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Can recent property price dynamics still be justified by fundamentals or are they indicating house price bubbles?

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Abstract

The burst of the housing bubble in the United States in 2007 and its far-reaching consequences have fueled the analysis of property price determinants. Using a Fixed Effects model, we analyze to what extent fundamental factors, such as macroeconomic, demographic or real estate market conditions, influence the evolution of housing prices in 15 OECD economies over the period 1970-2016. In the second part of this work, a Rolling Augmented Dickey-Fuller test was applied with the objective of providing evidence for potential bubbles in these OECD countries.

Keywords: Housing Bubbles, Fixed Effects Model, Right Tailed Augmented Dickey-Fuller Test, Rolling Augmented Dickey-Fuller

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Glossary

ADF Test	Augmented Dickey-Fuller Test
CPI	Consumer Price Index
GDP	Gross Domestic Product
HPI	House Price Index
MSCI	Modified Schwarz-Bayes Information Criteria
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
PRR	Price-to-Rent Ratio
PIR	Price-to-Income Ratio
RADF Test	Rolling Augmented Dickey-Fuller Test
RPPI	Residential Property Price Index
SADF Test	Supremum Augmented Dicker-Fuller Test
UK	United Kingdom
US	United Stated

Table of Symbols

ln_BP	log building permits
ln_CA	log current account balance
ln_CONST	log Construction Cost Index
ln_CPI	log Consumer Price Index
ln_CREDIT	log credit to private sector (as % of GDP)
ln_GDPPC	log GDP per capita
ln_LTR	log long-term bond yield
ln_ POP	log population growth
ln_RPPI	log Residential Property Price Index
ln_TAX	log tax on property (as % of GDP)
ln_UN	log unemployment rate

1 Introduction

The dramatic increase in house prices, such as the US experienced from 1996 until early 2007, along with the following price crash, are events in the real estate history that are hard to forget. Researchers have been expending considerable effort in trying to understand these events, but their understanding is still far from complete. How could the regional phenomenon of a real estate bubble in the US have a contagion effect and become a threat to the economic development in many other countries? Property price bubbles have repeatedly contributed to the emergence of major crises. The bursting of the US real estate bubble in 2008, for example, has contributed to the global financial crisis, of which the global economy has still not fully recovered from. During the course of the crisis, it became clear which key role residential real estate plays for the growth of an economy and how far-reaching consequences can be given speculative price exaggerations.[1] This is one of the reasons why developments in residential property markets are increasingly being brought to the forefront of the public and questioned critically. Consequently, an early detection of imbalances should gain importance in the future in order to avoid another global financial market crisis.

Real estate markets are closely linked to the financial markets through the protection of loans. In the ‘80s and ‘90s, liberalization of the financial and mortgage markets facilitated access to mortgage lending. This stimulated demand and contributed to more liquid real estate markets, and was, therefore, an important factor in real estate price development. However, there exist some differences among countries. For instance, in contrast to the US which loosened its lending requirements prior to the US subprime crisis, Germany retained stricter requirements for real estate financing and was characterized by a relatively stable real estate market. Whereas house prices did not increase tremendously prior to the crisis in Germany and no bubble formed, in Spain and Anglo-Saxon countries the enormous increases finally led to the bursting of the

1 Demary (2008), p. 1

bubbles. This indicates that property prices developments across countries are not equal and that business cycle divergence might exist.

Since it is also possible that the financial markets are the source of the unhealthy developments in the real estate markets, both markets must be considered together for a complete analysis. Nevertheless, even though recent history has shown that the development of a financial market crisis can be the cause of some weaknesses in the real estate market, this pattern cannot be explained by the general law. For example, during the Japan housing crisis in the early 1990s, there was no financial market crisis in Singapore and Hong Kong, as opposed to in Malaysia and Thailand, which was to a large extent due to higher liquidity reserves and equity ratios.[2]

Recently, several countries, especially in Northern and Western Europe, have been experiencing enormous price increases in the real estate market. Prices in London, for example, are roughly 15% higher than before the crisis.[3] In Germany, prices for residential properties have risen significantly in the metropolitan cities and areas in recent years. According to the Deutsche Bank, house prices doubled since 2009.[4] Real estate prices in Scandinavia have, since 2011, risen with strong rates of around five percent a year. Property prices in Sweden have doubled for homes in particularly sought-after locations, and prices of certain condos even tripled within ten years.[5] Besides in Northern and Western European countries, property prices in Canada have grown incredibly high. It is not surprising that with an increase of 50% in real housing prices over only five years, Toronto occupies the first place of the UBS Global Real Estate Bubble Index.[6] The risk of a bubble has considerably augmented in several major cities, according to UBS – and compared to inflation and economic growth, these increases are disproportionate. In view of these recent developments, memories of the tumultuous American real estate market are growing rapidly and many experts fear that another housing bubble is

2 Hilbers et al. (2001), p. 15ff
3 UBS Global Real Estate Bubble Index
4 Sackmann C. (2017)
5 Siedenbiedel C. (2015)
6 UBS Global Real Estate Bubble Index

approaching with risk of another explosion. Against this background, the following question arises: Are the current price developments still reasonable or is a price bubble forming on numerous residential property markets? In order to come up with an answer to this question, first of all, it is necessary to understand which factors drive real estate prices. Only then one will be able to better understand which factors are responsible for price increases and for the emergence of price bubbles on real estate markets. Accordingly, the aim of this work is to identify potential determinants of property prices and to investigate current dynamics on certain property markets.

For this purpose, the remainder of this work is structured as follows: the subsequent section provides an overview of existing literature regarding housing bubble definitions and the detection of housing bubbles. The third section includes a description of the dataset. The fourth section analyzes the main macroeconomic and real estate market determinants of house price bubbles in 15 OECD countries. This section follows a description of the econometric model performed to detect explosive property price behaviors and its results. Finally, the last section finishes with a conclusion and a discussion of the limitations of this study.

2 Definition and Literature Review

For the further course of the work, it is essential to know what is generally understood as a "price bubble". Even under economists, the term "price bubble" is not clearly defined, and opinions about it are widely divergent. In order to understand property price movements, it is essential to understand the determinants of house prices. Price increases in real estate can have different causes. On the one hand, these reflect the development of fundamental factors. On the other hand, a property price increase can also be caused by non-fundamental factors such as speculation. Besides, in order to be able to adequately answer the question of the existence of a bubble on residential property markets in some European countries and North America, it is indispensable to clarify the conditions under which a price bubble can be assumed. The fact

that this is by no means trivial is shown by popular examples of price bubbles in different markets from the recent past, notably the dot-com bubble in 2000 and the subprime crisis in 2007. In spite of exorbitant price exaggerations, bubbles were not recognized as such and only fully identified after their bursting.[7] Basically, one must keep in mind that the triggering factors for a bubble can be quite different in each case, and as some well-known experts say: "The fact that a bubble is a bubble is only known when it bursts." Prior to the burst, a bubble can almost never be identified without uncertainty.[8] This is why it is difficult to make a reliable statement beforehand about whether price increases are still realistic or reasonable or if an overvaluation already exists. There is no criterion or indicator for determining the point from which a "normal" property price revaluation changes into a bubble formation. Against this background, it is also not surprising that there is still no uniform opinion on a scientifically based definition of the price bubble phenomenon. Yet, a housing bubble is often defined as the deviation of the current real estate price far above its long-term 'fundamental value'. The fundamental value of any asset is the present value of all future cash flows implying that the price of a property depends on its anticipated future rents.[9] The market price, on the other hand, is determined daily by the combination of supply and demand.[10]

The Nobel Prize Recipient in Economic Sciences, Joseph Stiglitz, offers one of the most popular definitions of a price bubble. According to him, a price bubble is always present when the reason for high prices is based solely on the beliefs of the investors that higher resale prices can be achieved in the future. "If the reason is the price is high today, it is only because investors believe that the selling price will be high tomorrow – when 'fundamental' factors do not seem to justify such a price - then a bubble exists ".[11] Stiglitz interprets vast price declines, which occur without any apparent new information, as the breaking of the bubble. This explanation

7 Hens T. and Bachmann K. (2008), p. 94
8 Morita K. (2017), p. 119
9 Wang (2000), p. 186
10 Rombach (2011), p. 41f
11 Stiglitz (1990), p. 13

is, therefore, based on the excessive expectations of future prices, which lead to an excessive increase in demand and, in turn, to an increase in the volume of transactions.[12] Stiglitz's behavior-based perception, however, does not provide reliable information about the existence of an overheating of the real estate market. A distinctive definition of the term 'bubble" must, therefore, be able to distinguish a property bubble from a purely cyclical development. In view of this, economics usually speak of a bubble only when the market price of an asset deviates long-term and significantly from its fundamentally justified value. As market participants realize that their expectations are too optimistic, there is a regular sales wave that ultimately leads to a sharp correction in prices and to an adjustment of the fundamentally justified level, resulting in the burst of the bubble. Case and Shiller (2003) argue that households' anticipation of enormous price increases might have a great effect on demand, particularly when they believe that purchasing a property is associated with little risk. Nevertheless, they note that the simple occurrence of prompt price developments is not by definition a decisive indication of a bubble - as these increases might, to a great extent, be explained by economic fundamentals. Likewise, McCarthy and Peach (2004) claim that the growth in homes prices in the years before the burst in 2007 was essentially attributable to strong fundamentals - especially to low interest rates and high incomes. Himmelberg et al. (2005) also emphasize the role of economic fundamentals, such as the user cost of housing, to justify the latest house price movements. They argue that commonly used measures like price-to-rent or price-to-income ratios are misleading in revealing housing price bubbles. Analysts utilizing such conventional metrics might find evidence for overvaluation when, in fact, properties are rationally priced.

Another explanatory approach is dedicated to the behavior of market participants. Accordingly, individuals are driven by their expectations that prices may continue to rise. Speculators will enter the market in order to sell the properties soon after they purchased them for a higher price. This inspires other participants' expectations to rise, causing them to invest as well (herd

12 Irle M. (2010), p. 12

behavior). This does not only mean that the transactions of an industry are rising sharply, but that this is also accompanied by a significant increase in prices. The optimistic speculative motive drives individuals to behave irrationally in the marketplace, suggesting that fundamental and objective factors are not considered in the decision when buying.[13] Thus, when the summit is reached, a sharp fall in residential prices driven by panic sales occurs.[14] In this context, Alan Greenspan's term "irrational exuberance" became very popular in 1996 and forms the basis of a speculative price bubble.[15] Nonetheless, a bubble can also emerge by reason of rational expectations. Investors are accepting exaggerated market prices, assuming they will profit from further price increases in the future. However, this presupposes that they resell before the bubble bursts.

Mian and Sufi (2009) studied if expectations could stimulate the faster expansion of subprime lending by comparing house-price growth in subprime as well as non-subprime areas. They could not find evidence and thus concluded that the growth of mortgage credit was caused by supply factors such as the increase in subprime mortgage securitization and the easing of underwriting principles. Further exploring the expectations hypothesis of Mian and Sufi (2009), Brueckner, Calem and Nakamura (2011) found evidence that a positive alteration in future house-price outlooks, generated by fast previous appreciation, does lead to an extension of mortgage borrowers with lower credit ratings. Although the fundamental point of view is dominant, difficulties can sometimes arise in the determination of the fundamental value of assets. On the one hand, this is derived from a large number of economic variables, which are not always directly measurable or observable. At the same time, a price bubble, in reality, is often difficult to distinguish between cyclical fluctuations and structural breaks. In spite of these obvious criticisms, the term price bubble is used in the further course of this work whenever the market price differs from its fundamentally justified value. In light of the lack of general

13 Rombach (2011), p. 65-66
14 Kindleberger, C. (2011), p. 84
15 Shiller, R. (2015), p.2; Shiller (2000), p. 60-62

agreement regarding the definition of a housing bubble, it is not astonishing that the empirical approaches of how to measure or detect housing price bubbles differ.

