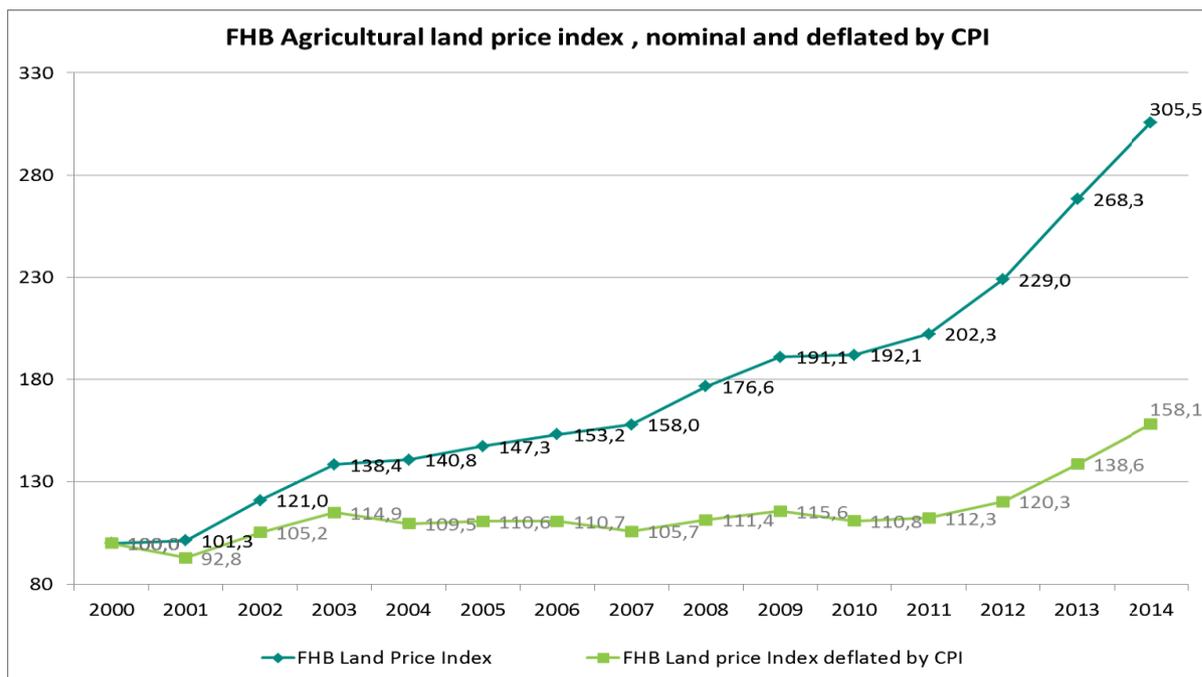


Figure 2.1. FHB Agricultural Land Price Index – nominal and inflation-adjusted value
(Source: FHB Index)

The recent regulatory changes (described later) clearly mark the end of an era in the history of Hungary's agricultural land markets. The new law lays down regulations for the long run, and therefore renders the acquisition of land more difficult. As a result, the price of agricultural land increased by 39.9 percent in the past 3 years – the period *before the land property acquisition restrictions*. (Figure 2.2)

The surge in 2013 reflects stakeholders' efforts to purchase land property before the market changes generated by the **new Land Market Regulations** take effect. The volume growth of agricultural produce alone, presented in our previous publications, does not fully explain the record increase in the price of agricultural land, which further corroborates our observation. To explain the market background

of the price increase a summary is presented of the new law, as well as its potential consequences.

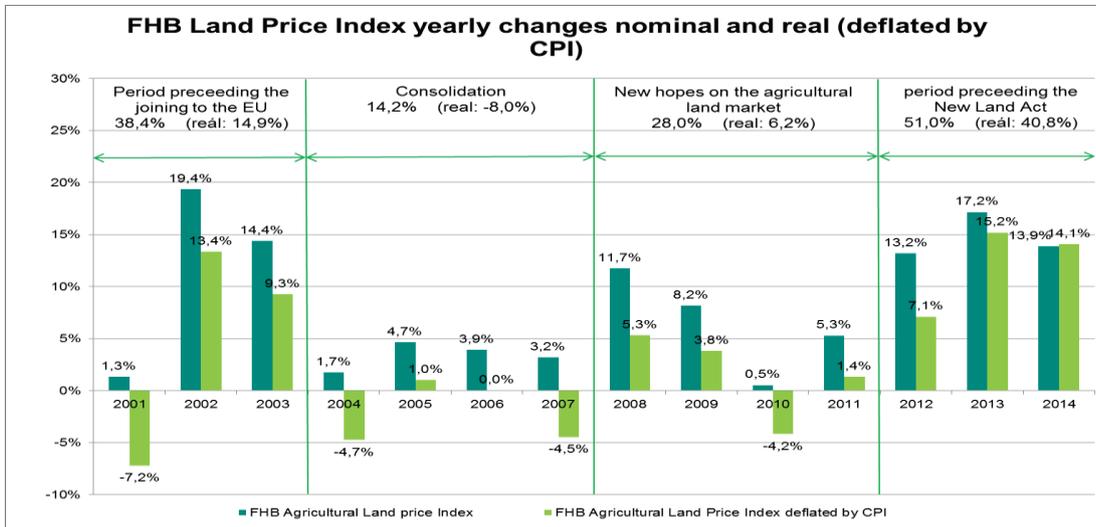


Figure 2.2. The annual change and periodization of FHB Agricultural Land Price Index.

Land market transactions dropped sharply since the entry into force of the new Land Transfer Act, while previously demand was high for agricultural land (Figure 2.4). Land market turnover in 2014 fell significantly short of the previous years, despite the record high number of transactions of the first quarter compared to the same period of the last few years. Q3 and Q4 showed a negative record in transaction numbers.

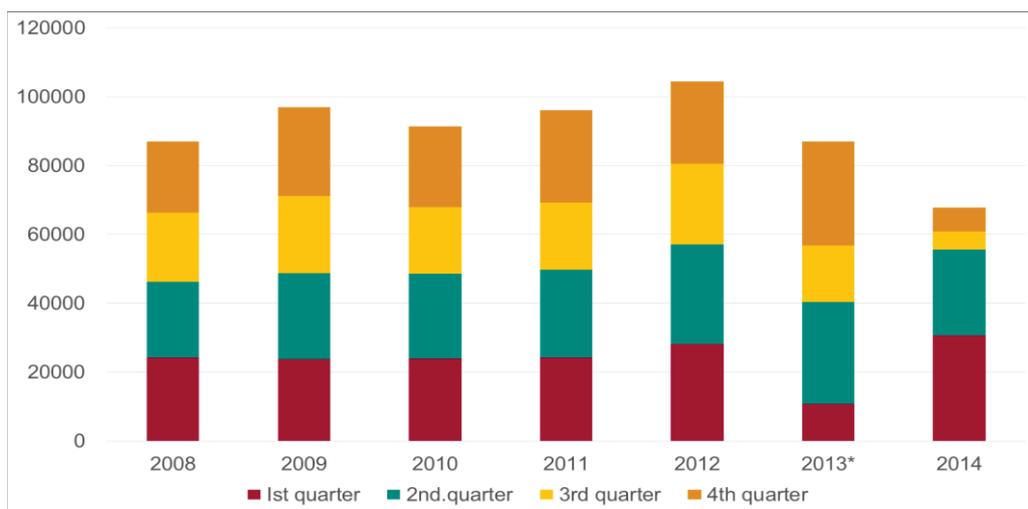


Figure 2.4. Quarterly changes in land market transactions between 2008 and 2015 (Source: FHB Agricultural Land Price Index) *2013 data based on estimation

3. Price development on submarkets

Among the various cultivation types, the average price of arable land grew significantly since 2013. In 2014 one hectare of arable land cost on average HUF 1,087,000, while in the previous year it averaged at HUF 945,000, which means a greater price increase than last year. Compared to HUF 823,000 per hectare, the growth in prices was 264,000 per hectare in 2014.

In 2014 arable land price rose in every region. The greatest rise – nearly 23 percent – occurred in the Southern Great Plain region. It was also close to 20 percent in the Northern Great Plain, and reached between 17-20 percent in Central Hungary, Northern Hungary and Central Transdanubia. The price increase was less pronounced in Western Transdanubia, where it merely reached 2.6 percent.

Average land prices were the highest in Central Hungary, where arable land by the hectare cost HUF 1,315,000; while they remained the lowest on Northern Hungary, averaging at HUF 678,000 for a hectare of arable land. After the price increase in Central Transdanubia land prices are nearly at the same level as in Western Transdanubia, approximately HUF 1,190,000; and Southern Transdanubia region follows closely behind. In Southern and Northern Great Plain regions the significant growth resulted in price levels above HUF one million per hectare.

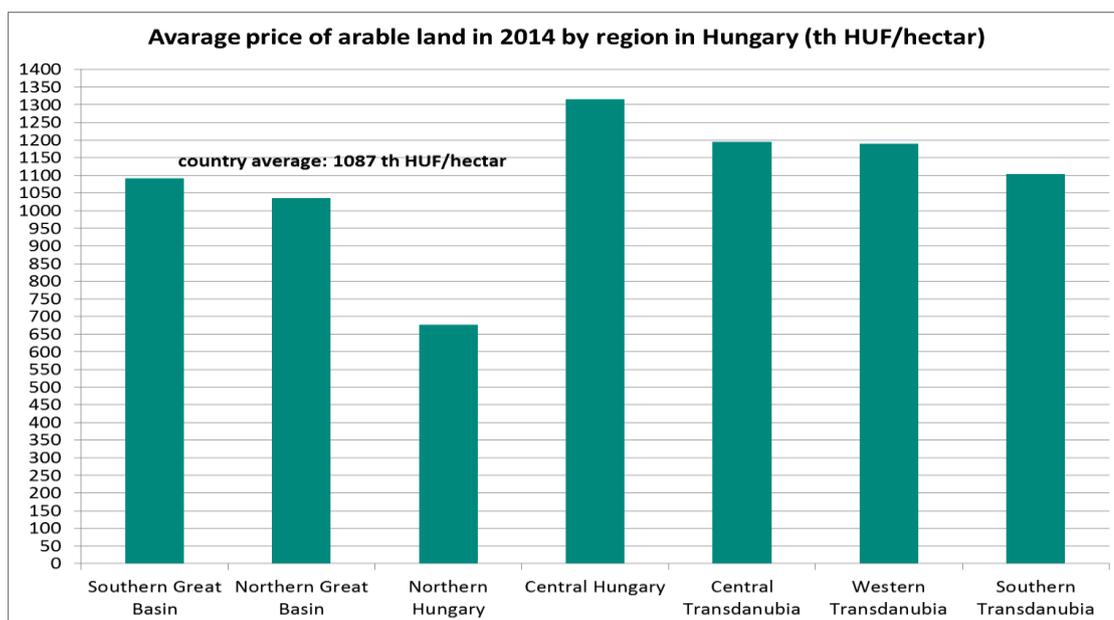


Figure 3.2. Average price of arable land in the different regions of Hungary

The various cultivation methods remain characterised by differing price trends (Figure 3.3). Arable land prices have been increasing continuously since 2007, and have doubled between 2007 and 2014. Although forests also showed a significant, 60 percent price increase until last year, their prices dropped in 2014 by 3.4 percent. The average market value of vineyards and grasslands grew significantly, by 27.4 percent in the case of the former, and by 14.7 percent for the latter. A hectare of vineyards increased by 75 percent since 2007, while the price of grasslands grew by 58 percent in the same period. Fruit plantations did not repeat their spectacular 20 percent increase in 2013 – per hectare prices grew by 9 percent last year, and hence their total price increase between 2007 and 2014 rose to 37.5 percent.

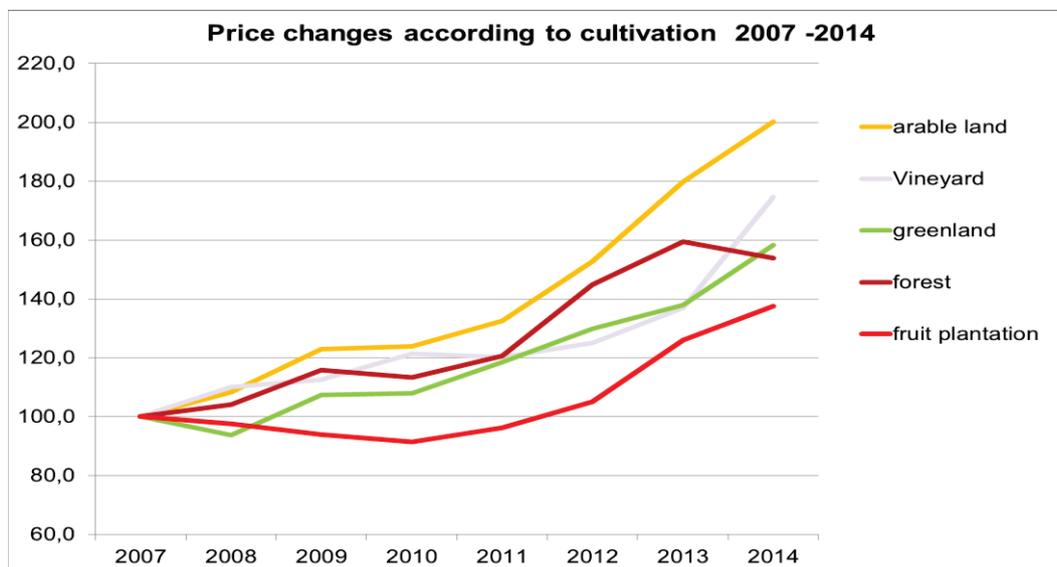


Figure 3.3. Price development by cultivation method (Source: FHB Agricultural Land Index)

Figure 3.4 shows the average price of land by cultivation methods compared to arable land, and their heterogeneity. Average prices are significantly lower for grasslands and cane, and are also characterised by higher standard deviation, which means a greater fluctuation in these cultivation types. The price of fruit plantations and fish ponds was slightly higher than arable land in 2014, but this may also be attributed to their lower market transaction intensity, meaning that their price trends followed that of arable land. Vineyards and gardens showed outstanding average estimated prices in comparison. Gardens surpassed arable land price by 32 percent, and vineyards by 30 percent, although price fluctuations were also higher in these two cultivation types. In the case of the former the

outstanding position is partly explained by the urban locality and the improved land, while high fluctuations can be attributed to greatly diverging local conditions.

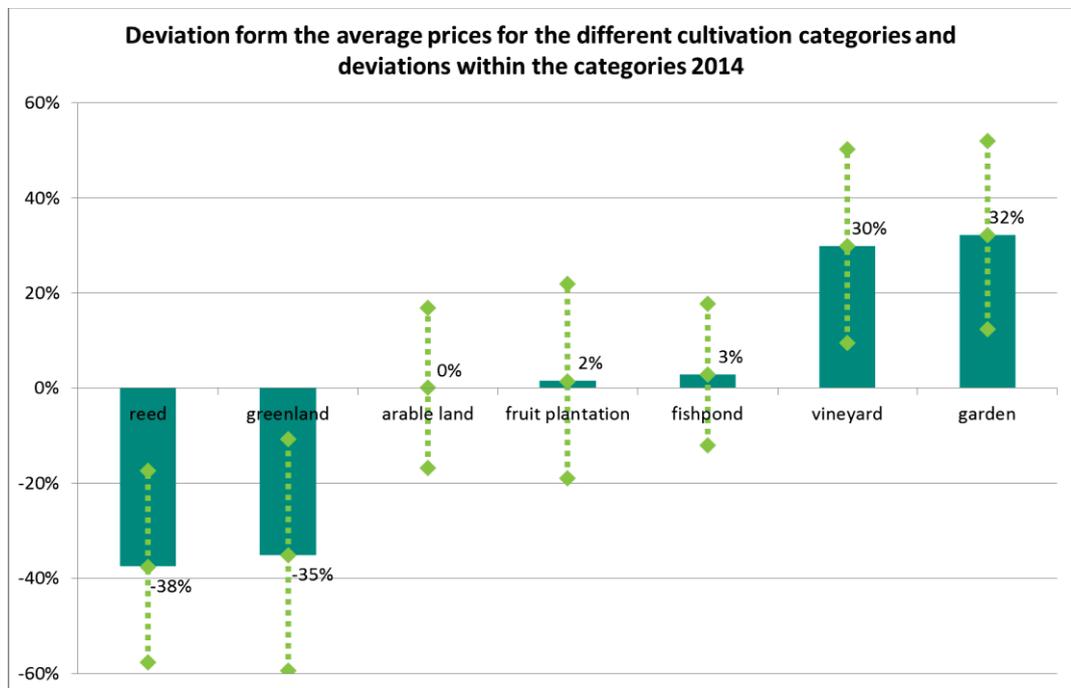


Figure 3.4. Comparative parcel prices of land by cultivation method (Source: FHB Agricultural Land Index)

4. Institutional changes

The new Land Act entered into force in 2014. According to the new legislation, agricultural land greater than one hectare can only be acquired by farmers who use it for cultivation. The Act defines a farmer as a person who has pre-defined qualification in agriculture or forestry, or has been working as a farmer or forester for at least three years in Hungary. Another limitation is that property rights can only be acquired by farmers with a local residence. The law defines that European Union citizens from outside of Hungary also have the right to buy agricultural land up to one hectare, but third country nationals are still excluded from buying land. Legal persons also remain excluded from acquiring agricultural land, but retain the right to rent.

The new law also affects the land rental market, as it rules that the entire size of the tenure – which is the combined area of owned and rented land – cannot exceed 1,200 hectares (or 1,800 hectares in the case of livestock farms and seed production plants) while previously the upper limit was 2,500 hectares in the case of agricultural cooperatives and joint-stock companies. Plants have to forego previously rented lands at the time of contract expiry. Contracts could be renewed prior to 1 May 2014 for up to 20 years, which will likely lead to a prolonged process of agricultural land tenure structure.

The new Land Transfer Act also prescribes that land purchase and tenancy contracts must be approved by a specialized agricultural administrative body. Before land acquisition, the body will have to request the opinion of land committees consisting of local farmers, which has a veto right on the purchase. Until such committees are established, acquisitions must be approved by the county chairs of the National Tax and Customs Administration. The Administration received 32,000 such requests until May 2015, and experience shows that acquisition times did not become excessively long, decisions are made before deadlines.¹

In terms of bank financing of agricultural land, the new law has brought about a number of changes; for instance the opinion procedure of land acquisition also

¹

http://www.agrarszektor.hu/foldpiac/komoly_vitakat_gerjeszthet_a_magyar_foldtorveny.4927.html

considers the contractual price and the person of the buyer, but the maximization of land size also hampers access to financing. The creation of larger land tenures and the improved profitability of agriculture can, on the other hand, reinforce bank financing.

Nonetheless, the entry into force of the new Land Act does not eliminate every uncertainty. The European Committee is currently undertaking two investigations with respect to the new law, one with regards to the abolition of usufruct contract, and another about the entirety of the new Act. The latter is prompted by the limitation on property acquisition by legal persons, the requirement of actively cultivating the land, and the rejection of professional experience gained abroad. A government communication also informed that the “fine tuning” of the Act is yet to be done, in light of the Commission’s opinion and feedback based on practical experience.²

The new subsidy system

The European Commission officially approved the Hungarian rural development plan: between 2014 and 2020 Hungary will have access to EUR 4.2 billion, or almost HUF 1,300 billion for rural development projects.

The agricultural subsidy system has been changing in accordance with the Common Agricultural Policy. According to the EU level legislation, member states do not have discretion, and have to dedicate 30 percent of all direct disbursements for greening, which will amount to EUR 1.47 billion in Hungary this year. This subsidy element aims to foster biodiversification, and contains requirements with regards to plant varieties to be cultivated on the subsidized land. **As opposed to the past years’ Single Area Payment Scheme, EU funding will be available on multiple grounds.** The **basic premium** for one hectare will be **EUR 144.7**, while **greening premium will amount to EUR 81.3**, which means that area based agricultural subvention remains close to its former level at EUR 226.³

²

http://www.agrarszektor.hu/foldpiac/komoly_vitakat_gerjeszthet_a_magyar_foldtorveny.4927.html

³http://www.agrarszektor.hu/europai_unio/most_johet_az_oriasi_bukas_ki_kell_szantani_az_ertekes_veteseket.4695.html

As a novelty, **basic premium becomes graduated** from this year on: the entire sum of the subsidy will be disbursed up to EUR 150,000, above which direct subsidy will be cut by 5 percent up to the 1,200 hectare limit, which means that above 1,037 hectares only 95 percent of the subsidy is paid; and SAPS subsidies will be entirely cut above 1,200 hectares, or EUR 173,640 (*table 3.1*).

Area based subsidies by hectare and by grounds from 2013 (HUF/EUR exchange rate: 300)				
	Greening		SAPS	Total
Under 1,037 ha (up to subsidy amount EUR 150,000)	390	24	43	67
		24	41	65
Between 1,037 és 1,200 ha	390		240	630
		24		24
Above 1,200 ha	390		-	390

Table 3.1. Area based subsidies from 2015 according to grounds (Source: FHB Index estimations)

A new subsidy scheme has been made available for **young farmers**, who can apply for an additional EUR 60-65 per cultivated hectare. Furthermore, smallholder farmers have the option to join the **simplified subsidy scheme**, if their annual subsidy amount is between EUR 500 and 1,250; but this option is only open in 2015. This possibility provides a flat rate support until 2020, at the amount specified at the time of joining the scheme. The revised new subsidy structure aims at reinforcing small, medium and family-run farms, and check the expansion of large farm holdings.

Land privatization and the consolidation of tenures

The state has published land acquisition tenders on multiple occasions under the framework of the “Land to Farmers” programme, and this year’s announcement suggests further such tenders. The government communication informed of **the sale of 300,000-380,000 hectares of state owned agricultural land on public auctions and advertisements**. The newly purchased land will be registered with a **20 year ban on alienation or lease**, during which period the state will also have a **repurchase option**. The sale will cover approximately **50,000 topographical lot numbers**, of which **41,000 will be areas smaller than 10**

hectares. This measure too is in place to strengthen small and medium holder family farmers.

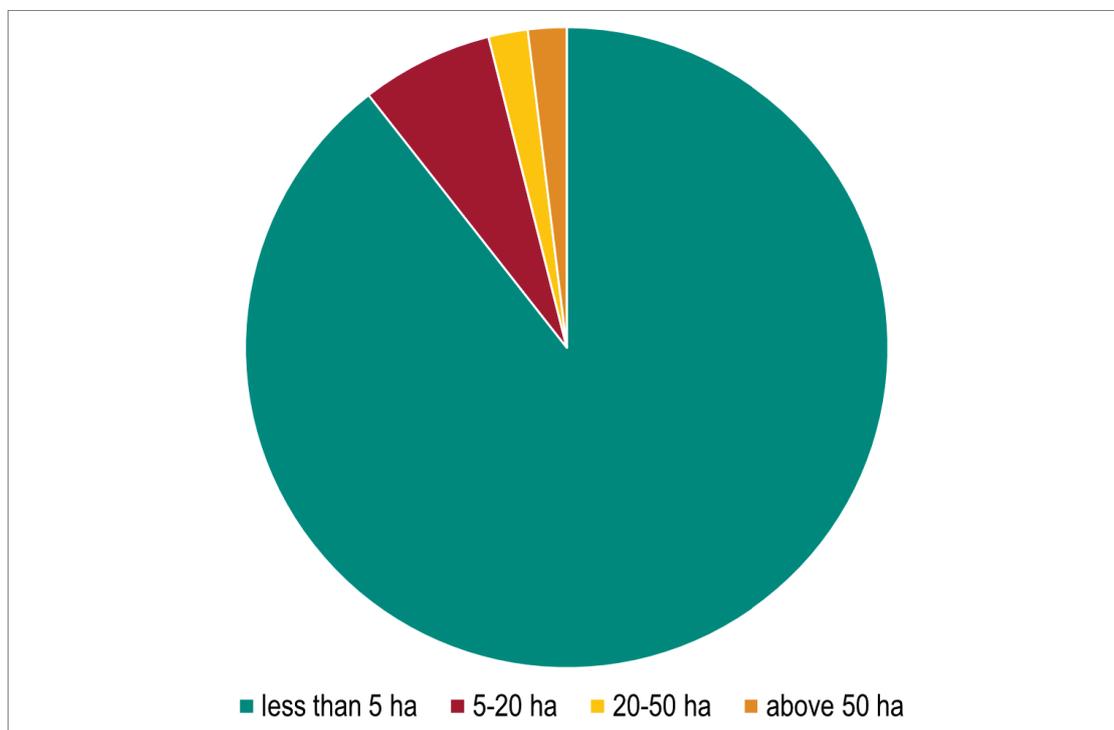


Figure 3.1. Land tenure structure of Hungary by size (Source: Eurostat)

As laid down in our previous publications, Hungary's agricultural land tenure structure is fragmented with regards to the number of holdings (Figure 3.1), and the share of so-called undivided common properties is high. After successfully closing the pilot programme, the **liquidation of such common properties will be initiated on a national level**, in order to obtain a healthier land tenure structure. According to the communication of the Ministry of Agriculture, this action will concern 970,000 hectares of land nationally, covering 64,000 land plots and more than 300,000 owners.⁴ The liquidation of common properties and the property transfer of plots is expected to **be finalized by 2018**. This year the procedure will begin in the jurisdiction of two cadastre offices per county.

