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House Price Dynamics and Bank Herding: European Empirical Evidence

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Abstract

This paper investigates the behavior of residential property and examines the linkages between house price dynamics and bank herding behavior. The analysis presents evidence that irrational behaviour may have played a significant role in several countries, including; United Kingdom, Spain, Denmark, Sweden and Ireland. In addition, we also provide evidence indicative of herding behaviour in the European residential mortgage loan market. Granger Causality tests indicate that non-fundamentally justified prices dynamics contributed to herding by lenders and that this behaviour was a response by the banks as a group to common information on residential property assets. In contrast, in Germany, Portugal and Austria, residential property prices were largely explained by fundamentals. Furthermore, these countries show no evidence of either irrational price bubbles or herd behaviour in the mortgage market. Granger Causality tests indicate that both variables are independent.

Keywords: House Prices; Mortgages; Price Bubble; Herding Behavior.

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1: Introduction

The events of the last decade have focused the attention of both policy makers and the media to the housing market. The implications arising from the extreme price movements, both upwards and downwards, during the most recent cycle have highlighted the importance of residential property in both an economical and financial context. In an academic context much of the recent research has considered the interaction of housing markets with other key macroeconomic variables (e.g., Campbell & Cocco, 2007; Goodhart & Hofmann, 2008; Bjørnland & Jacobsen, 2010). In addition, a large literature has explicitly considered whether the price behavior during recent housing booms reflects deviations of house prices from fundamentals (e.g., Levin & Wright, 1997; Himmelberg *et al.*, 2005; Payne & Waters, 2007; Stevenson, 2008; Brunnermeier & Julliard, 2008; Costello *et al.*, 2011). The cyclical behavior of housing is a key issue in understanding the behavior of residential property markets as they may reflect herding behavior on the part of market participants, caused by factors such as informational cascades, agency problems and/or informational inefficiencies (e.g., Baddeley, 2005; Uchida & Nakagawa, 2007; Piazzesi & Schneider, 2009; Pierdzioch *et al.*, 2012).

This paper considers two key issues concerning the behavior and dynamics in the European housing markets. Using data for the EU-15 we firstly consider the degree to which house prices during the recent cycle diverged from those that could be justified by fundamentals. Secondly, we consider whether lenders in these European markets displayed herding behaviour and if the dynamics at play in the housing market contributed to this. The contribution of the paper arises from the fact that not only have few papers considered such a range of European markets but no prior study has analyzed the relationship between house price dynamics and herding in the loan market. The results illustrate both the linkages between the housing and mortgage markets and the degree of variation across markets. In a number of the markets considered, specifically the U.K, Spain, Denmark, Sweden and Ireland we present empirical evidence that is supportive of the view that the high growth rates observed in house prices prior to 2007 could not be fully attributed to underlying fundamentals. For each of these markets the 'bubble' term has a significant impact on real house prices, revealing cumulative real growth in excess of 37% during the period 1995-2007. Based on the measure proposed by Lakonishok, Schleifer & Vishny (1992) (hereinafter referred to as LSV) we test for the presence of herding behavior across lenders in the residential mortgage loan market. The LSV herding measure was constructed based on the total amount of loans outstanding to five different asset classes of loans by each European bank analyzed, from 1995 to 2007. For those countries displaying substantial non-fundamental price behavior the LSV herding measure is shown to be meaningful and statistically significant. Granger Causality tests are then employed to examine the relationships between the house price 'bubble' term and the LSV herding measure. Significant causal relationships are reported. The results suggest that herding behavior was a response by banks, as a group, to common information concerning the residential property markets. The variation in country dynamics is clearly illustrated when considering the cases of Germany, Portugal and Austria. In these cases residential price dynamics can be fully explained by its fundamentals, with no evidence of house price bubbles. Furthermore, no evidence is found to support the notion of herding behavior in the mortgage market whilst the causality tests indicate that the two variables are independent. The paper is structured as follows. In section 2, we review the relevant and pertinent literature on both house price dynamics and herding behavior. Section 3 presents the key hypotheses and the research methodology and framework adopted. The empirical results are presented in Section 4 and 5, whilst the final section provides concluding comments.

2: Literature Review

2.1: Housing Price Bubbles

The concept of an asset bubble is usually associated with the idea of a significant and/or abnormal price increase (see Stiglitz, 1990 and O'Hara, 2008). Stiglitz (1990) provides an intuitive definition of an asset bubble: *"If the reason that the price is high today is only because investors believe that the selling price is high tomorrow – when fundamental factors do not seem to justify such a price – then a bubble exists."* Therefore, if an appreciation in prices is being primarily driven by speculative factors, rather than fundamentals, then it may be viewed that housing markets may display the characteristics of a bubble. However, merely observing strong or continuous price increases is far from being a sufficient condition for the identification of an asset bubble. Consideration of the estimated 'true' value that should anchor asset prices is necessary for a comprehensive and complete analysis (O'Hara, 2008; Stevenson, 2008). The underlying 'true' value is one that may be justified by the prevailing fundamentals. In the context of housing markets those economic, demographic/social and financial variables that are likely to exert a significant influence on both the demand and supply of the asset and therefore prices. Thus, the identification of an asset price bubble is effectively looking at price increases that are unrelated with fundamentals.

Generally the literature has attributed the divergence of asset prices from their fundamental values to momentum (speculative), intrinsic and explosive bubbles. Momentum bubbles are driven by unrealistic expectations – securities that had a long record of good news tend to become overpriced and are driven by price alone, whereby agents buy after price increases and sell after prices decreases (e.g., De Long *et al*., 1990 and Barberis *et al.*, 1998). Such momentum occurs when a price rises or falls and is expected to continue to rise or fall and is usually taken as evidence against market rationality[1]. As Froot & Obstfeld (1991) point out, intrinsic bubbles derive all of their variability from exogenous fundamental variables, and they are capable of generating persistent and stable deviations from fundamental prices. In common with explosive rational bubbles, intrinsic bubbles rely on bounded rationality and self-fulfilling expectations, but such expectations are driven by a non-linear relationship between prices and the fundamentals themselves, rather than extraneous or intrinsically irrelevant variables that are not part of the market fundamentals, as Diba & Grossman (1988) show. Furthermore, unlike explosive rational bubbles, such bubbles do not continuously diverge but periodically revert toward their fundamental value.

A large number of studies have considered whether price behavior that could be viewed as bearing the characteristics of a bubble have been present in both national and regional/city markets[2]. However, despite the large number of studies there is no definitive

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[1] Hence during an "up" market buyers will pile in pushing prices up even further encouraging other buyers to do likewise, while in a "down" market price falls lead to falling demand, discouraging buyers as they fear prices will fall further, leading to a slowing of demand even further. Giving that housing tends to be demand determined over the business cycle (due to relatively high supply constraints) this, along with the impediments to arbitrage, can lead to "inefficient" pricing of real estate being perpetuated for relatively long and often uncertain periods when compared to financial assets (Fraser *et al.* 2008).

[2] See for example Case & Shiller (1989); Abraham & Hendershott (1996) and Miles (2008) for the U.S.; Black *et al*. (2006), for the United Kingdom; Ayuso & Restoy (2006) for the U.K. and Spain; Bourassa *et al.* (2001) and Fraser *et al*. (2008) for New Zealand; Bourassa & Hendershott (1995) for Australia; Hort (1998)

test or a universally fully accepted methodological framework concerning the empirical testing for the existence, or not, of a bubble in housing prices. Some authors have analyzed trends in price-to-income ratios (e.g., Case and Shiller 2003; Black *et al*. 2006; Fraser *et al*. 2008) or price-to-rent ratios (e.g., Blanchard & Watson 1982; Leamer 2002; Krainer & Wei 2004). The rationale in both cases is that the ratios act as a measure of affordability. Blanchard & Watson (1982) argue that the price-to-rent ratio must increase over time when a growing rational bubble exists in the asset price of housing. Leamer (2002) illustrate the parallels in the behavior of the price-to-rent ratio to the price-to-earnings (PE) ratio in stocks. Krainer & Wei (2004) argue that the disparity in there being a 30% real increase in house prices over 1994-2003 in the U.S. whilst rents have only increased by 10% in real terms may suggest an element of overpricing.

However, these approaches may be considered as being descriptive studies and not definitive statistical tests. Wheaton & Nechayev (2006) discuss potential problems with using these descriptive measures in identifying a house price bubble and show that increase in house price-to-rent ratios may have been caused by increases in house prices, which in turn could be caused by increases in home ownership demand. Himmelberg *et al.* (2005) argue that, since differences in expected capital gain from owning homes and as well as differences in taxes can lead to substantial variability in the price-to-rent ratios across comparison groups, conventional metrics for assessing pricing in the housing market such as price-to income or price-to-rent ratios may not reflect accurately the state of housing cost, thus, the affordability. Moreover, Stevenson (2008) argues that factors such as equity build up can lead to measures such as the price-to-income ratio providing misleading or overly simplistic findings. In addition, in markets with high owner-occupancy rates it is questionable as to the degree to which a strong relationship exists between the rental and sale markets.