2.1 Literature Review - Detection of Price Bubbles

Nneiji et al. (2011) explore whether intrinsic bubbles and rational speculative bubbles caused deviations from fundamental values in the US housing market over 1960-2009 using a regime switching approach. Due to fundamental price-rent ratio changes, they split the data into two sub-periods and find an intrinsic bubble in the first sub-period (until 1999), suggesting that purchasers overreact to changes in renting costs. However, from 2000 onwards, their results show evidence of a rational speculative bubble. Agnello and Schuknecht (2011) use a Random Effects panel probit model for 18 industrialized European economies over 1980-2007 in order to identify real estate boom and bust periods. Among other things, they found out that this model is able to identify these periods early on and that several policy variables such as interest rates strongly influence the probability of booms and busts.

Cointegration analysis is often used to detect house price bubbles as it can give an indication of whether two variables move in the same magnitude. Gallin (2003) performed both standard cointegration tests at the national level and panel-data cointegration tests at the local level to examine the long-run relationship between property prices and income. For the purpose of the standard tests, he used national data over 27 years and for the panel-data tests he used data of 95 metropolitan areas over a period of 23 years. His results do not support cointegration between prices and fundamentals in either of the methods. From this, he concludes that prices are not related to fundamentals and, thus, error-correction models may be incorrect. Jian Zhou (2010) also analyzes the cointegration relationship between property prices and fundamental indicators. Besides linear cointegration, he tests for nonlinear cointegration for ten American cities. Linear cointegration was only found in one city, whereas six other cities showed nonlinear cointegration applying a two-step approach.

Brunnermeier and Julliard (2007) state that money illusion is the reason for the connection

between inflation and real estate market mispricing because people do not account for inflation when comparing rents and mortgage payments. Money illusion is defined by the incorrect assumption that real and nominal interest rates move in lockstep. They separate price-to-rent ratio movements into two parts: a rational as well as a mispricing part. Their findings show that, in the US and the UK, a great portion of the mispricing component can be explained by inflation and nominal interest rates.

3 Data

The empirical part of this paper deals with the determinants of property prices and with the analysis about whether a bubble is currently forming in 15 advanced OECD economies. Section 3.1 presents potential housing price determinants. Section 3.2 outlines how the hypothesis was constructed. In section 3.2, the sources and the timespan of the data will be described.

3.1 House Price Determinants

As every asset, house price dynamics are driven by several demand and supply factors. Therefore, econometric models of the determinants of supply and demand for real estate, as well as affordability indicators, are used to identify price bubbles. Demand for property and, subsequently, real estate prices are essentially determined by disposable income, mortgage rates, the legal environment and, in the long run, by demographic trends. Supply is among others determined by the availability of land, construction costs, and the profitability of the property. Housing supply is relatively inelastic because it takes time to react to demand and to construct a new property. Therefore, in the short term, a discrepancy between supply and demand is likely to exist – even though in the long-run demand and supply are presumed to be in equilibrium. Consequently, supply is rather fixed in the short run but can adjust in the long term.

According to the fundamental-based explanatory approach for house price bubbles, housing demand and supply are most commonly affected by fundamental determinants:

economic, financial and demographic determinants. Thus, the effect of GDP per capita, inflation, long-term interest rates (mortgage rates), construction costs, current account balances, unemployment, population growth, building permits, tax on property and domestic credit to the private sector on residential housing prices was evaluated.

3.2 Hypothesis Development

To do so, an equation which captures the influence of these variables on property prices was determined:

$$RPPI_{it} = \alpha_0 + ß_1 * GDPPC_{it}(+) + \beta_2 * CPI_{it}(+) + \beta_3 * LTR_{it}(-) + \beta_4 * POP_{it}(+) + \beta_5 * UN_{it}(-) + \beta_6 * CA_{it}(-) + \beta_7 * BP_{it}(+) + \beta_8 * CONST_{it}(+) + \beta_9 * CREDIT_{it}(+) + \beta_9 * TAX_{it}(-) + \mu_{it}$$

where RPPI stands for the Residential Property Price Index, GDPPC for gross domestic product per capita, LTR for the long-term bond yield, POP for the population growth, UN for the unemployment rate, CA for the current account balance, BP for building permits, CONST for the construction cost index, CREDIT for the domestic credit to private sector, TAX stands for the tax rate on property and μ_{it} represents the error term.

The signs in brackets behind each endogenous variable in the above-stated equation specify how housing demand and, hence, prices are influenced by these variables. A plus sign means that an increase in the explanatory variable is expected to lead to a growth in property prices and vice versa. In the following, the influence of each determinant on house prices will be explained in more detail.

GDP growth, disposable income, and unemployment rates are considered important indicators of wealth measurement and economic growth of a country. In our study, GDP per capita is used as a proxy for disposable income. Disposable income mainly determines the payments a household is able to make, thus, defining the affordability of housing. Households with higher income are wealthier and more likely to receive a mortgage because their probability of default is lower. An increase in the population's average income implies an increase in demand and consequently in prices. On the other hand, house prices also affect income since a property

price appreciation signifies a capital accumulation for households. This, in turn, can increase consumption beyond that related to current income.[16]

Given the amount a household can afford, if inflation is high and interest rates are low, this household will accept a higher property price. Deflation, on the contrary, has devastating consequences for homebuyers: the property value and the rental income of indexed leases decline. For the same reason, labor income and, thus, the ability to pay off debts decline. On the other hand, the real value of liability increases dramatically because the mortgage payments stay the same.[17] Financial advisor Max Herbst claims that housing prices often react earlier to changes in inflation because the risk is often prematurely included in the interest rate.[18] It is widely known that, in times of inflation, houses and apartments are often bought as a protection. Correspondingly, housing demand and prices will increase when inflation increases.

In order to account for demographic influences, unemployment and population growth were considered in the analysis. Unemployment drives housing demand and negatively affects house price dynamics. A higher unemployment rate reduces the number of potential homeowners as some people might no longer be able to afford a mortgage. This implies a decline in both housing demand and prices. Besides, higher unemployment implies that, in the long-run, homeowners might not be able to repay their mortgages and, thus, have to sell their properties, leading to a higher supply of housing. Furthermore, the unemployment rate is an indicator of economic growth of an economy. If economic development is expected to worsen, lenders will tighten their credit standards so that some people might no longer be able to receive credit. As result, tightened borrowing conditions reduce demand for housing and contribute to property price decreases. In many countries, lower unemployment rates combined with a steady growth in disposable income over the last years, have driven up housing demand.

In contrast to unemployment, population growth impacts housing demand positively.

16 DiPasquale and Wheaton (1996)
17 Jochims D. (2010)
18 Jochims D. (2010)

Population growth implies that the number of households increases and that the greater need for housing exerts pressure on housing prices.

Current account balances measure a country's foreign trade and are used as an indicator for foreign capital inflows. Greater current account balances reveal a drop of net capital inflows and should, therefore, reduce the pressure on housing prices. The more negative the current account balance, the higher are capital inflows.

In addition to these macroeconomic variables, real estate market factors are expected to affect housing prices. Hence, taxation on property, building permits, construction costs, and mortgage rates are included as explanatory variables in the model. The mortgage rate is a crucial real estate related factor that is influencing property prices. Mortgage rates determine the price of credit. Especially since most households finance their homes via mortgages, the interest rate on the loans will influence their decision as to whether they should lend or buy a property. We will use long-term bond yields to approximate mortgage interest rates of each country. If interest rates decrease, the cost of borrowing becomes less expensive, meaning that the affordability of credit goes up. Easier access to financing will increase housing demand and property prices. The theoretical inverse relationship between house prices and interest rates underlines this association. Another potential property price determinant is money supply. However, the close relation to inflation and interest rates makes it unnecessary to include this variable.

Construction costs and building permits capture the activity in the housing market. Both have a positive impact on the evolution of house prices. Construction costs consist of expenses for material and labor and are one of the main cost elements of a new house. Subsequently, higher construction costs undoubtedly result in higher house prices, reducing the affordability of housing. On the other hand, if construction costs decline, construction activity will expand, increasing the supply of housing. Although this will induce falling house prices in the short run, prices will go up in the long run due to an increase in demand. However, not only construction costs influence housing prices, but housing prices could also affect construction costs. This can

be explained by the fact that higher property prices encourage suppliers and construction workers to request higher prices and wages. This might not necessarily be revealed in house prices immediately or in the short-run, but maybe in the long-run.[19] Another indicator that is supposed to affect house prices is a country's taxation on property which is measured as a percentage of GDP. Including this indicator allows capturing the influence of fiscal policy. An increase in property taxes could change individuals' preferences and behaviors in such a way that demand for housing is reduced. "Favorable depreciation rules will increase the after-tax yield generated by real estate. This will increase the demand to hold real estate assets" (DiPasquale & Wheaton, 1992, p. 192).

As an indicator for mortgage lending standards or the level of development and regulation of the financial sector, domestic credit to private sector as a percentage of GDP was included as an explanatory variable. There exists a positive relation between domestic credit to private sector and house prices. In times when economic outlook remains stable or in times of better growth prospects, lenders expect lower default rates due to improved borrower creditworthiness, leading them to grant more credit and/or to relax credit conditions. This results in a higher volume of credit as well as in price appreciations. However, the relationship can also be interpreted the other way around: higher property prices stimulate future house price expectations and thereby drive up demand for credit. Moreover, increases in property prices lead to growing property values and, accordingly, to greater collateral values homeowners can offer to banks. This, in turn, leads to banks granting credit more easily, which could accelerate the formation of a housing bubble. In the next part, the data sources and data transformation of the above-described variables are explained.

3.3 Dataset

The dataset covers fifteen advanced economies in Europe, namely Germany, France, Italy, Spain, Ireland, Portugal, the Netherlands, Switzerland, Sweden, Denmark, Norway and

19 Chen, M. and Patel, K. (1998)

Finland, as well as the Anglo-Saxon economies, the US and the UK, and Canada. Residential Property Price Indices (RPPIs) were downloaded from Thomson Reuters DataStream from 1970 to 2017, on a quarterly basis. This corresponds to 190 data points per time series, at best. The time series for Germany and the Nordics start in the first quarter of 1973. With only 118 observations (starting in q1 of 1988), the Portuguese property price series is the shortest. Even though the RPPIs are based on quarterly OECD data, a yearly frequency was chosen since the availability of the right-hand side variables in quarterly frequency is limited. Although OECD can be considered a reliable source, residential property data is not easily available on a comparable basis, despite their importance in macroeconomic and financial stability analysis. This is due to the fact that the indices are based on national sources and are thus calculated differently.[20] According to this, it is very important to consider that these time series are not directly comparable between countries. This should be taken into account when interpreting the data. However, this drawback is irrelevant to the following study, as we do not intend to compare countries, but investigate potential transmission channels between price determinants and property prices. The majority of the independent variables were also extracted from Thomson Reuters DataStream. Taxes on property were extracted from the OECD website, credit to private sector as a percentage of GDP were extracted from the World Bank website and the long-term bond yields were extracted from Bloomberg. Unfortunately, due to limited data availability, not all explanatory variables could be extracted for the same timespan as the RPPIs. As the information is going to be pooled in a panel, because we are concerned with the evolution of comparable time series from numerous countries, this is not a serious problem. Besides, we apply the model specification in the log first differences (growth rates) of the variables. One of the advantages associated with year-over-year changes is that they

[20] House price indices correspond generally to seasonally unadjusted series constructed from national data from a variety of public and/or private sources (for example, national statistical services, mortgage lenders and real estate agents). National house price series may differ in terms of dwelling types and geographical coverage (most are country-wide and refer to existing apartments).

automatically neutralize seasonality. Natural-logarithmation enables to interpret the impulse responses as percentage deviations from the long-term equilibrium value. Only unemployment rates and tax on property were not transformed into growth rates. For an overview of the variables please see Table 6.