⁴ http://www.agrarszektor.hu/foldpiac/sokaknak_fogalmuk_sincs_hol_van_a_foldjuk.4567.html

5. Agricultural land as an investment

Agricultural land can yield a profit to its owner in multiple ways, as presented in detail in our previous publications. **Previously a number of investors considered it an investment opportunity**, and regarded it as an alternative of other fixed assets (*Figure 5.1*). Last year's stricter regulations with regards to agricultural land purchase (namely the requirement of professional qualification or relevant farming experience) has curbed the attractiveness of land as a merely speculative investment good with the entry into force of the new Land Act.

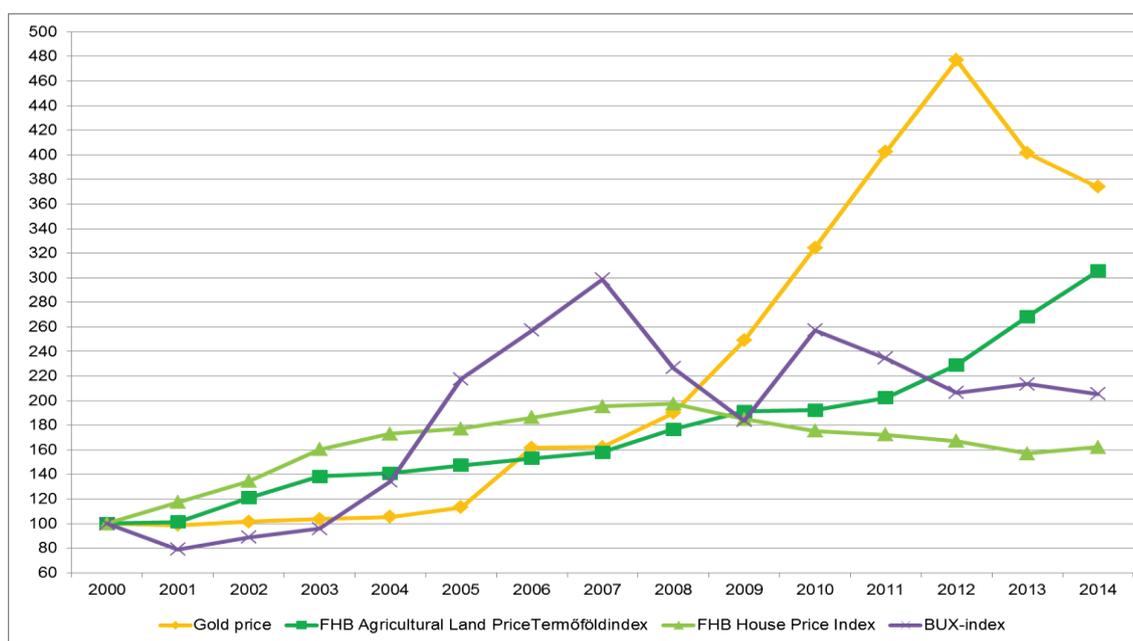


Figure 5.1. Returns on investment assets between 2007 and 2014 (Source: FHB)

Besides returns thanks to price increase and the possibility of leasing, agricultural land can also yield a profit through cultivation. This is made more attractive by the fact that subsidies ensure a steady flow of income regardless of cultivation yield, although typically the latter is also profitable. The next section presents the profitability of agricultural cultivation.

Profitability by cultivation type

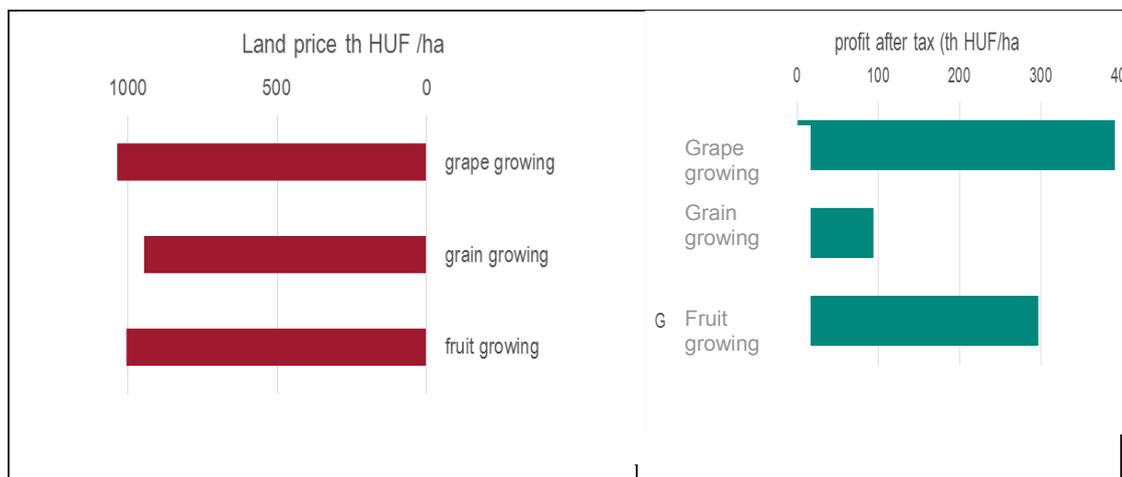


Figure 5.2.a. Land unit prices in Hungary in 2013 by cultivation method (Source: FHB Agricultural Land Index)

Figure 5.2.b. Profit after tax per hectare at a typical holding in 2013, by cultivation method (Source: FADN)

Profit on agricultural land shows great variations by cultivation type. In terms of profit after tax, viticulture was the most profitable cultivation methods in 2013, where profit after tax neared HUF 400,000 per hectare. The cultivation of arable crops yielded barely a quarter of this, while fruit production generated an income of HUF 300,000 per hectare (Figures 5.2. a and b.)

Land prices also follow this trend: the land price of the most profitable type, vineyards, was the highest, reaching HUF 1,030,000 per hectare in 2013. The price of fruit plantations was also at around HUF one million per hectare, while arable land cost HUF 945,000 per ha. Basing our calculation on 2013 profit yields and land prices, arable land has the longest return on investment period, where a full 10 years of profits after tax covers the price of land acquisition, while in 2013 in the cases of viticulture and fruit production the land price could be covered in 2.6 and 3.4 years, respectively.

Apart from profit after taxes, the profitability of various cultivation methods compared to return on capital must also be considered. Available FADN data shows that profitability per production vale, total equity and profitability of own equity

shows a similar ratio in the case of various plant cultivation methods. The best results could be achieved through open field vegetable production in 2013 in all three categories of profitability: profitability rate per production value was 33 percent, on total equity yielding a profit of almost 25 percent, and on own equity it reached 30 percent. The second best results were achieved by forced vegetable growers (Figure 5.3).

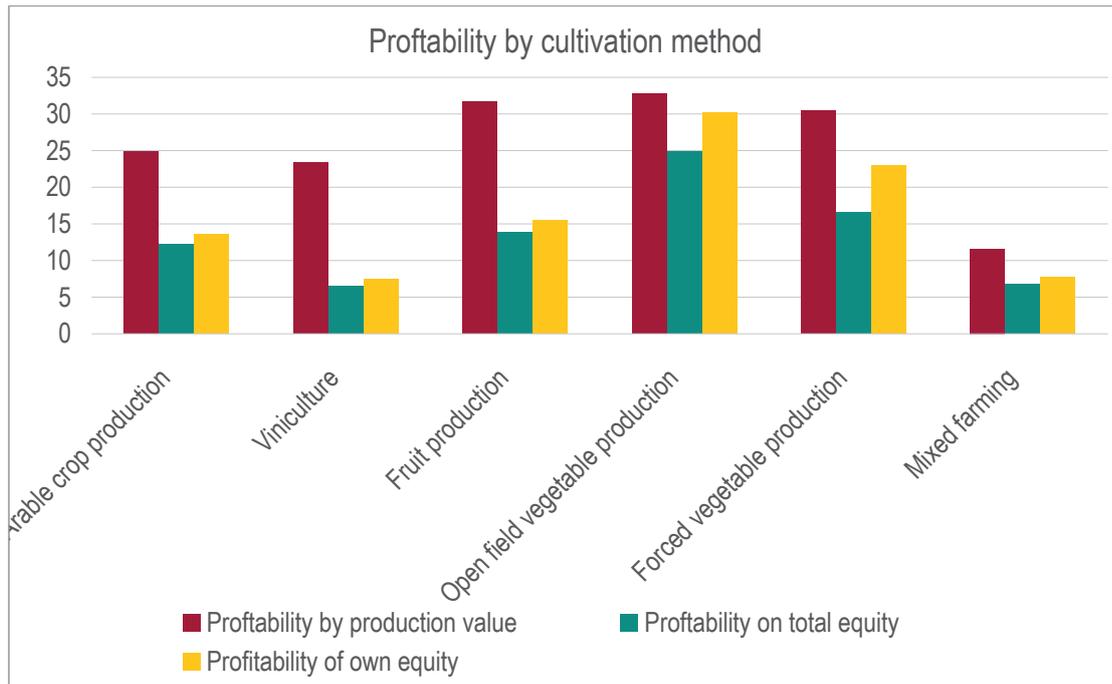


Figure 5.3. Profitability at a typical agricultural holding by plant production method in 2013
(Source: FADN)

The order on cultivation methods by profit after tax and return on equity shows great variation for viniculture, fruit production and arable crop production. This is explained by the fact that the former two are highly capital intensive, meaning that a much larger capital investment is required which cannot be offset by yields (Figure 5.4). Forced vegetable producers must also invest massively, but in their case the outstanding income ensures an attractive return on capital. Of all production methods, viniculture showed the worst return on capital in 2013: own equity yielded 7.5 percent, while total equity produced 6.54 percent in capital gains.

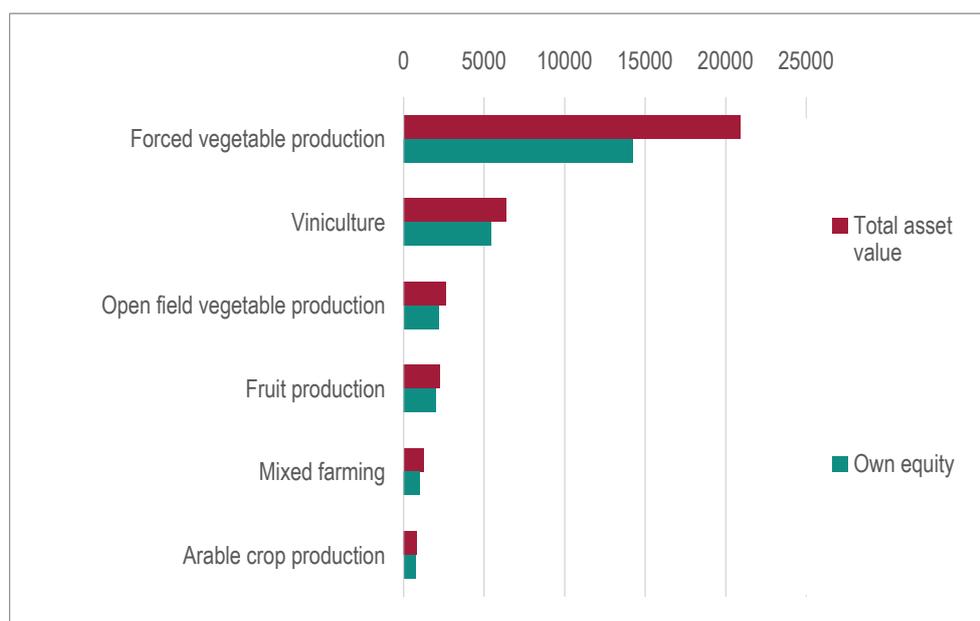


Figure 5.4. Own equity per hectare and total asset value at a typical agricultural holding by cultivation method in 2013 (Source: FADN)

Arable crop production results

Table 5.1 shows the arable crop production operating activity results of a plant farm holding. The numbers show that cultivation yields significantly greater profits than leasing. Between 2011 and 2013 farmers achieved a double digit income premium compared to land price; in 2011 it exceeded 14.5 percent, while land leasing yielded a meagre 4.3-4.8 percent profit between 2009 and 2013.

Arable crop production result in a typical agricultural farm holding					
Indicator	2009	2010	2011	2012	2013
Results of operating activities in agr. (HUF 1,000/ha)	33.4	56.2	109.8	118.0	99.2
Profit before tax (HUF 1,000/ha)	28.3	50.9	105.5	114.0	98.5
Profit after tax (HUF 1,000/ha)	25.9	48.0	101.3	108.8	94.4
Rent of land (arable) (HUF 1,000/ha)	25.9	28.9	32.8	38.6	40.6
Price of land (arable) (HUF 1,000/ha)	576	601	694	823	945
Return on leasing	4.5%	4.8%	4.7%	4.7%	4.3%
Results of operating activities / land price	5.8%	9.3%	15.8%	14.3%	10.5%
Profit before tax / land price	4.9%	8.5%	15.2%	13.8%	10.4%
Profit after tax / land price	4.5%	8.0%	14.6%	13.2%	10.0%

Table 5.1. Arable crop production operating results in a typical farm holding, Hungary, between 2009 and 2013 (Source: FADN, HCSO, FHB Agricultural Land Price Index, FHB calculations)

Wheat is one of the most important arable crops; it is cultivated on over one million hectare. Its profitability was discussed in multiple previous FHB Agricultural Land Price Index analyses. The latest results show that 2013 and 2014 were again fruitful years in wheat farming, unit yields on the hectare were high. Average buying-in prices were lower than in 2011 and 2012, but this was counterbalanced by good production output, and incomes were close to their 2012 level at HUF222-229,000 per hectare (*Table 5.2*).

Wheat production output

Wheat production income						
	2009	2010	2011	2012	2013	2014
Unit output kg/ha	3850	3710	4200	3750	4640	4730
Average buying-in price HUF/kg	29.9	39.2	51.2	60.4	47.8	48.4
Unit income HUF 1,000 /ha	115.1	145.4	215	226.5	221.6	228.9
SAPS area based subsidy HUF 1,000 /ha	42.9	46.5	56.9	59.7	69	68.4
Total income HUF/ha	158.1	192	272	287.5	290.6	297.3
Share of SAPS in total income	27.1%	24.2%	20.9%	20.8%	23.7%	23.0%
Annual rent of (arable) land, HUF 1,000 /ha	25.9	28.9	32.8	38.6	40.6	
Price of (arable) land HUF 1,000 /ha	576	601	694	823	945	1087

Table 5.2. Wheat production income, land rent and sales prices (Source: HCSO, FHB Agricultural Land Price Index, FHB calculations)

Together with EU subsidization, income per hectare was between HUF 290,000 and HUF 297,000 per hectare last year and the year before; subsidies accounted for 23-23.7 percent of incomes. Their role is significant not only because of their high share in income, but also in comparison with land rent prices. In 2012 subsidy per hectare surpassed the gradually increasing rent level by 55 percent, and in 2013 by 70 percent.

6. International outlook

It is well-known of Hungary that based on the country's favourable agricultural circumstances and its traditions, this sector plays an important role in the country's economy. A brief international outlook should assist in the assessment of the current conditions in Hungary. It is well-known of Hungary that based on the country's favourable agricultural circumstances and its traditions, this sector plays an important role in the country's economy. These favourable circumstances are shown in Figure 6.1. in an international comparison. In the case of some of the countries situated in the 'Eastern Block' (indicated with darker green colour), the utilization of favourable agricultural circumstances is significantly more important for the countries' economic growth. Although the direct proportion of agriculture in the country's GDP is lower than 5% even in the case of Hungary, the development of these sectors together with the food industry can greatly contribute to the long-term economic growth of the country.

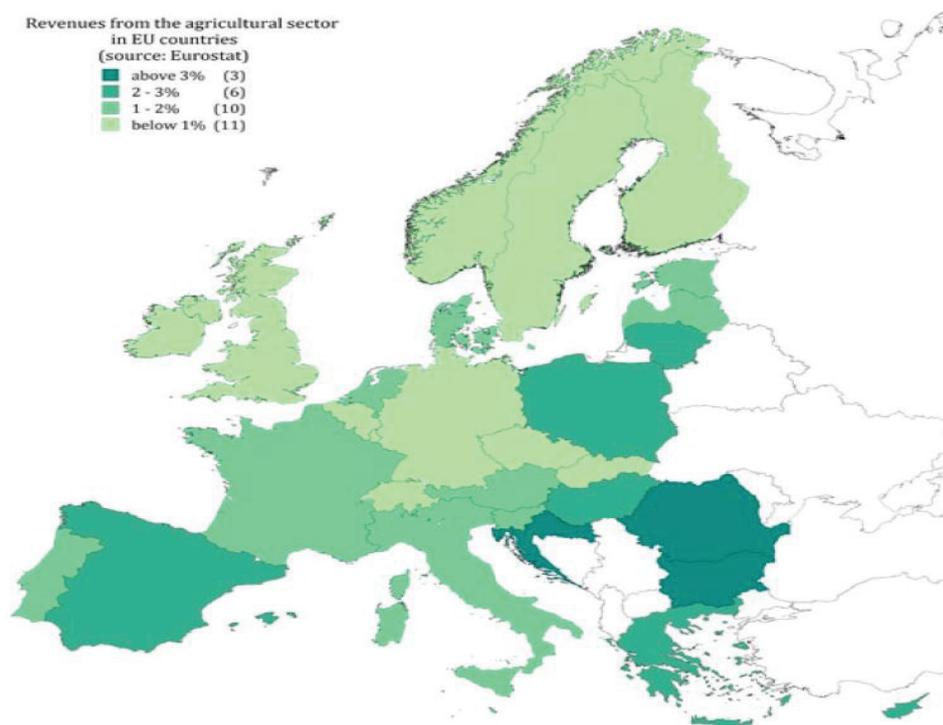


Figure 6.1. Revenues from the agricultural sector in the EU (Source Eurostat)

The agricultural structure of the countries is not uniform, the strategy of the different countries produce different achievements and results, which are, of course, also

influenced by the local conditions and circumstances of the given country. The higher geographical position, the wetter climate results in the higher proportion of pastures, which is quite visible in figure 6.2. in the cases of Slovenia and Austria. The sunny areas in Cyprus, Malta and Portugal provide excellent conditions to produce citrus fruits and grapes. It is worth pointing out, however, that with the development of agricultural technology, growing more expensive and sophisticated agricultural produces requiring higher production intensity and larger investment may also be a fruitful concept: Netherland has long been regarded as a superpower famous for vegetables and ornamental plants grown in greenhouses. Therefore, our third international chart gives an overview of the area of agricultural land in the individual countries. The high proportion of arable land also confirms the favourable agricultural circumstances of Hungary.

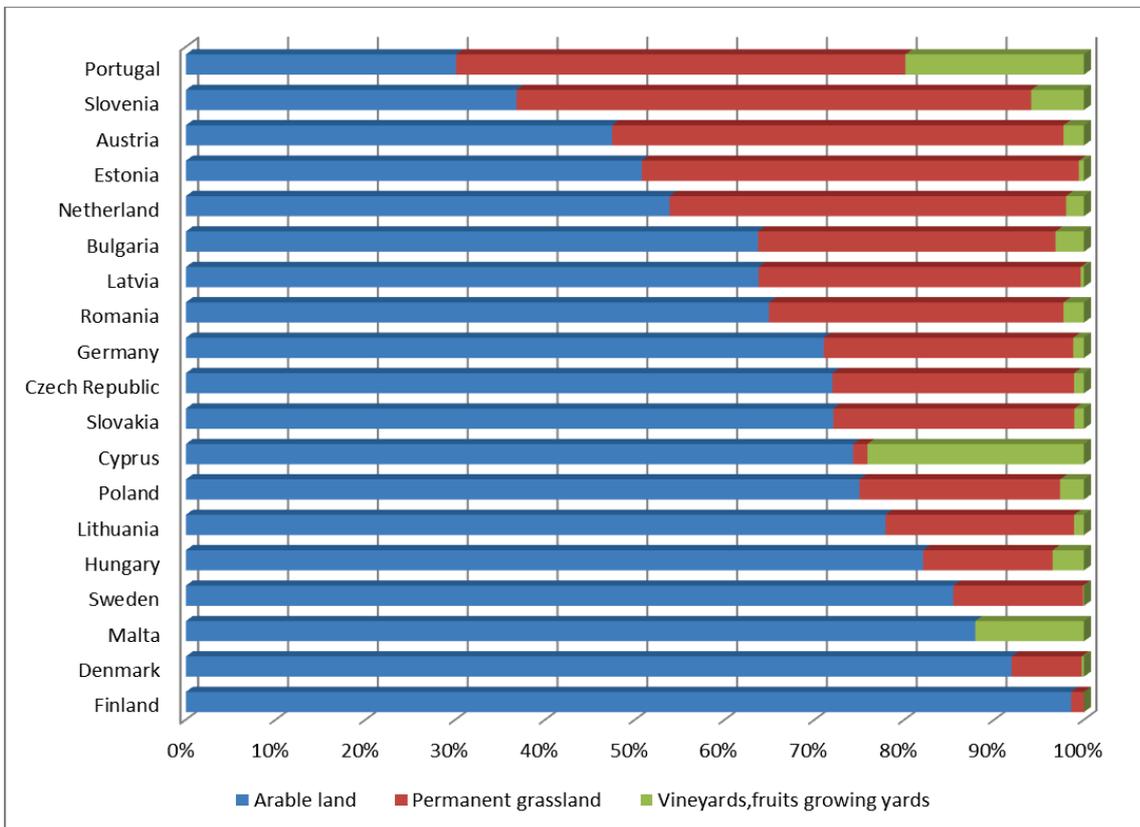


Figure 6.2. The distribution of different types of land utilisation in EU countries. (2009, source: Eurostat)

7. Conclusion

The measurement of house price changes and the analysis of the housing market by indexes is quite common practice today in Europe. After launching the FHB House Price Index project it was initially an experiment to start the FHB Farmland Index, however it was very well received by both the financial and the agricultural market players so it has become today a regular service provided by FHB

The FHB Agricultural Land Price Index confirms the general assumption that the evolution of agricultural land prices is fairly stable, ascending conservatively and it is less vulnerable to fluctuations than other investment facilities. Agricultural land has maintained its value even compared to other real assets and capital goods – it can thus be concluded that agricultural land is a crisis resistant investment.

Based on its geographic circumstances, Hungary's agricultural potential is really significant. The period preceding the introduction of changes in the Land ownership regulations (New Land Act) have brought the highest year on year increase in 2013 and 2014 of the agricultural farmland prices, however average hectare prices are still low compared to EU 16 countries and even to the neighbour countries,.

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14. Property prices and the real sector: comovements in European markets

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Abstract

The paper establishes stylised facts about residential and commercial property prices focusing on 12 European markets over the sample 1984-2013. Using the measure of dynamic correlation and cohesion we look at the medium and long-term dynamics in the real estate markets. We investigate how do comovements within real estate cycles relate to comovements within cycles of real activity variables over time.

Keywords: dynamic correlations, real estate, cluster analysis

JEL classification codes: C63 (computational techniques) E00 (general macroeconomics) E32 (business fluctuations, cycles), R30 (real estate markets – general), R33 (non-agricultural and non-residential real estate markets)

Introduction

Since the beginning of the great financial crisis real estate variables have gained unprecedented attention. Developments in real estate proved to be at the root of the building up of imbalances, especially in advanced economies, eventually leading to painful adjustments with negative effects on the real economy. As a result, research has focused more and more on models that include asset prices and in particular real estate assets. Given that the analysis of the characteristics of these variables is relatively new, with this paper we aim at adding empirical evidence to fill this gap. In particular we want to define some “stylised facts” about real estate variables looking purely at the data. Previous empirical works have focused mostly on residential property prices. With this paper, we will include both residential and commercial property markets. We make use of the recently published database on residential property price series by the BIS* and the commercial property prices database internally compiled.

In what follows we start by investigating how do comovements within real estate cycles relate to comovements within cycles of real activity variables over time. We first look at real estate variables cycles among a group of 12 European countries. This first part of the paper tries to answer the following question: how are real estate property prices series synchronized across our sample of countries and do these patterns compare with that of other real activity variables such as GDP and credit?

We then move on looking at how these patterns change when we take into account cross-comovements between variables. In other words we want to understand how the real estate series, taken as a whole across all countries, relate to the other real variables also taken as a whole across the whole sample.

Finally we break down the results by country. We group the countries according to their similarities in real estate markets in both the long and the short run and we

* See <http://www.bis.org/statistics/pp.htm>

see if there have been changes in the group of countries that move more closely together over different cycles.

In order to address all these questions we make use of the tools developed in Croux, Forni and Reichlin (2001). In particular, we use a measure of dynamic correlation and cohesion, concepts based on frequency domain analysis. Dynamic correlation allows us to distinguish between short-run and long-run dynamics, ie to separate long (showing persistent fluctuations), medium and short (transitory) cycles. Previous applications of this technique were limited to study aggregate macro variables across countries, see Croux, Forni and Reichlin (2001).

We find some interesting stylized facts regarding both residential and commercial property markets. First, cohesion within commercial property prices is generally higher than cohesion within residential property price series. Besides, when comparing these patterns to those of real activity variables, they show more similarity with the pattern of credit to the private sector than to that of GDP. This result supports the idea of pro-cyclicality of credit and real estate markets.

Second, when we turn to cross-cohesion we observe again how important is to take into account dynamics. Residential property prices co-move in fact quite highly with GDP but only in the long-run, showing static correlations of around zero at short-term frequencies. Commercial property prices also show high cross-cohesion with real economy variables, but rather than GDP it is industrial production that shows a higher degree of comovement.

Third, when breaking down the results by country, making use of the cluster analysis, we find some interesting results. First, in residential property markets the comovements across European countries in the sample have changed dramatically post-1999 (at all frequencies spectrum). Second, in commercial property markets, countries are clustered more closely together in the long run and no significant change is observed by looking at the sample periods.