As with any other asset market, house prices are a function of demand and supply. Typically, housing demand is driven by factors such disposable income, mortgage interest rates and the availability of credit. Demographic and social factors may also play an important role as well. The supply of housing is generally modeled as a function of land and construction costs and the availability of credit. Price behavior and the dynamics of the

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for Sweden and Stevenson (2008) for Ireland. Examples of studies that have considered city level data include; Levin and Wright (1997) - London; Roehner (1999) - Paris; Roche (2001) - Dublin; Hui & Yue (2006) - Beijing and Shanghai; Shimizu & Nishimura (2007) – Tokyo.

asset market for housing will also come into consideration[3]. A larger disposable income, greater availability of credit for house ownership and lower mortgage rates would all have a positive effect on housing demand. For example, Hendry (1984) expresses real house prices in terms of household income, house completions, construction costs and money supply[4]. A number of papers have included in their model specifications lagged house prices (e.g. Abraham & Hendershott, 1996; Case & Shiller, 2003). The rationale is that they may act as an expectations operator as participants in housing markets frequently display extrapolative and myopic expectations (Case & Shiller, 1989; Poterba, 1991; Malpezzi & Wachter, 2005). In this paper we base our analysis on the asset market approach of Meen (1990), in which the price house bubble term is incorporated into the empirical model by adding lagged house prices.

2.2: Herding

The literature on herding has proposed a variety of different definitions. Herding can therefore be understood as the behavior of "*a group of investors that trade in the same direction (buy or sell) for a given period of time*" (Nofsinger & Sias, 1999), as "*a phenomenon in which investors follow the behavior of others investors in the context of sequential decision without making use of their own information*" (Effinger & Polborn, 2001), or as a product of "*change of agents convictions in order to match more perfectly with the opinions publicly expressed by others*" (Cote & Sanders, 1997). However, this notion of similarity of behavior is not by itself sufficient. Patterns of correlated behavior can occur simply by accident or because agents have access to the same sources of information, or interpret information in a similar way. Therefore it is necessary to consider additional elements of intentionality that can limit the psychological factors such as social pressures, social learning, desire of imitation or conformity with a group membership or other factors that may result from the particular circumstances of each individual (Hirshleifer & Teoh, 2003).

The presence of price cycles in housing markets may reflect the existence of herding behavior by agents, caused by informational cascades, agency problems and/or informational inefficiencies (e.g., Baddeley, 2005; Uchida & Nakagawa, 2007; Piazzesi &

[3] Examples of papers to have examined considered housing supply include; Spiegel (2001), Riddel (2004), Green *et al.*, (2005) and Stevenson & Young (2014).
[4] See Stevenson (2008) for a comparison of a variety of alternative approaches to modeling fundamentals.

Schneider, 2009; Pierdzioch *et al.*, 2012). Keynes (1936) argues that herding may exist due to both uncertainty and agents having access to limited information. This therefore leads to agents imitating the behavior of others, assuming that the crowd has superior information. More recent literature (Banerjee, 1992, Bickhchandani *et al.*, 1992 and Scharfstein and Stein, 1990) has developed this idea, noting that there may be incentives for rational agents to ignore their own private information when the behavior and actions of others contains information that has value. Hirshleifer & Teoh (2003) note that in addition to informational cascades, agency problems and informational inefficiencies in the process of individual choice, imitation can be caused by behavioral factors, as predicted by models of quasi-rational or irrational herding.

The cascade informational model, initially advanced by Banerjee (1992) and Bikhchandani *et al.* (1992), illustrates how information asymmetry can lead uninformed, but rational, speculators to converge rapidly in the same direction as the first (few) agents. These initial agents therefore determine the choices of those who succeed them. Piazzesi & Schneider (2009) develop a model showing how a small number of optimistic investors (that designate a "momentum cluster") can have a significant effect on real estate prices without having previously purchased a high percentage of housing stock. The authors show that this small cluster of owners, who believe that it is time to buy, tends to grow strongly at the end of a house price cycle mainly due to increasingly favorable credit conditions.

When comparing institutional investors with individuals it is important to recognize that motivations and therefore explanations may differ. Unlike individual investors, institutional investors are subject to regular evaluations about their performance, comparisons with respect to a benchmark and/or to other(s) institutions. These considerations may lead to institutional investors imitating each other with respect to the choices of assets (e.g., Scharfstein & Stein, 1990). Baddeley (2005) notes how there are a limited amount of research to have explicitly considered the housing market. This is despite informational inefficiency not only being a contributory factor in herding behavior, but also being of importance in any analysis of housing markets. Information in housing markets tends to be imperfect due not only to the characteristics of the asset (i.e. illiquid, heterogenous, supply constrained and high transaction costs) but also due to the absence of a centralized market exchanges. Among the different causes for the existence of herding behavior by agents in a housing market it is concluded that agents imitation behavior tend to be higher or lower depending on the size of a markets informational inefficiency, i.e., the information asymmetry. However, there tends to be a lower probability for the existence of herding behavior among agents when they are subject to less frequent performance evaluations.

Uchida & Nakagawa (2007) emphasize how irrational herding behavior by Japanese banks during the house price boom of the late eighties was a major contributory factor behind the increase in bad debt following the collapse of the sector in the early nineties. In a broader banking context Acharya & Yorulmazer (2007) show how bank closure policies tend to suffer from an implicit "*too-many-to-fail*" problem. This gives banks an incentive to herd with respect in lending to a specific sector or in taking exposures to a systematic risk factor. This in turn increases the risk that banks may either see an increase in defaults at the same time, or at the extreme, fail. Acharya & Yorulmazer (2007) show that big banks have an incentive to differentiate themselves, whereas small banks have incentives to herd with their larger counterpart banks.

3: Hypotheses and Methodological Framework

3.1: Research Hypotheses

The coincidence of cycles in bank credit and property has been extensively discussed in the policy-oriented literature (BIS, 2001; Zhu, 2005; IMF, 2008). Among others, Hofmann (2004) and Davis & Zhu (2009) find that there is a significant two-way dynamic interaction between bank lending and property prices. Others, such as Iacoviello (2004, 2005) and Gerlach & Peng (2005) have shown that property prices may influence the availability of bank lending via the wealth effect as the increase in house prices raises the borrowing capacity of households. On the other hand, the opposite unidirectional causality may exist. Bank lending may affect house prices as increases in credit availability may expand the demand for what is in a short-run sense, the fixed supply of housing stock (e.g. Kindleberger, 1978 and Minsky, 1982). However, irrespective of the direction of the interaction it is undeniable that there is a high correlation between credit cycles and house prices, with possible adverse effects on the financial system and on the economy[5]. This is especially so given the importance of real estate assets in banks' balance sheets[6].

The identification of a housing price bubble requires the comparison between housing market prices and its fundamentals. This results in the following hypothesis:

Hypothesis 1: Do house prices in EU-15 countries display dynamics not explained by fundamentals?

Given that house price behavior in both rising and falling market conditions may reflect the presence of herding behavior caused by informational cascades, agency problems and/or informational inefficiencies[7], we assess the extent of herding behavior observed across banks. We use the measure proposed by Lakonishok *et al.* (1992) and apply this to the total amount of credit granted by banks to 5 different asset classes. Based on the results, we analyze to what extent the banks have deviated from the credit policy appropriate given the macroeconomic conditions and collectively increased or decreased credit for certain specific assets each year.

Hypothesis 2: Do European banks display herding behavior with respect to residential property loans

If herding behavior exists in the mortgage loan market, it is important to analyze the direction of the causal relationship between herding behavior and the estimated house price bubble term. The direction of the causal relationship between the two variables will allow an analysis of whether banks that intentionally (rationally or not) mimic each other in terms of their market conduct, do that as response to common and relevant information on prices. Uchida & Nakagawa (2007) report that banks are not necessarily presenting irrational behavior when the LSV measure indicates the presence of herding. The LSV

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[5] See in particular the "*disaster myopia"* effect (Herring & Wachter, 1999).
[6] Davis & Zhu (2009) report that real estate assets either directly or indirectly (they are used as a collateral when granting others loans) tend to represent about 50% of total banking assets.
[7] See for example, Baddeley (2005), Uchida & Nakagawa (2007), Piazzesi & Schneider (2009) and Pierdzioch *et al.* (2010).

measure may simply reflect an increase or decrease of credit granted based on rational factors associated with the specificity of a given industry. Kim & Wei (2002) argue that high values may simply reflect the fact that investors are responding to common information which is return-relevant. Based on Granger causality tests we consider the following hypothesis:

Hypothesis 3: Is there a causal relationship between herding behavior among European banks and the house price bubble term? What is the direction of any causal relationship observed?