4 Panel Data Models - Fixed Effects Model

Panel data modeling is a method to estimate data which is both time-series and cross-sectional and which accounts for individual specific heterogeneity. One speaks of a balanced panel if each individual, in our analysis each country, is observed in every period. On the other hand, if some data points are missing in the time series, one speaks of an unbalanced panel. Our sample panel data is unbalanced as each country is not observed in all time periods. The Random Effects model and the Fixed Effects model are the two elementary panel data models. They differ with regard to the individual-specific effects. In the Random Effects model, this effect is a random variable which is uncorrelated with the independent variables whereas it is correlated in the Fixed Effects model.[21] To determine which model is the most consistent, the Durbin-Wu-Hausman test can be applied. Under the null, there is no correlation between the independent variable and the error term and the appropriate model is the Random Effects model, whereas under the alternative, this correlation is statistically significant and the Fixed Effects model is appropriate.[22] If the unobservable factors are time-invariant, then a Fixed Effects regression will eliminate omitted variable bias. Before performing the aforementioned regression models with Stata, the data was organized as panel data in the long form in excel. Then, the correlation between the explanatory variables was analyzed (see Table 1). As no correlation between the variables could be discovered (none of them had a value over 0.80), all of them were kept in the regression model. In the next step, the Random Effects model and the Fixed Effects model were performed, followed by the Hausman Test. Unfortunately, the model fitted on these data

21 Schmidheiny K. (2016)
22 Karlsson S. (2014), p. 11

failed to meet the asymptotic of the Hausman test, resulting in no outcome about whether the Random or the Fixed Effects model would better fit the data. In panel data models with fixed effects, the estimate is based on the unobserved individual-specific influencing factors. This increases the number of parameters to be estimated according to the number of individuals. The precedent condition for this regression being that you have a time series and, at the same time, within each cross-section time variation. As the name implies, this model controls for the average differences across the countries, it fixes the average effects of each country in any unobservable or observable predictors. Each of the variables contained in the equation is subtracted from the respective individual-specific mean values. The within-transformation thus eliminates the individual effects, since they are time-invariant. The transformed equation can then be estimated using OLS. In the basic Fixed Effects model, the effect of each predictor variable (i.e., the slope) is assumed to be identical across all the groups, and the regression merely reports the average within-group effect. Thus, the across-group action is being eliminated whereas the within-group action is kept. As result, the problem of omitted variable bias can be significantly reduced.[23] The advantage of this approach is that the unobserved individual effects may be correlated with the influencing factor contained in the model. Moreover, in contrast to the Random Effects model, the Fixed Effects model allows for endogeneity.[24] This seems to be more realistic in our model because the direction of causality is very dubious for some explanatory variables. Accordingly, house prices affect some of the independent variables as well – and not just the other way around as it would be the case for the random effects model. For instance, as already explained in section 3, higher housing prices can lead to higher construction costs. On the basis of these facts, the Fixed Effects model is preferred over the Random Effects model in the analysis of house price determinants.

In Stata, we first loaded the panel data using the command *xtsset*. Subsequently, three Fixed

23 Dranove D. (2012), p. 9
24 Dranove D. (2012), p. 2

Effects regressions were performed which vary in the way the explanatory variables were included. We regressed the explanatory variables on the RPPIs of the same period, then on the lags, and finally on both using the command *xtreg* with the option of robust standard errors and year dummies. Robust standard errors were added in order to handle the problem of heteroscedasticity and autocorrelation in the idiosyncratic errors. Serial correlation of idiosyncratic errors is common when the number of time periods exceeds two.[25] In case serial correlation is present in the Fixed Effects model, the standard errors are severely understated.[26] Moreover, it is likely that all countries are, in the same way, affected by time-specific effects. Therefore, in order to account for aggregate trends, the dummies for each year were included. The first regression which included the contemporaneous changes of the explanatory variables relies on the assumption that house prices react immediately to shocks - based on the fact that asset prices should react immediately to new arriving information. However, there are some reasons why lags of the right-hand side variables could better explain the evolution of property prices. First, house prices are most likely delayed in responding to changes in the macroeconomic environment. Second, in terms of the aforementioned direction of causality, some endogenous variables might follow house price increases. In addition, previous year's house prices most likely affect the expectations of market participants regarding future prices, which can influence demand and housing prices. This is why, in the second regression, all explanatory variables enter the equation with their preceding values. In the third step, a mixture of the first and the second estimation was chosen: the right-hand variables entered both in contemporaneous changes and in changes lagged once.

25 Schmidheiny K. (2016), p. 9
26 Bertrand, Duflo and Mullainathan (2004), p. 18

4.1 Estimation Results of the Fixed Effects Model

Table 3: Results Fixed Effects - Regression 1(contemporary specification)

```
. xtreg ln_RPPI ln_GDPPC ln_LTR ln_CPI ln_POP ln_CONST ln_UNEMP ln_CA ln_BP ln_Credit ln_TAX i.YEAR, fe vce(robust)

Fixed-effects (within) regression               Number of obs      =       211
Group variable: id                              Number of groups   =        14

R-sq:  within  = 0.6639                         Obs per group: min =        11
       between = 0.6119                                        avg =      15.1
       overall = 0.6309                                        max =        19

                                                F(13,13)           =         .
corr(u_i, Xb)  = -0.2613                        Prob > F           =         .

                                  (Std. Err. adjusted for 14 clusters in id)
------------------------------------------------------------------------------
             |               Robust
      ln_RPPI |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    ln_GDPPC |   .0766672    .189733     0.40   0.693    -.333226    .4865603
      ln_LTR |   .0061682   .0129292     0.48   0.641   -.0217637    .0341001
      ln_CPI |   .1695346   .5716349     0.30   0.771   -1.065408    1.404477
      ln_POP |   .5504842   1.177061     0.47   0.648   -1.992401     3.09337
    ln_CONST |   .9157733   .2340173     3.91   0.002    .4102096    1.421337
    ln_UNEMP |  -.3803043   .2143791    -1.77   0.099   -.8434423    .0828337
       ln_CA |   .0944614   .1434047     0.66   0.522   -.2153456    .4042684
       ln_BP |   .1614272   .0286315     5.64   0.000    .0995726    .2232817
   ln_Credit |   .0000984   .0165493     0.01   0.995   -.0356542    .0358511
      ln_TAX |  -1.282861   2.031527    -0.63   0.539   -5.671707    3.105985
             |
        YEAR |
        1991 |    .126137   .0252913     4.99   0.000    .0714985    .1807755
        1992 |   .1057414   .0197402     5.36   0.000    .0630954    .1483874
        1993 |   .0553076   .0182824     3.03   0.010    .0158109    .0948042
        1994 |   .0705606   .0247602     2.85   0.014    .0170694    .1240518
        1995 |   .0336897   .0229974     1.46   0.167   -.0159931    .0833725
        1996 |   .0260703   .0195511     1.33   0.205   -.0161672    .0683078
        1997 |   .0384977   .0322201     1.19   0.253   -.0311095    .1081048
        1998 |   .0572532   .0338625     1.69   0.115   -.0159022    .1304086
        1999 |   .0464174   .0218183     2.13   0.053   -.0007182     .093553
        2000 |   .0597104   .0304083     1.96   0.071   -.0059827    .1254036
        2001 |   .0248893   .0244565     1.02   0.327   -.0279459    .0777244
        2002 |    .065469   .0220569     2.97   0.011     .017818     .11312
        2003 |   .0510907   .0195391     2.61   0.021     .008879    .0933025
        2004 |   .0553986    .024258     2.28   0.040    .0029923    .1078049
        2005 |    .065506    .027933     2.35   0.036    .0051604    .1258516
        2006 |   .0498411   .0185694     2.68   0.019    .0097243     .089958
        2007 |    .046581   .0223187     2.09   0.057   -.0016356    .0947976
        2008 |  -.0189857   .0170304    -1.11   0.285   -.0557777    .0178063
        2009 |   .0828499   .0194101     4.27   0.001    .0409169    .1247829
        2010 |   .0156487   .0184752     0.85   0.412   -.0242646     .055562
        2011 |  -.0029778   .0209805    -0.14   0.889   -.0483033    .0423478
        2012 |   .0447304   .0183918     2.43   0.030    .0049973    .0844634
        2013 |   .0495775   .0184903     2.68   0.019    .0096317    .0895233
        2014 |   .0608949   .0307421     1.98   0.069   -.0055193    .1273091
        2015 |   .0363553   .0289441     1.26   0.231   -.0261745    .0988851
             |
       _cons |   .0130231   .0400336     0.33   0.750   -.0734643    .0995105
-------------+----------------------------------------------------------------
     sigma_u |  .02008717
     sigma_e |  .03835746
         rho |  .21522116   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Table 4: Results Fixed Effects –Regression 2 (only lags)

```
. xtreg ln_RPPI L.ln_GDPPC L.ln_LTR L.ln_CPI L.ln_POP L.ln_CONST L.ln_UNEMP L.ln_CA L.ln_BP L.ln_Credit L.ln_TAX i.YEAR,
>  fe vce(robust)

Fixed-effects (within) regression               Number of obs      =       211
Group variable: id                              Number of groups   =        14

R-sq:  within  = 0.5938                         Obs per group: min =        11
       between = 0.2193                                        avg =      15.1
       overall = 0.4044                                        max =        19

                                                F(13,13)           =         .
corr(u_i, Xb)  = -0.5106                        Prob > F           =         .

                                    (Std. Err. adjusted for 14 clusters in id)
```

ln_RPPI	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_GDPPC						
L1.	.0994669	.1981841	0.50	0.624	-.3286838	.5276177
ln_LTR						
L1.	-.0491058	.0144504	-3.40	0.005	-.080324	-.0178877
ln_CPI						
L1.	.5204956	.5136262	1.01	0.329	-.5891263	1.630118
ln_POP						
L1.	-1.076389	1.116073	-0.96	0.352	-3.487518	1.334741
ln_CONST						
L1.	.8805174	.2636032	3.34	0.005	.3110373	1.449998
ln_UNEMP						
L1.	-.1385451	.2672731	-0.52	0.613	-.7159535	.4388633
ln_CA						
L1.	.2504219	.1675338	1.49	0.159	-.1115129	.6123567
ln_BP						
L1.	.0797259	.0236571	3.37	0.005	.0286178	.130834
ln_Credit						
L1.	-.009972	.0237874	-0.42	0.682	-.0613615	.0414175
ln_TAX						
L1.	-2.714522	1.783656	-1.52	0.152	-6.567877	1.138833
YEAR						
1992	.0390316	.0274809	1.42	0.179	-.0203373	.0984006
1993	-.0342337	.0169632	-2.02	0.065	-.0708804	.002413
1994	-.0201751	.0174579	-1.16	0.269	-.0578906	.0175405
1995	-.0733472	.0245411	-2.99	0.010	-.1263649	-.0203294
1996	-.0662145	.0229362	-2.89	0.013	-.1157652	-.0166638
1997	-.0755389	.0341893	-2.21	0.046	-.1494005	-.0016774
1998	-.0702318	.0229242	-3.06	0.009	-.1197566	-.020707
1999	-.0171143	.0160817	-1.06	0.307	-.0518567	.0176281
2000	-.0294328	.0249376	-1.18	0.259	-.0833072	.0244417
2001	-.0621658	.0183219	-3.39	0.005	-.1017478	-.0225837
2002	-.0239515	.0219598	-1.09	0.295	-.0713928	.0234897
2003	-.0491384	.015559	-3.16	0.008	-.0827517	-.0155252
2004	-.0161835	.0207175	-0.78	0.449	-.060941	.028574
2005	-.0308171	.0254849	-1.21	0.248	-.0858738	.0242396
2006	-.0233107	.021015	-1.11	0.287	-.0687108	.0220894
2007	-.0560091	.0163699	-3.42	0.005	-.0913742	-.0206441
2008	-.1306213	.0213539	-6.12	0.000	-.1767535	-.084489
2009	-.0768814	.0184292	-4.17	0.001	-.1166952	-.0370675
2010	-.0074872	.0124329	-0.60	0.557	-.0343468	.0193724
2011	-.1041173	.0249719	-4.17	0.001	-.1580657	-.0501689
2012	-.107338	.0142848	-7.51	0.000	-.1381983	-.0764776
2013	-.0612839	.007409	-8.27	0.000	-.07729	-.0452778
2014	-.0056481	.0151506	-0.37	0.715	-.0383789	.0270827
2015	-.0630803	.0123711	-5.10	0.000	-.0898065	-.036354
2016	-.0303375	.0214211	-1.42	0.180	-.0766149	.0159399
_cons	.1147588	.0481078	2.39	0.033	.0108282	.2186893
sigma_u	.03646454					
sigma_e	.04108312					
rho	.44065254	(fraction of variance due to u_i)				

Table 5: Results Fixed Effects – Regression 3 (contemporary specification and lags)