European real estate markets

Data

Our dataset consists of a broad range of variables: residential property prices (based on BIS long time series dataset, see Scatigna et al. (2014), commercial property prices (from both national sources and commercial real estate agencies); real GDP, industrial production, total credit to the private non-financial sector (also from the BIS[†]) and its components: total credit to households and total credit to the private non-financial corporations and equity prices. Most of the data come from BIS statistics on real estate and credit, whereas the other variables are taken from national statistical sources. Our unique data set, at quarterly frequencies, covers 30 years allowing us to study cycles at different frequency. For details regarding the data sources see Appendix I.

Our sample covers 12 European countries: Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom for the period 1984:Q1 to 2013:Q4. We analyse the data by looking at the full sample, but also at two subsamples 1984-1999 and 2000-2013 to see if anything has changed after the introduction of the euro. The data are transformed to have certain statistical properties. We analyse 4th log differences in real terms (data are deflated by CPI) and further demeaned.

[†] See <http://www.bis.org/statistics/credtopriv.htm>

Co-movement in European real estate markets

We first investigate the degree of comovement between real estate variables amongst European markets. In this paper in order to assess the “comovement” between time series variables we follow the methodology developed by Croux, Forni and Reichlin (2001). In this approach, the co-movements are defined by using a measure of dynamic correlation.

Dynamic correlation is a measure that is defined in whole frequency domain and on frequency band where it equals to the static correlation on band-passed filtered series (using given cycle lengths). We use this measure to see the comovements between two variables. This approach is useful to study problems of short and long run properties of time series as well of business cycle coordination.

Dynamic correlation in a frequency domain is defined as follows:

$$\rho_{xy}(\lambda) = \frac{C_{xy}(\lambda)}{\sqrt{S_x(\lambda)S_y(\lambda)}}$$

Where x and y are two zero-mean real stochastic processes, $S_x(\lambda)$ and $S_y(\lambda)$ with $-\pi < \lambda < \pi$ be a spectral density functions of x and y and $C_{xy}(\lambda)$ a *cospectrum*.

Dynamic correlation for a frequency band on the other hand allows us to look at correlations at different cycle lengths as defined above, for the formula see Croux, Forni and Reichlin (2001). Dynamic correlation varies between -1 and 1.

As the aim of our study is to see the common movement of these series across set of countries, we turn to the measure of *cohesion* that draws on the concept of dynamic correlation.

Cohesion is defined as a multivariate index of co-movements of more than two time series variables, constructed using individual dynamic correlations between two series within a given group of variables and the weights of these

variables. As in the case of dynamic correlation, cohesion is calculated over the whole frequency domain and over given frequency band (cycle).

For a whole frequency, cohesion is defined as follows:

$$coh_x(\lambda) = \frac{\sum_{i \neq j} w_i w_j \rho_{x_i x_j}(\lambda)}{\sum_{i \neq j} w_i w_j}$$

And for the given cycle as, (results in Table 1):

$$coh_x(\Delta_+) = \frac{\sum_{i \neq j} w_i w_j \rho_{x_i x_j}(\Delta_+)}{\sum_{i \neq j} w_i w_j}$$

The formula refers to individual dynamic correlation between pairs of variables over the cycle and the weights assigned to these variables - w . The weights used in the cohesion measure are calculated using average population in a given time frame for each country, all weights sum to 1. We use IMF *World Economic Outlook* data at annual frequency. We also applied PPP weights as the alternative measure and this did not have much influence on the general results.

Graph 1 shows cohesion of residential and commercial property prices across all countries and over the whole frequency domain. The intervals are calculated over the horizon 0 to π , where $(0, \pi/16)$ corresponds to long cycle over 8 years; $(\pi/16, \pi/3)$ which corresponds to the medium cycle 1.5 - 8 years and $(\pi/3, \pi)$ - which corresponds to the short cycle, up to 1.5 years.

Our results show that country cohesion within residential property prices and within commercial property prices exhibit quite different shapes and levels.

Commercial property prices cohesion is very high at low frequencies (most left-hand side of the chart) but declines rapidly at frequencies corresponding to the medium cycle to rise again afterwards (ie instantaneous correlation, right-hand side of the chart).

Cohesion of real estate property prices across countries

12 European countries¹; based on dynamic correlation of the country series pairs over frequency band Graph 1



The vertical lines delimit the business cycle frequencies (8 and 1.5 years)

¹ Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom.

Sources: BIS; national data, Authors' estimates.

Residential property price cohesion, on the other hand, is quite stable over the whole frequency spectrum and in general is lower than that within commercial property prices.

We now turn to analyse how these patterns compare with those of some real activity variables, such as real GDP and credit to the private sector. Graph 2 shows the cohesion measure in real estate and real activity variables.

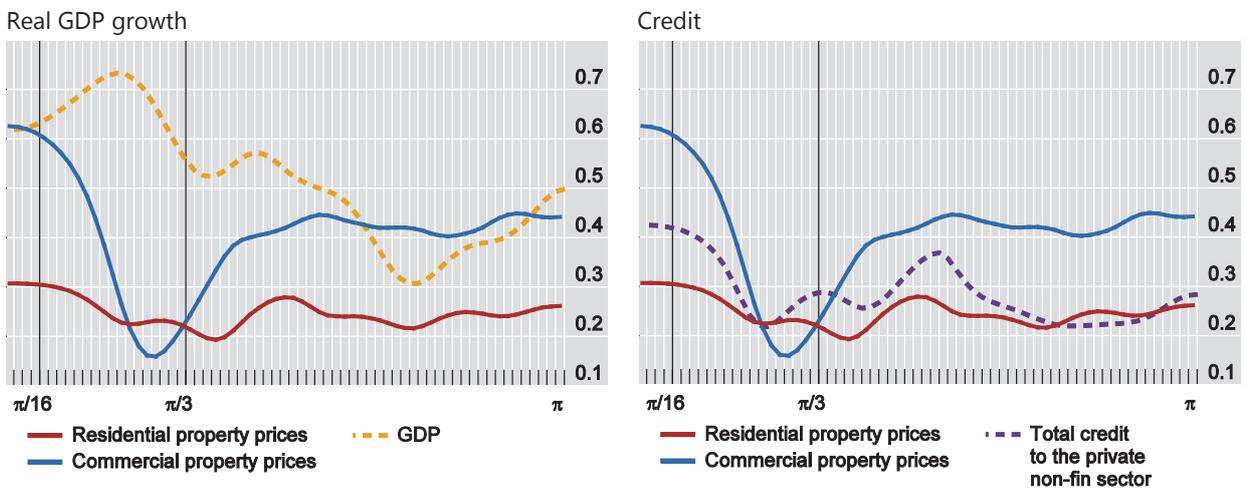
When we analyse cohesion in credit series (Graph 2, right-hand panel), both the comovement patterns and magnitude are very similar to those observed in the real estate variables.

Cohesion is higher at low frequencies, decreases during the business cycle frequencies to rise again at short-term frequencies.

Cohesion of real estate market , real GDP growth and credit

12 European countries¹, 1984–2013; based on dynamic correlation of the country series pairs band

Graph 2



¹ Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom.

Sources: BIS; national data, Authors' estimates.

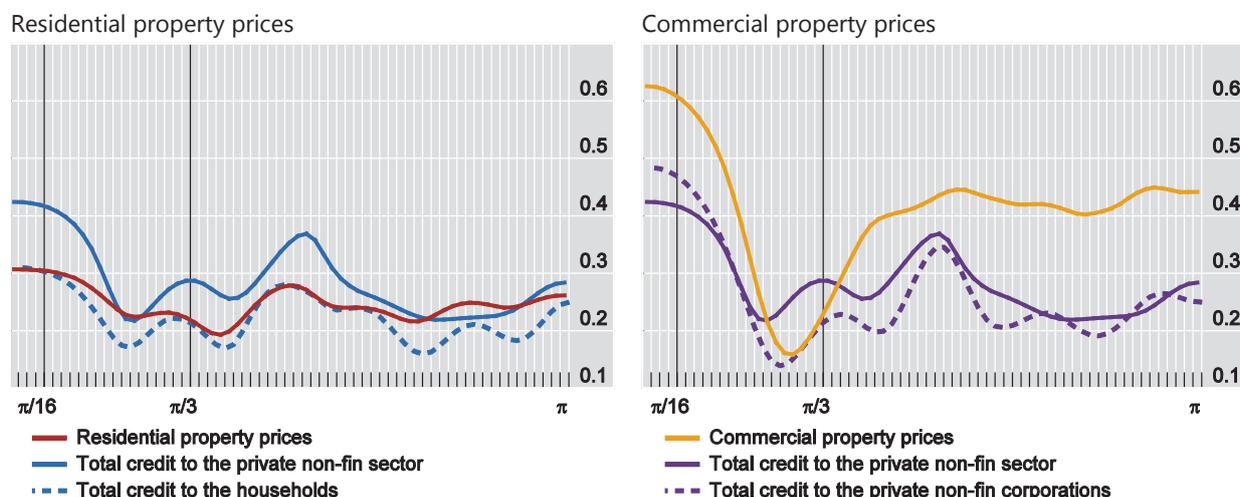
Real GDP shows very high cohesion over the long cycle and even though it declines, its level stays quite high throughout the whole frequency range. When comparing the patterns with both commercial and residential property prices, the estimates do not highlight any significant similarities. This result can be due to the fact that we estimate cohesion over the whole sample period. If we indeed split the sample we find that the patterns of GDP and housing prices are more similar in the post-1999 period.

We also look at the components of credit: credit to households and credit to non-financial corporations (see Graph 3). In the case of residential property prices the pattern of correlation is similar to that of credit to households for which mortgage credit is its biggest component (left-hand panel). In the case of commercial property prices, both the pattern and the magnitude of the dynamic correlations are more in line with the pattern of credit to the non-financial corporates (ie total credit excluding credit to households).

Cohesion of real estate market, real GDP growth and credit

12 European countries¹, 1984-2013; based on dynamic correlation of the country series pairs over frequency band

Graph 3



¹ Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom.

Sources: BIS; national data, Author's estimates.

These results are summarised in Table 1. Commercial and residential property prices comove most strongly over the long cycle. Real GDP, as expected, comoves most at the medium term cycle (ie the business cycle). Credit series also show highest comovements at long-term frequencies and in particular during the post 1999 sample confirming the influence of financial markets integration and innovation, see Kose (2003).

In almost all series groups the correlations increased in post-1999 sample confirming previous results established in the stylised facts literature, see Bordo and Heibling (2003).

Cohesion over the frequency band (cycles)

12 European countries¹, using dynamic correlation between the country pairs data in a time series category Table 1

	Short cycle: <1.5 years	Medium cycle 1.5-8 years	Long cycle >8 years
Residential property prices			
1984-2013	0.23	0.28	0.31
1984-1999	0.29	0.33	0.36
2000-2013	0.25	0.22	0.23
Commercial property prices			
1984-2013	0.39	0.46	0.62
1984-1999	0.43	0.51	0.67
2000-2013	0.35	0.45	0.45
Gross Domestic Product			
1984-2013	0.46	0.68	0.63
1984-1999	0.24	0.38	0.40
2000-2013	0.71	0.81	0.77
Total credit to the private non-fin sector			
1984-2013	0.27	0.35	0.42
1984-1999	0.25	0.30	0.37
2000-2013	0.39	0.44	0.49
Total credit to the households			
1984-2013	0.21	0.26	0.31
1984-1999	0.12	0.14	0.14
2000-2013	0.42	0.39	0.39
Total credit to private non-fin corporations			
1984-2013	0.23	0.34	0.47
1984-1999	0.25	0.30	0.44
2000-2013	0.33	0.46	0.55
Industrial production			
1984-2013	0.37	0.70	0.66
1984-1999	0.24	0.47	0.54
2000-2013	0.61	0.84	0.84

¹ Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom.

Source: Authors' calculations.

Cross comovement of European real estate markets with the real sector

In the previous section we looked at the comovements of variables within our sample of countries separately for each type of variable. In order to understand the relationship between real estate market and real activity over different cycle lengths we will turn to analyse the cross-cohesion between the twelve European countries in our sample. In other words we analyse how real estate variables comove with other variables across our country sample. In order to analyse the relations between the real estate, real sector and credit we will use the cross-cohesion measure. The cohesion index is easily generalised to an index measuring the cross-cohesion between an n -variable vector x and an m -variable vector y . We assume that these two vectors have no common elements. Cross-cohesion is also defined over the frequency domain (see Graphs 4 and 5) and over different cycles, see Table 2.

Cross-cohesion of x and y at a given frequency is defined as follows:

$$coh_{xy}(\lambda) = \frac{\sum_{i=1}^n \sum_{j=1}^m w_{x_i} w_{y_j} \rho_{x_i y_j}(\lambda)}{\sum_{i=1}^n \sum_{j=1}^m w_{x_i} w_{y_j}}$$

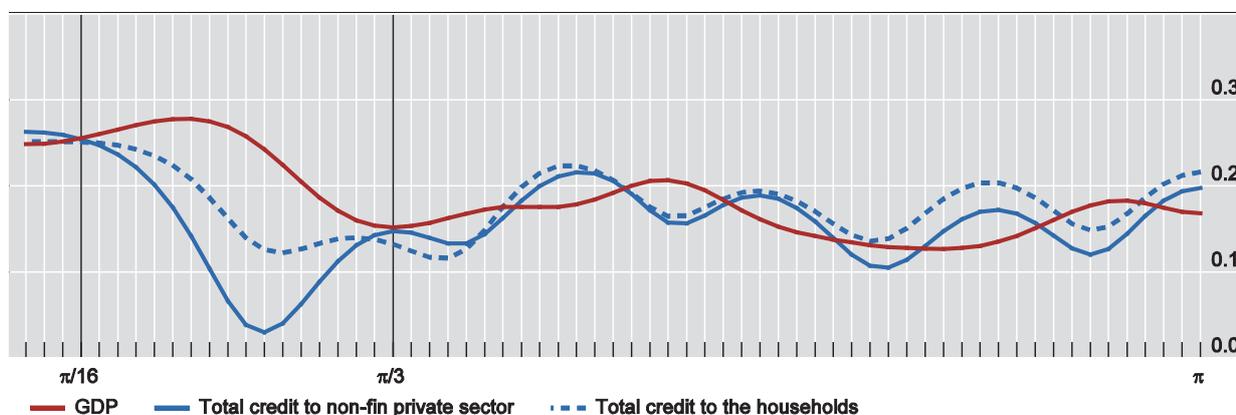
The formula refers to individual dynamic correlation between pairs of variables from vector x and y over the frequency and the weights previously assigned to these variables - w .

Graph 4 shows the cross-cohesion of residential property prices with real GDP, total credit and credit to households over the whole sample period. The dynamics shown here are quite different between the long and the short-run. In fact, residential property prices highly comove with GDP and credit, with similar patterns, in the long run, more than static correlation would suggest.

Cross-cohesion of residential property prices with other variables

12 European countries¹, 1984–2013; based on dynamic correlation of the country series pairs over different frequencies

Graph 4



¹ Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom.

Sources: BIS; national data, Author's estimates.

If we look at the detailed results by sub-sample and isolated cycles (Table 2) it is clear that comovement between house prices and real variables has increased in the post-1999 period.

Cross-cohesion over the frequency band: Residential property prices with other variables

12 European countries¹, using dynamic correlation between the country time series category

Table 2

	Short cycle: <1.5 years	Medium cycle 1.5-8 years	Long cycle >8 years
With Gross Domestic Product			
1984-2013	0.16	0.26	0.25
1984-1999	0.16	0.24	0.33
2000-2013	0.30	0.35	0.37
With total credit to the private non-fin sector			
1984-2013	0.16	0.18	0.26
1984-1999	0.23	0.24	0.29
2000-2013	0.22	0.19	0.23
With total credit to the households			
1984-2013	0.17	0.21	0.25
1984-1999	0.16	0.19	0.21
2000-2013	0.33	0.32	0.35

¹ Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom.

Source: Authors' calculations.

These results seem to confirm the procyclicality of residential property prices with GDP and credit and are consistent with the financial accelerator theory (Bernanke, et al. 1996).

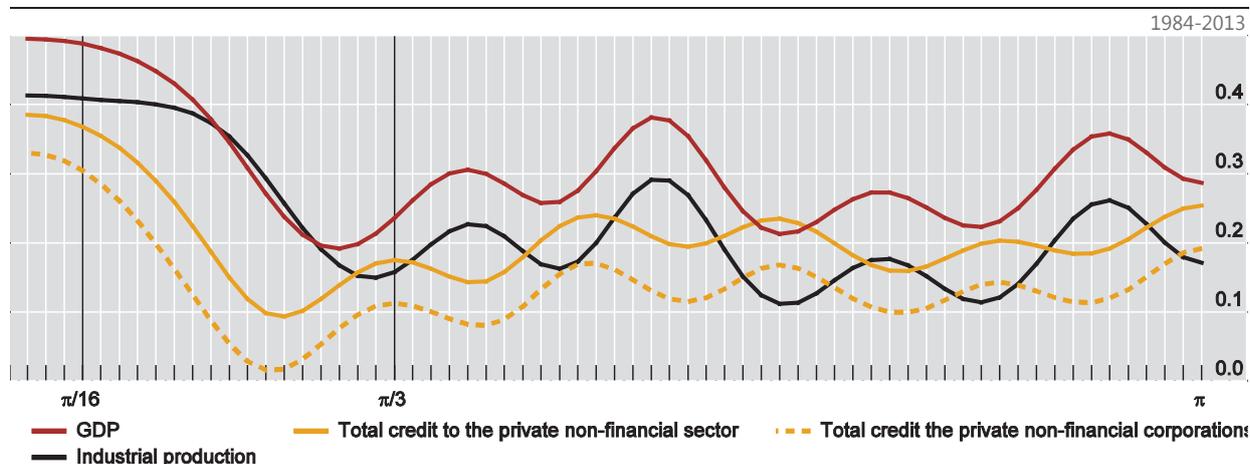
Also the comovement between residential property prices and total credit to households is stronger in the long run and grew in post-1999 sample to 0.35 compared to 0.21 in the pre-1999 sample.

Turning to commercial property prices, Graph 5 shows the cross-correlation with real GDP, total credit total credit to the private non-financial corporations and industrial production. The long-run relationship between commercial property prices and industrial production is much higher than the static one would suggest, making this variable good predictor for real estate market developments in the long run.

Cross-cohesion of commercial property prices with other variables

12 European countries¹, 1984-2013; based on dynamic correlation of the country series pairs over different frequencies

Graph 5



¹ Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom.

Sources: BIS; national data, Author's estimates.

Table 3 shows the cohesion over the selected cycles. In general there seem to be a stronger comovement with real variables than what we found in residential property prices. Also looking at only the 2000-2013 samples we can see that

commercial property prices comove strongly both with industrial production and with GDP. This result is to be expected as commercial property includes properties (industrial buildings, warehouses, retail etc.) that are used for manufacturing and services production.

Cross-cohesion over the frequency band: Commercial property prices with other variables

12 European countries¹, using dynamic correlation between the country data in a time series category

Table 3

	Short cycle: <1.5 years	Medium cycle 1.5-8 years	Long cycle >8 years
With Gross Domestic Product			
1984-2013	0.28	0.39	0.49
1984-1999	0.27	0.39	0.55
2000-2013	0.43	0.54	0.59
With total credit to the private non-fin sector			
1984-2013	0.19	0.25	0.37
1984-1999	0.25	0.27	0.33
2000-2013	0.24	0.27	0.33
With total credit to the private non-fin corporations			
1984-2013	0.12	0.16	0.31
1984-1999	0.17	0.19	0.28
2000-2013	0.19	0.22	0.30
With Industrial production			
1984-2013	0.19	0.34	0.41
1984-1999	0.15	0.29	0.38
2000-2013	0.35	0.51	0.55

¹ Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom.

Source: Authors' calculations.

Cluster analysis: similarities between European countries

Up to now the analysis has focused on the aggregate comovement of series of residential and commercial property prices and their interactions with real sector variables. The previous graphs show the aggregated trend in co-movement without looking at individual countries. We can analyse more closely the relationship between individual countries over different cycles by using cluster analysis. This approach will help us to answer the question: which real estate markets (residential and commercial) are more closely correlated with each other over different cycle lengths?

For this purpose, we will use the measure of dynamic correlation as a measure of distance between countries. We have calculated dynamic correlations between all the country pairs (66 pairs) over 3 frequency bands: short, medium and long cycle. In each case we obtain the upper triangular 12x12 matrix of the dynamic correlations that is used to calculate a matrix of positive "dissimilarities" $D(\Lambda_+)$ with elements:

$$D_{ij}(\Lambda_+) = 1 - \rho_{ij}(\Lambda_+)$$

The values in this matrix can be interpreted as a measures of dissimilarity, ie countries that strongly comove within a given frequency band, will have smaller dissimilarities (distances). We transform our matrix into a full dissimilarity matrix that is real and symmetric, and has zeros along the diagonal and positive elements everywhere else and apply the classical multidimensional scaling in order to represent our dissimilarities in a 2-dimensional space, see Seber (1984). This allows us to represent the 12x12 matrix into 12x2-dimensional coordinates' matrix.

Graphs 6 and 7 depict these coordinates. The relative position of each country with respect to another tells us how “similar” two countries are over different cycle lengths and different subsamples.

In the case of residential property markets, see Graph 6, the first striking observation is that markets became more “similar” after 1999. This may be explained by the increased financial integration of the markets and the increase in house prices registered in almost all countries in the sample.

Germany and Switzerland stand out as possible outliers. This could be explained by the fact that these two countries did not experience the housing booms witnessed by the other countries in Europe.

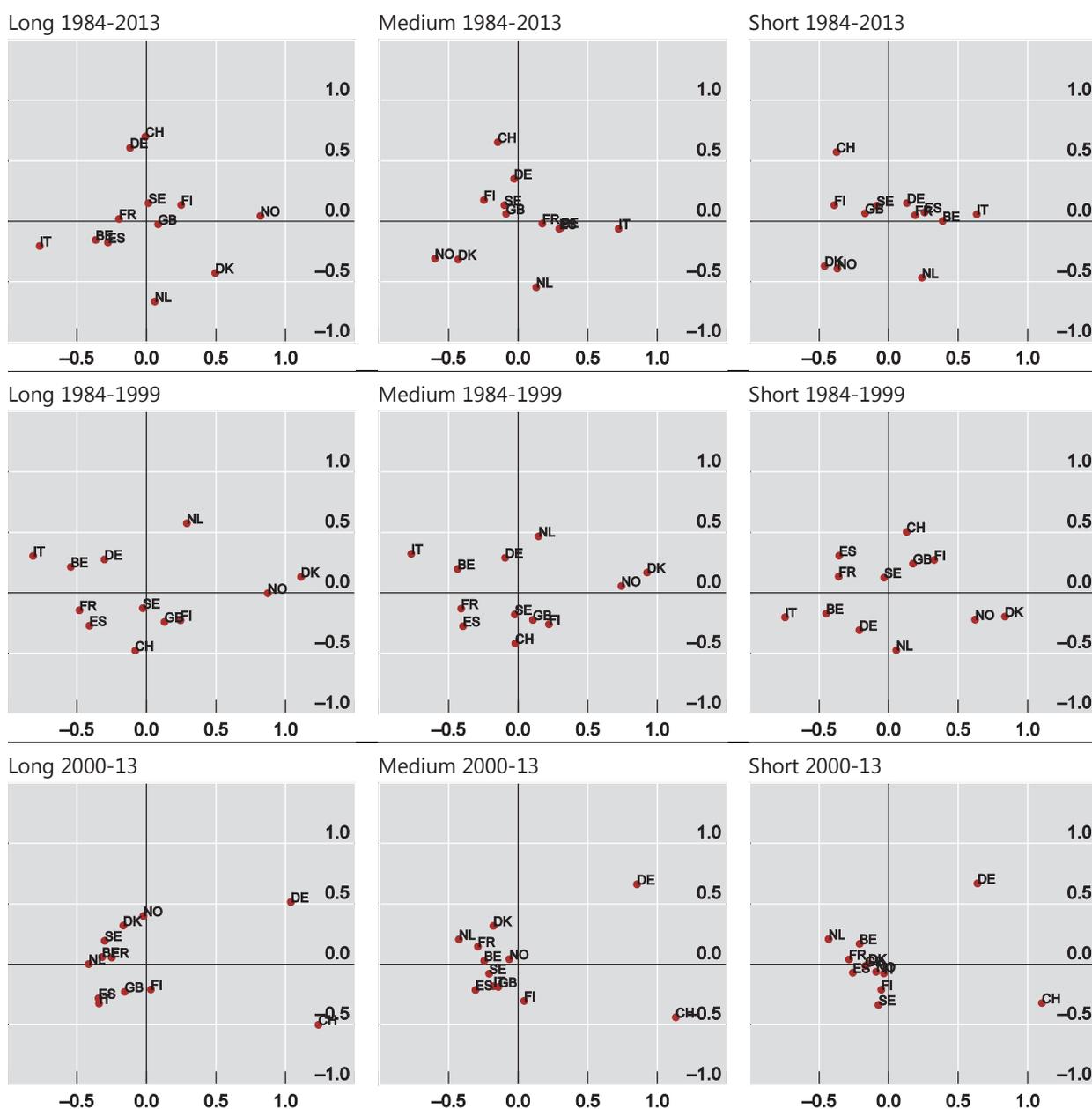
Over the whole sample and during the pre-1999 period, we can see that some countries comove closely together: Germany with Switzerland, Norway with Denmark, and France with Spain. Some explanation of this behaviour can be drawn from institutional characteristics of these housing markets. In both Germany and Switzerland, for example, low homeownership rates, well organised rental market and relatively more conservative lending practices are some important factors that could explain this vicinity.