3.2: Asset Market Housing Model

The model we use to consider the degree to which house price dynamics deviate from fundamentals is based upon the "*Asset Market Approach*" proposed by Buckley & Ermisch (1982), Poterba (1984), Meen (1990, 1996), and Breedon & Joyce (1993). In the spirit of this model, the problem facing the consumer is to maximize lifetime utility ***U***. Assuming a real discount rate ***r***, in continuous time, the lifetime utility is an integral of the discounted period utilities, which are a function of housing services (housing stocks ***H(t)***) and the consumption of composite non-durable goods ***C(t)***:

$$U = \int_0^\infty e^{-rt} U\big(H(t), C(t)\big) d(t). \quad (1)$$

Utility is maximized subject to the household's budget constraint (2) and two technical constraints [(3) and (4) below] that describe the evolution of the stock of houses ***H(t)*** and of the real net non-housing assets ***A(t)***, respectively:

$$RHP(t)X(t) + S(t) + C(t) = (1-\theta)RY(t) + (1-\theta)i\,A(t), \quad (2)$$

$$\dot{H}(t) = X(t) - \partial H(t), \quad (3)$$

$$\dot{A}(t) = S(t) - \pi A(t), \quad (4)$$

where ***RHP(t)*** is the real purchase price of housing, ***S(t)*** is real saving net of real new loans, ***RY(t)*** is the real household income, ***i*** is the nominal interest rate at which a household can borrow or lend in case of no credit market constraints, $\boldsymbol{\theta}$ is the marginal household tax rate, $\boldsymbol{\pi}$ is the inflation rate (constant), $\boldsymbol{\delta}$ is the physical depreciation rate on the housing stock and ***X(t)*** represents new purchase of dwellings. ($\dot{}$) relates to a time derivative.

The first-order solution of the Lagrangian function can be obtained as follows:

$$\frac{U_h}{U_c} = RHP(t)\left[(1-\theta)i - \pi + \delta - \left(\frac{R\dot{H}P(t)}{RHP(t)}\right)\right]. \quad (5)$$

Bowden (1978) shows that equation (5) can be written in terms of the unobservable market clearing rental price of housing services *R(t)*, as follows:

$$RHP(t) = \frac{R(t)}{\left[(1-\theta)i - \pi^e + \delta - (\frac{RHP^e}{RHP(t)})\right]}, \quad (6)$$

or equivalently,

$$RHP(t) = \frac{R(t)}{[NMR(t) - PHE(t) + \delta]}, \quad (7)$$

where ***e*** represents the expected value, [$PHE(t) = \pi^e + (RHP^e/RHP(t))$], is the expected nominal capital gains, and [$NMR(t) = (1\text{-}\theta)i$] is the nominal after tax mortgage interest rate. In logarithms, equation (7) can be rewritten as:

$$lnRHP(t) = lnR(t) - \ln[NMR(t) - PHE(t) + \delta]. \quad (8)$$

Meen (1990) show that the unobservable real rental price of housing service (***R(t)***) can be represented by its observable determinants, as follows:

$$R(t) = f(RY, POP, HS, RM), \quad (9)$$

where ***RY*** is real disposable income, ***POP*** is the population, ***HS*** is the supply of dwellings, and ***RM*** is the consumers' asset wealth.

In line with Case & Shiller (1989), Abraham & Hendershott (1996) and Bourassa *et al.* (2001), lagged housing prices are incorporated into the price equation. Other similar studies that have examined the dynamics of housing prices emphasize the importance of including other fundamentals in housing prices forecasts, such as the total amount of credit granted (***TM***) and construction costs (***CC***). Additionally, a "bubble burster" term (***PDEV***) is incorporated to capture the tendency of actual house prices to converge to their long-run equilibrium values. Thus, equations (8) and (9) suggest the following final specification for house prices:

$$RHP(t) = f\{RY(t), RM(t), TM(t), HS(t), POP(t), CC(t), lagged\ RHP(t), PDEV(t)\}. \quad (10)$$

3.3: Lakonishok *et al.* (1992) Herding Measure

In order to detect the degree of herding behavior among European banks we use the LSV herding measure as proposed by Lakonishok *et al.* (1992). Suppose that in each year, indexed by *t*, banks have loans outstanding to asset class *i*. The LSV measure is defined as follows:

$$LSV_{i,t} = |p(i,t) - p(t)| - AF(i,t) \quad (11)$$

where:

$$p(i,t) = \frac{B(i,t)}{B(i,t)+S(i,t)} \text{ , and} \quad (12)$$

$$p(t) = \frac{\sum_{i=1}^{n} p(i,t)}{n}. \quad (13)$$

B (i, t) [S (i, t)] is the number of banks that purchase [sells] the asset class *i*, in year *t*.; *p(i,t)* is the expected proportion of banks that increase their loans outstanding in asset class *i* in year *t*, and *p(t)* is a proxy of expected proportion of banks that increase their loans, for all asset classes in a given year, which changes with time.

The adjustment factor *AF(i,t)* is given by equation (14):

$$AF(i,t) = E[|p(i,t) - p(t)|], \quad (14)$$

computed under the null hypothesis that there is no herding behavior and taking into account that *B(i,t)* follows a binomial distribution with parameter *p=p(t)*. Under the null hypothesis that the investment decisions of banks are independent, the percentage of net buyer banks of any asset in the total of active banks follows a binomial distribution. We can then calculate the value of *AF(i,t)* for asset class *i* in year *t* starting by considering the following known parameters: *N(i,t)* as the number of banks that increase their loans outstanding in asset class *i* in year *t*, and *p(i,t)* is defined as above.

The null hypothesis postulates that in the absence of herding, the ratio of the banks that bought [sold] and the number of banks that are active in the market has the same expected value for all asset classes in a given period. Under the null hypothesis, the propensity to buy [sell] is constant for any bank and for any asset class in a given year. Under the null hypothesis, the probability of a randomly chosen bank is a net buyer [seller] of an asset *i* is then *p(t)*[1-e(t)]* and therefore, in this case, the value of |*p(i,t)-p(t)*| equals

AF(i,t) and thus *LSVi,t = 0*. Deviations from *p(t)* higher than expected, taking into account random fluctuations are signals of herding.

The LSV herding measure is the most frequently-used measures to quantify herding behavior among investors. Although alternative herding measures have been proposed studies such as Uchida & Nakagawa (2007) note that the LSV measure is more appropriate in the specific context of measuring herding between banks. This does not mean that the LSV measure is free of limitations. Bikhchandani & Sharma (2001) argue that the measure (1) only uses the number of investors that sold or purchased a particular stock, (2) cannot identify intertemporal trading patterns, and (3) may not be a good measure unless the time interval and the choice of investment category over which the measure is averaged are appropriately chosen. Uchida & Nakagawa (2007) report that the use of annual data and the focus on a particular type of banks reduces the likelihood of results suffering the biases mentioned in (2) and (3). The accuracy of the Lakonishok *et al.* (1992) herding measure rests on two implicit conditions: no short-selling constraints and no conditional propensity to buy depending on investors' initial holding in the stock and liquidity needs. Wylie (2005) states that unless both of these conditions are satisfied there is a bias in the LSV herding measure. Uchida & Nakagawa (2007) argue that in banking context, it should be reasonable to presume that all of these conditions are satisfied.

4: Empirical Analysis I – House Price Dynamics, Fundamentals and Bubbles

The quarterly house price data used to estimate the model specified in equation (10) was obtained from the Bank for International Settlements (BIS). The BIS collate house price index data for a variety of markets and we selected those indices that are either the primary benchmark index for that market or have the longest time series[8]. The explanatory variables used consist of real disposable income (***RY***), real house user cost (***RM***), real total mortgage credit (***TM***), "building permits" and "new buildings orders" indices as proxies for housing supply (***HS***) and construction costs indices (***CC***) [9]. The house price data does not extend back to the exact same time period for each country. Where possible we use a starting point of Quarter 1 1990. However in a number of cases data availability issues led to a curtailed sample[10]. Given our focus upon conditions during the last housing boom our analysis stops at the end of 2007.

The real user cost is defined by the following formula (Hort, 1998): $[(1-ti)*i-\pi^e+t_h+\delta]$, where, ***ti*** is the marginal rate of income tax, in each country, ***i*** is the interest rate in the interbank money market, $\boldsymbol{\pi^e}$ is the expected inflation rate, approximated by the arithmetic mean of the current inflation rate and the previous year inflation rate, ***th*** is the property tax rate and $\boldsymbol{\sigma}$ the property depreciation rate. The depreciation rate is calculated according to the following formula (Ott, 2006): $\sigma_t= [GFCF_t – (NCS_t – NCS_{t-1})]/NCS_{t-1}$, where, *GFCF* and *NCS* denote Gross Fixed Capital Formation and Net Fixed Capital Stock in the housing sector, respectively[11].

The model used to assess the degree to which prices reflect fundamentals requires an assumption of a period when the market is in equilibrium[12]. In order to provide a

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[8] The detailed information concerning the exact indices used can be obtained from the authors.

[9] As with the house price data used, the detailed information on the independent variables is available from the authors upon request. Initial specifications also included *Population* as an explanatory variable. However, we did not find the existence of a positive and statistically significant relationship between the population and housing prices. Hort (1998) argues that such a result may be possibly due to population changes being captured in variables such as disposable income. This is because this variable can be obtained by multiplying the per capita income and population variables together. Whilst studies such as Stevenson (2008) do find demographic variables important they use a per capita income measured and thus avoid a double counting of overall demographic effects.

[10] These were Austria (Q1 1996); France (Q1 1995); Greece (Q1 1995); Luxembourg (Q1 1992); Portugal (Q1 1994) and Sweden (Q1 1994).