```
. xtreg ln_RPPI ln_GDPPC ln_LTR ln_CPI ln_POP ln_CONST ln_UNEMP ln_CA ln_BP ln_Credit ln_TAX L.ln_GDPPC L.ln_LTR L.ln_CP
> I L.ln_POP L.ln_CONST L.ln_UNEMP L.ln_CA L.ln_BP L.ln_Credit L.ln_TAX i.YEAR, fe vce(robust)

Fixed-effects (within) regression               Number of obs      =       195
Group variable: id                              Number of groups   =        14

R-sq:  within  = 0.7548                         Obs per group: min =        10
       between = 0.3166                                        avg =      13.9
       overall = 0.5294                                        max =        18

                                                F(13,13)           =         .
corr(u_i, Xb)  = -0.5244                        Prob > F           =         .

                                  (Std. Err. adjusted for 14 clusters in id)
```

ln_RPPI	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_GDPPC	-.0740623	.1635829	-0.45	0.658	-.4274616	.2793371
ln_LTR	-.0002123	.0128494	-0.02	0.987	-.0279717	.027547
ln_CPI	.3105768	.4613965	0.67	0.513	-.6862098	1.307363
ln_POP	.7174751	.9155906	0.78	0.447	-1.260538	2.695488
ln_CONST	.5772573	.2349851	2.46	0.029	.0696029	1.084912
ln_UNEMP	-1.505477	.6981578	-2.16	0.050	-3.013755	.0028015
ln_CA	-.1303263	.1622584	-0.80	0.436	-.4808642	.2202117
ln_BP	.1406704	.0185181	7.60	0.000	.1006645	.1806763
ln_Credit	.0214921	.0183743	1.17	0.263	-.0182032	.0611873
ln_TAX	-.3636031	1.550102	-0.23	0.818	-3.712395	2.985188
ln_GDPPC						
L1.	.0696876	.2179082	0.32	0.754	-.4010744	.5404496
ln_LTR						
L1.	-.0539598	.014065	-3.84	0.002	-.0843453	-.0235743
ln_CPI						
L1.	.041589	.5083321	0.08	0.936	-1.056596	1.139774
ln_POP						
L1.	-.3274621	.9572856	-0.34	0.738	-2.395552	1.740628
ln_CONST						
L1.	.4567609	.279864	1.63	0.127	-.1478486	1.06137
ln_UNEMP						
L1.	1.303705	.6139768	2.12	0.053	-.0227115	2.630121
ln_CA						
L1.	.1595727	.1093384	1.46	0.168	-.0766384	.3957839
ln_BP						
L1.	.0347053	.0266955	1.30	0.216	-.0229668	.0923775
ln_Credit						
L1.	-.0161461	.0171439	-0.94	0.363	-.0531833	.0208911
ln_TAX						
L1.	-3.369726	1.366886	-2.47	0.028	-6.322704	-.4167484
YEAR						
1992	.2564616	.1122045	2.29	0.040	.0140585	.4988648
1993	.0532433	.0680977	0.78	0.448	-.0938728	.2003594
1994	.0551385	.0689681	0.80	0.438	-.093858	.204135
1995	.0519641	.0690932	0.75	0.465	-.0973026	.2012308
1996	.0050978	.073207	0.07	0.946	-.1530562	.1632518
1997	-.0098505	.0724252	-0.14	0.894	-.1663155	.1466145
1998	.0241569	.0807367	0.30	0.770	-.1502642	.198578
1999	.0441423	.0695663	0.63	0.537	-.1061464	.1944311
2000	.0464483	.0733929	0.63	0.538	-.1121074	.2050041
2001	.0022196	.0813555	0.03	0.979	-.1735383	.1779775
2002	.0658796	.0635805	1.04	0.319	-.0714776	.2032369
2003	.0319561	.0766389	0.42	0.684	-.1336121	.1975243
2004	.0525762	.0801363	0.66	0.523	-.1205478	.2257002
2005	.0460703	.0903352	0.51	0.619	-.1490871	.2412276
2006	.0301675	.0802002	0.38	0.713	-.1430946	.2034295
2007	.0272814	.074868	0.36	0.721	-.1344612	.189024
2008	-.0416506	.0701682	-0.59	0.563	-.1932398	.1099387
2009	.0582195	.0803716	0.72	0.482	-.1154127	.2318517
2010	.0382774	.0632987	0.60	0.556	-.0984711	.1750259
2011	-.031547	.0717973	-0.44	0.668	-.1866556	.1235617
2012	.0020756	.0767421	0.03	0.979	-.1637156	.1678667
2013	.0230111	.0709011	0.32	0.751	-.1301615	.1761837
2014	.0564114	.0719637	0.78	0.447	-.0990566	.2118795
2015	-.0167169	.0763806	-0.22	0.830	-.1817272	.1482934
_cons	.061137	.0628441	0.97	0.348	-.0746293	.1969034
sigma_u	.03921132					
sigma_e	.03400572					
rho	.57074054	(fraction of variance due to u_i)				

Table 3, 4 and 5 display the Fixed Effects regression outputs. We find that construction costs and building permits are an especially strong predictor of property price increases. In the first regression, construction costs, building permits (both at a 1% confidence level) and unemployment (at a 10% confidence level) were statistically significant. More precisely, the results were as follows: An increase in the growth rate of log construction costs of 1%, would lead to an increase in log house price growth rates of around 0.92%, respectively, holding all other variables constant. This seems reasonable since one of the main price determinants of properties is the cost of construction. A 1% increase in the growth rate of log building permits would lead to a 0.16% increase in log house price growth rates, respectively. A 1% increase in log unemployment rates would lead to a decrease of around 0.38% in log house price growth rates. The regression explains 66.39% of the within variation.

In the regression that only contained lags of the independent variables, construction costs, building permits and mortgage rates were statistically significant. This regression explains less of the within variation than the previous regression, specifically 59.39%. According to the results, a 1% increase in the previous year's long-term interest rate is associated with a 0.05% decrease in log property price growth rates. If mortgage rates are increasing, the number of households that can afford housing is decreasing and thus demand and property prices decrease. A 1% increase in log construction cost growth rates would lead to an increase in log property price growth rates of 0.88% in the following year. Comparing this result with the one from the first regression, we can see that the impact of previous year's construction costs on current prices is less strong than the impact of current construction costs. Furthermore, a 1% increase in growth rates of log building permits is associated with a 0.08% increase in the growth rate of log property prices in the forthcoming year. Even though building permits have a very small impact on prices, it can be observed that the building permits of the previous year affect current

housing prices a little more. This was expected as it probably takes a while to start building a new house and until the additional building permits are reflected in the prices.

The explanatory variables included in the last regression were able to explain 75.48% of the within-variation of housing prices. Thereby, this model explained house price dynamics more precisely compared to the previous two regression models. We find evidence that construction costs, building permits, unemployment rates as well as the lag of unemployment rates, the lag of mortgage rates, and the lag of the taxation on property were statistically significant. A 1 % increase in log unemployment rates would lead to a decrease in log housing price growth rates of 1.51%, whereas an increase in last year's unemployment rate by the same amount would lead to an increase of 1.30%. This regression output is questionable because we expected last year's unemployment rate to have a negative effect on property prices. A 1% increase in the growth rate of log building permits leads to a 0.14% increase in log housing price growth rates. A 1% increase in the log long-term interest growth rates would lead to a 0.05% decrease in prices in the following year. Taxes on property seem to exercise a quite strong impact on prices: a 1% increase in the log tax rate is associated with a 3.37% decrease in log housing price growth rates in the following year.

It is striking that primarily real estate market indicators such as construction costs, building permits and mortgage rates influence housing prices. However, we expected mortgage rates to have a greater impact. Maybe this small influence could be explained by the fact that institutional investors have greater bargaining power and, therefore, influence prices to a greater degree than private investors who greatly depend on mortgage rates to finance their acquisitions. Furthermore, the importance of funds is steadily increasing and for the fund industry, institutional investors such as insurance companies or pension funds are far more important than private investors. Currently, real estate funds find themselves in a dilemma: they are getting too much money from investors and, at the same time, they can hardly find profitable

assets to invest in.[27] The development of the fund industry may be one of the reasons why lending rates, which are primarily of interest to private investors, have relatively little or no impact on real estate prices. Moreover, as these funds possess many equity commitments, we believe that they might be willing to pay prices that are not justified by market fundamentals. The fact that the majority of the macroeconomic factors are not statistically significant might indicate that, compared to a few years or decades ago, when several analysis found evidence of the statistical significance of these factors, they may not explain as many of the deviations of housing prices anymore. Instead, speculation and expectations of market participants might play a bigger role in addition to real estate market factors.

5 Indicators