This result confirms that even within the euro area important divergences in housing market can coexist (see for example Gros 2006). However, in order to explore more in detail the factors behind these results, further analysis on border linkages is needed.

Cluster analysis for residential property prices

12 European countries¹, 1984-2013; based on classical multidimensional scaling²

Graph 6



¹ Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden and Switzerland and the United Kingdom. ² The dissimilarities matrix is translated into two dimensional coordinates matrix showing relative position of all the countries

Sources: BIS; national data, Author's estimates.

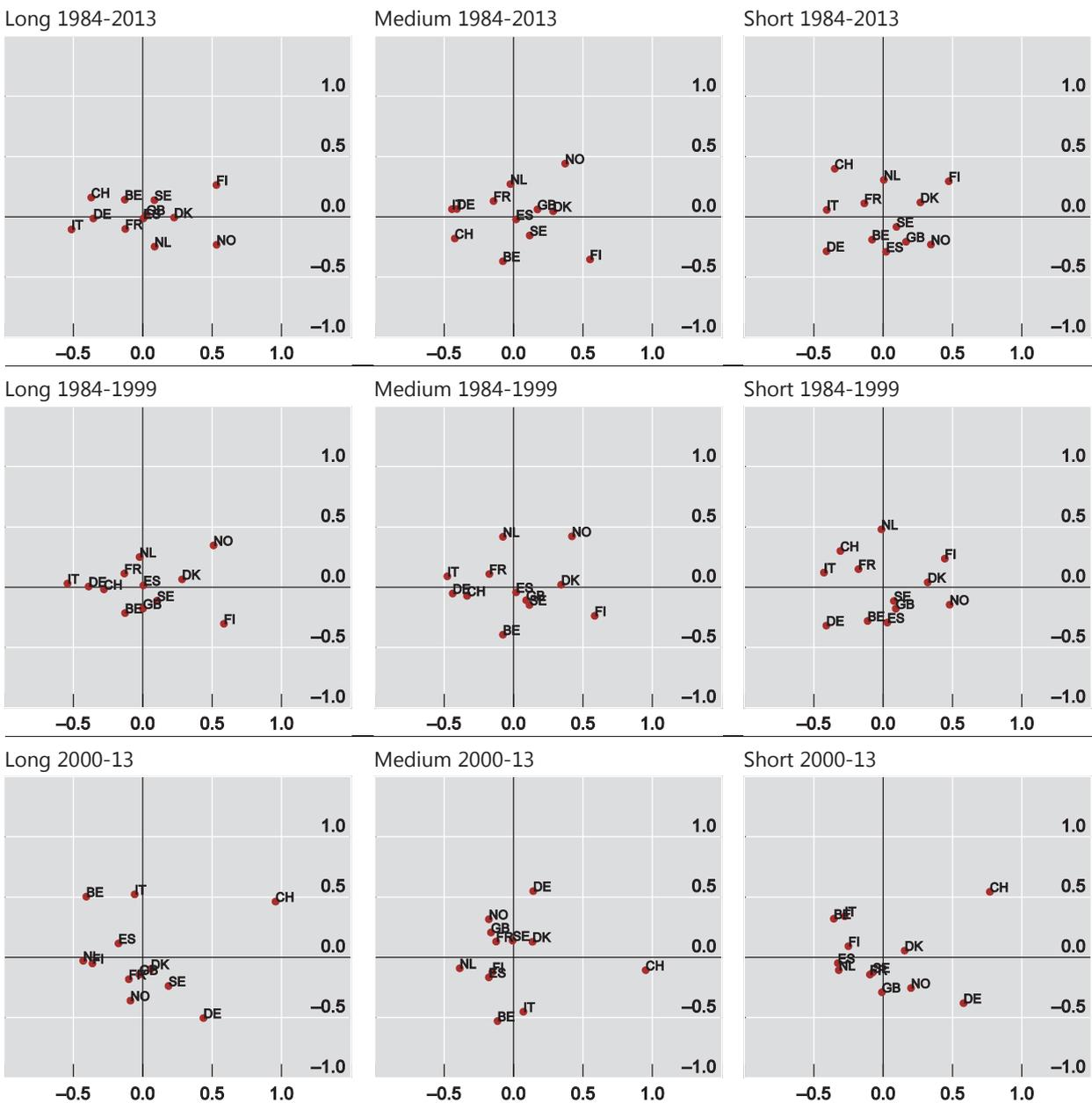
Looking at commercial property markets, we can observe that countries are positioned more closely over all cycles and subsamples, which may suggest that the cycles in all countries tend to be driven by some common shock and this is quickly

transmitted to other countries. This would suggest also that investment in commercial properties has more international dimension and it is mainly driven by firms with international linkages rather than local households.

Cluster analysis for commercial property prices

12 European countries¹, 1984-2013; based on classical multidimensional scaling²

Graph 7



¹ Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden and Switzerland and the United Kingdom. ² The dissimilarities matrix is translated into two dimensional coordinates matrix showing relative position of all the countries

Sources: BIS; national data, Author's estimates.

By performing this cluster analysis we have documented two interesting facts regarding real estate markets in Europe. First, in residential property markets the comovement across the countries in the sample has changed dramatically post-1999 (at all frequencies spectrum). Second, in commercial property markets countries are clustered more closely in the long run but no change is observed in the different sample periods.

Conclusions

By making use of a measure of dynamic comovement between series we analysed real estate markets using both residential and commercial property price time series. The measure we use comes from Croux, Forni and Reichlin (2001) and it is particularly useful as it allows us to distinguish between transitory and persistent cycle dynamics. We find some interesting results in terms of different relationships and patterns when looking at short-run versus long-run dynamics in real estate markets and also in their comovement with other real economic activity variables. Cohesion within commercial property prices is generally higher than cohesion with residential property prices. The comovement with GDP is more important for residential property while industrial production moves more closely together with commercial property price time series. Moreover residential property markets comovement across European countries has become stronger after 1999 (at all frequencies spectrum). And commercial property markets across our sample are clustered more closely together in the long run while no significant change is observed in the post-1999 sample.

Looking forward it would be interesting to extend the analysis to a larger set of countries and in particular to compare the patterns with the United States and other countries outside the euro area. Besides, further estimations exploring the causation between variables could also provide interesting insights regarding the link between real estate cycles and the economic cycles. Finally, another path that could be explored is related to the analysis of the border linkages between countries in order to assess if markets that are geographically closer are also more correlated.

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Appendix

Commercial property prices

Commercial property prices, internal database				
Country	Frequency	Start date	Source	Coverage
Belgium	Annual	1980	IPD	Office
	Annual	1970	JLL	Brussels
Denmark	Annual	1999	IPD	Office
	Annual (disc)	1982	Sadolin	Copenhagen
	Quarterly	1992	NSO	Denmark (all business properties)
Finland	Annual	1997	IPD	Office
	Annual (disc)	1971-2009	Yuoneistomarkkinointi	Helsinki Central Business District
France	Annual	1985	IPD	Office
	Annual (disc)	1980	JLL	Paris
Germany	Annual	1985	IPD	Office
	Annual (disc)	1980	JLL	Frankfurt
	Quarterly	2004	VDP	Germany
Italy	Annual	2002	IPD	Office (Rome)
	Annual	1983	JLL	Milan
Netherlands	Annual	1994	IPD	Office
	Annual (disc)	1980	JLL	Amsterdam
Norway	Quarterly (disc)	Q4 2006	IPD	Office
	Annual	1999	IPD	
	Annual	1980/90	OPAK	Oslo
Spain	Annual	2000	IPD	Office
	Annual	1980	JLL	Madrid
Sweden	Annual	1983	IPD	Office
	Annual (disc)	1980	JLL	Amsterdam
Switzerland	Quarterly	1970	Wuest&Partner (DBS)	Office
	Quarterly (disc)	1983	Wuest&Partner	
United Kingdom	Monthly	1986/12	IPD	
	Quarterly	2000Q1	IPD	Office
	Annual	1970	IPD	
	Annual(disc)	1974	JLL	London

15. A Hedonic House Price Index for Turkey

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Abstract

In the 2010-2015Q1 period, housing prices increased 78.8 percent in Turkey, which raises needs to carefully monitor the housing market dynamics. This increase is widespread across the country where prices have even doubled in some regions. Our study performs a hedonic price adjustment for the housing market in Turkey, where we control for the price effects of increases in observed house characteristics in time. Results show significant increases in quality of houses sold, which in turn suggests that identifying all the price increase as real appreciation may be misleading. In particular, we estimate that one fourth of nominal changes and one half of real changes in price stem from quality improvements in general.

JEL Codes: R31

Keywords: House price index, hedonic regression, characteristic prices, asset price bubbles.

1 Introduction

Houses are the most important wealth component of most households and property prices influence economic dynamics. Therefore, it is crucial for authorities including central banks to have a reliable index for monitoring the fluctuations in house prices. However, many countries including Turkey did not have an official house price index until the recent global financial crisis. In an effort to fill this gap, the Central Bank of the Republic of Turkey (CBRT) started to publish a house price index from 2010 by using the median price method.¹ It measures nominal price changes for the whole Turkish housing market and according to this official statistic, nominal house prices in 2015Q1 are 78.8 percent more expensive on average than in 2010. When we deflate it by the consumer price index for Turkey (CPI), the increase is 25.0 percent in real terms. This significant rise in house prices raises needs to carefully monitor the housing market dynamics.

The housing market is inherently heterogeneous in terms of its characteristics such as location, number of bedrooms, age, size, etc. On the other hand, differences in quality across such properties may be challenging to control because of the high heterogeneity. Therefore, changes in property prices can reflect pure price changes as well as changes in the quality of houses. Increase in a property price index might result from at least one of these two factors, hence identifying big changes as a bubble may be misleading if the main driver of the increase is the latter. Several approaches have been proposed in the literature to distinguish these two factors, such as the hedonic method, the repeat-sales method and hybrid methods. In an extensive literature survey paper, Hill (2013) discusses advantages and disadvantages of these methods and concludes that hedonic indices have been increasingly preferred due to the weaknesses of alternatives. The hedonic regression method makes it possible to control for many observed characteristics of a property and measures pure price changes as well as price effects of quality changes. In fact, hedonic regression is the only method that enables us to create an index that takes into account the characteristics of houses (Kunovac et al., 2008). These lead us to opt for the hedonic method; however, the main reason is the unavailability of unique identifiers of houses in Turkey, which makes the repeat-sales method inapplicable in our case.²

¹See Kaya et al. (2012) and the CBRT website, www.tcmb.gov.tr

²There are some criticisms of the repeat sales indices in the literature. For example, Clapp and Giaccotto (1992) provide evidences that houses sold repeatedly are mostly lemons and have different characteristics compared to other houses traded in the market. Since lemons dominate the transactions in the sample, the data used to produce the house price index may

The hedonic method, on the other hand, includes time dummy and characteristic prices approaches, where the former performs a single regression for the full time horizon assuming that quality improves in time and is indifferent in characteristics while the latter uses sequential regressions and computes intertemporal differences in quality. The former has the advantage of pooling data and this leads lower standard errors in estimation. On the other hand, one disadvantage of the former is that the assumption of no structural change in parameters over time might be too restrictive (Shimizu and Nishimura, 2006, 2007 and Shimizu et al., 2010). Moreover, official statistics providers prefer the characteristics prices approach mainly because of its simplicity as well as the fact that the former approach needs revisions in past data every time new data arrives (Eurostat, 2011). As a result, we propose a residential property price index in this study by using the hedonic method with characteristics prices approach. Our results show that the house prices increased 60.6 percent in nominal terms and 12.3 percent in real terms when we hold their characteristics fixed, and that an 11.3 percent increase is estimated to have stemmed from the quality changes from 2010 to March 2015. Equivalently, 18.2 percentage points of the 78.8 percent nominal increase and 12.7 of the 25.0 percent real increase in property prices in Turkey can be attributed to quality improvements and the rest was caused by pure price changes. Although some discrepancies across regions are observed, one fourth of nominal price increases and one half of real appreciation can be attributed to quality improvements in general.³

The hedonic method was first developed and applied to land characteristics by Waugh (1928) while the term “hedonic pricing method” was first used by Court (1939) in the context of developing price measures for automobiles. On the other hand, the method was popularized by Griliches (1961, 1971) and Rosen (1974). Following these seminal papers, several early studies discuss mainly location

not represent all the transactions well enough, causing sample selection bias or so-called lemon bias issue. Moreover, houses traded at least twice are in the scope in this approach and this leads to huge loss of information. Yet, the underlying assumption is constant quality, ignoring the quality improvements (or depreciation) which often occur for the exact same house.

³Increases observed in the components of houses should not always be considered as quality improvements. For instance, it is wrong to state that two bedroom apartments are certainly better in quality than one bedroom ones. As a matter of fact, it is very common these days that one bedroom apartments (and also smaller ones) are preferred more compared to two bedroom ones in some districts in Istanbul. Yet, it may not be correct to interpret this as a decrease in quality. Therefore, it could be better to use the term “composition change” rather than “quality change”. However, it is opted to use “quality” in this study to have the similar terminology with other studies in this field. See, for example, http://ec.europa.eu/eurostat/cache/metadata/en/prc_hps_esms.htm for the European Union Harmonised Indices of Housing Price Statistics.

effects on house prices. Later, hedonic quality adjustments in house prices have been extensively used.⁴ The first official hedonic house price index was US Census Bureau's "One-Family Houses Index" which was first published in 1968 (Triplet, 2004). In the Turkish case, using the same dataset as we do in this paper, Kaya (2012) employed the time dummy approach in analyzing Turkish housing market for the period between December 2010 and June 2012. Her findings suggest that of 18.9 percent change in property prices, pure price changes contributed to 6.2 percent whereas we compute that as 14.5 percent by using the characteristic prices approach. There are also a few papers focusing on Turkish housing market and applying hedonic adjustment on prices.⁵ However, they mostly use regional or local data, or analyze cross sectional data to estimate the determinants of house prices (see Selim, 2008). Our paper, on the other hand, covers the whole country and uses the time dimension to construct a hedonic house price index. Nevertheless, our results on which characteristics are important for the Turkish market are inline with the common findings in the literature.

The rest of the paper is organized as follows. Next, we explain our data source, scope and methodology of hedonic price index model used in the study. Section 3 provides our estimation and index results and conclusions are drawn in section 4.

⁴See, for example, Straszheim (1973, 1974). For more recent studies, see Wilhelmsson (2008) and Widlak and Tomczyk (2010). Hill (2013) documents a wide literature survey in this topic.

⁵An extensive list of studies for Turkey includes Üçdoğruk (2001), Yankaya and Çelik (2005), Cingöz (2010), Baldemir et al. (2008), Karagöl (2007), Mutluer (2008), Kördiş et al. (2014).

2 Data and Methodology

In this study, we use monthly House Price Index for Turkey (THPI) data compiled by the CBRT, which covers the period from January 2010 to March 2015. The THPI is compiled from valuation reports prepared by real estate appraisal companies at the stage of approval of individual housing loans extended by banks. The actual sale or utilization of the loan is not required and all appraised residential properties are included in the scope.⁶ On the other hand, our dataset is rich in variety of observable property characteristics. In particular, it has information on buildings including location (city, sub-city, neighborhood and block information), the year of construction, build quality, availability of an elevator and whether the building resides in a gated community where security staff protect the site 24/7. Moreover, it also has information about the apartment such as gross area of use, heating type, and number of bedrooms, bathrooms and balconies. This rich dataset enables us to identify the shadow prices of each quality component and to compute pure price changes by keeping average characteristics constant.

The THPI uses the (geographically) stratified median price method to measure price movements in the Turkish housing market. In the current THPI implementation, properties are grouped together to form homogenous strata and the median unit price for each stratum is weighted by the number of residential properties sold to reach the overall price index. Specifically, the previous year house sales statistics from the General Directorate of Land and Cadastre are used to determine the weights. In the geographical stratification, sub-cities with sufficient number of observations are determined as strata.⁷ The THPI relies on the assumption that the median unit price of appraised properties is indicative of the median unit price of all properties sold. In that, a unit price is the appraisal value divided by its gross area of use and the median unit price is calculated -excluding extreme values- for each stratum.

The THPI is calculated by using the Chain Laspeyres Index method:

$$I^{ty} = \frac{\sum_i w_i^y p_i^{ty}}{\sum_i w_i^y p_i^{12(y-1)}} I^{12(y-1)}, \quad (1)$$

⁶For detailed information, see the “Methodological Information on the House Price Index” at www.tcmb.gov.tr

⁷In case of insufficient number of observations for sub-cities, NUTS-Level 2 regions constitute one stratum. If any stratum has a sample size smaller than 50 appraisal reports in a period, this stratum is excluded and its weight is distributed to other strata in the geographical region.

where I^{ty} is the price index for the reference month t in year y , w_i^y is the weight for stratum i , p_i^{ty} is the median price of all properties in i . We denote the reference month as ty while $12(y-1)$ denotes 12th month of the previous year.⁸

In this paper, we use characteristic prices based hedonic regression method. The basis of the hedonic hypothesis is that a good is characterized by the set of all its characteristics. The high heterogeneity of the housing market necessitates this approach. In this context, regression methods can be used to estimate shadow prices of the features of a property.⁹

In particular, our log-linear regression model is as follows:

$$\ln p_n^t = \beta_0^t + \sum_k \beta_k^t z_{nk}^t + \varepsilon_n^t, \quad (2)$$

where p_n^t is the price of property n and z_{nk}^t is the characteristic k of the property.

In order to avoid adverse effects of potentially problematic initial data points on the whole index, we carefully choose January 2012 as the base period ($t=0$) to construct our Hedonic House Price Index for Turkey (THHPI).¹⁰ Then, we run separate regressions for each period and keep the estimates of regression coefficients, $\hat{\beta}_k^t$. To compute fixed-characteristics prices, we use $\hat{\beta}_k^t$ along with the average characteristics for the base period, $\overline{z_{nk}^0}$. From this perspective, average characteristics for the base period resembles “standardized property with fixed characteristics”. Our Laspeyres-type index for each stratum i is as following:

$$P_i^t = \frac{\exp(\hat{\beta}_0^t) \exp[\sum_k \beta_k^t \overline{z_{nk}^0}]}{\exp(\hat{\beta}_0^0) \exp[\sum_k \beta_k^0 \overline{z_{nk}^0}]}, \quad (3)$$

where P_i^t is the hedonic house price index.¹¹ Equation (3) gives the quality adjusted property price index because characteristics are kept constant in time.

⁸In fact, THPI uses quarterly data where one quarter data consist of valuation reports of the reference, preceding and succeeding months. We adopt the same approach in our hedonic index.

⁹According to the “Residential Property Price Index Handbook” (Eurostat, 2011), the hedonic prices approach can be used to obtain estimates of willingness to pay the different characteristics and to construct quality-adjusted price indices.

¹⁰As a robustness check, we also computed a similar index with 2012=100 but differences are negligible.

¹¹Since the THPI is a Laspeyres index, we also follow the same methodology. However, for a robustness check, we compute Paasche and Fisher indices -as in Eurostat (2011)- but they show no significant differences. Results are available from authors upon request.

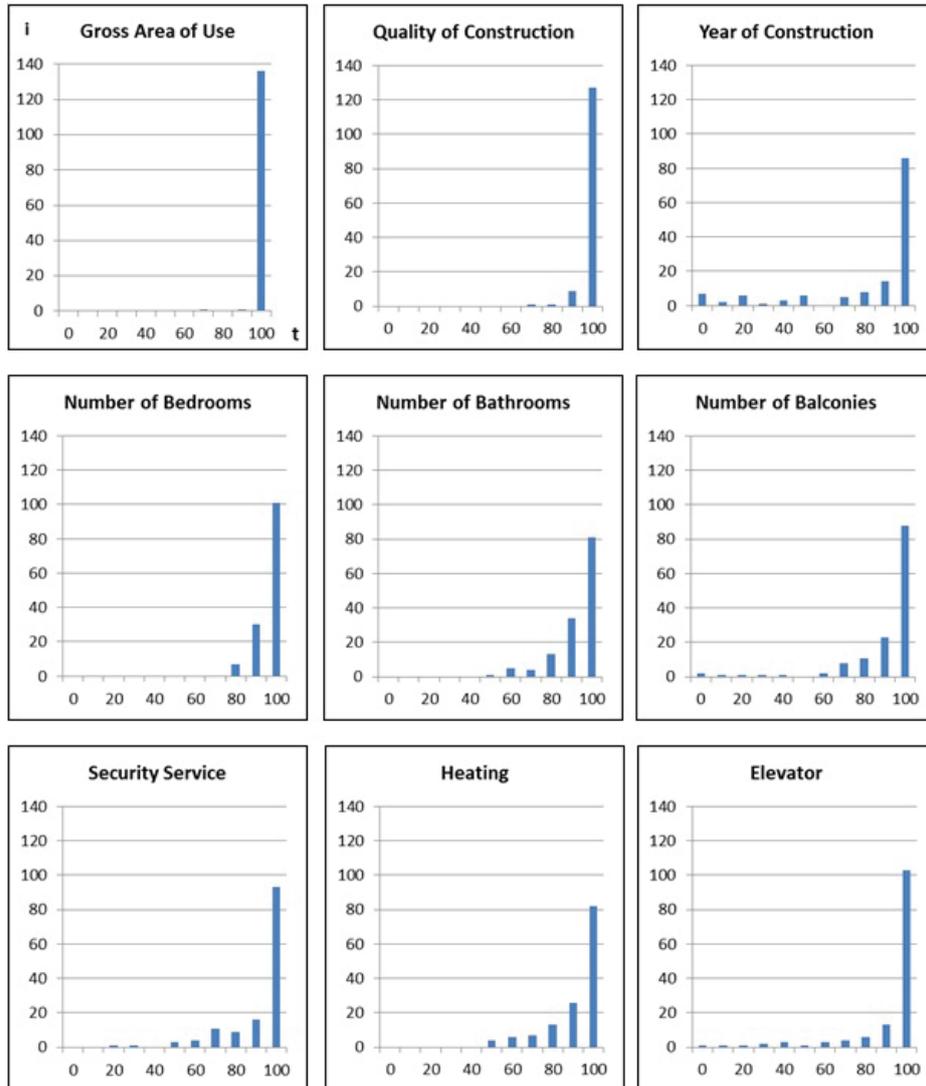
2.1 Model selection

By its nature, the hedonic regression, which considers the price of each good as a bundle of characteristics, may suffer from two different and interrelated statistical problems, namely the omitted variable bias and multicollinearity. The former is a common problem in such studies because all characteristics that have an effect on house prices could not be included in the regression model due to data limitations. In general, characteristics of a house can be divided into three categories; structural, neighborhood and location characteristics (see, for example, Chin and Chau, 2003). In our data set, we don't have neighborhood characteristics such as the income level of residents or the air quality in the region, but we have observable structural features as well as location information of an appraised house. However, using location information itself can not provide fully homogeneous data on the market because even houses in the same building have different values. Moreover, there is a trade-off in stratifying the market with respect to location, i.e. the more you homogenize the less data you will have in each strata. On top of these, obtaining the full set of structural characteristics in practice is almost impossible. Therefore, we can say that, like in any other hedonic regression study, our model may be subject to omitted variable bias to some extent. While hedonic price indices potentially suffer from this problem, well-constructed models that use the characteristic prices approach or double imputation indices significantly reduce the sensitivity to omitted variable bias (Triplett, 2004, Hill and Melser, 2008, and Hill, 2011).

A second potential statistical problem is the existence of multicollinearity among explanatory variables. This is a common issue in applying hedonic methods to houses because there can be statistical dependencies among characteristics of a house. For example, a larger house will probably have more bedrooms and a regression might suffer from multicollinearity if it has both variables on the right hand side. In this case, high correlation among these variables will make coefficient estimates unstable and it complicates the interpretation of variable importance in price determination. However, according to Eurostat (2011), indices created with this method will not suffer too much from this issue. In particular, multicollinearity does not interfere with the characteristics price interpretation in the sense that the value of an estimated coefficient will converge on the true characteristics price in repeated samples. Thus, the estimates are consistent in econometric terms and the hedonic index is still valid under the presence of multicollinearity. Furthermore, there is a tradeoff between the omitted variable bias

and the multicollinearity issues, i.e. excluding a relevant variable due to high correlation with other might increase the former bias. As a result, we opt to include such highly correlated variables in our regression models.

Figure 1: Histogram of Variable Significance



Note: Histograms show the number of strata (on y-axis) that the variable (each histogram) is significant -at 5 percent level- while x-axis represents the percentage of times the variable is significant for the stratum.

There are more than 130 strata in our study.¹² Since we run regressions for every period and every stratum in the characteristics prices approach, it is almost impossible to have significance of the same variables in all regressions.¹³

¹²To be exact, 137, 153, 175 and 191 strata for 2010-2012, 2013, 2014 and 2015 periods, respectively.

¹³We have enough observations for each strata by construction. In particular, 50 observations

Table 1: Regression Models

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Gross area of use	✓	✓	✓	✓	✓	✓	✓
Quality of construction	✓	✓	✓	✓	✓	✓	✓
Year of construction	✓	✓	✓	✓	✓	✓	✓
Number of bedrooms	✓	✓	✓	✓	✓	✓	✓
Number of bathrooms	✓	✗	✓	✓	✓	✓	✗
Number of balconies	✓	✓	✗	✓	✓	✓	✗
Security service	✓	✓	✓	✗	✓	✓	✗
Heating	✓	✓	✓	✓	✗	✓	✗
Elevator	✓	✓	✓	✓	✓	✗	✗

Notes: (1) See the appendix for variable explanations. (2) Checkmarks show inclusion of the variable in the respective model while crossmarks represent exclusion.