[11] Our proxy for the mortgage rate is the 3 month interest rate on the interbank money market. Hofmann (2001) for the euro area countries and Hofmann & Mizen (2004) for the UK show that the interbank rate is a good proxy.

[12] See studies such as Abraham & Hendershott (1996), Garcia *et al.* (2007), and Stevenson (2008).

consistent and therefore a somewhat less subjective definition, we use the same method adopted by Garcia *et al.* (2007). The authors, in their analysis of the Spanish market, define the equilibrium point as when the direction of real house price movements turned from negative to positive. We therefore, for example, use Q2 2000 in the case of Spain and Q2 1998 for the U.K. [13] Unit root tests, in the form of Augmented Dickey-Fuller test, confirm that the first differences of all of the variables, dependent and independent, are stationary[14].

Table 1 presents a summary of descriptive statistics for real housing prices and the explanatory variables. Those countries that display the highest average real house price appreciation are Denmark, Ireland, Spain, Sweden and the U.K. There is also a tendency for the volatility of house price movements to be high in these markets. However, the mere fact that over the sample period these markets have observed high rates of growth, does not automatically mean that prices were in excess of fundamentals. Part of the increase in prices can be explained by fundamentals. These markets have some of the highest growth rates in disposable income, as well as falls in user costs. This justifies the more detailed analysis adopted in the paper.

INSERT TABLE 1

Given the results of Dickey-Fuller unit root test and equations (8), (9) and (10), we estimate the following empirical specification of house prices fundamentals:

$$\Delta \ln(RHP_t) = \alpha + \beta_1 \Delta \ln(RHP_{t-1}) + \beta_2 \Delta \ln(RHP_{t-4}) + \beta_3 \Delta \ln(RY_{t-1}) + \beta_4 \Delta(RM_{t-1}) + \beta_5 \Delta \ln(TM_{t-1}) + \beta_6 \Delta \ln(CC_{t-1}) + \beta_7 \Delta \ln(HS_{t-1}) + \beta_8 PDEV_{t-1} + \varepsilon_t \quad (15)$$

In equation (15) two lagged real house prices (one and four lags) are included to account for housing bubbles in the price equation (Garcia *et al.*, 2007). We adopt the same procedure as Abraham & Hendershott (1996) to calculate the "bubble burster" (***PDEV***). Firstly, equation (15) is estimated without including ***PDEV***, with the equilibrium growth rate of real price calculated as follows:

[13] The date obtained for each of the 15 markets is available upon request from the authors.
[14] The complete ADF test results are available from the authors.

$$\Delta \ln(\widehat{RHP_t}) = \alpha + \widehat{\beta_3}\Delta \ln(RY_{t-1}) + \widehat{\beta_4}\,\Delta(RM_{t-1}) + \widehat{\beta_5}\Delta \ln(TM_{t-1}) + \widehat{\beta_6}\Delta \ln(CC_{t-1}) + \widehat{\beta_7}\Delta \ln(HS_{t-1}) \quad (16)$$

Then based upon the previously defined equilibrium period we estimate the natural logarithm of the equilibrium real house prices. For example, in the case of Spain where Q2 2000 represents the equilibrium period the calculation of the equilibrium real house prices is as follows:

$$\widehat{lnRHP}_t = lnRHP_{2000:02} + \sum_{l=2000:02+1}^{t} \left(\Delta \widehat{lnRHP}_l\right), para\ t = 2000:03, \ldots, 2007:04,\ e$$

$$\widehat{lnRHP}_t = lnRHP_{2000:02} - \sum_{l=t}^{2000:02-1} \left(\Delta \widehat{lnRHP}_l\right), para\ t = 1990:01, \ldots, 2000:01.$$

(17)

Finally the ***PDEV*** term is calculated as follows:

$$PDEV_t = \widehat{lnRHP}_t - lnRHP_{t,} \quad (18)$$

Equation (15) is then re-estimated with the initial calculation of ***PDEV*** included. The generated regressors problem is resolved by re-estimating equation (15) and updating the computations of ***PDEV*** until the percentage change in each estimated coefficient from one iteration to the next is less than 0,01%[15]. Table 2 presents the estimation results of equation (15) after correcting for autocorrelation through the application of the Newey-West method. All of Spain, Ireland, UK, Sweden and Denmark, exhibit positive and statistically significant coefficients for the first and fourth lags of *Δln(RHP)* variable. The results also suggest that the "bubble burster" has not played a significant role in these countries in restoring equilibrium real house prices as the coefficient on the ***PDEV*** variable is insignificant. The empirical estimates show that the user cost (*RM*) and real total mortgage credit (*TM*) are statistically significant with the exception of mortgage credit in Sweden. In contrast, in Germany, Austria and Portugal, the coefficients for the first and fourth lags of *Δln(RHP)* variable are not statistically significant. In addition, in all of these countries the ***PDEV*** variable is significant, indicating that it has played an important role

[15] An alternative approach to this procedure is to formally estimate an error-correction specification as done in papers such as Malpezzi (1999) and Stevenson (2008).

in restoring equilibrium in real house prices. The results thus show the existence of house price behavior that implies the presence of asset price bubbles in Spain, Ireland, UK, Denmark and Sweden. In comparison, the empirical evidence for Germany, Austria and Portugal reveals an absence of a house price bubble effect and prices that can be explained by fundamentals[16].

INSERT TABLE 2

In order to study the main characteristics of house price bubbles ($\Delta \boldsymbol{RHP_t^b}$) and the fundamental components of real house prices($\Delta \boldsymbol{RHP_t^f}$), we calculate the growth in each component, as follows:

$$\Delta \ln\left(\widehat{RHP_t^b}\right) = \widehat{\beta_1}\Delta \ln(RHP_{t-1}) + \widehat{\beta_2}\Delta \ln(RHP_{t-4}) \tag{19}$$

$$\Delta \ln\left(\widehat{RHP_t^f}\right) = \hat{\alpha} + \hat{\beta}_3\Delta\ln(RY_{t-1}) + \hat{\beta}_4\Delta(RM_{t-1}) + \hat{\beta}_5\Delta\ln(TM_{t-1}) + \widehat{\beta}_6\Delta\ln(CC_{t-1}) + \hat{\beta}_7\Delta\ln(HS_{t-1}) \tag{20}$$

$$\Delta\widehat{RHP_t^b} = \left(e^{\left(\Delta \ln\left(\widehat{RHP_t^b}\right)\right)} - 1\right) * RHP_{t-1} \tag{21}$$

$$\Delta\widehat{RHP_t^f} = \left(e^{\left(\Delta \ln\left(\widehat{RHP_t^f}\right)\right)} - 1\right) * RHP_{t-1} \tag{22}$$

The growth in real house prices is then accumulated in order to analyze the importance of each component during the sample period. Finally, we calculate the market fundamentals and the house price bubble based on the accumulated growth obtained in the previous step and based upon a real house price of 100, for the initial period of the sample. Table 3 and Figure 1 shows the evolution over time and by country of real house prices, its market fundamentals and the house price bubble component. The UK, Spain, Denmark, Sweden and Ireland are those countries that reveal the existence of a greater bubble

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[16] As a robustness test we estimate two alternative specifications. The first re-estimates equation (15): omitting real lagged house price growth rates. The second in turn excludes the fundamental explanatory variables. The empirical evidence supports the earlier findings. The full results from these specifications are available from the authors.

component in the 1995-2007 period. In contrast, Germany, Portugal and Austria have a negative bubble during the same sample period. This empirical evidence is supportive of Miles & Pillonca (2008) who find that expectations concerning future price appreciation played a major role in Belgium, Sweden, Spain, Denmark and the U.K.

INSERT TABLE 3

INSERT FIGURE 1

Maclennan *et al.* (1998) and Martins *et al.* (2010), among others, argue that countries with less conservative mortgage markets (characterized by higher leverage ratios, the possibility of equity extraction and the use of open market value) have institutional conditions that would encourage greater house price growth[17]. In Spain, UK and Ireland, these institutional characteristics are present and they are also linked to a small rental market. These factors further help in explaining why these are the three countries that recorded the highest real house price growth in the 1995-2007 period. In contrast, Germany and Austria, who observe lower rates of house price appreciation, have high transaction costs, low loan-to-value ratios and a smaller owner occupancy rate.

5: Empirical Analysis II – Herding Behavior in the Mortgage Market

To analyze herding behavior we firstly divide the loans outstanding into five different classes of bank assets, namely; (1) sovereign and other government agencies, (2) non-financial institutions, (3) financial institutions, (4) residential property loans and (5) other classes of bank assets (see, Acharya *et al.* 2006)[18]. The data was obtained for the

[17] Martins *et al.* (2010) develop an analysis of clusters which reveals significant differences in terms of institutional characteristics across the EU-15 countries. The authors argue that Spain, Ireland, UK, Denmark, Sweden and Finland, are those EU-15 countries where there is a less conservative mortgage market, a smaller rental market and a generous fiscal system. From Table 3, it is clear that in these countries there has been a substantial increase in the weight of mortgage loans to GDP from 1998 to 2007.