As the first indicator of an overvaluation of housing prices one usually looks at the development of the property prices as well as Price-to-Rent (PRR) and Price-to-Income ratios (PIR). Residential Property Prices Indices (RPPIs), also known as House Price Indices (HPIs), are index numbers that measure the price of residential properties over time. Besides being used by citizens and households, these broadly used key statistics also assist to display risk exposure of the financial sector and macroeconomic imbalances for economic and monetary policymakers. This is due to the fact that, as aforementioned, turmoil on real estate markets can have far-reaching consequences. For the valuation of properties, discounted cash flow methods are mainly used. Accordingly, the discounted future cash flows, rents, define the real estate value.[28] Respectively, rents and property prices are closely linked to one another. Hence, the PPRR is one important criterion for the identification of the valuation level and of a speculative price bubble on property markets.[29] The ratio sets the development of housing prices in relation to the development of rental prices and is thus a benchmark that helps to understand whether is it

27 Karl, P. (2017)
28 DiPasquale and Wheaton (1992)
29 Geltner et al. (2007), p. 14

better to buy or to rent a property. In other words, it measures the profitability of owning a house. The PRR is a widespread concept which is decisive both for the future disbursed payment flows and the market price of a property. Another indicator of overvalued house prices is the Price-to-Income Ratio which sets nominal house prices in relation to nominal household disposable income per capita. It is used as a measure of affordability.

Figure 1 shows the evolution of RPPIs in our sample set of countries. It can be observed that housing prices in Norway, Sweden, the UK and Canada are currently extremely high (Index Q2 2017 Norway = 496.75, Index Q1 2017 Sweden = 458.20, Index Q2 2017 UK = 388.59, Index Q2 2017 Canada = 369.84). The development of prices in Germany, Portugal, and Switzerland was quite flat over the period, even after the bursting of the US subprime bubble. On the contrary, the RPPIs in the Nordics grew strongly and steadily since 1995, except Denmark's prices which experienced a drop after 2007.

Although price indices have moved quite similarly on a first glance, a quite mixed can be observed when looking at average returns and volatility of RPPIs picture across countries over the sample period (see Table 2). Whereas the average growth rate for countries like Spain, UK and Ireland stood at 8.95%, 8.75% and 8.21%, respectively, countries like Portugal, Switzerland and Germany only experienced an average annual growth rate of 3.54%, 3.37% and 2.29%, respectively. A similar picture can be observed when looking at volatility: the indices vary from 7.95% in Ireland to 1.85% in Germany. It is to be expected that countries which experienced housing price bubbles – defined by a sharp increase in housing prices followed by a sharp bust - such as Ireland, the UK or Spain have high average returns and relatively high volatilities.

As aforementioned, house price increases alone do not indicate an unjustified fundamental property value. They have to be examined along with rents and income. Therefore, the price-to-rent and price-to-income ratios were retrieved from Thomson Reuters DataStream for the sample countries. Figure 3 and 4 show the evolution of standardized PRRs and PIRs in our

sample countries. Standardized means that the two measures are indexed to a reference value equal to 100 over the full sample period. Thus, both ratios are displayed relative to their respective long-term averages. In case that PRR and PIR exceed their long-term averages, property prices have been increasing faster than rents and income. This is a sign of possible pressures in the housing markets. Correspondingly, the imbalance between rents and property prices signals overvaluation and the potential presence of a house price bubble.[30] The graphics (Figure 3 and 4) give a first impression of the common dynamics of real estate prices in these countries. It can be observed that, in most countries, the ratios stay well above their reference value indicating that prices have grown faster than incomes and rents in a number of countries. Often, people interpret sustained periods of high or above reference price-to-rent and/or price-to-income ratios as an indication of unrealistic expectations of future price increases rather than being caused by the fundamental value - and hence believe in a bubble. Not only the RPPIs of Canada, Norway and Sweden have been increasing for a long period, but also their PRRs have been experiencing a sharp increase since 2009 with a current value of around 170, followed by the UK with a value of 138 in 2016. These are also the countries with the highest PIRs in 2016. Even if the price-to-income ratios of Portugal, Germany, US and Finland have been growing in recent years, they still remain below their long-term average. Portugal's and Italy's price-to-rent ratios are currently below their reference values, Germany's and Switzerland's price-to-rent ratio have been increasing since 2009 and passed the threshold in 2016 and 2013. As result, RPPIs, PRRs and PIRs indicate an overvaluation, primarily in the Norwegian, the Swedish, the Canadian and in the British property market. Yet, even though price-to-income and price-to-rent ratios are valuable in providing information on the development of housing prices, they suffer from limitations. Only if the expected inflation, the expected nominal long-term interest rate and the long-term growth rate of the economy do not change over time, a stable ratio can

30 Rombach (2011), p. 231-233

be expected.[31] Because this is difficult to be certain about, these indicators might not always be reliable in detecting a bubble and should, therefore, be interpreted carefully. Looking solely at house price developments, PRR and PIR will not be sufficient to understand if house prices are too high compared to their fundamental values, and to be able to claim that in some of the countries a bubble might be forming.

6 Analyzation method for the detection of housing bubbles: Rolling ADF Test

For a more comprehensive analysis on whether the 15 OECD economies are experiencing price increases that are not justified by fundamentals, a Right Tailed Augmented Dickey-Fuller (RTADF) test was performed. RTADF unit root tests have become a popular method for detecting asset price bubbles. This type of model tests the null hypothesis of a unit root against the alternative of a (mildly) explosive process:

$$H_0: \delta = 1$$

$$H_A: \delta > 1$$

Empirically, rejecting the null may provide proof for a property price bubble. The empirical analysis of the price level is carried out with the help of the econometrics software EViews. Since only the normal left-side unit root tests count as basic features of EViews, an add-in must be installed to apply the RTADF tests. There are four variations of the RTADF unit root test: the standard ADF test, a rolling window ADF (RDAF) test, the more recent PWY supremum ADF (SADF) test and the PSY generalized SADF (GSADF) test. Similar to left-sided unit root tests, the analysis results of these tests are significantly influenced by the consideration of a constant or deterministic trend in economic time series. Consequently, the determination of the underlying model is of crucial importance for the validity of the test procedure. Phillips et al. (2013) argue that the inclusion of both a constant drift parameter and a deterministic trend is empirically unrealistic.[32] The same suggestion was made by Chong and Hurn (2016) which also

31 Himmelberg, Mayer, Sinai (2005), p. 17
32 Pedersen/Schütte (2014), p. 32-33

recommend a model without a constant or trend. However, opinions as to which of the four RTADF tests to favor differ. For example, while Chong and Hurn's (2016) results speak for the superiority of the RADF method over the SADF and GSADF method, Diba and Grossman (1988a) favor the GSADF test. Due to the extremely long computation time of the critical GSADF test statistics in EViews, the RADF test was chosen. The normal ADF test is repeatedly performed when choosing a Rolling ADF test and each of them is applied to a different sub-sample size so that an adaptation of the lag length of each subsample is needed. A fixation of the number of lags would not be optimal. Against this background, when deciding upon the lag length, *MSIC* was chosen in EViews as lag length selection criteria and the number of lags was set to automatic selection, for more consistent lag length estimates.[33] Critical t-values are determined by a Monte Carlo simulation with 1000 repetitions at a 95% confidence level. The initial window size was the one proposed by EViews.[34] The advantage of the RADF test is that it is able to capture multiple price bubbles due to the estimation of multiple ADF tests for different sub-samples.

6.1 Results RADF Test

The RADF test results for the quarterly RPPIs of the 15 OECD countries between 1970Q1 and 2017Q1 provide evidence for price bubbles in some of these real estate markets. Figure 4 shows the graphical test results of the RADF tests, where the green line represents the house price evolution, the blue line the test statistic and the red line the critical value sequence for a 95% significance level. If the blue line lies above the critical value sequence, we view this as an indication for overvalued housing prices. In a few countries, especially in Canada, Sweden, Norway, Germany, Switzerland, the UK, and the US, the outcomes are thus suggestive of a bubble.