Therefore, we first regress all independent variables for each stratum for the first 36 periods (2010-2012). Then, the p-values of each variable are recorded and a suitable model is chosen for each stratum accordingly. To illustrate how significance changes in time and strata, Figure 1 depicts histograms for each variable, in which rows represent the rate of significance (according to 5 percent level) in time and columns represent the number of stratum. For example, as we see from the upper left histogram, the gross area of use is a significant variable for almost all strata. Some variables have less significance rate for some strata; heating, for instance, is significant 90 percent of the time for 26 strata and 80 percent of the time for 12 strata. Here we determine an ad-hoc limit for the significance rate: if a variable is significant less than 70 percent of the time for a stratum then we exclude this variable for that stratum. Based on the outcomes and this strategy, we determine seven different regression models and assign one to each stratum. Table 1 lists our 7 regression models.¹⁴

in a period is a requirement to form a stratum, as explained in a previous footnote.

¹⁴In general, how old a house is important in determining its price. The exact age (equivalently, the year of construction) or a categorical classification of age groups can be used, where the latter covers nonlinearity effects of age in price. We computed both alternatives and observed negligible differences. Therefore, for simplicity purposes, we prefer using the year of construction.

3 Results

According to a sample regression result given in Table 2, all independent variables used in this regression are statistically significant and signs of all coefficients are consistent with the economic theory. In other words, all shadow prices, i.e. the additional contribution of a coefficient to appraisal value, result in increasing the house price. For example, keeping other physical characteristics constant, a 100 square meters larger house is 50 percent more expensive than average. Higher quality houses are valued at a 10.9 percent higher price on average while an elevator in the building adds 13.3 percent to its value. Security is another important characteristic for this stratum, meaning that if a house receives a 24/7 security service within a gated community then one would expect its price to be 33.3 percent higher on average.¹⁵

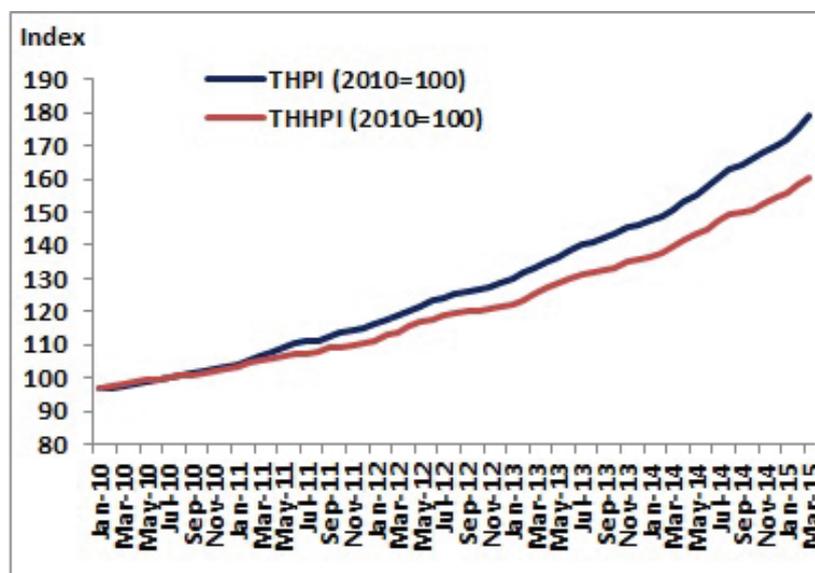
Table 2: House Price Estimation Results

Characteristic	Estimates
Gross area of use (Sq. m.)	0.005 (0.000)***
Quality of construction	0.109 (0.022)***
Year of construction	0.003 (0.001)**
Number of bedrooms	0.033 (0.017)**
Number of bathrooms	0.084 (0.029)***
Number of balconies	0.071 (0.017)***
Security service	0.333 (0.032)***
Heating	0.118 (0.045)***
Elevator	0.133 (0.028)***
Constant	5.655 (2.040)***
Number of observations	621
R-squared	0.641

Notes: (1) Dependent variable $\ln P_i^t$ is the logarithm of total appraisal value of the house in Turkish Liras. (2) The numbers in parenthesis are standard errors while (**) and (***) denotes significance at 5% and 1% level, respectively. (3) Quality of construction is a dummy variable equal to 1 for higher quality houses and 0 for lower. (4) Security service is a dummy variable equal to 1 if the house resides in a gated community. (5) Heating denotes central heating and wall hung gas boiler systems. (6) Elevator denotes whether the building has an elevator or not. (7) Sample regression covers one of the sub-cities of Istanbul with one quarter data. More regression results are available upon request.

¹⁵Average R-squared values across all strata and all months for each year are 0.511, 0.586, 0.637, 0.629 and 0.667 for 2010-2014, respectively.

Figure 2: Comparison of THPI and Hedonic Price Index for Turkey

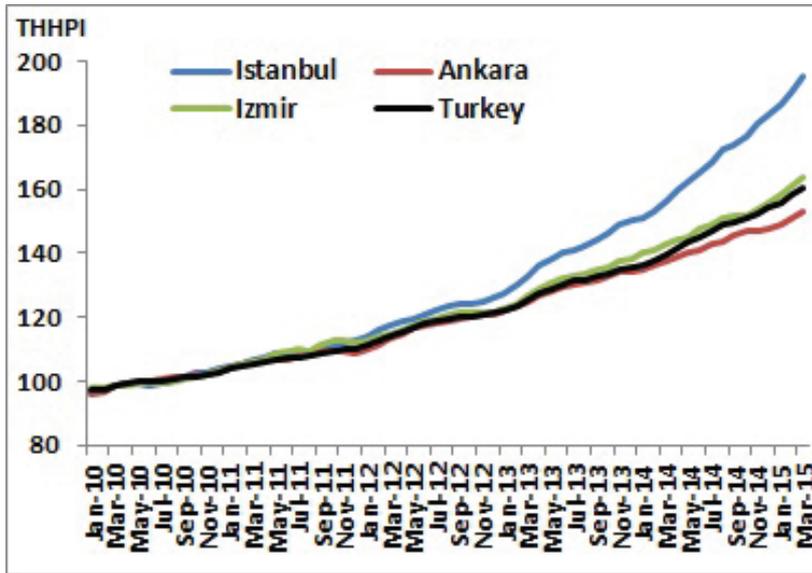


Following the methodology described above, we first compute regional indices and then aggregate them to reach the index for Turkey. The THHPI shows an increasing trend starting from the first period, similar to the THPI. Figure 2 shows that, the THHPI increased by 60.6 percent in nominal terms (and 12.3 percent in real terms) while the THPI increased nominally by 78.8 percent (25.0 percent in real terms) in almost five years.¹⁶ These findings suggest that, an 11.3 percent increase was due to quality improvements in housing characteristics in the given period. In order to analyze what form these improvements are taking, one can see from Table 3 that there are more than one house characteristic which improved over time. Particularly, on average, houses sold in 2015 have better quality of construction, more bathrooms, more elevators and security service compared to houses sold in 2010. On the other hand, we can see that smaller houses with less number of rooms and balconies are generally sold recently but their diminishing effects are dominated. Although there exist some discrepancies in these findings across different sub-cities, they are valid for almost all regions.

The general tendency of hedonic prices in the three largest cities in Turkey, i.e. Istanbul, Ankara and Izmir, followed the same pattern until late 2012 and diverged after. Following a period of similar inflation rates, hedonic prices in Istanbul showed a faster pace and dissociated from the others as shown in Figure 3. In particular, the highest nominal increase in five years is seen in Istanbul by 95.3 percent, while the increase in Ankara is 53.2 percent and in Izmir is 63.6

¹⁶The THHPI is rebased into 2010 from January 2012 to make a comparison with the THPI.

Figure 3: Hedonic Price Indices for Three Large Cities



percent (respective CPI-deflated increases are 36.5, 7.0 and 14.4 percent). The respective official THPI increases are 116.7, 57.2 and 72.5 percent in nominal terms (and 51.5, 9.9 and 20.6 percent in real terms). One can see that the lowest quality change is observed in Ankara with only 2.7 percent (less than one tenth of total change) whereas average house quality increase observed in Istanbul is 11.0 (almost one fifth of total price increase).

4 Conclusion

Excessive property price movements can be a threat to financial stability because houses are considered as the largest part of household wealth. Therefore, price movements in housing markets have a major role in policymaking and need to be monitored using a reliable statistic. Due to potential quality changes in residential properties, house prices can reflect these effects and might result in misinterpretation of a large increase as a -false- real appreciation.

Since the Turkish house price index computed by the CBRT are prone to abovementioned effects, we construct a quality adjusted property price index by using the hedonic regression method. In other words, we distinguish quality changes and pure price increases in the index. According to our results, one fourth of the nominal and one half of the real property price increase can be attributed to quality improvements in general.

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A Data Appendix

Real estate appraisal companies prepare valuation reports at the stage of approval of individual housing loans extended by banks.¹⁷ We use the exact same database in this study which the CBRT forms to compile the house price index using such valuation reports.

The final sample used in our study covers valuation reports observed over the 2010-March 2015 period. The dependent variable in our regressions is the log of appraised value of the house in Turkish liras, $\log P_i^t$. Other variables, which are used as explanatory variables in our study, are listed below.¹⁸ We also give summary statistics of these characteristics by year in Table 3, and their latest statistics by region in Figure 4.

- Gross area of use (in square meters).
- Quality of construction. Luxury or good (higher quality)=1, bad or others (lower quality)=0.
- Year of construction.
- Number of bedrooms.
- Number of bathrooms.
- Number of balconies.
- Security service. House resides in a gated community=1, otherwise=0.
- Heating. Central heating or wall-hung gas boiler=1, others=0.
- Elevator. If the building has an elevator=1, otherwise=0.

¹⁷The actual sale of the property and utilization of the loan is not required and all houses appraised are included in our scope.

¹⁸Appraisal reports include other variables such as type of dwelling, construction level of the dwelling, parking lot, swimming pool, number of total floors, structure of the construction, number of saloons and kitchens. These variables show no or little significance in the determination of the appraised value.

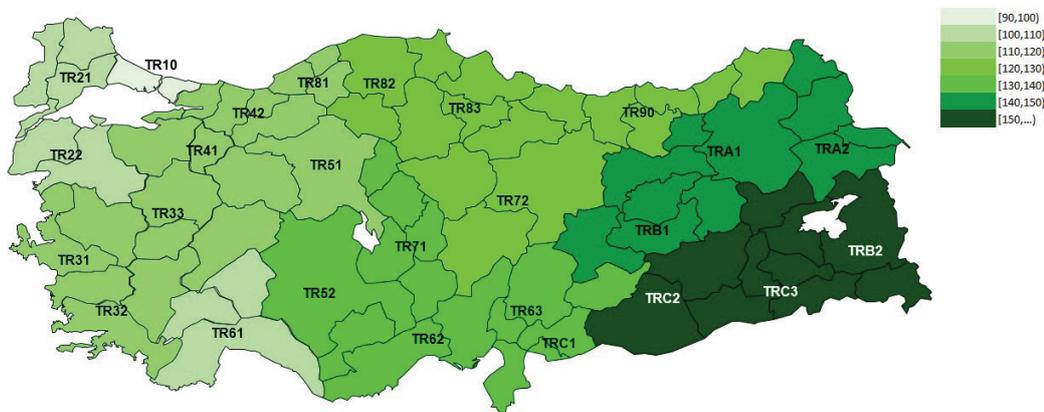
Table 3: Summary Statistics of House Price and Characteristics

Variables	2010		2011		2012		2013		2014		2015	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Price	100,124	95,000	106,054	100,000	115,981	110,000	127,426	120,000	141,081	135,000	151,579	145,000
Gross area of use	123.00	110.00	117.60	110.00	113.95	108.00	114.33	109.00	112.14	106.00	111.48	106.00
Quality of construction	0.59	1.00	0.60	1.00	0.60	1.00	0.61	1.00	0.62	1.00	0.61	1.00
Year of construction	2000.86	2006.00	2001.68	2007.00	2002.89	2008.00	2004.21	2010.00	2005.62	2011.00	2005.95	2011.00
Number of bedrooms	2.81	3.00	2.79	3.00	2.74	3.00	2.77	3.00	2.73	3.00	2.72	3.00
Number of bathrooms	1.22	1.00	1.22	1.00	1.23	1.00	1.24	1.00	1.25	1.00	1.25	1.00
Number of balconies	1.59	2.00	1.61	2.00	1.60	2.00	1.59	2.00	1.55	2.00	1.54	2.00
Security service	0.09	0.00	0.08	0.00	0.09	0.00	0.09	0.00	0.10	0.00	0.10	0.00
Heating	0.73	1.00	0.74	1.00	0.76	1.00	0.74	1.00	0.72	1.00	0.72	1.00
Elevator	0.38	0.00	0.40	0.00	0.46	0.00	0.47	0.00	0.47	0.00	0.49	0.00

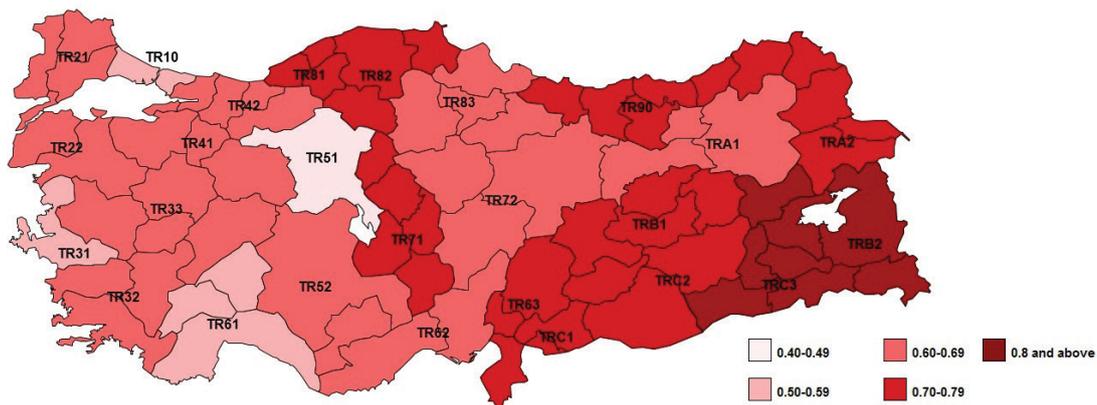
Notes: (1) 2015 data covers January-March months.

Figure 4: Average House Characteristics by Region (as of March 2015)

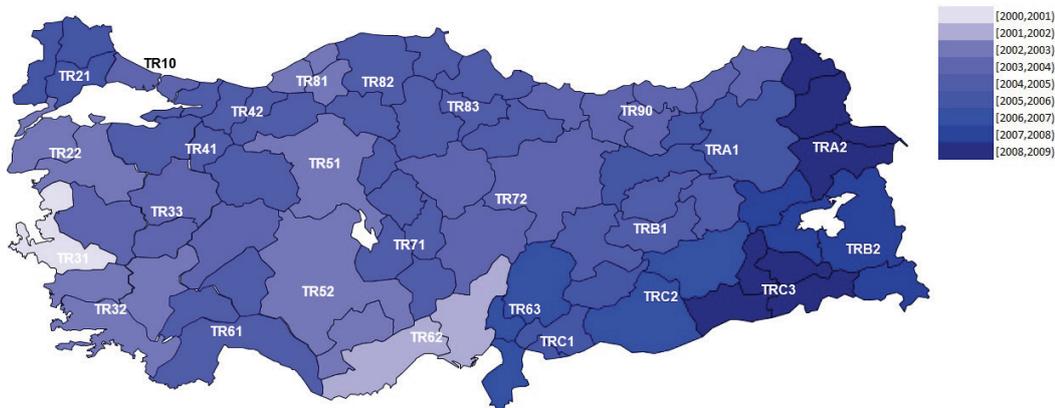
(a) Gross Area of Use (in square meters)



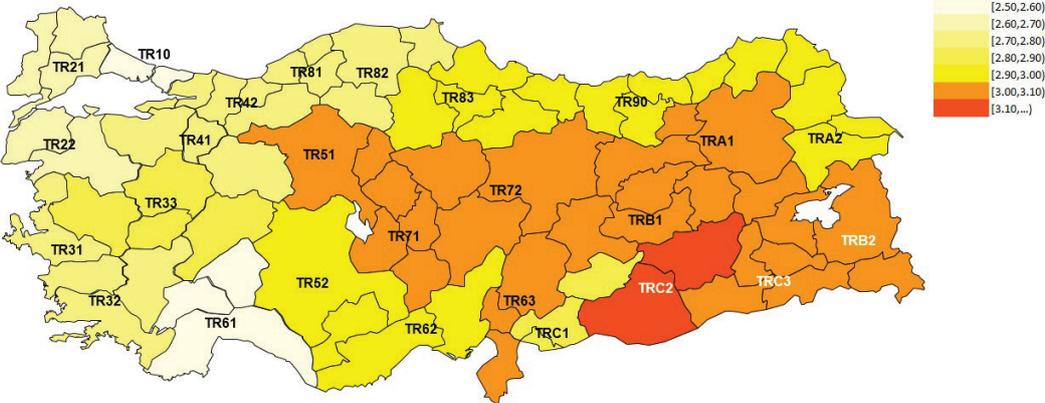
(b) Quality of Construction



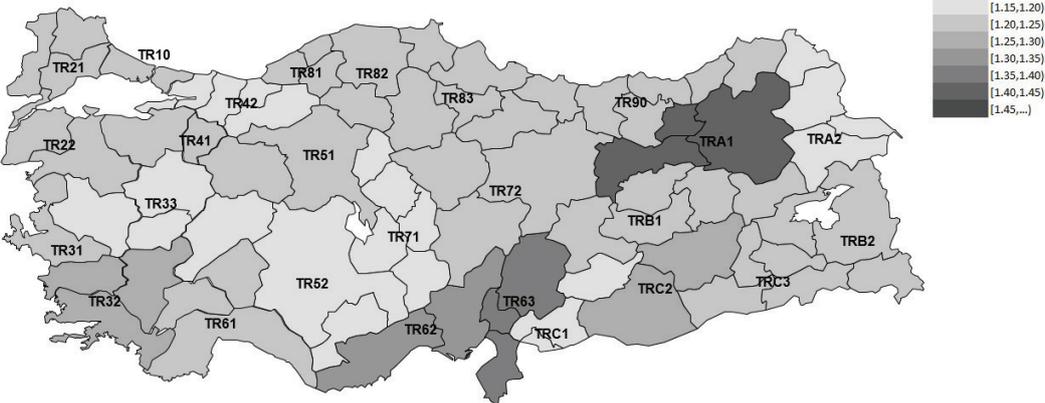
(c) Year of Construction



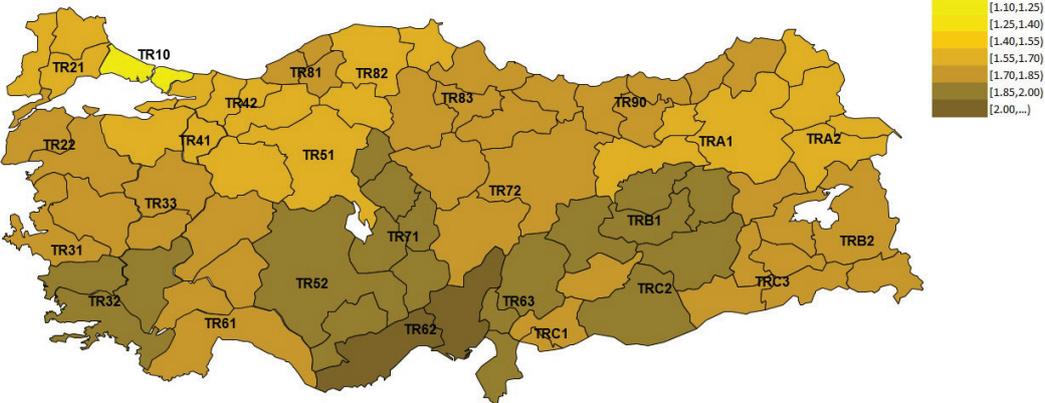
(d) Number of Bedrooms



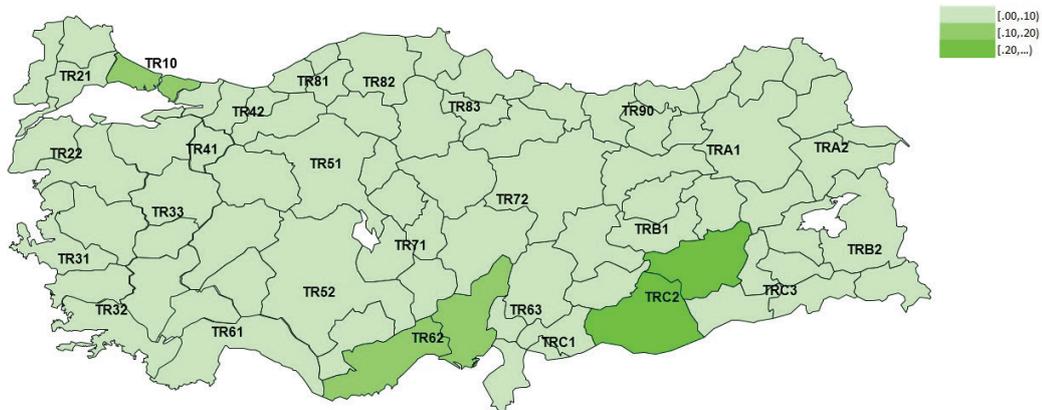
(e) Number of Bathrooms



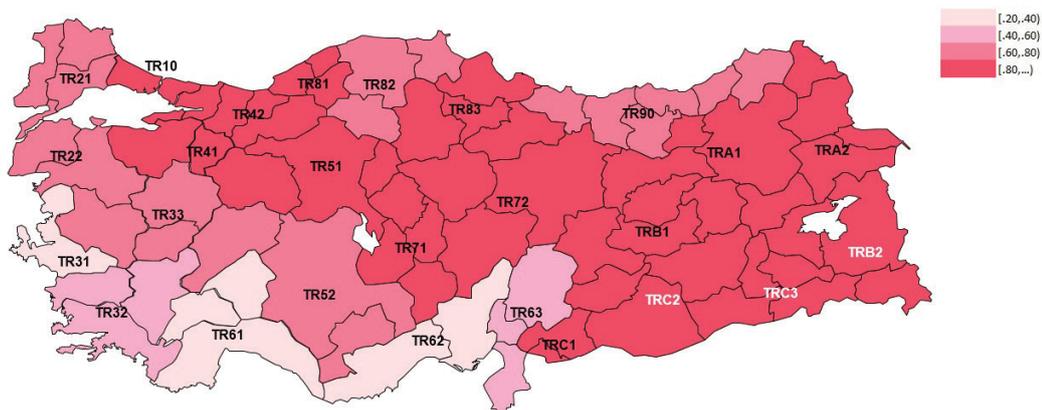
(f) Number of Balconies



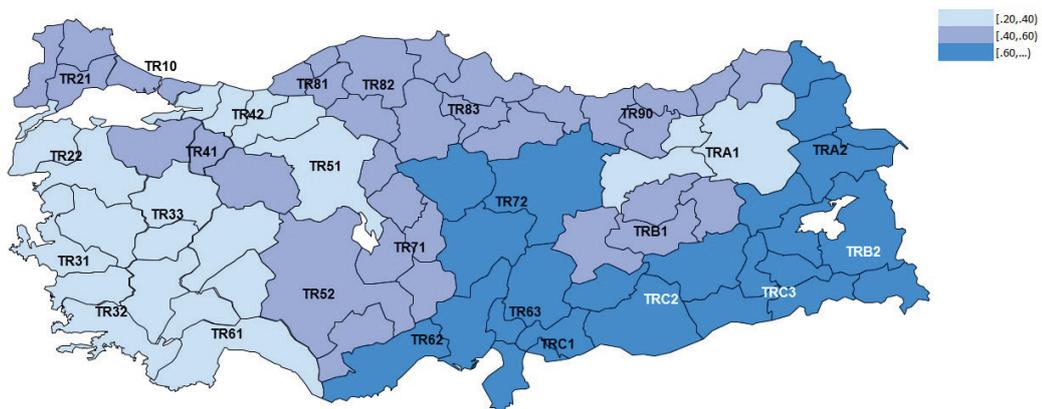
(g) Security Service



(h) Heating



(i) Elevator



16. Renewed momentum in the German housing market: real-time monitoring of boom vs. bubble

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Abstract

The renewed momentum in the German housing market has led to concerns that Germany is vulnerable to asset price shocks. In this paper, we apply recently developed recursive unit root tests to detect the beginning and the end of potential speculative bubbles in Germany over the sample period 1971Q1–2013Q4. Overall, we find that actual house prices are not significantly disconnected from underlying economic fundamentals. Thus, there is no evidence of speculative house price bubbles in Germany.

Keywords: Germany, House Price Bubbles, Real-Time Monitoring, Right-Tailed Unit Root Tests

JEL-Classification: C22, C53, E52, R31

1. Introduction

After more than a decade of stagnating or even falling house prices, the German real estate market started to surge in 2010 and house prices in larger cities have experienced large mark-ups. On the one hand, the prevailing expectations that central banks in advanced economies will not tighten monetary policy in the near future play a role in this development, as low interest rates can fuel excess borrowing and push asset prices ever higher. On the other hand, the euro crisis matters. Not only are German households acquiring more real estate, but foreigners see Germany as a safe haven. In light of increasing house prices and the previous experience of how the bursting of real-estate bubbles triggered 2007–2009 recessions in several countries, there are increasing concerns that Germany might be destined for a similar fate. Unbounded enthusiasm could be a real danger in this context. History is replete with examples of plenty of prolonged periods of low interest rates that encouraged speculative housing bubbles.