[18] Acharya *et al*. (2006) decompose banks' portfolio assets based on exposure to: (1) sovereigns, (2) other governmental authorities, (3) nonfinancial corporations, (4) financial institutions, (5) households, (6) other

period 1995-2007 from BANKSCOPE. BANKSCOPE reported, as of the end of 2007, balance sheets and income statements for 2,423 banks for the 15 countries we consider in this study[19]. Based on this initial sample we select only banks whose specialization is one of the following: “commercial banks”, “cooperative banks”, “real estate & "mortgage”, “bank holdings & holding companies”, “savings banks” and “investment banks”. This first filtration resulted in the loss of 436 banks. Secondly, we delete all banks with less than three subsequent years of time series observations or who do not have loans outstanding for the five classes of bank assets[20]. The number of banks excluded in this second filtering was 1,437 banks in 2007. The final sample was therefore reduced to 550 banks. Figure 2 shows the percentage of the loans outstanding that were to residential property over the sample period.

INSERT FIGURE 2

INSERT TABLE 4

Table 4 shows the results of for Lakonishok *et al.* (1992) herding measure for the sample means over the five different classes of bank assets and for the residential property loan asset class. The calculation of sample means of the LSV herding measure consists of the average (for the five classes of bank assets) of the proportion of banks that have increased or decreased the loans outstanding amount due to herding behavior. Table 4 also shows the *p-values*, relating to the statistical significance of the herding measures. For both LSV herding measures we provide two tests of statistical significance, the *t* test and the

counterparties. In the present study we merge the first two classes of assets as BANKSCOPE do not distinguish between the two in their database.

[19] Note that in almost all the banks analyzed, there is a breaking of the series concerned due to the change in accounting systems from “Local Generally Accepted Accounting Principles (GAAP)” to “International Financial Reporting Standards (IFRS)”. Tthere are however, no substantial changes in the data series used in this study due to this change. In line with studies such as Lepetit *et al.* (2008) we exclude the large number of small local cooperative banks in Germany, who number more than 1,500.

[20] For some banks there is no information available on BANKSCOPE about loans outstanding for residential property loans. In these situations, we consulted directly the banks’ balance sheets and income statements. The IAS14 (replaced by IFRS 8 on January 1, 2008) “Operating Segments” requires that companies disclose the main operating segments. Given the importance of loans outstanding for residential property loans on banks’ asset portfolio, it is possible by consulting the banks’ balance sheets and income statements to know the total amount of loans outstanding for residential property loans.

Chi-square test. Uchida & Nakagawa (2007) report that the chi-square test tends to be more suitable in detecting herding behavior in small-samples. Given the small number of banks in some of the countries it was decided to present the results of statistical significance obtained from both tests. We find different results for the herding behavior analysis. While the sample means over the five different classes of bank assets shows no statistical significance for most countries and time periods analyzed, the LSV measure for the residential property asset class reveals the existence of countries where statistically significance is evident. Of specific interest we find evidence of herding behavior in markets such as Spain, Ireland, UK, Greece and Denmark. There are all countries in which it was illustrated that the house price bubble component assumes a high importance in explaining price movements. In contrast, in the cases of Germany, Portugal and Austria, whose house prices are predominantly explained by their market fundamentals, the LSV herding measure for the residential property loans asset class reveals no statistical significance.

In order to analyze the robustness of the results, we test the hypothesis that the LSV measure for the residential property sector is statistically different from the overall LSV measure. For the purposes of this test we use a means one-sample *t* test, the results from which are reported in Table 5. The findings report a negative and statistically significant *t* test for the difference between the LSV measure over the five different classes of bank assets (sample mean) and the herding measure for the residential sector for Spain, Ireland, UK, Greece and Denmark. The results therefore imply that there is enhanced herding behavior in residential loans than for other loan sectors. In contrast, in the case of Germany, Austria, France, Italy and Portugal, whilst a significant *t*-statistic is observed, the LSV measure for the residential sector is smaller than for other asset classes. For the remaining markets (Belgium, Luxembourg, Finland, the Netherlands, Sweden), the residential property LSV herding measure is not statistically different from the overall LSV measure. The results would appear to indicate that a high level of outstanding loans to residential property not only results from institutional factors - less conservative lending practices by banks and a generous fiscal system (Maclennan *et al.*, 1998 and Martins *et al.*, 2010), but also from herding behavior among banks. In turn, this behavior may have contributed to the emergence of irrational bubble like behavior in the housing markets in Spain, Ireland, the U.K. and Denmark.

The results do not preclude possibility of the presence and/or contribution of "disaster myopia" in these countries. This refers to the tendency over time to underestimate the probability of low-frequency shocks. Herring & Wachter (1999) report that during the ascending phase of a real estate price cycle the subjective probability of collapse in prices tends to decrease. This leads to banks taking on greater exposures relative to their capital positions. Moreover, customers judged too risky at the previous stage of the cycle, tend to get credit more easily in the expansion phase. Consequently, the quality of the loan portfolios is likely to deteriorate and become too risky in the mature stage of the cycle and the banking system becomes more vulnerable to disaster[21]. Herring & Wachter (1999) argue that disaster myopia may not only be exacerbated by competition but it may also be related to herding in that banks take on similar exposures, in this to the residential property market[22].

INSERT TABLE 5

The final component of the empirical analysis extends the preceding analysis by considering the causal relationships present. In order to analyze the rationality of herding behavior, correlations and Granger causality tests for the herding measure and housing bubble term are estimated. Table 6 reports shows the correlations between the two variables while the Granger Causality results are displayed in Table 7. The correlation results show the existence of a strong and statistically significant positive correlation between herding and bubble measures in Denmark, Spain, Greece, Ireland, the U.K. and Sweden. For the remaining countries the correlations are not statistically significant. The results also highlight across all 15 countries the lack of statistical significance between the overall LSV measure and the house price bubble term. The correlation though is a simplistic measure and crucially does not by itself a causal relationship. This is therefore why Granger Causality tests are employed to formally examine the causal relationships

[21] See studies such as Demyanyk & Van Hemert (2011) who consider related issues in the context of the U.S. subprime crisis.
[22] The authors also argue that disaster myopia can also affect the supervisory authorities in that they are likely to be subject to the same perceptual biases as the banks.

between the LSV herding measure and the house price bubble term. The results are reported in Table 7.

The results interestingly reveal that in no case is their evidence of a significant causal relationship from the banks, in terms of herding, to the house market and any non-fundamental, bubble like, behavior. However, in contrast, for five of the markets there is significant evidence of a causal relationship in the direction of bank herding. Of particular interest and relevance is that these five markets are Denmark, Spain, Ireland, Sweden and the U.K. For the remaining countries of the EU-15, the results show that two variables are independent. Our results therefore suggest that for the five markets that observed strong house price appreciation, to the extent that it can be argued that a bubble was present, this behavior in the housing market led to herding behavior on the part of banks. The finding may reflect the fact that banks are responding as a group to common information and that this information is return-relevant. However, the findings can also be explained by the fact that the choices of banks may be taken as a group, given the “too-many-to-fail” hypothesis (Acharya & Yorulmazer, 2007).

INSERT TABLES 6 & 7

6: Conclusion

Despite the process of economic convergence and monetary union within he Eurozone, there remain significant differences in housing and financial market institutions across the different member states of the EU. While in countries like Germany, Portugal and Austria movements in house prices seem to be explained by market fundamentals, in Spain, UK, Ireland, Denmark and Sweden, much of the house price behavior observed during the last cycle can be argued to have been driven by non-fundamental, speculative factors. The results presented in this paper reveal the existence of a significant house price bubble component bubble in the UK, Spain, Denmark, Sweden and Ireland, where the house price bubble component shows an accumulated real growth of 37% between 1998 and 2007. For this group of countries the LSV herding measure for the residential mortgage market is shown to be expressive and statistically significant. The results also indicate the existence of unilateral Granger Causality from these housing markets to the banking sector. In contrast, in markets such as Germany, Portugal and Austria, whose house prices are predominantly explained by their market fundamentals, the LSV herding measure revealed no statistical significance. For these countries it is not possible to establish a Granger causality relationship between herding and house prices.

The results reported for Spain, Ireland, UK, Sweden and Denmark have important implications in terms of economic policy and regulation. Given the importance of the mortgage market in these countries and the fact that these countries display less conservative mortgage systems it is possible that we observed “disaster myopia”. A phenomena, fueled by herding behavior in the loan market, that in a situation of economic recession with a decrease in house prices has had have serious consequences for financial stability. This situation is further exacerbated in the case of Spain, Ireland and UK, given the higher level of owner occupancy and household debt.

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Table 1: Descriptive Statistics: Real House Prices and Market Fundamentals

The table shows the mean, standard deviation and Jarque-Bera test for real house prices and market fundamental for each EU-15 countries. The following variables are used in the analysis: real house prices indices (*RHP*), real disposable income (*RY*), real house user cost (*RM*), total mortgage credit (*TM*), construction costs indices (*CC*), and "building permits" or "new buildings orders" indices as a proxy for the level of housing supply (*HS*). The analysis is performed for the first difference of the logarithm of the variables, except for *RM*. The null hypothesis for the Jarque-Bera test is that the data are normally distributed. [a, b, c] indicate the existence of statistical significance of 1%, 5% and 10%, respectively.