Canada's house prices are since 1998 above the critical value sequence for a 95% significance

33 Pedersen and Schütte (2014), p. 35-36
34 Caspi I. (2017)

level. The test statistic (blue line) dropped sharply after the crisis and increased strongly in 2015. A similar picture can be observed in Sweden. The country's prices are since 1998 above the critical line and also experienced a huge drop in 2007, before increasing in 2014. Norway's house prices remain above the line for a long time but are always pretty close to it. Moreover, Norwegian prices seem to be quite volatile. Even though the outcomes show that Finland's house prices were overvalued since 1998, they are now almost fairly priced. In contrast to many other countries in the sample, Germany did not experience a drop in 2007. German prices increased since 2006 and are now pretty far above the critical line. Additionally, the price movement seemed relatively smooth until 2002 and has become more volatile ever since. After the decrease in property prices in 2007, prices in the US and the UK increased around 2013 and show overvaluation since 2015. Although Switzerland's property prices display overvaluation since 2003, they have been moving towards 'fair pricing' since 2012. Portugal's house prices showed no sign of overvaluation until the first quarter of 2017 but it appears like they soon will. The other countries such as Spain, the Netherlands, Italy, Denmark and France showed no sign of overvaluation as of the beginning of 2017.

In contrast to Chen and Funke (2013), who applied a GSADF test to examine the German housing market between 1987 and 2012 and who could not find evidence of house price bubbles, our test results show overvaluation from 1990 until approximately 2000.

André Anundsen (2016) analyzed imbalances on the US, the Norwegian and the Finnish housing market by considering an ADF regression on log price-to-rent ratios including four lags and a deterministic trend. The results demonstrate that, in the early 2000s, the US property market transformed into a bubble regime until 2006, whereas the other Nordic markets did not show any sign of explosive behavior. Our test results, however, indicate that Norway's housing market has been experiencing overvaluation for several years. This might indicate that the regression results as to whether or not a country or a city is experiencing a housing bubble may

differ depending on the regression model and the options (number of lags, the inclusion of trend or constant, etc.) chosen. Further, existing literature differs regarding the time series examined: some studies consider house prices whereas others consider price-to-income or price-to-rent ratios.

7 Conclusion

The objective of this work was to investigate the price dynamics on European and North American real estate markets and whether, in this context, a real estate price bubble can be empirically demonstrated. There is still no uniform opinion on a scientifically based definition of the price bubble phenomenon. Yet, a bubble is often defined as a situation in which the market price of an asset rises far above its long-term fundamental value, which is the present value of the anticipated rents.

The development of property prices as well as of Price-to-Rent (PRR) and Price-to-Income ratios (PIR) can give a first insight into the valuation level of property prices. The PRR is a measure of profitability of owning a house and the PIR is a measure of affordability. In most countries the standardized ratios stay well above their reference value, indicating that prices have grown faster than incomes and rents. This is often interpreted as an indication of unrealistic expectations of future price increases or of a house price bubble. We could observe that property prices in the sample countries have been increasing over the recent years, especially in Norway, Sweden, Canada, and the UK the Indices are extremely high. This is in line with the findings for PRRs and PIRs: Norway, Canada, Sweden and the UK have the highest ratios. These extremely high conventional measures that are well above their long-term average indicate that these countries are experiencing price increases that are no longer justified by rents and income. We conclude that property prices in these countries are most likely overvalued.

The main objective of the first part of the empirical section was to identify determinants of property prices by applying the Fixed Effects model. This panel methodological framework explores the relationship between residential property prices and macroeconomic variables such as GDP per capita, current account balance, inflation, unemployment, population growth, domestic credit to private sector, mortgage rates, construction costs, building permits and tax on property for a sample of 15 OECD economies between 1970 and 2016. According to the results, real estate market factors such as construction costs, building permits and mortgage rates and tax on property classified as statistically significant determinants of property prices. With the exception of unemployment rates, most macroeconomic factors are not statistically significant. This could result from the fact that speculation and expectations of market participants might nowadays play a bigger role compared to fundamentals. And this, in turn, is associated with a higher risk of a bubble formation.

Following the analysis of key bubble indicators, a Rolling Augmented Dickey-Fuller test was used to examine the house price dynamics in order to find evidence of possible house price exaggerations. From the outcomes of the RADF, it follows that house prices were misaligned in Canada, Sweden, Norway, Switzerland, Germany, the UK, and the US in the first quarter of 2017, signifying possible bubble behavior.

To sum up, according to the RPPIs, PRRs and PIRs, we find evidence of unjustified house price increases in Norway, Sweden, Canada, and the UK. According to the RADF test, Switzerland, Germany and the US are showing evidence of house price overvaluation in addition to Norway, Sweden, Canada and the UK.

Even though indicators and the empirical test results display that property prices in some countries might no longer be justified by fundamentals, this needs to be interpreted carefully. The current macroeconomic situation is very good and the conditions –an inflation rate below

the target, very low interest rates, income growth, population growth and a reduction in the unemployment rates - speak in favor of rising prices.

In addition, econometric methods aiming at the justification of property price determinants and of house price bubbles face multiple limitations and drawbacks: Unfortunately, high-quality real estate data for international comparison is scarcely available. Unlike liquid assets such as equities, it is not easy to find a suitable price index for real estate. It is especially difficult to price real estate because properties are very heterogeneous. Furthermore, the frequency of trading is quite low. House price series are usually constructed from national data sources, so that these series may differ in terms of dwelling types and geographical coverage. Moreover, Himmelberg (2005) found evidence that price dynamics on property markets are a local phenomenon. Hence, certain countries might not indicate a bubble even though some cities might, in fact, be overvalued – and it might, therefore, be difficult to make a judgment about a country as a whole. Also, changes in fundamentals might have a different effect on countries or cities. Price-to-rent and price-to-income ratios should be carefully interpreted since prices are more sensitive to interest rate fluctuations and will be higher relative to rents when housing supply is rather inelastic. Besides, it is problematic to discover regularities in the formation of bubbles using econometric methods because bubbles are rather rare. Last but not least, a bubble is only identified as a bubble after it bursts.

References

Adelino M. (2014). House Prices, Collateral and Self-Employment.

Agnello L. and Schuknecht L. (2009). Booms and Busts in Housing Markets, Determinants and Implications. European Central Bank, Working Paper Series.

Arentz O., Eekhoff J., Wolfgramm C. (2010). Zur Finanzmarktkrise: Die Rolle der Immobilienbewertung. IWP Discussion Paper No. 2010/1,

Anundsen A.K. (2015). Econometric Regime Shifts and the US Subprime Bubble. Journal of Applied Econometrics, 30, pp.145-169.

Anundsen A.K. (2016). Detecting imbalances in house prices: What goes up must come down? Working Paper, 2016-11, Norges Bank. R&R in Scandinavian Journal of Economics.

Bertrand M., Duflo E. and Mullainathan S. (2004). How much should we trust differences-in-differences estimates?.

Brueckner, J.K., Calem, P.S. and Nakamura, L.I. (2011). Subprime Mortgages and the Housing Bubble. Research Department Federal Reserve Bank of Philadelphia.

Brunnermeier, Markus K., and Juillard, C. (2007). Money Illusion and Housing Frenzies. The Review of Financial Studies 21.