Prior to the global recession of 2007–2009 and the associated disruptions in financial markets, asset price bubbles were often considered as a sideshow to macroeconomic fluctuations. The global recession demonstrated painfully that this dominant pre-crisis presumption was dangerously wrong. A rapidly growing literature is now seeking to remedy this shortcoming and has begun to address this knowledge gap head-on. In particular, Agnello and Schuknecht (2011), Claessens et al. (2009), Hirata et al. (2013) and Igan and Loungani (2012) have taken a global perspective and have provided an assessment of the linkages between house prices and real economic activity. Drehmann et al. (2012) have recently characterised empirically the financial cycle and its relationship with the business cycle. The analysis shows that the medium-term financial cycle is a different phenomenon from the business cycle. Furthermore, the length and amplitude of financial cycles have increased markedly since the mid-1980s. The IMF (2003) has documented the information content of house prices for both business cycles and systemic banking crises with serious macroeconomic dislocations. These studies also discuss the surprisingly high synchronization of house price downturns as observed during the global financial crises, which is likely to have exacerbated the deep recession.¹

At the same time, a new empirical literature on early warning indicators has emerged.² This literature reflects a desire to better identify speculative bubbles in real time. Since boom-and-bust cycles possibly lead to serious financial and macroeconomic strains, central banks have reconsidered their monetary policy strategies with regard to asset bubbles. Prior to the global recession 2007–2009, the European Central Bank (2002) had expressed doubts about the ability to detect bubbles with a sufficient degree of certainty. A first change of course occurred in 2005, when the European Central Bank (2005) argued that, firstly, there are a number of tools to detect asset bubbles and, secondly, emerging asset bubbles

¹ Another relevant strand of literature concerns the role of housing within dynamic stochastic general equilibrium (DSGE) models. See, for example, Funke and Paetz (2013), Iacoviello and Minetti (2008), Iacoviello and Neri (2010). This literature is beyond the scope of the brief review presented in this section.

² See, for example, Alessi and Detken (2011), Crespo Cuaresma (2010), Gerdesmeier et al. (2012) and the literature cited therein.

should be taken into consideration when making interest rate decisions. In the light of the global recession the European Central Bank (2010) has finally acknowledged that the case for pre-emptive monetary policy responses to emerging asset bubbles has been strengthened. In light of the recent momentum in German house prices, the question of house price bubbles is also a matter of concern for the Deutsche Bundesbank. In the same spirit as the European Central Bank, the Deutsche Bundesbank (2012) has emphasized that a combination of low interest rates and high liquidity may pose a considerable danger to financial stability. Furthermore, easy monetary policy and especially unconventional monetary policy that lowers interest rates all along the yield curve facilitate low risk premiums. Therefore, monetary policymakers should deploy micro- and macro-prudential policy tools to cool down housing markets in case of emerging price escalations.

Against this backdrop, our study complements and extends the existing literature in several ways. In particular, we employ a new statistical test pioneered by Phillips and Yu (2011) and Phillips et al. (2012) and up-to-date house prices data to assess the renewed momentum in the German housing market. We find no evidence of an emerging speculative housing bubble in Germany at the present moment. It goes without saying that this is just a snapshot of the current situation and no clean bill of health can be given for the future.

The structure of this paper is as follows. Section 2 reviews some theoretical and econometric issues related to housing valuation and bubble identification. In section 3, we introduce the house price database. In section 4, we proceed by discussing the results of the real-time econometric diagnostics. The final section concludes with a summary and suggestions for further research.

2. Modelling and testing strategy

In the first stage, we need to define bubble periods. Based on this, we can then identify inflated house prices and bubble periods. The classical literature on rational bubbles derives conditions under which bubbles can occur when all agents are perfectly rational. Classical rational house price bubbles can arise because of the indeterminate aspect of solutions to rational expectations models. The house price that agents are prepared to pay today depends on the expected house price at some point in the future. But the latter depends on the expected house price even further in the future. The resulting process governing house prices does not pin down a unique house price level unless, somewhat arbitrarily, a transversality condition has to be imposed to obtain a unique solution. However, in general, the possibility that house prices may systematically deviate from their fundamental value cannot be ruled out. Even if risk-neutral agents are perfectly rational, the actual house price may contain a bubble element, and thus there can be a divergence between the house price and its fundamental value. The resulting real estate bubble is an upward house price movement over an extended range that then suddenly collapses.

Our goal is to ascertain how house prices evolve over time, given the behaviour of fundamentals. Time is discrete. In the modelling framework, fundamental house prices H_t can be represented as follows:

$$(1) \quad H_t = \left(\frac{1}{1+r}\right) E_t(R_t + H_{t+1}),$$

where E_t is the expectations operator, R_t is the rental value at time t , and r is the discount rate. To solve the model, we need to eliminate the term involving the expectation of the future value of the endogenous variable. It is straightforward to show that the fundamental house price H_t^F can be solved under rational expectations by repeated forward substitution. This implies

$$(2) \quad H_t^F = \sum_{j=1}^{\infty} \left(\frac{1}{1+r}\right)^j E_t(R_{t+j}).$$

The logic of equation (2) is that house market prices contain expectations of future rents. No specific assumptions are made about the process followed by R_t . The rational bubble components B_t follow

$$(3) \quad B_t = \left(\frac{1}{1+r}\right) E_t(B_{t+1}).$$

Solving for H_t finally yields

$$(4) \quad H_t = H_t^F + B_t.$$

Equation (4) breaks up house prices into a ‘fundamental’ and a ‘bubble’ component. Without a bubble, house prices equal the fundamental value H_t^F . Under bubble conditions house prices may show an explosive behaviour inherent in B_t . If B_t is strictly positive, this builds the stage for speculative investor behaviour: a rational investor is willing to buy an ‘overpriced’ house, since he/she believes that future price increases will sufficiently compensate him/her for both the extra payment he/she has to make and the risk of the bubble bursting. In that sense, the house price bubble is a self-fulfilling prophesy. Eventually the bubble implodes, house prices fall with a sharp correction, and deleveraging occurs.

In recent years, a new generation of behavioural models capable of generating bubbles has emerged. This literature is quite broad, so we will touch on only a few important papers here. The unifying feature behind this class of model is bounded rationality for at least one group of agents. In the behavioural models, a bubble may arise when asset prices overreact to a potentially informative signal about fundamentals. Behavioural models can be classified into three categories. Firstly, differences of opinion and short sale constraints may generate asset bubbles. Scheinkman and Xiong (2003) provide a dynamic model, in which optimistic investors exhibit bounded rationality and fail to take into account that other agents in the economy may have more pessimistic views about an asset but cannot sell that

asset due to short sale constraints. Secondly, feedback trading mechanisms may allow bubbles to grow for a period of time before they eventually collapse. An example of a model that contains feedback traders is Hong and Stein (1999). The model includes two groups of traders-news watchers and feedback traders. Neither group is completely rational. News watchers do not condition on past prices. On the other hand, feedback traders do not observe the signals about the fundamentals and condition their trading decisions entirely on past asset price changes. Thirdly, biased self-attribution may lead to asset price bubbles. The term self-attribution was coined by research emanating from the field of psychology. Biased self-attribution leads agents to take into account signals that confirm their beliefs and dismiss as noise signals that contradict their beliefs. Daniel et al. (1998) have formulated a comprehensive model with noisy signals and agents suffering from biased self-attribution. As a result they grow overconfident, which leads to the formation of a bubble.³

Next we discuss how the theoretical frameworks can be linked to an econometric testing strategy. In the econometric literature, identifying an emerging bubble in real time has proved challenging and remains an elusive task. In addition, subtle econometric problems result from finite samples. Standard unit root and cointegration tests may be able to detect one-off exploding speculative bubbles, but are unlikely to detect periodically collapsing bubbles.⁴ The reason is that traditional unit root tests are not well equipped to handle changes from $I(0)$ to $I(1)$ and back to $I(0)$. This makes detection by cointegration techniques all the more difficult, due to bias and kurtosis [Evans (1991)].⁵

A nuanced and persuasive approach to identification and dating multiple bubbles in real time has recently been pioneered by Phillips and Yu (2011) and Phillips et al. (2012).⁶ The idea is to spot speculative bubbles as they emerge, not just after they have collapsed. Their point of departure is the observation that the explosive property of bubbles is very different from random walk behaviour. Correspondingly, they have developed a new recursive econometric methodology interpreting mildly explosive unit roots as a hint for bubbles. If we consider the typical difference of stationary vs trend stationary testing procedures for a unit root, we usually restrict our attention to regions of ‘no more than’ a unit root process, i.e. an autoregressive process where $\rho \leq 1$. In contrast, Phillips and Yu (2011) model mildly explosive behaviour by an autoregressive process with a root ρ that exceeds unity but is still in the neighbourhood of unity. The basic idea of their approach is to recursively calculate right-sided unit root tests to assess evidence for mildly explosive behaviour in the data. The test is a right-

³ A frequent argument against behavioural models is that the presence of rational investors in the market should stabilise prices. Remarkably, the models of DeLong et al. (1990) and Abreu and Brunnermeier (2003) show that under certain conditions rational arbitrageurs may even amplify rather than eliminate the asset mispricing.

⁴ Figure 1 in Chen and Funke (2013, p. R41) illustrates, at the risk of oversimplification, the taxonomy and conceptual differences between a one-off bubble versus periodically collapsing bubbles.

⁵ For a survey of traditional econometric bubble tests, see Gürkaynak (2008).

⁶ The diagnostic for multiple speculative bubbles modifies a previous method for identifying one-off bubbles suggested in Phillips et al. (2011). A different class of tests for identifying periodically collapsing bubbles based on Markov-switching models has been explored in Funke et al. (1994) and Schaller and van Norden (2002), among others.

sided test and therefore differs from the usual left-sided tests for stationarity. More specifically, consider the following autoregressive specification estimated by recursive least squares:

$$(5) \quad x_t = \mu + \rho x_{t-1} + \varepsilon_t, \quad \varepsilon_t \sim iid(0, \sigma^2).$$

The usual $H_0: \rho = 1$ applies, but unlike the left-sided tests which have relevance for a stationary alternative, Phillips and Yu (2011) have $H_1: \rho > 1$, which, with $\rho = 1 + c/k_n$, where $c > 0$, $k_n \rightarrow \infty$ and $k_n/n \rightarrow 0$, allows for their mildly explosive cases.⁷ Phillips and Yu (2011) argue that their tests have discriminatory power, because they are sensitive to the changes that occur when a process undergoes a change from a unit root to a mildly explosive root or vice versa. This sensitivity is much greater than in left-sided unit root tests against stationary alternatives. But this is not all. It should be added that bubbles usually collapse periodically. Therefore, standard unit root tests have limited power in detecting periodically collapsing bubbles.⁸ To overcome this drawback, Phillips and Yu (2011) have suggested using the supremum of recursively determined Dickey-Fuller (*DF*) *t*-statistics. The estimation is intended to identify the time period where the explosive property of the bubble component becomes dominant in the price process. The test is applied sequentially on different subsamples. The first subsample contains observations from the initial sample and is then extended forward until all observations of the complete sample are included. The beginning of the bubble is estimated as the first date when the *DF t*-statistic is greater than the corresponding critical value of the right-sided unit root test. The end of the speculative bubble will be determined as the first period when the *DF t*-statistic is below the aforementioned critical value. In other words, as long as the statistic has crossed the critical values, a bubble is deemed to be imminent.

Formally, Phillips et al. (2011, 2012) suggest calculating a sequence of *DF* tests. Let $\hat{\rho}_\tau$ denote the OLS estimator of ρ and $\hat{\sigma}_{\rho,\tau}$ the usual estimator for the standard deviation of $\hat{\rho}_\tau$ using the sub-sample $\{y_1, \dots, y_{[\tau T]}\}$. The forward recursive *DF* test of H_0 against H_1 is given by

$$(6) \quad \sup DF(r_0) = \sup_{r_0 \leq \tau \leq 1} DF_\tau,$$

where $DF_\tau = \frac{\hat{\rho}_\tau - 1}{\hat{\sigma}_{\rho,\tau}}$. Note that the *DF* statistic is computed for the asymmetric interval $[r_0, 1]$. In applications, r_0 will be set to start with a sample fraction of reasonable size. The limiting distribution is

⁷ The H_1 hypothesis is motivated by the theory of rational asset bubbles, which claims that asset prices should be explosive in the presence of an asset bubble. See Diba and Grossman (1987, 1988).

⁸ Busetti and Taylor (2004), Kim et al. (2002) and Leybourne et al. (2006) have shown that traditional unit root tests have low power in the case of gradually changing persistence and/or the existence of persistence breaks.

$$(7) \quad \sup_{r_0 \leq \tau \leq 1} DF_{\tau} \xrightarrow{D} \sup_{r_0 \leq \tau \leq 1} \frac{\int_0^{\tau} W dW}{\int_0^{\tau} W^2},$$

where ' \xrightarrow{D} ' denotes convergence in distribution and W is a standard Wiener process. Analogously, the augmented *supADF* (*SADF*) test can be derived. Thereby, the optimal lag length of the $AR(k)$ -process is chosen using the Akaike information criterion.

In addition, Phillips et al. (2012) have suggested employing the 'generalized' *supADF* (*GSADF*) test as a dating mechanism. The *GSADF* diagnostic is also based on the idea of sequential right-tailed *ADF* tests, but the diagnostic extends the sample sequence to a more flexible range. Instead of fixing the starting point of the sample, the *GSADF* test changes the starting point and ending point of the sample over a feasible range of windows. In other words, it calculates the right-tailed DF statistic in a more flexible recursive manner. In particular, it varies not only the number of observations but also varies the initial observation of each regression. The *supDF* statistic is then used to pinpoint the presence of periodic bubbles. The *supDF* statistic is obtained by taking the supremum twice with respect to the fractional window size of the regression and the ending fraction of the sample. In order to identify the beginning and end dates of a housing bubble, the *supDF* statistic can then be compared with the corresponding critical value. Phillips et al. (2012) demonstrate that the moving sample *GSADF* diagnostic outperforms the *SADF* test based on an expanding sample size in detecting explosive behaviour in multiple bubble episodes and seldom gives false alarms, even in relatively modest sample sizes. The reason for this is that the *GSADF* test covers more subsamples of the data.⁹ For these reasons the continuous scale *GSADF* test becomes the method of choice in our application and we shall apply the *GSADF* test to monitor periodic explosive sub-periods under real-time conditions, as shown below.

3. The dynamics of German house prices vis-à-vis other OECD countries

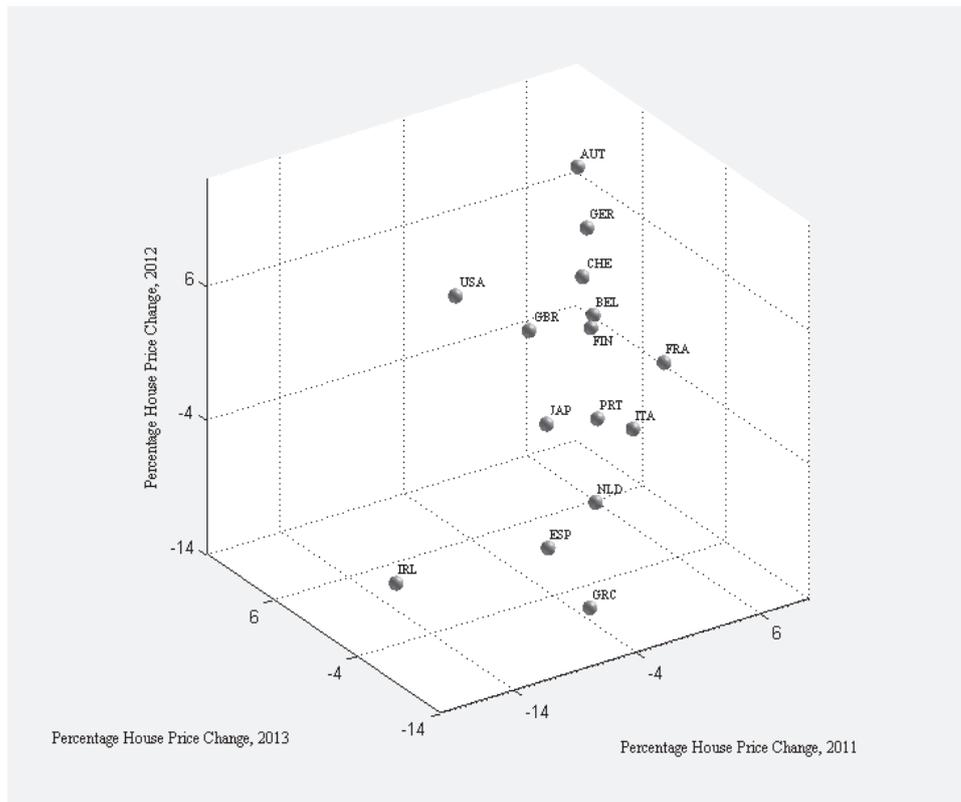
The section begins by presenting the most recent house price surge in Germany in the context of the experiences of other OECD countries.¹⁰ A graphical tool that is very helpful in highlighting recent house price developments is a 3-dimensional scatter plot of house price developments across OECD countries for 2011, 2012 and 2013. Figure 1 mirrors the experiences of various economies in these years. The following stylised facts are noteworthy. First, within the OECD countries there are large divergences. Cases of rapidly rising house prices co-exist along with cases of constant or even falling house prices. Housing markets are depressed in southern Euroland, notably in Greece, Portugal and

⁹ In the interests of brevity, further technical details are not presented here. The interested reader is referred to the above-mentioned papers introducing the right-tailed unit root testing strategy. A technical supplement providing a complete set of mathematical derivations of the limit theory underlying the unit root tests is available at http://sites.google.com/site/shupingshi/TN_GSADFtest.pdf?attredirects=0&d=1.

¹⁰ The seasonally-adjusted quarterly house price dataset employed in this paper stems from the Organization for Economic Cooperation and Development (OECD) which is a widely watched multi-country house price database.

Spain. House prices are also falling fast in Ireland and the Netherlands. This contrasting performance of housing markets reflects the broader trend towards a two-speed Euro area. Second, in several countries including Germany a strong positive house price dynamic has prevailed over the period 2011–2013. Several mechanisms are at work. The renewed momentum in the German housing market was triggered by positive prospects for German GDP growth and employment as well as historically low mortgage financing rates.¹¹ Furthermore, the Euro crisis triggered an international flight to attractive safe assets. It is for these reasons that lingering worries about a German house price bubble have emerged.¹² Third, as in Germany house prices have climbed towards new heights in Austria and Switzerland.¹³

Figure 1: Recent House Price Changes across OECD Countries, 2011–2013



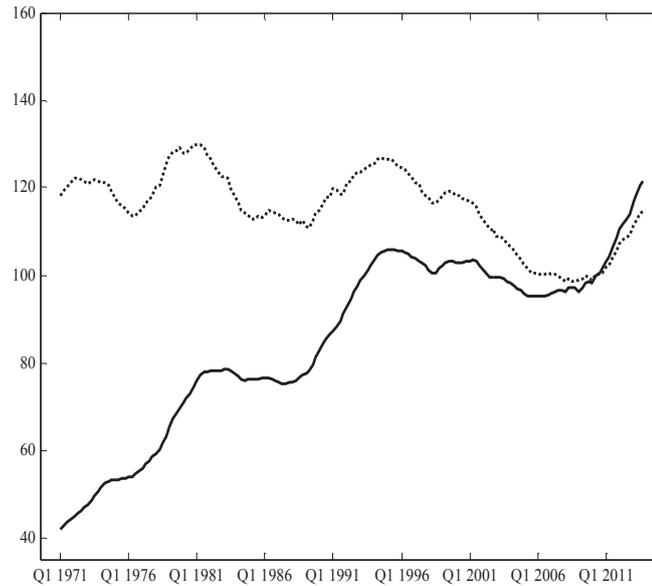
¹¹ We use the term momentum in a purely time series context. In finance momentum also has a cross-sectional notion, denoting the fact that if some assets exhibit higher returns than others at time t , they will continue to exhibit higher returns than the other assets in the future [see, for example, Jegadeesh and Titman (1993)].

¹² The Bundesbank (2013) has pointed out that house prices in German cities have risen so strongly since 2010 that a possible overvaluation cannot be ruled out any more. The IMF has also warned that “loose liquidity conditions in the banking sector may lead to excessive asset price increases” in Germany [IMF (2012), p. 39].

¹³ It is therefore not surprising that the Austrian and Swiss housing markets are also under close surveillance. The overall assessment of the market development is that the Swiss house price level clearly lies in the risk zone. For example, The *UBS Swiss Real Estate Bubble Index 2014Q1* indicates a clear correction potential. The overall assessment is that the risks of high prices triggering a substantial subsequent price correction are high. See http://www.ubs.com/global/en/wealth_management/wealth_management_research/bubble_index.html. The Austrian National Bank has recently diagnosed an increasing degree of overvaluation in Austrian property prices (by 20% in the second quarter of 2013). See http://www.oenb.at/dms/oenb/Publikationen/Volkswirtschaft/MOP-GEWI/2013/Monetary-Policy-and-the-Economy-Q4-13/chapters/mop_2013_q4_analyses2.pdf

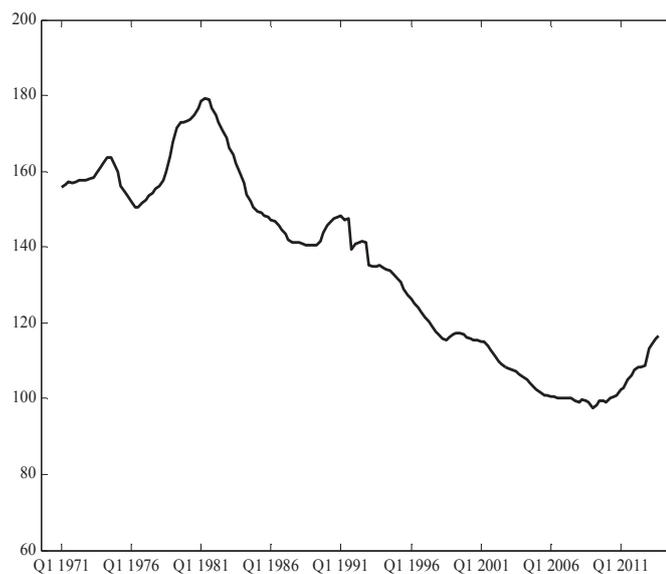
All in all, one can conclude that Germany is one of a few countries constituting special cases. Of course, strong house price increases in a few years are not necessarily evidence of an overvaluation. To address this issue, one has to put the current period of house price increases into historical perspective. Furthermore, it is necessary to relate house prices to their putative underlying determinants. To this end, Figure 2 and 3 present seasonally adjusted quarterly time series for German nominal and real house prices and the associated price-to-rent ratio for 1971Q1–2013Q4, respectively.

Figure 2: German Nominal and Real House Prices, 1971Q1–2013Q4, 2010 = 100



Note: The solid (dashed) line represents the seasonally-adjusted quarterly nominal (real) house price index. Real house prices are deflated by the CPI.

Figure 3: German Price-To-Rent-Ratio, 1971Q1–2013Q4, 2010 = 100



Over the last 30 years, nominal house prices in Germany have been growing rather moderately, whereas real house prices have been stagnating or even declining. German house prices - both in nominal and real terms – have only started to rise since 2010.¹⁴ Consequently, German house prices have been moving in opposite direction to those in other countries: while in the majority of OECD countries the early 2000s had been characterized by a strong house price increase (especially, in Ireland, Spain, the Netherlands and the UK), which culminated 2007–2008 in a spectacular burst of speculative house price bubbles, starting from 1995 German house prices have been going down and have only recently recovered from their protracted decline. Another summary measure used to get an indication of over or undervaluation is the price-to-rent ratio (the nominal house price index divided by the rent component of the consumer price index). This measure, which is akin to a price-to-dividend ratio in the stock market, could be interpreted as the cost of owning versus renting a house. When house prices are too high relative to rents, potential buyers find it more advantageous to rent, which should in turn exert downward pressure on house prices. Unlike in many other countries, the price-to-rent ratio in Germany steadily declined until 2010 when the ratio began to rebound.

What does this mean for macro-prudential market surveillance? Systemic risk in the housing market has to be addressed preemptively at an early stage of the bubble. However, preemption is difficult in the context of tail events that are experienced after long time intervals of moderate house price changes during which public memory of past asset price bubbles has faded. In the next section of the paper we shall implement the recursive *GSADF* bubble dating algorithm outlined above to monitor periodic explosive periods in real time.