Country		**Δln(RHP)**	**Δln(RY)**	**ΔRM**	**Δln(TM)**	**Δln(CC)**	**Δln(HS)**
Austria	Mean	-0.0019	0.0079	-0.0490	0.0209	0.0028	0.0155
	Std. deviation	0.0227	0.0485	0.0030	0.0193	0.0078	0.1498
	Jarque-Bera	0.517	7.676[b]	3.394	17.525[a]	0.152	2.031
Belgium	Mean	0.0122	0.0090	-0.0445	0.0089	0.0013	0.0004
	Std. deviation	0.0218	0.0179	0.0754	0.2290	0.1474	0.1400
	Jarque-Bera	0.777	1.747	1.051	1.898	4.052	50.863[a]
Denmark	Mean	0.0149	0.0100	-0.0786	0.0086	0.0027	-0.0033
	Std. deviation	0.0208	0.0156	0.1434	0.0515	0.0078	0.1664
	Jarque-Bera	0.228	1.550	1.042	86.190[a]	0.977	6.513[b]
Finland	Mean	0.0106	0.0086	-0.0707	0.0139	0.0003	-0.0093
	Std. deviation	0.0473	0.0718	0.0246	0.0677	0.0084	0.1578
	Jarque-Bera	0.323	11.063[a]	1.744	20.935[a]	12.117[a]	42.570[a]
France	Mean	0.0126	0.0053	-0.0788	0.0153	0.0030	0.0072
	Std. deviation	0.0209	0.0036	0.0382	0.0121	0.0059	0.0853
	Jarque-Bera	3.438	0.273	0.8838	1.262	3.637	123.62[a]
Germany	Mean	-0.0023	0.0078	-0.0005	0.0109	0.0007	-0.0121
	Std. deviation	0.0055	0.0192	0.0141	0.0197	0.0071	0.0971
	Jarque-Bera	3.231	51.389[a]	0.251	11.403[a]	84.545[a]	1.188
Greece	Mean	0.0107	0.0111	-0.3021	0.0510	0.0007	0.0086
	Std. deviation	0.0150	0.0049	0.0072	0.0776	0.0078	0.1919
	Jarque-Bera	0.026	22.051[a]	1.4733	16.512[a]	1.598	51.492[a]
Ireland	Mean	0.0192	0.0103	-0.0823	0.0359	0.0034	0.0175
	Std. deviation	0.0274	0.0178	0.0131	0.1273	0.0154	0.1419
	Jarque-Bera	0.046	2.211	0.0322	31.233[a]	10.915[a]	0.383
Italy	Mean	0.0085	0.0095	-0.0613	0.0138	0.0003	0.0126
	Std. deviation	0.0294	0.0275	0.0071	0.0199	0.0095	0.0879
	Jarque-Bera	0.628	13.485[a]	2.155	3.494	24.250[a]	3.413
Luxembourg	Mean	0.0098	0.0081	-0.0583	0.0145	-0.0004	0.0010
	Std. deviation	0.0117	0.0153	0.0035	0.1455	0.0062	0.2552
	Jarque-Bera	0.325	0.648	0.761	1.066	1.626	0.138
Netherlands	Mean	0.0142	0.0104	-0.0550	0.0221	-0.0002	-0.0014
	Std. deviation	0.0212	0.0173	0.0789	0.0202	0.0083	0.1382
	Jarque-Bera	8.849[b]	10.024[a]	1.300	21.411[a]	4.571[c]	2.557
Portugal	Mean	0.0005	0.0126	-0.1355	0.0348	0.0022	-0.0038
	Std. deviation	0.0109	0.0223	0.0038	0.0259	0.0104	0.0702
	Jarque-Bera	2.338	15.715[a]	2.598	4.017[c]	19.152[a]	7.887[b]
Spain	Mean	0.0224	0.0115	-0.1359	0.0261	-0.0004	0.0203
	Std. deviation	0.0239	0.0264	0.0753	0.1076	0.0102	0.0973
	Jarque-Bera	2.249	1.519	2.329	9.681[a]	0.074	0.314
Sweden	Mean	0.0143	0.0121	-0.0502	0.0311	0.0005	0.0064
	Std. deviation	0.0162	0.0731	0.0161	0.0577	0.0070	0.0309
	Jarque-Bera	1.715	3.793	0.844	21.879[a]	0.877	70.898[a]
United Kingdom	Mean	0.0176	0.0131	-0.0273	0.0269	0.0065	0.0104
	Std. deviation	0.0257	0.0316	0.0593	0.2011	0.0197	0.1035
	Jarque-Bera	0.146	2.333	1.109	0.779	7.728[b]	1.796

Table 2: Estimation Results of Real House Price Equation

The table presents the estimation results of real house price equation (15) for the EU-15 countries. The following variables are used in the analysis: real house prices indices (*RHP*), real disposable income (*RY*), real house user cost (*RM*), real total mortgage credit (*TM*), construction costs indices (*CC*), and "building permits" or "new buildings orders" indices as a proxy for the level of housing supply (*HS*). PDEV is the bubble burster term. The analysis is performed for the first differences of the logarithm of the variables except for *RM*. Numbers in parenthesis are *p-values*. RESET is the Ramsey's regression specification error test. ARCH is the Engle's Lagrange multiplier test for ARCH disturbances. The null hypothesis for the Jarque-Bera test is that the data are normally distributed. [a, b, c] indicate the existence of statistical significance of 1%, 5% and 10%, respectively. # is the number of observations.

	Aus	Bel	Den	Finland	France	Ger	Greece	Ireland	Italy	Lux	Neth	Port	Spain	Sweden	UK
Constant	0.001	0.010[a]	0.002	0.002	0.022[a]	0.009	0.009[c]	0.010[b]	0.002	0.001	0.011	-0.004[b]	0.002	-1.742	0.001
	(0.709)	(0.000)	(0.309)	(0.690)	(0.000)	(0.118)	(0.051)	(0.031)	(0.513)	(0.102)	(0.151)	(0.029)	(0.461)	(0.278)	(0.545)
$\Delta\ln(RHP_{t-1})$	-0.038	-0.005	0.813[a]	0.193	0.182[c]	-0.321	0.464[a]	0.228[c]	0.346[a]	0.235[a]	-0.204	0.121	0.324[b]	0.506[a]	0.251[c]
	(0.821)	(0.970)	(0.000)	(0.423)	(0.087)	(0.333)	(0.007)	(0.097)	(0.001)	(0.000)	(0.435)	(0.605)	(0.023)	(0.000)	(0.066)
$\Delta\ln(RHP_{t-4})$	0.080	0.139[c]	0.066	0.198[b]	-0.162	-0.055	-0.090	0.351[c]	-0.082[c]	0.163	0.136[c]	0.137	0.250[b]	0.074	0.252[b]
	(0.546)	(0.089)	(0.322)	(0.040)	(0.315)	(0.734)	(0.449)	(0.085)	(0.097)	(0.110)	(0.094)	(0.352)	(0.050)	(0.378)	(0.013)
$\Delta\ln(RY_{t-1})$	-0.121	-0.029	0.117[c]	0.214	0.091	0.030[c]	0.252	0.224[c]	0.044	0.007	0.296[c]	0.010	0.100[c]	0.003	0.129[b]
	(0.231)	(0.704)	(0.098)	(0.381)	(0.255)	(0.080)	(0.183)	(0.080)	(0.364)	(0.827)	(0.055)	(0.973)	(0.094)	(0.917)	(0.018)
$\Delta(RM_{t-1})$	-0.003[a]	-0.002[a]	-0.003[a]	-0.002[a]	-0.003[a]	-0.003[a]	-0.002[a]	-0.002[a]	-0.001[a]	-0.002[a]	-0.004[a]	-0.002[a]	-0.002[a]	-0.002[a]	-0.002[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\Delta\ln(TM_{t-1})$	-0.076	0.024[b]	0.053[c]	0.018	0.047[b]	0.035	0.005	0.045[b]	0.013[b]	-0.006	0.028[b]	0.018[a]	0.043[c]	0.004	0.034[a]
	(0.609)	(0.018)	(0.089)	(0.795)	(0.027)	(0.199)	(0.838)	(0.030)	(0.026)	(0.482)	(0.048)	(0.004)	(0.075)	(0.863)	(0.004)
$\Delta\ln(CC_{t-1})$	0.468	0.004	-0.065	0.731	0.113	0.062[c]	0.727[a]	0.096	0.080	0.570[a]	0.613[c]	0.189	0.215	0.767[b]	0.171[c]
	(0.376)	(0.627)	(0.718)	(0.237)	(0.593)	(0.085)	(0.008)	(0.464)	(0.576)	(0.003)	(0.078)	(0.294)	(0.331)	(0.019)	(0.092)
$\Delta\ln(HS_{t-1})$	0.037	0.025[b]	0.008	0.018	0.067[b]	-0.001	0.002	0.035[c]	-0.026	0.002	0.018	0.011	0.010	-0.061[c]	0.044[b]
	(0.267)	(0.014)	(0.224)	(0.438)	(0.020)	(0.788)	(0.774)	(0.063)	(0.308)	(0.380)	(0.158)	(0.456)	(0.498)	(0.053)	(0.029)
$PDEV_{t-1}$	0.059[c]	-0.022	-0.004	0.030	-0.006	-0.056[b]	-0.007	-0.001	0.004	0.003	0.016	0.113[b]	-0.002	-0.010	-0.005
	(0.090)	(0.183)	(0.910)	(0.357)	(0.711)	(0.021)	(0.725)	(0.971)	(0.723)	(0.611)	(0.704)	(0.045)	(0.813)	(0.290)	(0.562)
#	43	67	67	67	47	67	47	67	67	59	67	28	67	51	67
R^2 Adj.	0.525	0.736	0.788	0.463	0.650	0.451	0.518	0.543	0.678	0.679	0.278	0.550	0.560	0.718	0.664
RESET	0.500	0.489	1.514	0.571	0.530	0.959	0.468	0.103	2.702[c]	0.530	0.302	1.007	0.116	0.748	0.443
	(0.684)	(0.691)	(0.221)	(0.636)	(0.667)	(0.415)	(0.706)	(0.957)	(0.071)	(0.667)	(0.823)	(0.420)	(0.949)	(0.530)	(0.722)
ARCH	0.090	0.851	0.338	1.553	0.975	0.872	1.929	0.721	0.691	1.338	0.686	1.879	0.522	1.032	1.026
	(0.984)	(0.498)	(0.849)	(0.198)	(0.439)	(0.483)	(0.134)	(0.581)	(0.604)	(0.268)	(0.607)	(0.155)	(0.719)	(0.401)	(0.401)
Jarque-Bera	0.978	0.500	3.602	0.383	0.557	0.499	0.634	0.484	1.388	4.624[c]	2.447	0.739	0.169	5.326[c]	2.010
	(0.613)	(0.778)	(0.165)	(0.825)	(0.756)	(0.778)	(0.728)	(0.784)	(0.499)	(0.099)	(0.294)	(0.690)	(0.918)	(0.069)	(0.366)