Case, K.E, and Shiller, R.J. (1989). The efficiency of the market for single-family homes. The American Economic Review, 79(1), pp. 125–137.

Case, K.E., and Shiller, R.J. (1990). Forecasting prices and excess returns in the housing market. Real Estate Economics, 18(3), pp. 25327.

Case, K.E.; Shiller, R.J. (2003): Is There a Bubble in the Housing Market? in: Brookings Papers on Economic Activity, Issue 2, p. 299-362.

Caspi, I. (2017) (forthcoming). Rtadf: Testing for Bubbles with EViews. Journal of Statistical Software, Volume 81.

Chen and Funke (2013). Renewed Momentum in the German Housing Market: Real-Time Monitoring of Boom vs. Bubble.

Chen, M.-C. and Patel, K. (1998). House Price Dynamics and Granger Causality: An Analysis of Taipei New Dwelling Market. International Real Estate Review, vol.1, issue 1, pp. 101-126.

Chong, J. and Hurn, A.S. (2016) Testing for Speculative Bubbles: Revisiting the Rolling Window.

Coleman IV M., LaCour-Little M., Vandell K.D. (2008). Subprime Lending and the housing bubble: Tail wags dogs?. Journal of Housing Economics 17, pp. 272-290.

Demary, M. (2008). Die ökonomische Relevanz von Immobilienpreisschwankungen, in: IW-

Trends, 35.Jg., No. 4/2008, pp. 1-14.

Diba, B.T., and Grossman, H.I. (1988a). Explosive Rational Bubbles in Stock Prices?. The American Economic Review, Vol. 78, pp. 520-530.

DiPasquale, D. and Wheaton, W.C. (1992). Journal of the American Real Estate and Urban Economics Association, V20, pp. 181-197.

Dranove, D. (2012). Practical Regression: Fixed Effects Models KTN Fixed Effects. Kellogg School of Management, Northwestern University

Engle, R. F., and Granger, C.W.J. (1987). Co-integration and Error Correction: Representation, Estimation, and Testing. Econometrica, Vol 55, pp. 251-276.

Gallin, J. (2003). The Long-Run Relationship between House Prices and Income: Evidence from Local Housing Markets. Real Estate Economics, 34(3), pp. 417–438.

Gallin, J. (2008). The long-run relationship between house prices and rents. Real Estate Economics, 36(4), pp. 635–658.

Geltner et al. (2007). Commercial Real Estate Analysis and Investments. p. 14.

Gengenbach C., Palm F.C., Urbain J. (2008). Panel Unit Root Tests in the Presence of Cross-Sectional Dependencies: Comparison and Implications for Modelling.

Glaeser, Edward L.; Gyourko, Joseph; Saiz, Albert (2008): Housing supply and housing bubbles. In Journal of Urban Economics, Vol. 64 (2), pp. 198–217.

Green R.K, Malpezzi S., Mayo S.K. (1996). Metropolitan-specific estimates of the price elasticity of supply of housing, and their sources.

Henger R., Pomogajko K., Voigtländer M. (2012).Gibt es eine spekulative Blase am deutschen Wohnimmobilienmarkt?. IW-Trends, 39.Jg., No. 3/2012, pp. 1-15.

Hens, T. and Bachmann, Kremena (2008): Behavioural Finance for private Banking.

Himmelberg C, Mayer C and Sinai T. (2005). Assessing High House Prices: Bubbles, Fundamentals and Misperceptions. Journal of Economic Perspectives, Vol. 19, No.4, pp.67-92.

Hilbers et al. (2001). Real Estate Market Developments and Financial Sector Soundness. In: IMF Working Paper. Available at: http://ssrn.com/abstract=879898.

Hott C., Monnin P. (2006). Fundamental Real Estate Prices: An Empirical Estimation with International Data.

Irle, Martin (2010): Preisblasen in Wohnimmobilienmärkten. Eine Betrachtung aus Sicht der Behavioural Finance. Immobilien Manager Verlag.

Im, K., Pesaran, M.H., and Shin, Y. (1997). Testing for Unit Roots in Heterogeneous Panels.

Mimeo, Department of Applied Economics, University of Cambridge.

Jochims D. (2010). Inflation oder Deflation: Akuter Handlungsbedarf für Immobilienkäufer, Handelsblatt 15.07.2010, available at: http://www.handelsblatt.com/finanzen/immobilien/inflation-oder-deflation-akuter-handlungsbedarf-fuer-immobilienkaeufer-seite-3/3490780-3.html [09.12.2017].

Joebges H., Dullien S. Márquez-Velázquez A. (2015). What causes housing bubbles? A theoretical and empirical inquiry. Macroeconomic Policy Institute.

Kahn J.A. (2009). What Drives Housing Prices?.

Karl P. Interview, CEO of Erste Immobilien KAG. Immobilien: „Bei manchen Transaktionen bin ich sprachlos", Fonds professionell 07.12.2017, available at: http://www.fondsprofessionell.at/news/maerkte/headline/immobilien-bei manchentransaktionen-bin-ich-sprachlos-139411/ [09.12.2017].

Karlsson S. (2014). The Accuracy of the Hausman Test in Panel Data: a Monte Carlo Study

Kindelberger C. (2011). Manias, Panics, and Crashes, A History of Financial Crises.

Kuert, Robert (2016). Analysis of Real Estate Bubbles in Eight Residential Markets. Testing for econometric regime shifts and concordance of bubble indicators using fundamental based methods.

Lambertini L., Mendicino C., Punti M.T. (2012). Expectations-Driven Cycles in the Housing Market. Bank of Finland Research Discussion Papers.

Levitin, A. and Lin, C. F. (1992). Unit Root Tests in Panel Data: Asymp totic and Finite Sample Properties. Department of Economics, University of California at San Diego, Discussion Paper No. 92-93 (revised 1993).

Levitin A. and Wachter S. (2012). Explaining the Housing Bubble.

Malpezzi, Stephen. (1999). A Simple Error Correction Model of House Prices. Journal of Housing Economics, 8, pp. 27-62.

Mian A. and Sufi A. (2009). Household Leverage and the Recession. Presented at the 10th Jaques Polak Annual Research Conference.

Mikhed V., Zemčík P. (2007).Testing for Bubbles in Housing Markets: A Panel Data Approach. Working Papers Series (ISSN 1211-3298).

Morita K. (2017). Emerging Capital Markets and Transition in Contemporary China.

Nneji, O., Brooks C. and Ward C. (2011). Intrisinc and Rational Speculative Bubbles in the U.S. Housing Markets 1960-2009. ICMA Centre Discussion Papers in Finance DP 2011-01.

Pedersen A., Schütte E. (2014). Detecting and Predicting Housing Bubbles: An Application of the Generalized Sup ADF Test and Dynamic Probit Models.

Peyton, Martha; Pierzak, Edward F (2016). Real estate: The impact of rising interest rates. TIAA Global Real Assets Research.

Poterba, J. (1991). House Price Dynamics: The Role of Tax Policy and Demography. Brookings Papers on Economic Activity, Issue 2, pp. 143-183.

Rombach, Tobias (2011). Preisblasen auf Wohnimmobilienmärkten. Eine theoretische und empirische Analyse der internationalen Märkte.

Phillips et al (2013). Testing for Multiple Bubbles 1: Historical Episodes of Exuberance and Collapse in the S&P 500. Economics and Statistics Working Paper Series, Nr. 4-2013. Singapore Management University.

Sackmann C. (2017). Preisanstieg "unvermeidbar": Deutsche Immobilien werden noch viel teurer, Focus 24.05.2017, available at: http://www.focus.de/immobilien/kaufen/immobilien-preise-preisanstieg-unvermeidbar-deutsche-immobilien-werden-noch-viel-teurer_id_7168655.html [04.10.2017].

Schild, K.-H. (2017). Panel-Daten I (Grundlagen; Fixed- und Random-Effects), available at: https://www.uni-marburg.de/fb02/statistik/studium/vorl/mikoeko/panel1.pdf

Schmidheiny, Kurt (2016). Panel Data: Fixed and Random Effects. Short Guides to Microeconometrics, pp. 2-7.

Shiller (2000). Irrational Exuberance. pp. 60-62.

Siedenbiedel C. (2015). Woanders sind die Häuser noch teurer, FAZ 01.01.2015, available at: http://www.faz.net/aktuell/finanzen/meine-finanzen/mieten-und-wohnen/immobilienpreise-anderswo-sind-die-haeuser-noch-teurer-13343289.html [04.10.2017].

Smith M.H., Smith G. (2006). Bubble, Bubble, Where's the Housing Bubble?. Brookings Papers on Economic Activity.

Stiglitz, Joseph E. (1990) Symposium on Bubbles. In Journal of Economic Perspectives, Vol.4, No.2, pp.13-18.

UBS, 28.09.2017, Global Real Estate Bubble Index, available at: https://www.ubs.com/global/en/wealth-management/chief-investment-office/key-topics/2017/global-real-estate-bubble-index-2017.html [25.11.2017].

Wüstenrot Studie: Jeder Dritte Deutsche fürchtet Immobilienblase, Handelsblatt 26.05.2012, available at: https://www.handelsblatt.com/politik/deutschland/wuestenrot-studie-jeder-dritte-deutsche-fuerchtet-immobilienblase/6678352-all.html [Stand 09.12.2017].

Zhou, J. (2010). Testing for Cointegration between House Prices and Economic Fundamentals. Real Estate Economics 38(4), pp. 599-632.

Appendix

Figure 1: Residential Property Price Indices in advanced European economies 1970q1-2017q1

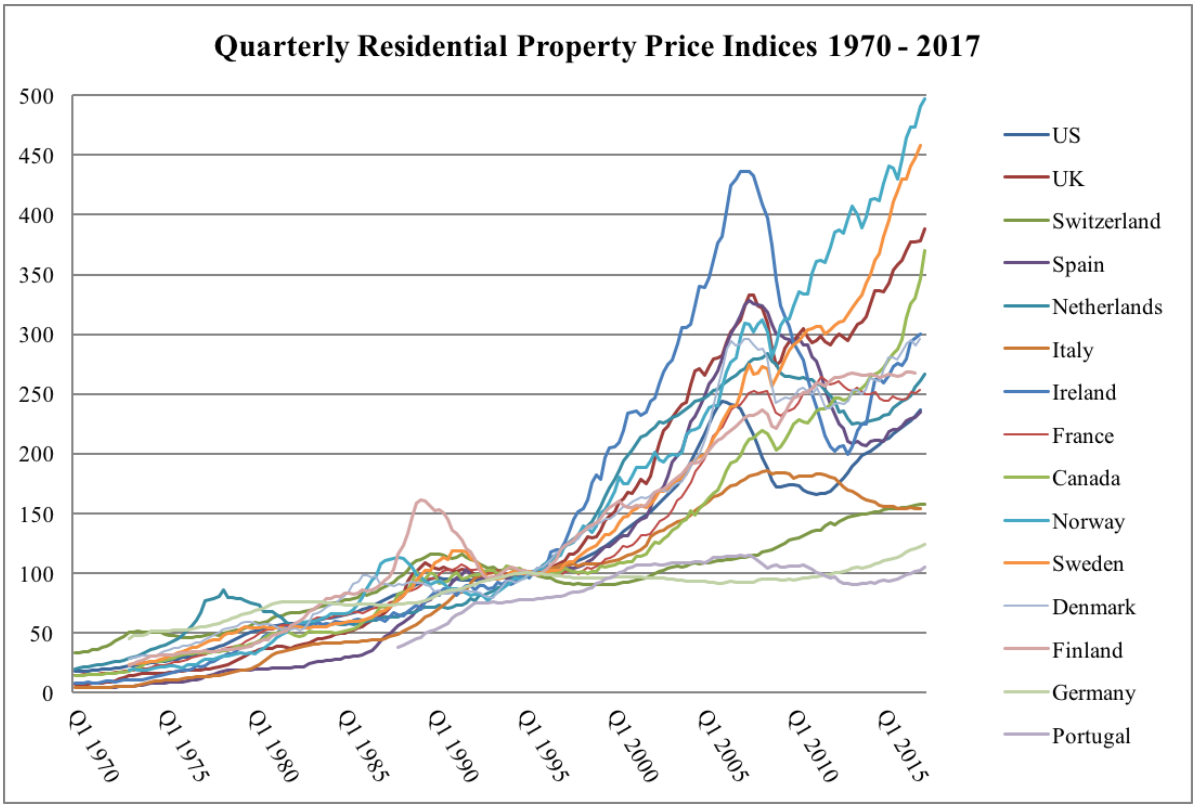


Figure 2: Annual Price-to-Rent Ratios 1990-2016

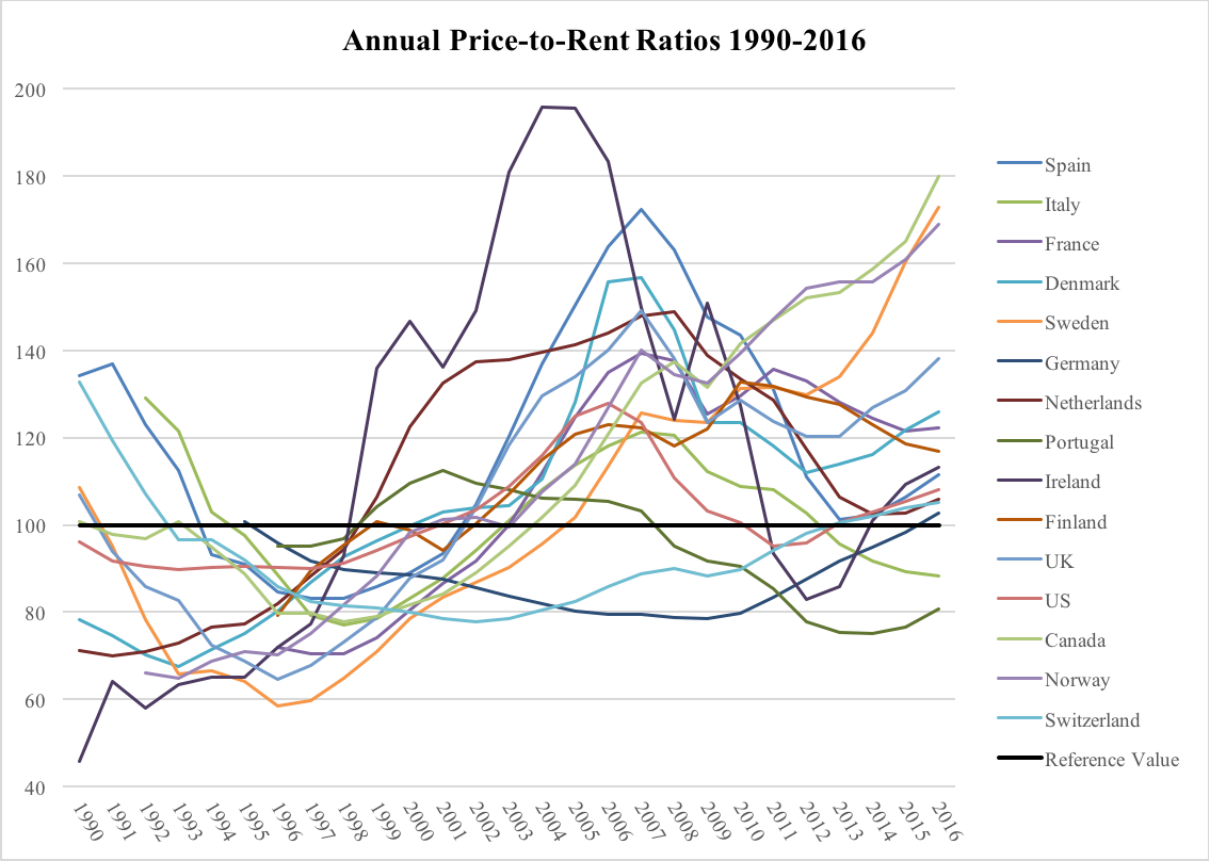


Figure 3: Annual Price-to-Income Ratio 1990-2016

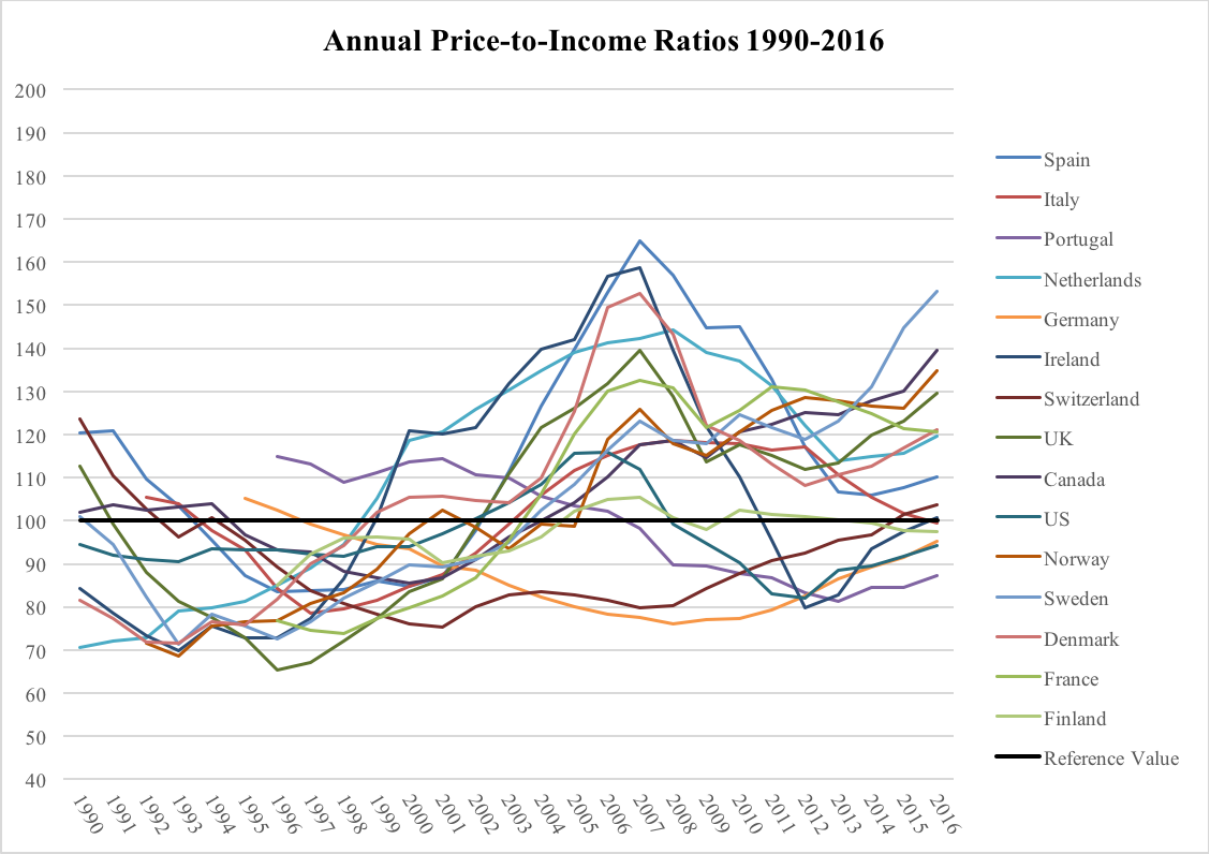


Table 1: Descriptive Statistics Residential House Price Indices (1970q1-2017q1)

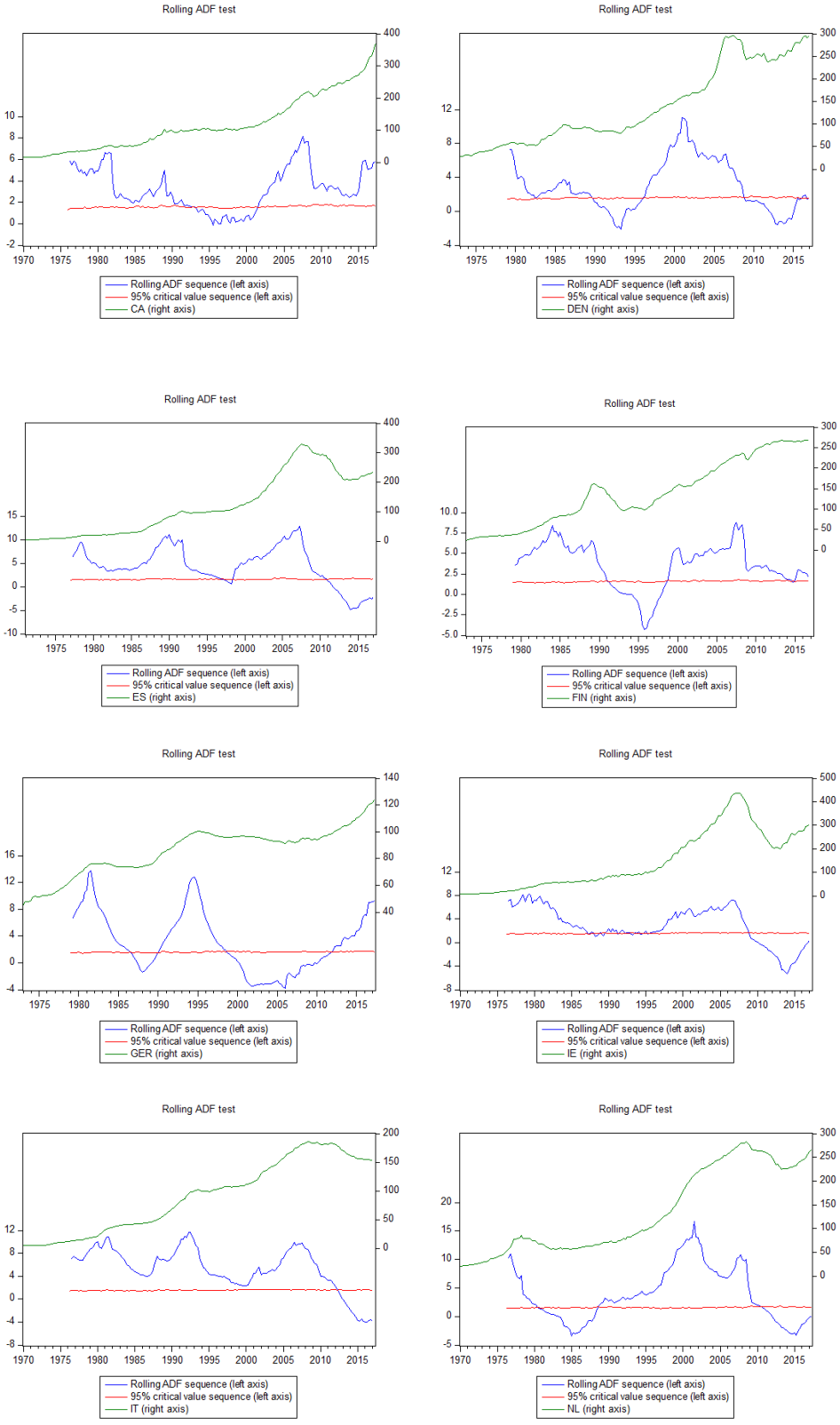
	US	UK	Switzerland	Spain	Netherlands	Italy	Ireland	France	Canada	Norway	Sweden	Denmark	Finland	Germany	Portugal
Avg Return	5,63%	8,74%	3,37%	8,95%	5,69%	7,81%	8,21%	6,19%	7,06%	7,66%	6,88%	5,54%	5,88%	2,29%	3,54%
St. Dev	3,38%	5,89%	3,44%	6,67%	5,53%	5,46%	7,95%	4,08%	5,65%	6,77%	4,49%	5,66%	5,74%	1,85%	3,65%
Skew	-1,18	0,70	0,77	0,69	0,57	1,76	0,02	-0,03	0,11	0,38	-0,49	0,16	0,47	0,94	0,55
Kurtosis	2,93	2,36	1,76	0,88	3,65	3,80	-0,59	-0,33	1,61	0,51	1,19	1,66	2,46	1,68	1,54

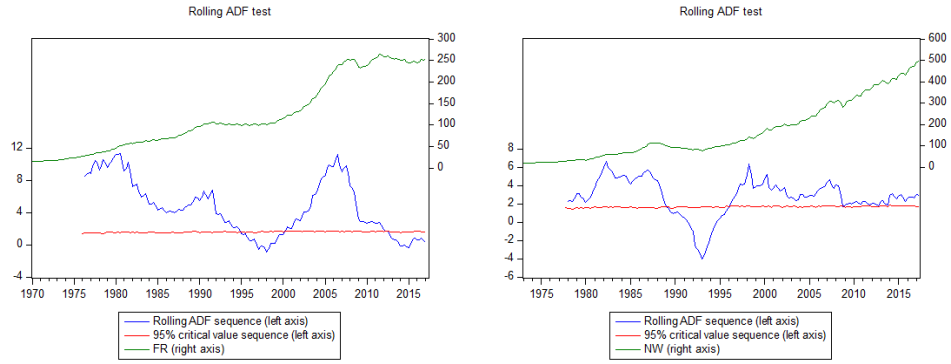
Table 2: Results Correlation Test