4. Real-time monitoring of periodically collapsing bubbles

Could Germany be heading for a housing bubble? In order to identify speculative house price bubbles, the fundamental part of house prices has to be separated from the speculative part. There are various ways to estimate the fundamental value of house prices. The asset pricing equation (2) suggests looking at the German price-to-rent ratio as a yardstick, i.e. house price changes should be in line with rental changes, given constant interest rates. A corollary of this is that the price-to-rent ratio should be constant over time in the absence of a speculative bubble. When house prices are low relative to rent, future increases in house prices are likely to be high. Thus, the price-to-rent ratio can be viewed as “an indicator of valuation in the housing market” [Gallin (2008), p. 635]. In the following, we will therefore

¹⁴ It is well known that house price developments are uneven. At present, Germany experiences a wide range of appreciation in house prices, with house prices in the largest cities increasing at a faster pace. Therefore, one might argue that closer inspection should be placed on city-level house price developments. Yet, this argument is not very conclusive. This is because macro-prudential policy measures would have nationwide effects in all geographic areas of the country, not just in those areas where house prices are rising rapidly. Therefore, a widely held view is that macro-prudential and monetary policies should focus only on aggregate economic conditions because they cannot control or target the conditions of particular geographic regions.

apply the real-time dating method to the price-to-rent ratio behaviour to detect emerging bubbles using quarterly data from 1980Q1 to 2013Q4. A delicate point of the procedure is the choice of the fractional window size of the regression. Suppose the minimum number of observation used in any regression is r_0T , for some fraction $r_0 \in (0,1)$. So far, no automatic algorithm for the selection of r_0 is available. In our application, we choose $r_0 = 0.4$. Robustness testing indicates that the pictures painted by Figure 4 10 below do not change for changes in r_0 .¹⁵ The beginning of the bubble is estimated as the first date when the *GSADF* statistic is greater than its corresponding critical value. The end of the speculative bubble will be determined as the first period when the *GSADF* statistic is below the aforementioned critical value. The finite sample critical values are obtained via Monte Carlo simulations with 2,000 iterations. These simulations incorporate the sampling uncertainty of the data generating process. We rely on the critical values to determine the optimal thresholds. All calculations have been executed in the MATLAB programming environment.

Table 1 reports some summary descriptive statistics for the price-to-rent ratio, including sample size, sample minimum, date of the minimum, sample maximum, date of the maximum, as well as the maximum *GSADF* statistic based on the entire sample for the seven OECD countries considered.

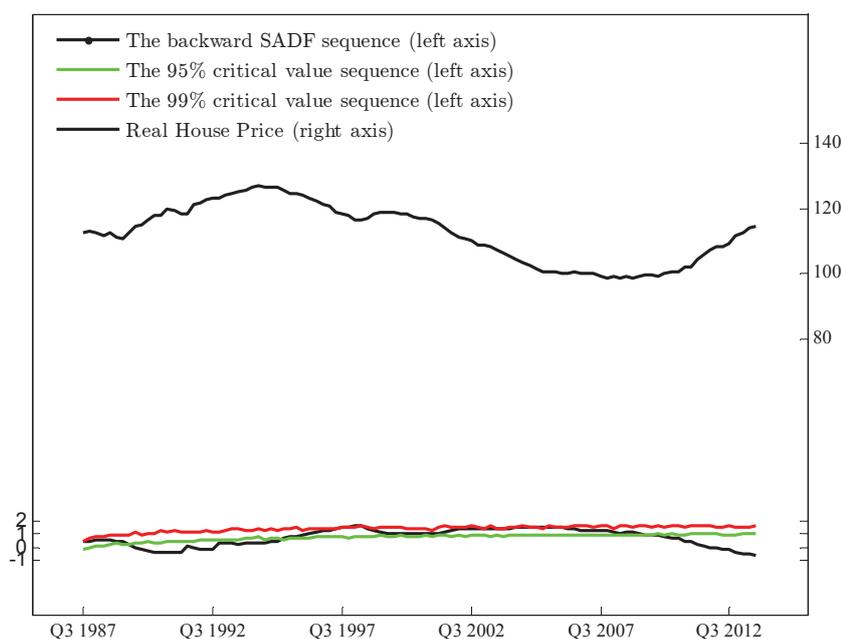
Table 1: Summary Statistics and the Maximum *GSADF* Statistic for 1971Q1–2013Q4

Price-to-Rent Ratio	ESP	GBR	GER	IRL	NLD	NZL	USA
Summary Statistics							
Sample Size	172	172	172	172	172	172	172
Min	24.66	48.05	97.53	23.18	45.33	39.15	88.55
Date(min)	1971Q1	1971Q1	2009Q1	1973Q2	1985Q3	1971Q1	1997Q1
Max	122.22	112.62	179.22	151.66	110.32	111.74	127.28
Date(max)	2006Q4	2007Q4	1981Q2	2004Q3	2008Q3	2007Q2	2006Q1
Maximum Test Statistics							
<i>GSADF</i>	4.13	3.31	1.63	8.41	10.08	9.13	12.05
Finite sample critical values							
	90%			95%		99%	
	1.15			1.42		1.99	

Note: Critical values of *GSADF* test are obtained from 2,000 Monte Carlo simulations with a sample size of 172.

Figure 4 provides the real-time house price bubble barometer for Germany. The solid blue line shows the recursively calculated *GSADF* statistic sequence, along with the associated 95 percent (green line) and 99 percent (red line) critical values, respectively. The dashed line gives the real house price index.

¹⁵ 172 observations and $r_0 = 0.4$ yield a minimum window size of $n = 68$. Then employing the algorithms, we obtain the backward *SADF* sequence from 1987Q3 onwards. The choice of r_0 may also be thought of as a trade-off between efficiency and robustness.

Figure 4: Recursive Calculation of the GSADF Test for Germany

At first glance it turns out that the continuously evolving *GSADF* statistics signal no statistically significant periodic misalignment at the 1 percent significance level. In other words, German house prices were out of the significant danger zone. It is noticeable that this confirms the preliminary results illustrated in Figure 3.¹⁶

But things are not that simple. Unfortunately, early warning indicators don't "make" definite diagnoses; they supplement a careful housing market monitoring and reduce the level of monitoring uncertainty. While after the global recession 2007–2009 real-time warning systems of housing bubbles were a much sought-after diagnostic tool, there is also a lot of scepticism on the ability to monitor housing crises or, more generally, any type of financial crises in real time. This scepticism stems from the alleged poor out-of-sample performance of many early warning models. Diagnostics are rarely 100 percent accurate, so false positives and false negatives can occur. Notwithstanding the sophistication of the statistical toolbox described above, any proposed real-time warning indicator is certain to face challenges in generating "misses" rather than "hits". It is therefore an open question whether the line of enquiry presented above proves empirically fruitful. A reliable real-time warning indicator would correctly call all bubbles and would not issue bubble announcements unnecessarily. Erroneous misses represent a failure to call a bubble (false negative type I error), while erroneous hits generate a false alarm (false positive type II error). It should be borne in mind that there is an inherent trade-off between type I and type II errors which are both functions of the chosen significance level. Changing the significance level to allow more housing bubbles to be picked up necessarily raises the likelihood of false bubble alarms.

¹⁶ At the very most, the procedure flashed some borderline „red flags“ in the mid 1990s which coincides with the concurrent increase in house prices.

Traditionally, monetary policymakers tended to have a stronger preference for missing crises than to act on noisy signals. The global financial crisis 2007–2009 may have changed that. In other words, policymaker concerned with avoiding housing bubbles may now choose to minimise type I errors even if this entails unnecessary macro-prudential policy intervention. One rationale behind this could be that monetary policymakers are willing to take a “bubble insurance” and to accept a possible false alarm rather than be taken by surprise by a financial crisis. In other words, since the global financial crisis a gradual policy change from a “benign neglect” towards a “leaning against the wind” strategy has occurred. This shift of policy implies that now, more than ever, monetary policymakers are willing to dampen asset bubbles at the early stage of their formation.¹⁷

One simple way of assessing the genuine validity and reliability of the univariate screening toolkit is to calculate the statistics across a range of countries known to have experienced boom/bust episodes in the global recession 2007–2009.¹⁸ In defence of our real-time warning signal we have therefore also calculated the test statistics for Ireland, Spain, the Netherland, the UK, the U.S., and New Zealand. This allows one to determine the accuracy of the indicator, i.e. the cross-country comparison provides a rough indication of the type I and type II error rates of our real-time monitoring toolkit. It may also help to dispel misconceptions that people have about early warning indicators. Again we have applied the real-time dating method to the price-to-rent ratio behaviour to detect emerging bubbles using quarterly data from 1971Q1 to 2013Q4 (left axis). In addition, the real house price indices are also plotted (dashed lines; right axis). The results of our screening indicator’s ability to correctly identify bubble periods are available in Figure 5–10 below.

¹⁷ Given the difficulties of detecting emerging housing bubbles in real time, the situation policymakers are facing is one of Knightian uncertainty. The associated question on the optimal dynamic path of monetary policy is of great interest, but lies beyond the scope of this paper. Agur and Demertzis (2013) have recently shown that financial stability objectives make optimal monetary policy more aggressive, i.e. monetary policy tightens as soon as bank risk profiles increase. In other words, the optimal approach to dealing with unknown unknowns is to move away from the danger zone. For an axiomatic foundation of Knightian uncertainty, see Gilboa and Schmeidler (1989).

¹⁸ In most countries only one (most recent) house price boom-bust-cycle can be analysed. Thus although the sample is long enough for sound econometric analysis, the informational content along the time dimension is selective. However, it is reassuring that the indicator matches the two turning points for housing busts in Spain in 1991Q4 and the UK in 1989Q3 documented in IMF (2003), p. 91.

Figure 5: Recursive Calculation of the GSADF Test for Ireland

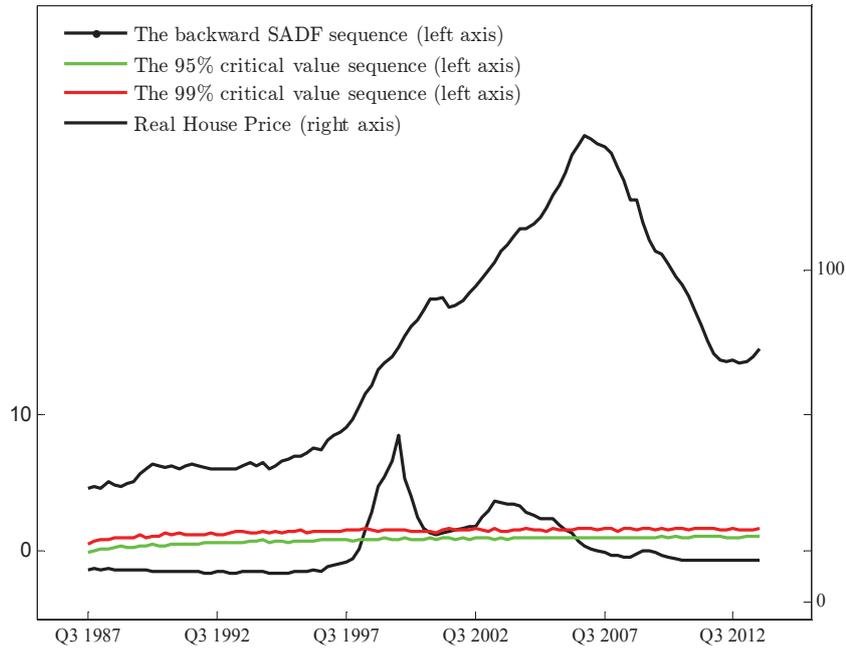


Figure 6: Recursive Calculation of the GSADF Test for the Netherlands

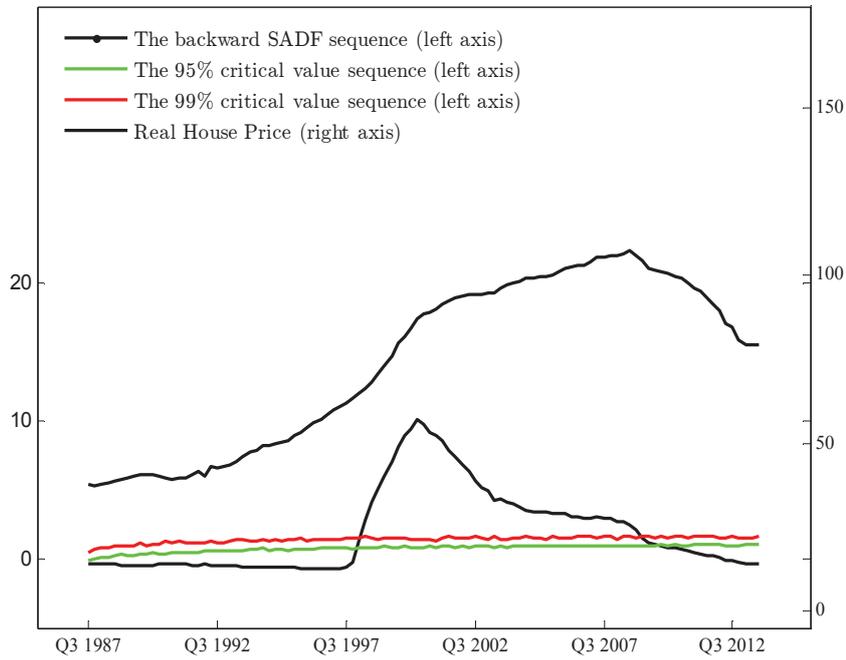


Figure 7: Recursive Calculation of the GSADF Test for Spain

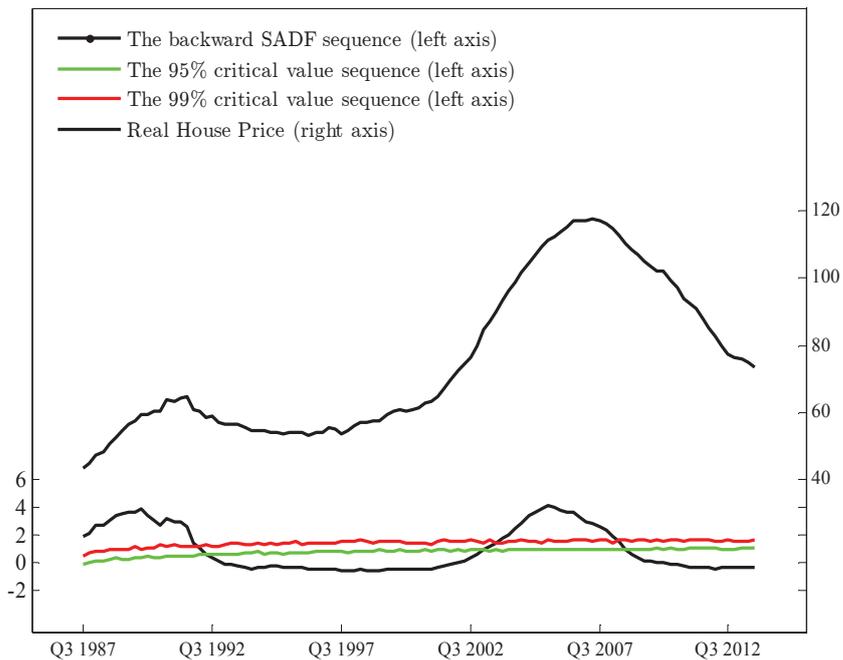


Figure 8: Recursive Calculation of the GSADF Test for the UK

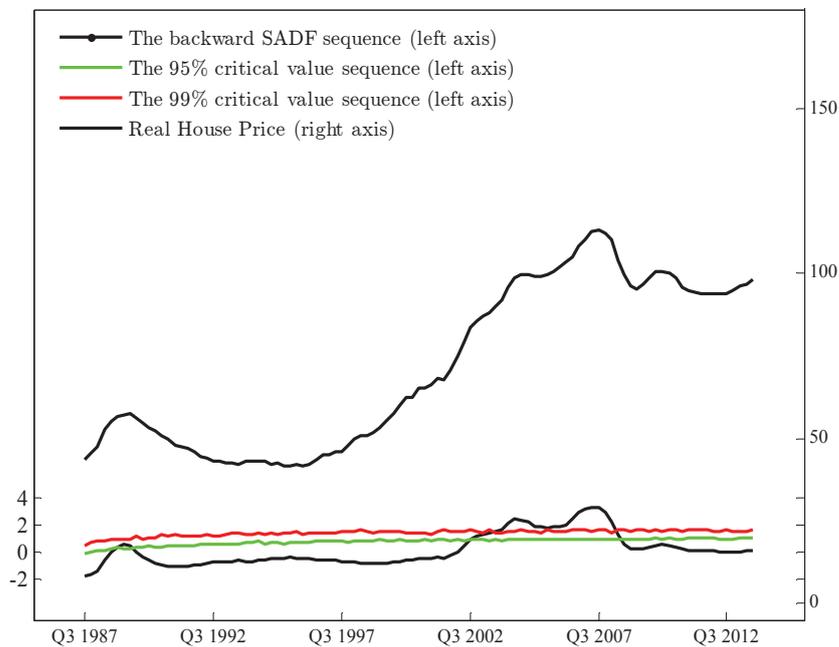


Figure 9: Recursive Calculation of the GSADF Test for the U.S.

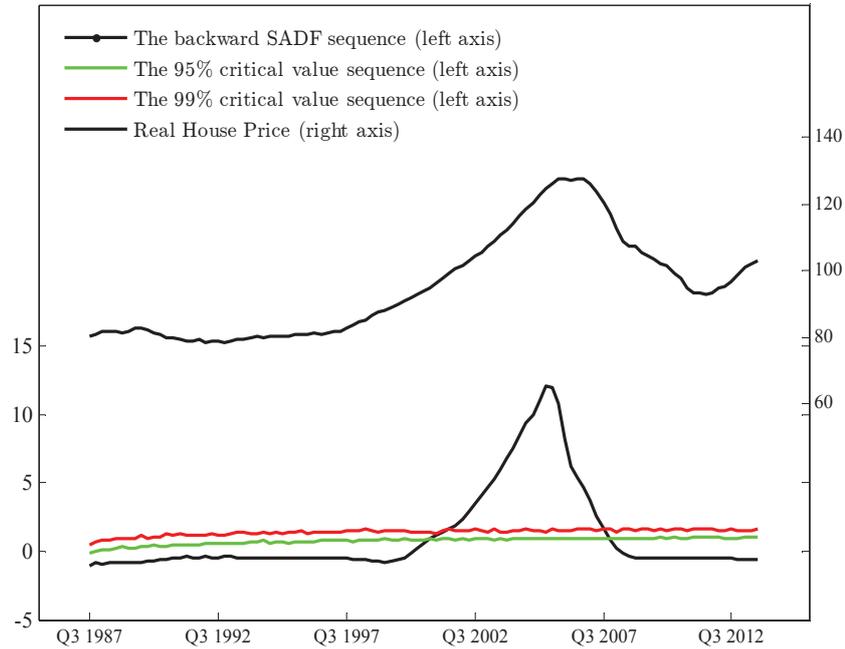
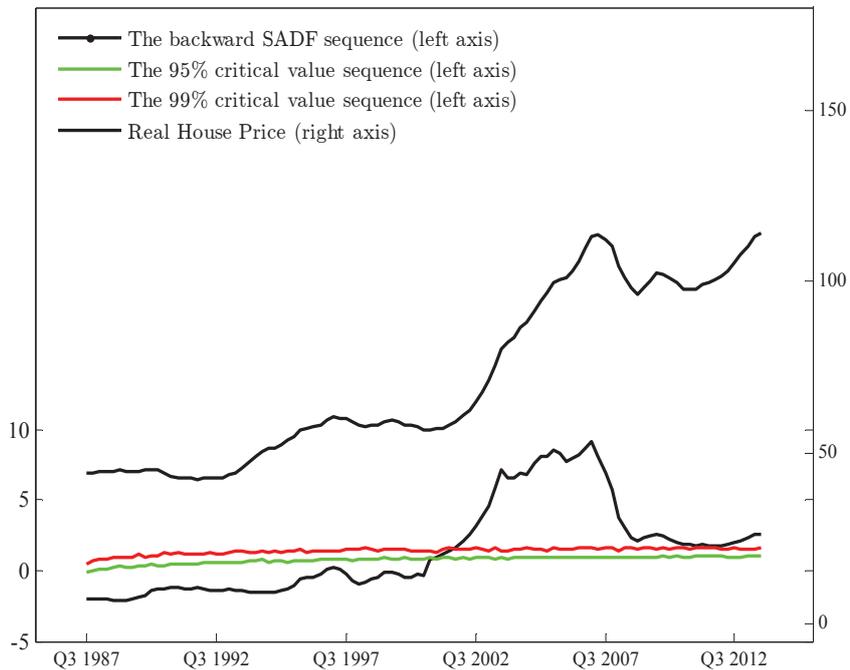


Figure 10: Recursive Calculation of the GSADF Test for New Zealand



Casting the net more widely for illustrative purposes, and looking across several “housing bubble countries”, the following results warrant attention. The visual inspection of Figure 5–10 shows the

fundamental suitability of the GSADF house price bubble early warning indicator. Note that despite the simple methodology employed the real-time predictive content is remarkably good and delivers a cohesive picture. In all countries the statistic signalled the build-up of risk and forthcoming trouble in real time with fairly good accuracy. This early warning in all countries leads one to reject the existence of type I error. On the other hand, the indicator is apparently fraught with type II errors. Examples are Ireland, the Netherlands and New Zealand, where the signals flashed at the end of the 1990s and/or the beginning of the year 2002 but these warning signs did not culminate into bursting bubble until 2007–2008. Therefore a country may be vulnerable in the sense that the GSADF statistic is signaling trouble, yet a bursting bubble may be averted through good luck and/or good policies. On the other hand, synchronized house price shocks across countries may reinforce each other and may lead to a significant increase in the probability of a bursting housing bubble in one country, conditional on a bursting housing bubble occurring in another country and exposure to the foreign cycle. Finally, it should be noted that the probability of a crisis typically increases the larger the house price increase and the longer the duration of the boom is. This mechanism linking asset booms to crisis is clearly visible for the U.S. indicator in Figure 9. To summarize, the flag-raising GSADF statistic in Figure 9 indicates that the synchronized global crisis 2007–2009 originated in the U.S. with the unravelling of the subprime U.S. mortgage market and has quickly spread to the European countries, due to asset price linkages and in particular the process of securitization and reinsurance in the derivatives market across banks worldwide. This has triggered credit crunches and consequent economic crises in various advanced countries. In addition, informational cascades and herding by agents, unregulated off-balance sheet vehicles and/or correlated risk premiums across countries have also transmitted the U.S. shock to other countries. This shift-contagion has led to the global recession 2007–2009.

Overall, the evidence in Figure 5–10 delivers timely warnings of underlying misalignments, vulnerabilities, and tail risks that predisposed the international housing markets to the crisis 2007–2009. This gives us confidence in the potential applicability of the proposed testing strategy to German house price data in Figure 4. Lacking a gold standard procedure for monitoring periodically collapsing house price bubbles in real time, an early warning bubble test with high sensitivity can be considered as a reliable indicator when its result is negative, since it rarely misses true positives among those who are actually positive. Put differently, highly sensitive diagnostics have few false-negative results and are therefore most useful to rule out a beginning decoupling of house prices from their underlying fundamentals. Such highly sensitive diagnostics should particularly be used when we need to detect house price exaggerations and flag vulnerabilities in real time. Finally, the estimation results can also be interpreted as an indirect validation of the main argument put forth in Reinhart and Rogoff's (2009) celebrated book *This Time is Different*. Therein they have provocatively argued that there are strong regularities attached to financial crises, which are therefore predictable based on economic fundamentals.

5. Wrapping up: real-time monitoring of risk with univariate time series methods

It is sometimes alleged that monetary policy is closer to art than to science because it is frequently confronted to new, poorly anticipated and poorly understood, developments and shocks. It is claimed that in such situations common sense and experience are more powerful tools than a slavish adherence to theoretical and econometric models.

Since the global recession 2007–2009, the emphasis on systemic risk assessment and macro stress tests has gained importance. When rapid increases in house prices occur concerns are frequently voiced that prices may have lost touch with the underlying fundamentals. In such a circumstance, there is the fear a bubble may be developing that may eventually burst. This can potentially impart ripple effects throughout the rest of the economy. The main objective of this paper is not to pretend that a simple model can predict emerging bubbles perfectly, but rather to show that even a parsimonious univariate statistical toolbox can do a good job at indicating housing market vulnerabilities in real time. To this end we have employed the state-of-the-art *GSADF* unit root tests suggested by Phillips and Yu (2011) and Phillips et al. (2012) as a barometer. The methodology offers a simple and straightforward real-time monitoring of housing cycles. Based on the *GSADF* statistic, so far there is no reason to believe that a German housing bubble is emerging.

It is important to stress that, just as any other methodology for monitoring house price bubbles in real time, this one is not a panacea. Nevertheless it is hoped that it will help to move the debate forward on this vital topic. However, whether this line of enquiry will ultimately prove fruitful and paves the way for early enough macro-prudential policies will probably continue to be a subject of debate. In any case, results suggested here should be interpreted carefully and should only be considered as part of a suite of indicators used in a complementary manner.

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17. How should we measure residential property prices to inform policy makers?

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This paper represents the authors' personal opinions and does not necessarily reflect the views of the Deutsche Bundesbank or its staff.

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1 Motivation

Data on house prices provide valuable information as a key macroeconomic indicator for identifying price signals, as an indicator for monetary policy impact analyses via the monetary transmission mechanism and, furthermore, as a tool for measuring an economy's real property assets. The data are also used to assess asset price bubbles as well as weaknesses and sources of potential risks in the financial sector, thus forming a basis for financial stability.

In order to make a statement about the residential real estate market as a whole, aggregation of the available price information is required. This can be done by forming the average using weights covering two different populations. On the one hand, the building stock – that is, all residential buildings existing in an economy – can be used as a basis; this results in a wealth perspective. On the other hand, the calculation can be made using transactions. This reflects market activity. It is appropriate to use different measurement approaches and weights depending on the specific analysis objective. Therefore, a single indicator cannot satisfy all user requirements equally.