Table 3: Real House Prices and Bubble Term

The table shows the real house prices growth and the house prices bubble term for two time periods: whole period (1995:1 to 2007:4) and temporal window of the last five years (2003:1 to 2007: 4) for EU-15, based on equations (19), (20), (21) and (22). For each country and period analysis it is presented the real house price growth rate for each temporal period. In the column "Household Debt" comes the weight of mortgage loans as a % of GDP, by country in 1998 and 2007.

Country	1995:1 to 2007:4		2003:1 to 2007:4		Household Debt*	
	Real House Price Growth (%)	Bubble Term (%)	Real House Price Growth (%)	Bubble Term (%)	1995	2007
Austria	-4.99	-0.03	9.09	0.62	13.7%	23.9%
Belgium	93.07	9.44	50.81	6.33	26.5%	36.8%
Denmark	81.40	48.22	51.77	33.27	75.0%	92.8%
Finland	70.26	26.34	43.70	15.15	29.5%	45.7%
France	83.95	9.66	58.80	5.52	20.0%	34.9%
Germany	-12.23	-18.69	-9.37	-13.03	51.9%	47.7%
Greece	62.07	27.70	22.40	11.27	6.3%	30.2%
Ireland	111.52	37.32	32.70	14.47	26.5%	75.3%
Italy	61.62	14.60	29.40	7.29	7.8%	19.8%
Luxembourg	74.71	27.69	33.02	24.25	23.3%	38.5%
Netherlands	72.27	8.94	11.85	2.07	60.8%	98.6%
Portugal	4.30	-7.80	-4.25	-4.49	36.9%	62.1%
Spain	117.99	54.87	51.98	31.63	23.8%	61.4%
Sweden	110.22	46.45	46.64	21.90	44.5%	57.0%
United Kingdom	146.03	57.22	45.16	23.11	50.6%	86.3%

*Source: European Mortgage Federation, "*Hypostat 2008- A Review of Europe's Mortgage and Housing Markets*", November 2009

Table 4: Results of LSV Herding Measure for Loans Outstanding

The table presents the results of Lakonishok, Schleifer and Vishny (1992) (LSV) herding measure, given by equation (11), for the period 1995-2007 for the EU-15 countries. The LSV herding measures are based on the total amount of loans outstanding and weight of loans outstanding to the five different classes of bank assets, which is based on the banks' exposure to: (1) sovereigns and other governmental authorities, (2) nonfinancial corporations, (3) financial institutions, (4) residential property and (5) other counterparties (see Acharya *et al*. 2006). The "**LSV Total**" column refers to the value of the sample means of LSV herding measures over the five different classes of banks assets. The "**LSV House**" column refers to the residential property loans asset class LSV herding measure. For both LSV herding measures are presented their *t*-statistic and Chi-square statistic *p-values*. Data were obtained from BANKSCOPE. Only were selected for analysis, banks whose specialization is one of the following: "commercial banks", "cooperative banks", "real estate & mortgage", "bank holdings & holding companies", "savings banks" and "investment banks".

Year	Austria						Belgium						Denmark					
	LSV Total	*p-value*		LSV House	*p-value*		LSV Total	*p-value*		LSV House	*p-value*		LSV Total	*p-value*		LSV House	*p-value*	
		t	*Chi²*		*t*	*Chi²*		*t*	*Chi²*		*t*	*Chi²*		*t*	*Chi²*		*t*	*Chi²*
1996	0.1251	0.35	0.25	0.0495	0.15	0.45	0.0557	0.37	0.75	0.0107	0.34	0.94	0.0568	0.42	0.51	0.0467	0.21	0.52
1997	0.0994	0.41	0.26	0.0519	0.18	0.49	0.1240	0.34	0.51	0.0233	0.31	0.87	0.0777	0.45	0.35	-0.0219	0.56	0.75
1998	0.1232	0.36	0.22	0.0710	0.11	0.34	0.1236	0.37	0.50	0.0803	0.19	0.55	0.1126	0.44	0.13	0.1893	0.00	0.00
1999	0.0986	0.36	0.37	0.0739	0.10	0.29	0.0793	0.40	0.54	0.0932	0.13	0.44	0.1956	0.51	0.16	0.2593	0.00	0.00
2000	0.0426	0.42	0.55	0.0502	0.16	0.45	0.1781	0.40	0.17	0.1620	0.03	0.17	0.1714	0.35	0.22	0.2051	0.00	0.00
2001	0.0715	0.39	0.45	0.0222	0.31	0.76	0.0610	0.42	0.66	-0.0509	0.56	0.67	0.0821	0.39	0.27	0.0994	0.05	0.17
2002	0.1234	0.36	0.29	0.0579	0.16	0.43	0.1492	0.44	0.33	0.1947	0.03	0.14	0.0803	0.46	0.25	0.1151	0.02	0.08
2003	0.0332	0.45	0.64	-0.0277	0.60	0.67	0.0816	0.41	0.58	0.1130	0.13	0.39	0.0680	0.40	0.48	0.0162	0.35	0.81
2004	0.0964	0.40	0.17	0.0738	0.07	0.24	0.1080	0.39	0.40	0.0793	0.15	0.48	0.1330	0.44	0.20	0.2072	0.00	0.00
2005	0.0677	0.43	0.35	0.0695	0.10	0.29	0.1109	0.43	0.33	0.1029	0.07	0.31	0.1399	0.50	0.17	0.1849	0.00	0.00
2006	0.0624	0.45	0.42	0.0851	0.07	0.22	0.0865	0.40	0.54	0.1062	0.12	0.39	0.1658	0.58	0.03	0.2166	0.00	0.00
2007	0.0901	0.43	0.32	0.0735	0.11	0.31	0.1725	0.40	0.29	0.1200	0.08	0.31	0.1263	0.54	0.10	0.1831	0.00	0.00

Table 4: Results of LSV Herding Measure for Loans Outstanding (cont.)

The table presents the results of Lakonishok, Schleifer and Vishny (1992) (LSV) herding measure, given by equation (11), for the period 1995-2007 for the EU-15 countries. The LSV herding measures are based on the total amount of loans outstanding and weight of loans outstanding to the five different classes of bank assets, which is based on the banks' exposure to: (1) sovereigns and other governmental authorities, (2) nonfinancial corporations, (3) financial institutions, (4) residential property and (5) other counterparties (see Acharya *et al*. 2006). The "**LSV Total**" column refers to the value of the sample means of LSV herding measures over the five different classes of banks assets. The "**LSV House**" column refers to the residential property loans asset class LSV herding measure. For both LSV herding measures are presented their *t*-statistic and Chi-square statistic *p-values*. Data were obtained from BANKSCOPE. Only were selected for analysis, banks whose specialization is one of the following: "commercial banks", "cooperative banks", "real estate & mortgage", "bank holdings & holding companies", "savings banks" and "investment banks".