```
. corr ln_GDPPC ln_LTR ln_CPI ln_POP ln_CONST ln_UNEMP ln_CA ln_BP ln_Credit ln_TAX
(obs=211)
```

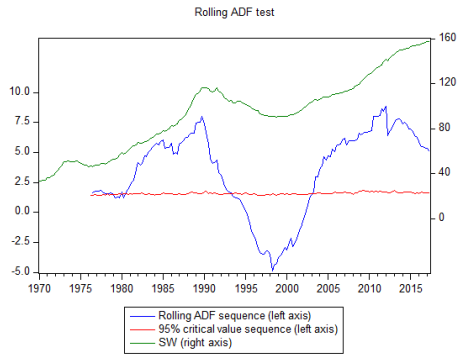
	ln_GDPPC	ln_LTR	ln_CPI	ln_POP	ln_CONST	ln_UNEMP	ln_CA	ln_BP	ln_Cre~t	ln_TAX
ln_GDPPC	1.0000									
ln_LTR	-0.0146	1.0000								
ln_CPI	-0.1457	-0.0350	1.0000							
ln_POP	-0.0483	0.0389	0.0922	1.0000						
ln_CONST	0.3851	0.0965	0.1621	-0.0645	1.0000					
ln_UNEMP	-0.0494	-0.0819	-0.2126	-0.3203	-0.3033	1.0000				
ln_CA	0.1679	-0.0624	-0.2314	0.0376	0.0977	-0.3748	1.0000			
ln_BP	0.4830	-0.0800	-0.1545	0.0652	0.1863	-0.1905	0.2349	1.0000		
ln_Credit	-0.1050	0.0969	0.2239	0.0143	0.1533	-0.2286	-0.0115	-0.0639	1.0000	
ln_TAX	0.0149	0.0516	0.1154	0.2920	0.0478	-0.0306	-0.4142	0.0366	-0.0302	1.0000

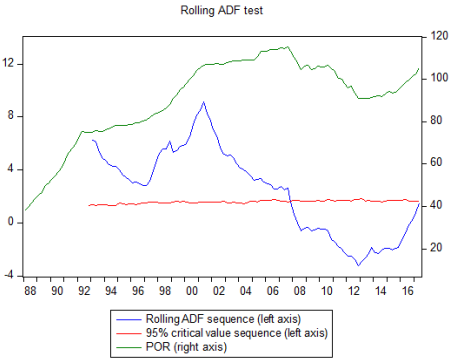
Figure 4: RADF Test Results

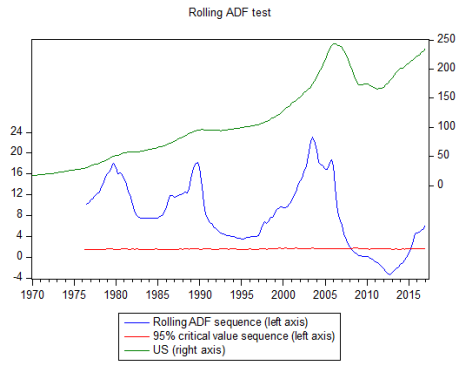


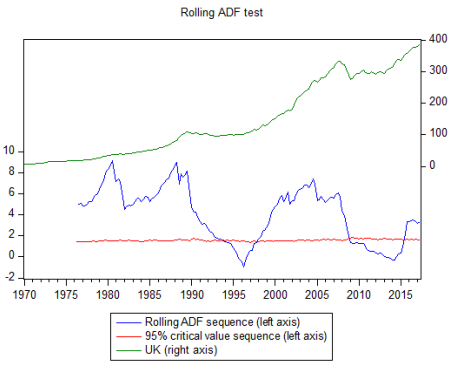

Rolling ADF test
Rolling ADF sequence (left axis)
95% critical value sequence (left axis)
FR (right axis)

Rolling ADF test
Rolling ADF sequence (left axis)
95% critical value sequence (left axis)
NW (right axis)


Rolling ADF test
Rolling ADF sequence (left axis)
95% critical value sequence (left axis)
SW (right axis)


Rolling ADF test
Rolling ADF sequence (left axis)
95% critical value sequence (left axis)
POR (right axis)


Rolling ADF test
Rolling ADF sequence (left axis)
95% critical value sequence (left axis)
US (right axis)


Rolling ADF test
Rolling ADF sequence (left axis)
95% critical value sequence (left axis)
UK (right axis)

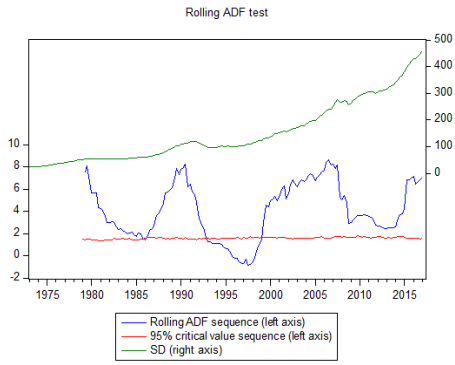

Rolling ADF test
Rolling ADF sequence (left axis)
95% critical value sequence (left axis)
SD (right axis)

Table 6: Overview Variables

Variable	Data Provider	Description	Timespan	Conversion Method	Adjustment	Source	Dataset
Residential Property Price Index	Thomson Reuters Datastream	Residential Property Price Index	Q1 1970 - Q1 2017, quarterly			OECD Economic Outlook, copyright OECD	National Sources
Construction Cost Index	Thomson Reuters Datastream	Construction Cost Index, Residential Buildings, except residences for communities, Change Y/Y	Q1 1996 - Q3 2017, quarterly	Average	Not SA	Eurostat	National Sources
Except for Canada: CN Cost of Construction: Houses	Thomson Reuters Datastream	Canada, Cost of Construction, Residential, Total, Cost of Construction: Houses, Index 2010=100	1981 - 2016, annually	Average	Price index, not SA	Main Economic indicators, copyright OECD	International Sources
GDP per capita	Thomson Reuters Datastream	Growth Ratesm Gross Domestic Product Per Capita Growth (Annual %) -	1961 - 2016, annually	Average	Not SA	World Bank WDI	International Sources
Long Term Bond Rate	Bloomberg		1985 - 2016, annually				
Unemployment Rate	Thomson Reuters Datastream	Labour Markets Unemployment Rate, annual	1950 - 2016, annually	Average	Not SA	IMF International Financial Statistics	International Sources
Population Growth	Thomson Reuters Datastream	Population Grwoth (Annual %)	1960 - 2016, annually	Average	Not SA	World Bank WDI	International Sources
Current Account Balance (as % of GDP)	Thomson Reuters Datastream	Current Account Balance, % of Gross Domestic Product	1960 - 2018 (forecast), annually	Average	SA	OECD Economic Outlook, copyright OECD	International Sources
CPI	Thomson Reuters Datastream	Consumer Price Indices, Percentage Change from previous period,	1961 - 2018 (forecast), annually	Average	Not SA	OECD Economic Outlook, copyright OECD	
Tax on Property	OECD data, https://data.oecd.org/tax/tax-on-property.htm	Tax on property is defined as recurrent and non-recurrent taxes on the use, ownership or transfer of property. These include taxes on immovable property or net wealth, taxes on the change of ownership of property through inheritance or gift and taxes on financial and capital transactions. This indicator relates to government as a whole (all government levels) and is measured in percentage both of GDP and of total taxation.	1965 - 2016, annually				
Building Permits	Thomson Reuters Datastream	Building Permits (m2 floor area): Residential Buldings (%YOY) PERMITS(M2 FLOOR AREA): RESIDENTIAL BLDG.S(%YOY)	1995 - 2016, annually				
Domestic Credit to private sector (as % of GDP)	The World Bank: https://data.worldbank.org/indicator/FS.AST.PRVT.GD.ZS	Domestic credit to private sector refers to financial resources provided to the private sector by financial corporations, such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment.	1960 - 2016, annually	Weighted average		International Monetary Fund, International Financial Statistics and data files, and World Bank and OECD GDP estimates.	
Price-to-Rent Ratio	Thomson Reuters Datastream		1990 - 2016, annually				
Price-to-Income Ratio	Thomson Reuters Datastream		1990 - 2016, annually				