This paper examines the various motivations for the analysis of house prices and the alternative measures to be applied in each case. Since for short-term business cycle analysis, the most recent developments are at the centre of attention, aggregation should be performed using transactions. In the case of national accounts, housing price data are needed to convert nominal values into real values. If the price-induced change in the property stock is to be measured, as a component of an economy's assets, and not just traded properties, it is appropriate to apply stock weighting. From a financial stability point of view, the potential build-up of asset price bubbles and the risks of banks' credit exposures associated to the financial soundness of private households are most relevant. Much like in short-term business cycle analyses, transactions can be used as a proxy for financings in order to provide valuable clues on the build-up of risks in banks' new business. It should be noted however, that important information on the regional heterogeneity is lost through aggregation.

Owing to newly available data sources for weighting from the 2011 Census of buildings and housing and data on the number of transactions and transaction values for Germany, this paper expands the previous method of calculating house price indices at the Deutsche Bundesbank with regard to weighting schemes. Starting from a methodological framework, this paper examines the distinctive purposes of house price indices and the appropriate information on prices and weights to be applied. The analysis then turns to assessing the

differences in the weights as well as a comparison of the resulting price indices. The final section intends an empirical quantification of differences in the results.

2 Conceptual framework

The market value of a specific building depends on a variety of factors, such as the location, fittings, age and size of the property. The breakdown of this value¹ into its three main components – price, quality and quantity – can be shown as follows.

$$\text{Value} = \underbrace{\text{Price} \times \text{Quality}}_{\text{Unit value}} \times \underbrace{\text{Quantity}}_{\text{Volume}}. \quad (1)$$

In the calculation, quantity is measured in square metres, for example. The unit value is calculated as the value divided by quantity, ie as the value in euro per square metre. It is thus dependent on the quality of the building concerned and contains not just pure price movements but also changes in quality over time. The quotient of value and price is termed volume and describes the real change in value, adjusted for pure price movements. It can also express, for example, an increase in effective expenditure if this comes about due to energy refitting or modernisation (ie improved quality).

The price in euro per square metre shown in the equation is given with all quality factors eliminated, so that quality appears as a dimensionless mark-up (or mark-down). The intertemporal comparison of prices therefore shows how much more or less would have to be spent today compared with previously under the assumption that the same property would have identical price-relevant fittings and characteristics.

In order to make a statement about the residential real estate market as a whole, aggregation is required. This can be done by forming the average using weights covering two different populations. On the one hand, the building stock – that is, all residential buildings existing in an economy – can be used as a basis; this results in a wealth perspective. On the other hand, the calculation can be made using transactions. This reflects market activity.

¹ The derivation of this breakdown is based to a lesser extent on theoretical model considerations, eg portfolio theory, on the value of a reproducible, durable consumer good such as a residential building, but more on the breakdown of the value into a price and quantity component while taking into account changes in quality, as is customary in index theory (and hence for consumer prices as well).

3 Macroeconomic perspective

3.1 Identification of price signals to allocate resources

In a market economy, prices provide signals about relevant shortages through the balance of supply and demand. In this way, enterprises and consumers receive important indications for their production and purchase decisions. Prices and the changes in them thus play a role in the saving and investment decisions of households and commercial investors.

Housing prices are also a key macroeconomic indicator. Rising housing prices tend to stimulate construction activity. What is more, there are indications that inflation in housing prices is linked to transaction frequency. In particular, price rises for housing, which entail increases in value for the owners, can indirectly boost household consumption via wealth effects.

As an indicator for monetary policy, housing prices constitute a key component of headline inflation measurement.² The prices of owner-occupied housing may be included in the Harmonised Index of Consumer Prices in future. As with other durable consumer goods, the net acquisition approach is also to be applied here. This takes as its basis expenditure on the acquisition of new housing and on the maintenance and insurance of existing apartments and houses.

Measuring prices based on constant quality and quantity of a well-defined good is crucial to identifying undistorted signals. The measurement objective of a price index is not to portray the development of average expenditure on the acquisition of houses and apartments, which also incorporates higher or lower spending on changes in quality or quantity. Rather, the measurement objective is to record pure price developments under the assumption of identical price-relevant fittings and characteristics. To do this, prices have to be normalised to a uniform standard, which means eliminating quality-related differences.

Aggregation on the basis of transactions, which only incorporates price information on properties actually sold, should be undertaken for business cycle analysis. Ideally, the relevant purchase transactions would be used here as a weighting matrix, which reflect structural differences in the transaction frequency for different property types or regions. Cyclical fluctuations in the weights should be avoided, however.

² The same applies to interregional and international comparisons.

3.2 Uses in the national accounts

Housing price data are also needed to convert nominal values into real values (deflating) in the national accounts.³ In simplified terms,⁴ the volume can be derived as follows.

$$\text{Volume} = \frac{\text{Value}}{\text{Price}}. \quad (2)$$

This requires a pure price index for this asset class, which is also termed a deflator.

If the price-induced change in the property stock⁵ is to be measured, as a component of an economy's assets, and not just traded properties, it is appropriate to apply stock weighting.⁶ In conceptual terms, a prerequisite for this is the availability of price information on both sold and unsold properties. Depending on the source of the price data, it is possible that information will only be available for sold properties; however, their price development can differ from that of unsold properties.

Deflators are additionally used in other sections of the national accounts. First, for overall sales of housing, to depict the real production value of real estate and housing services. Second, a price index for the production value of new buildings is needed, which forms part of gross (fixed) capital formation.⁷ Deflating these variables requires a transaction-weighted price index which comprises only the prices of new properties for the new buildings component.

³ Naturally, the nominal figures are also justified in their own right as a key indicator.

⁴ This document does not address the problem of breakdown into a country and structural component in further detail.

⁵ The value of the property stock is a significant component of an economy's assets. For example, gross domestic capital stock as reported at replacement cost at year-end 2013 in the area of dwellings constitutes around 265% of nominal gross domestic product for the same year.

⁶ This approach would also be appropriate in terms of estimating wealth effects, as the values of households' individual asset portfolios are influenced by changes in housing prices, which diverge between regions.

⁷ There is a link between the definitions of stock and transaction values. The stock value at the beginning of the period plus the net change in that period gives the stock at the beginning of the subsequent period. Depreciation (devaluations and disposals) and write-ups (owing to construction and renovation, for example) also have to be taken into account.

4 Application to financial stability

From a financial stability perspective, besides the possible emergence of asset price bubbles, the market risk associated with households' debt sustainability posed to lending banks is of particular relevance. In this connection, the change in value of the financed properties must be noted, taking into account two dimensions: risks involved in newly granted loans and changes in the value of properties in the loan portfolio.

However, aggregation can result in important information about regional heterogeneity being lost.⁸ After all, in line with the experiences of other countries with exaggerations in the housing market, regional trends can definitely develop systemic relevance. Ultimately, undesirable regional developments in lending that initially arise in isolation can multiply, allowing the rise in housing prices to continue gaining ground.⁹ Disaggregated price levels are therefore required to examine geographical transmission channels in more detail.

4.1 Assessment of the emergence of asset price bubbles at the current juncture

The emergence of asset price bubbles is often associated with misallocations, for example on account of a significant increase in construction investment and the corresponding capacities which, in the case of a trend reversal, involves higher default risk in the non-financial corporate sector, amongst other things. However, the acquisition of housing by households, which is credit-financed to a significant degree, merits particular attention. In this context, the value of a property at the time of purchase plays a particular role in lending to households. Thus, for example, the initial ratio of the loan amount to the market value is a key figure in macroprudential analysis.¹⁰ The price dynamics have to be assessed in connection with additional financing indicators. The concurrent increase in lending and easing of lending standards, which can be observed in typical house price booms, is especially risky.

Like the user requirements for business cycle and price analysis, transaction weighting of the properties sold on the market, as an approximation value for financing and construction

⁸ For further details, see Deutsche Bundesbank, The determinants and regional dependencies of house price increases since 2010, Monthly Report, October 2013, pp 13-29.

⁹ For further details, see Financial Stability Committee, Erster Bericht an den Deutschen Bundestag zur Finanzstabilität in Deutschland, June 2014.

¹⁰ This kind of monocausal analysis falls short of prudential practice in that there are more factors between property appraisal and customer rating than just the loan-to-value ratio, such as the posting of collateral. Furthermore, the normal loan-to-value ratio in Germany is not necessarily a good measure of a property's actual value, as this "may not exceed the value resulting from a prudent appraisal of the future marketability of a property" pursuant to section 16 (2) of the Pfandbrief Act (Pfandbriefgesetz).

investment,¹¹ can provide important information for assessing the build-up of risk positions in new business.

4.2 Observation of the development of financed properties over time

Another relevant variable that is an important indicator is the change in value over time – changes in price including quality. This is because, with respect to the banks' default risk, the residual value of a property is only of interest when there is a default on loan payments (exposure), as the property would then revert to them and might have to be sold on the market.¹²

As shown in equation (1), the value of an individual property is made up of the three variables of price, quality and quantity. The quantity (eg living space) of a property is generally approximately constant over time. However, the price and quality change over time. Thus, the change in value from the time of house purchase until possible default of the loan amounts to:

$$\text{Change in value} = \text{Price change} + \text{Change in quality.} \quad (3)$$

The condition of the house, ie its quality, is not a fixed variable in the equation, however; rather, a discount is subsequently assumed as a constant annual depreciation factor. A property's value is thus correlated with the price change on the market.¹³

Consequently, only the price developments of bank-financed properties would be relevant from a macroprudential perspective. Equally, the portfolio to be analysed should incorporate only these properties into the weighting scheme. This is crucial in that its composition changes over time. Newly financed buildings and apartments are added, and others are removed, as the loans granted for them were paid off.

For the purposes of financial stability, supplementary institution-specific data for the identification of sources of potential risk are therefore imperative.¹⁴ The question of the

¹¹ For the construction sector, however, there are vastly more suitable indicators available to directly measure activity.

¹² Of course, this is only weighed against the average probability of default in the loan portfolio. In principle, the market value of a property can also fall below the loan amount. As long as households can still make the interest and redemption payments, however, these non-defaulted loans do not play a role in the effectiveness of banks' risk management.

¹³ In this context, the absolute residual value of the property is not the decisive factor, but rather the ratio to the outstanding loan amount at the time of the possible loan default. Particularly in the first few years of the mortgage term, however, the principal component of the annuity is very low, while the rate of depreciation here was assumed to be constant, which means that the outstanding loan amount/residual value ratio normally initially deteriorates compared with the time the loan was granted.

¹⁴ In addition, developments broken down by year of loan granting are interesting as these can express the prevailing regime at the time in the form of lending standards.

breakdown's borders naturally cannot be answered using the available data. The weighting scheme which comes closest to the measurement objective discussed in this section is probably weighting based on the building stock.¹⁵

¹⁵ Nonetheless, this approximation is rough at best. For example, the situation regarding households' ownership of real estate property is as follows, based on the income and consumption sample for 2008: just over half of all households live in rented housing and another fifth own the property without a mortgage loan on it; only around one-quarter of households own housing for which they still have to settle an outstanding loan.

5 Data sources

Previously in Germany, there were no granular data nor any statistical register about the property stock available. The results of the building and apartment count in the 2011 Census, which was a complete survey,¹⁶ can now be used as a source of data on the housing stock in Germany and the supply of housing to the population at the granular level. The survey must be repeated every ten years in future.¹⁷ The results thus form a new data set for the building and apartment stock, which also contains information on the number of freehold apartments and single and two-family houses.

The Bundesbank obtains data on the number of transactions and transaction values for freehold apartments as well as for single and two-family houses at the administrative district level from a subsidiary of the Association of German Pfandbrief Banks (Verband deutscher Pfandbriefbanken) called vdpResearch GmbH. In methodological terms, these data are analyses of the market reports issued by the relevant appraisal committees, which are supplemented with estimates.

To determine the weights for new buildings and existing properties, the information on weighting shares in the house price index (HPI) calculated by the Federal Statistical Office (Destatis) can be used. A large number of data sources are used to derive the weights.¹⁸ This involves a breakdown of transaction values which are attributable to new buildings and existing properties; a regional breakdown of the purchase transactions is not possible. Since the HPI is calculated as a chain-linked index on the basis of European requirements, these weights are updated annually.¹⁹ The breakdown of new buildings and existing properties that underlies the Bundesbank's index is the arithmetic average of the data from 2010 to 2012, based on the selected period for the number of transactions.²⁰

The underlying price information is provided by bulwiengesa AG.²¹ This refers to price data which are quality-adjusted using the method of typical cases²² which means that only the prices of similar properties are included in the index calculation.²³

¹⁶ All of the approximately 17.5 million owners and administrators of real estate were surveyed, by post, on the kind of building, the number of apartments in the building, the building type, the proprietorship, the year of construction and various fittings and fixtures of the apartments.

¹⁷ Regulation (EC) No 763/2008 of the European Parliament and of the Council of 9 July 2008 on population and housing censuses.

¹⁸ For a precise description of how the weights are derived, see J Dechent, *Preisindizes für Wohnimmobilien*, *Wirtschaft und Statistik*, November 2011, pp 1126-1134.

¹⁹ Commission Regulation (EU) No 93/2013 of 1 February 2013 laying down detailed rules for the implementation of Council Regulation (EC) No 2494/95 concerning harmonised indices of consumer prices, as regards establishing owner-occupied housing price indices.

²⁰ See section 3.2 for the calculation of the mean value for transaction-based figures.

²¹ bulwiengesa AG uses information taken, among other sources, from its own appraising activity, from building and loan associations, research institutes, appraisal committees, estate agent associations, chambers of industry and commerce as well as from independent experts. The calculations thus also incorporate valuations, meaning that the data are not purely transaction prices.

6 Deriving the weights

In principle, the available information permits two options for weighing together the properties – freehold apartments, terraced houses and detached houses – within an administrative district or city as well as for condensing these data into an aggregate for Germany as a whole. Specifically, one averaging based on stocks and another based on purchase transactions.

It should be noted that weighting is based on space data (stocks or turnover) since the price data provided by bulwiengesa AG are absolute figures in euro per square metre or are converted into such using the classification of building types.²⁴

6.1 Stock-weighting

Data from the Census as at 9 May 2011, broken down by municipality, are available on apartments in residential buildings containing one apartment, broken down by construction type (detached house, semi-detached house and terraced house), and on apartments in residential buildings divided up according to the Act on Cooperative Apartments and Proprietary Leases (*Wohnungseigentumsgesetz*). This allows apartments in single-family houses to be clearly distinguished from freehold apartments.

Semi-detached houses and terraced houses are accounted for together in the "terraced houses" category. The space available for the property types in question can be determined directly on this basis. Additionally, the above-mentioned transaction-based HPI weights are used consistently for the breakdown into first-time occupancy and re-sale for all administrative districts and cities as well as for property types. The space is formally calculated as follows.

$$\text{Total space}_{i,j,k} = \text{Stock}_{i,k} \times \text{Share}_j \times \text{Living space}_i, \quad (4)$$

where i refers to the three above-mentioned property types, j reflects re-sales or first-time occupancies and k represents the relevant municipality.

²² See Deutsche Bundesbank, Price indicators for the housing market, Monthly Report, September 2003, pp 45-58.

²³ The standardised properties are freehold apartments with living space of around 80 square metres and terraced houses with living space of around 110 square metres, each providing comfortable living conditions and in average to good locations, as well as existing single-family houses with living space of around 175 square metres, standard fittings and a standard property size.

²⁴ To do this, the price data are divided by 110 square metres in the case of terraced houses and by 175 square metres in the case of detached houses. These values are also used for multiplying the stock figures and the transactions; for freehold apartments, 80 square metres are used. For more information, see footnote 3.

Although this weighting scheme results in a simple and complete solution, the next count of buildings and apartments will only be conducted in 2021, meaning that a new basis can only be introduced with a time lag.

6.2 Transaction-weighting

Purchase transactions (Purch trans) for freehold apartments (FA) and single and two-family houses (STFH) are available at the level of the rural districts and urban municipalities. The latter category thus first needs to be broken down into terraced houses (TH) and detached single-family houses (DSFH). The Census data are used to do this; however, this only applies to the relationship between these two types of house. The ratio of freehold apartments to houses, on the other hand, is specified from the transaction data. For the cities, a discount must additionally be made on the data from the districts; the Census results are likewise used for this purpose. A factor specific to the property type is determined from the ratio of the stocks in a city to the districts. Using the above notation, the equation can be explicitly presented as follows.

$$\text{Purch trans}_{i,k} = \text{Purch trans}_{\text{STFH},k} \times \frac{\text{Stock}_{i,k}}{\sum_{l \in \{\text{TH}, \text{DSFH}\}} \text{Stock}_{l,k}}, \quad i \in \{\text{TH}, \text{DSFH}\}, \quad (5)$$

$$\text{Purch trans}_{i,m} = \text{Purch trans}_{i,k(m)} \times \frac{\text{Stock}_{i,m}}{\text{Stock}_{i,k(m)}}, \quad i \in \{\text{FA}, \text{TH}, \text{DSFH}\}, \quad (6)$$

where m refers to the cities and $k(m)$ to the districts to which the cities belong.

The breakdown into newly constructed properties and existing properties again uses the HPI weights, and the previously mentioned property spaces are used to provide the relevant turnover of space.

Figures from the years 2010 to 2012 are used for the transactions since purchase transactions are subject to cyclical fluctuations.²⁵ This is not least because in a chain-linked index where there is a (positive) correlation between prices and transactions, there is the risk of index drift.²⁶ No chain-linked index was calculated here.

²⁵ Even when the weighting scheme is based on the transactions from a single year, there were no notable differences in the aggregates considered here.

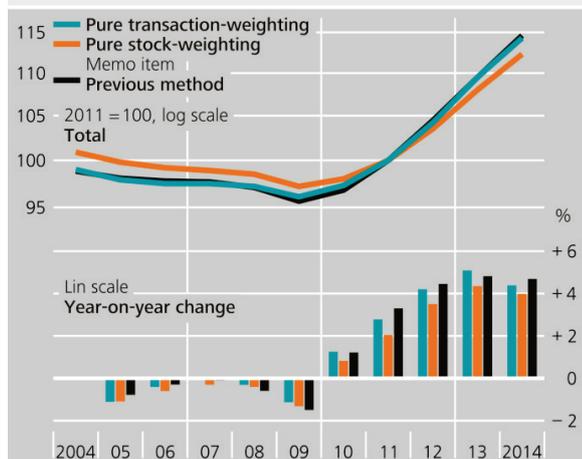
²⁶ For an exact description of this effect, see J Hoffmann and A Lorenz, Real estate price indices for Germany: past, present and future, paper presented at the OECD/IMF workshop on real estate price indices in Paris from 6 to 7 November 2006.

7 Differences in the weights

The differences in the weights can be explained by structural differences in the sales rates (the ratio of purchase transactions to housing stock) of both between municipalities and property types. For example, freehold apartments are given a higher weight in a transaction-weighting scheme. Their sales rate is higher than that of houses. A breakdown by municipality also reveals that urban regions have a higher share when weights are transaction-based. The reason for this is, again, the higher sales rate compared with rural municipalities, not just for apartments but also for houses. The convention can therefore hold that the sales rate is higher in cities than in rural areas and is likewise higher for apartments than for houses.



Comparison of purchase prices for residential real estate in Germany according to different weighting schemes



Source: Bundesbank calculations based on data provided by bulwiengesa AG.
Deutsche Bundesbank
12 Jun 2015, 08:17:33, S3PR0212.Chart

8 Comparison of the price indices

In principle, no fundamentally different statements can be made on trend patterns and the timing of turning points than could be made on the basis of the previous method. Equally, the signs of the annual rates of change remain unaffected, as does the determination of an acceleration or deceleration of price dynamics.

In principle, however, the stock-weighted data show a flatter pattern compared with the price indices calculated using transactions.

9 Empirical quantification of differences

Based on a variation of the theorem of von Bortkiewicz (see annex), we derived a breakdown of the difference in the year-on-year rates of the weightings using purchase transactions and housing stocks.²⁷ It can be seen that the difference is the product of two factors.

1. The correlation between the price changes of properties in cities and the corresponding sales rates (the ratio of purchase transactions to housing stock).
2. A "scaling factor", the temporal development of which is driven by the standard deviation of the price changes.

Considering the results regarding the differences in weights, the stylised fact can hold that the sales rate is generally higher in cities than in rural areas and is likewise higher for freehold apartments than for terraced houses and detached single-family houses.

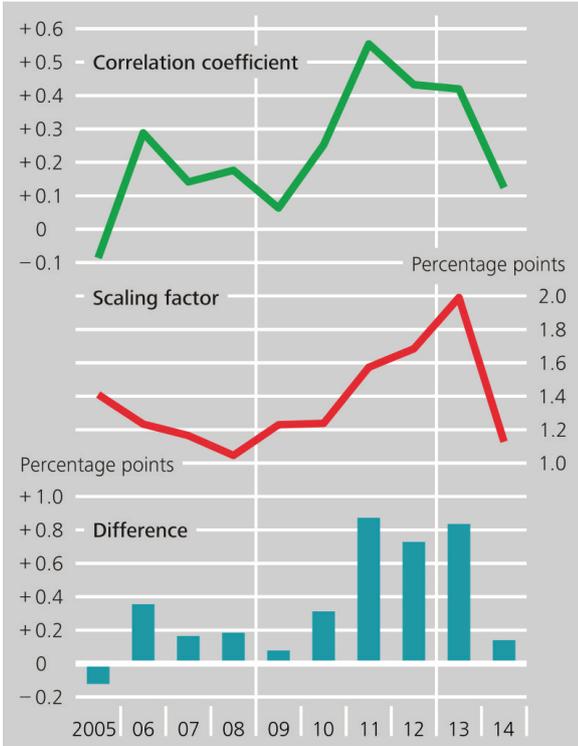
At the current end, it can be seen that the fact that the difference between the results on the basis of the two weighting schemes is now only minor can be explained by the correlation having fallen sharply and the standard deviation having decreased.²⁸ With regard to the results of the calculations for urban housing, the price dynamics of the market segments houses and apartments and also those of the seven largest cities and the 127 cities moved closer together last year.

The evident connection between price changes and sales rates on the one hand and the difference between transaction and stock weightings on the other can therefore be proven analytically and thus also quantified empirically (see the chart for 127 cities).

²⁷ For information on the theoretical foundations, see v d Lippe, P (2007), "Index Theory and Price Statistics", P Lang, pp 194-196.

²⁸ The latter is partly due of course to the overall weaker price developments, as the standard deviation depends on the level of the price changes. With regard to the generally positive correlation, the literature points out that it is transactions that follow developments in prices (and not the reverse).

Breakdown of the difference in the year-on-year rates of the weightings using purchase transactions and housing stocks in 127 cities



Deutsche Bundesbank

S3IN0378.Chart

Derivation of the adaptation of the theorem of von Bortkiewicz on the difference in year-on-year rates

The absolute data for the average prices per square metre in a year t are produced based on the new weighting of housing prices as follows

$$P^t = \sum_{l \in L} p_l^t \cdot \frac{\bar{q}_l}{\sum_{l \in L} \bar{q}_l},$$

where the summation can be carried out using the property types, re-sales or first-time occupancies, and administrative districts or cities. The price p stated in the equation is in euro per square metre, the quantities q are either space available (“B”) or take-up of space (“U”), each in square metres.

Consequently, the published Laspeyres price indices with the base year 2011 are as follows

$$P^{2011:t} = \frac{P^t}{P^{2011}} = \frac{\sum_{l \in L} p_l^t \cdot \bar{q}_l}{\sum_{l \in L} p_l^{2011} \cdot \bar{q}_l}.$$

A rebased Lowe price index is used for the year-on-year change

$$\frac{P^{2011:t}}{P^{2011:t-1}} = \frac{\sum_{l \in L} p_l^t \cdot \bar{q}_l}{\sum_{l \in L} p_l^{t-1} \cdot \bar{q}_l} = \frac{P^t}{P^{t-1}} = P^{t-1:t}.$$

The theorem of von Bortkiewicz provides the following equation for comparing year-on-year change based on transaction and stock weightings

$$\frac{P_U^{t-1:t}}{P_B^{t-1:t}} - 1 = \frac{\text{Cov} \left[\frac{p^t}{p^{t-1}}, \frac{\bar{q}_U}{\bar{q}_B} \right]}{E \left[\frac{p^t}{p^{t-1}} \right] \cdot E \left[\frac{\bar{q}_U}{\bar{q}_B} \right]},$$

where the ratio of take-up of space to space available reflects the sales rate and all moments are weighted with $p^{t-1} \cdot \bar{q}_B$, which gives $E \left[\frac{p^t}{p^{t-1}} \right] = P_B^{t-1:t}$.

This results in the following equation for the difference in the year-on-year rates of both weightings

$$P_U^{t-1:t} - P_B^{t-1:t} = \frac{\text{Cov} \left[\frac{p^t}{p^{t-1}}, \frac{\bar{q}_U}{\bar{q}_B} \right]}{E \left[\frac{\bar{q}_U}{\bar{q}_B} \right]}.$$

Finally, the breakdown is shown as the product of two factors

$$P_U^{t-1:t} - P_B^{t-1:t} = \text{Corr} \left[\frac{p^t}{p^{t-1}}, \frac{\bar{q}_U}{\bar{q}_B} \right] \cdot \sqrt{V \left[\frac{p^t}{p^{t-1}} \right]} \cdot \frac{\sqrt{V \left[\frac{\bar{q}_U}{\bar{q}_B} \right]}}{E \left[\frac{\bar{q}_U}{\bar{q}_B} \right]} \sim \text{Corr} \left[\frac{p^t}{p^{t-1}}, \frac{\bar{q}_U}{\bar{q}_B} \right] \cdot \sqrt{V \left[\frac{p^t}{p^{t-1}} \right]},$$

where the rough proportionality is the result of the approximate constancy of the variation coefficient of the sales rates over time.

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