Year	Finland						France						Germany					
	LSV Total	p-value		LSV House	p-value		LSV Total	p-value		LSV House	p-value		LSV Total	p-value		LSV House	p-value	
		t	Chi^2		t	Chi^2		t	Chi^2		t	Chi^2		t	Chi^2		t	Chi^2
1996	0.0990	0.33	0.54	0.1100	0.20	0.75	0.0967	0.41	0.15	0.0556	0.14	0.34	0.0636	0.48	0.45	0.0241	0.29	0.72
1997	0.1200	0.29	0.69	0.1000	0.18	0.73	0.0833	0.43	0.21	0.0546	0.14	0.34	0.0580	0.41	0.55	0.0119	0.36	0.86
1998	0.3667	0.39	0.23	0.4167	0.00	0.09	0.0763	0.34	0.34	0.0449	0.17	0.42	0.1089	0.47	0.29	0.0336	0.25	0.62
1999	0.1800	0.28	0.38	0.1500	0.00	0.40	0.1009	0.42	0.09	0.0522	0.10	0.27	0.1246	0.33	0.26	0.0920	0.05	0.17
2000	0.2400	0.28	0.37	0.2000	0.00	0.32	0.1280	0.42	0.09	0.0480	0.15	0.36	0.0874	0.45	0.36	0.0486	0.21	0.52
2001	0.0960	0.32	0.52	0.1200	0.00	0.41	0.0778	0.44	0.15	0.0459	0.14	0.35	0.0639	0.46	0.49	0.0468	0.22	0.54
2002	0.1867	0.38	0.35	0.1000	0.16	0.58	0.0830	0.48	0.33	0.0501	0.13	0.32	0.0380	0.43	0.69	0.0731	0.14	0.36
2003	0.3147	0.48	0.15	0.3933	0.01	0.05	0.0827	0.41	0.19	0.0467	0.14	0.34	0.0716	0.40	0.50	0.0303	0.29	0.69
2004	0.1013	0.37	0.58	0.2067	0.00	0.21	0.0947	0.41	0.11	0.0475	0.12	0.30	0.0949	0.52	0.27	-0.0456	0.68	0.53
2005	0.0747	0.35	0.67	0.0733	0.19	0.67	0.0583	0.38	0.34	0.0409	0.13	0.32	0.0759	0.50	0.33	-0.0667	0.78	0.36
2006	0.2533	0.30	0.36	0.2000	0.06	0.31	0.0729	0.40	0.17	0.0477	0.11	0.28	0.0640	0.45	0.45	0.0686	0.14	0.35
2007	0.1493	0.36	0.39	0.0133	0.30	0.93	0.0910	0.57	0.15	0.0489	0.12	0.29	0.0380	0.46	0.64	-0.0460	0.69	0.53

Table 4: Results of LSV Herding Measure for Loans Outstanding (cont.)

The table presents the results of Lakonishok, Schleifer and Vishny (1992) (LSV) herding measure, given by equation (11), for the period 1995-2007 for the EU-15 countries. The LSV herding measures are based on the total amount of loans outstanding and weight of loans outstanding to the five different classes of bank assets, which is based on the banks' exposure to: (1) sovereigns and other governmental authorities, (2) nonfinancial corporations, (3) financial institutions, (4) residential property and (5) other counterparties (see Acharya *et al*. 2006). The "**LSV Total**" column refers to the value of the sample means of LSV herding measures over the five different classes of banks assets. The "**LSV House**" column refers to the residential property loans asset class LSV herding measure. For both LSV herding measures are presented their *t*-statistic and Chi-square statistic *p-values*. Data were obtained from BANKSCOPE. Only were selected for analysis, banks whose specialization is one of the following: "commercial banks", "cooperative banks", "real estate & mortgage", "bank holdings & holding companies", "savings banks" and "investment banks".

Year	**Greece**						**Ireland**						**Italy**					
	LSV Total	***p-value***		**LSV House**	***p-value***		**LSV Total**	***p-value***		**LSV House**	***p-value***		**LSV Total**	***p-value***		**LSV House**	***p-value***	
		t	***Chi^2***		***t***	***Chi^2***		***t***	***Chi^2***		***t***	***Chi^2***		***t***	***Chi^2***		***t***	***Chi^2***
1996	0.1300	0.36	0.36	0.1500	0.00	0.23	0.1177	0.42	0.45	0.2186	0.00	0.09	0.0974	0.48	0.31	0.0528	0.18	0.47
1997	0.1120	0.31	0.44	0.1200	0.00	0.24	0.1046	0.40	0.55	0.2217	0.00	0.09	0.1034	0.37	0.42	0.0549	0.17	0.44
1998	0.0960	0.39	0.36	0.1200	0.00	0.24	0.1106	0.44	0.49	0.2428	0.01	0.09	0.1171	0.42	0.14	0.0503	0.17	0.44
1999	0.0400	0.36	0.72	0.0000	0.35	1.00	0.0956	0.41	0.55	0.2019	0.00	0.07	0.1305	0.42	0.10	0.0753	0.10	0.26
2000	0.2182	0.39	0.08	0.1818	0.00	0.12	0.0832	0.44	0.59	0.2080	0.01	0.10	0.1509	0.45	0.14	0.0305	0.27	0.64
2001	0.2691	0.38	0.09	0.2545	0.00	0.00	0.1385	0.41	0.40	0.2142	0.01	0.09	0.1512	0.38	0.12	0.0800	0.07	0.21
2002	0.2867	0.45	0.20	0.3500	0.00	0.01	0.1502	0.45	0.33	0.2408	0.01	0.05	0.0898	0.49	0.31	0.0634	0.13	0.33
2003	0.2277	0.49	0.17	0.2462	0.01	0.01	0.1968	0.41	0.32	0.2492	0.00	0.05	0.1116	0.40	0.20	0.0815	0.07	0.18
2004	0.2031	0.39	0.33	0.2462	0.01	0.06	0.1023	0.45	0.34	0.1695	0.00	0.09	0.1019	0.54	0.25	0.0467	0.18	0.43
2005	0.1908	0.42	0.21	0.2615	0.00	0.05	0.0691	0.44	0.56	0.1729	0.00	0.09	0.0990	0.45	0.25	0.0693	0.09	0.24
2006	0.1736	0.41	0.31	0.2692	0.00	0.02	0.1341	0.40	0.45	0.2229	0.02	0.08	0.0962	0.44	0.31	0.1013	0.03	0.09
2007	0.2295	0.49	0.15	0.2868	0.00	0.00	0.1381	0.40	0.42	0.2262	0.01	0.08	0.1100	0.49	0.24	0.0650	0.10	0.26

Table 4: Results of LSV Herding Measure for Loans Outstanding (cont.)

The table presents the results of Lakonishok, Schleifer and Vishny (1992) (LSV) herding measure, given by equation (11), for the period 1995-2007 for the EU-15 countries. The LSV herding measures are based on the total amount of loans outstanding and weight of loans outstanding to the five different classes of bank assets, which is based on the banks' exposure to: (1) sovereigns and other governmental authorities, (2) nonfinancial corporations, (3) financial institutions, (4) residential property and (5) other counterparties (see Acharya *et al*. 2006). The "**LSV Total**" column refers to the value of the sample means of LSV herding measures over the five different classes of banks assets. The "**LSV House**" column refers to the residential property loans asset class LSV herding measure. For both LSV herding measures are presented their *t*-statistic and Chi-square statistic *p-values*. Data were obtained from BANKSCOPE. Only were selected for analysis, banks whose specialization is one of the following: "commercial banks", "cooperative banks", "real estate & mortgage", "bank holdings & holding companies", "savings banks" and "investment banks".

Year	Luxembourg						Netherlands						Portugal					
	LSV Total	*p-value*		LSV House	*p-value*		LSV Total	*p-value*		LSV House	*p-value*		LSV Total	*p-value*		LSV House	*p-value*	
		t	*Chi*^{2}		*t*	*Chi*^{2}		*t*	*Chi*^{2}		*t*	*Chi*^{2}		*t*	*Chi*^{2}		*t*	*Chi*^{2}
1996	0.0864	0.39	0.59	-0.0114	0.42	0.93	0.0652	0.41	0.52	0.0814	0.12	0.40	0.0762	0.44	0.62	-0.0119	0.44	0.92
1997	0.1718	0.28	0.32	0.1159	0.08	0.34	0.0848	0.43	0.40	0.1060	0.07	0.26	0.2057	0.38	0.18	0.1000	0.11	0.38
1998	0.0867	0.42	0.53	0.0167	0.33	0.88	0.1035	0.36	0.46	0.1098	0.10	0.31	0.2040	0.38	0.21	0.1022	0.13	0.41
1999	0.1467	0.45	0.24	0.1833	0.00	0.10	0.0747	0.43	0.52	0.0567	0.21	0.56	0.2010	0.41	0.15	0.0821	0.16	0.48
2000	0.0807	0.38	0.54	0.0530	0.22	0.64	0.0538	0.41	0.59	0.0756	0.13	0.40	0.1277	0.40	0.27	0.0904	0.11	0.38
2001	0.0752	0.39	0.60	0.0598	0.22	0.63	0.0805	045	0.51	0.0440	0.25	0.65	0.1815	0.41	0.12	0.0966	0.09	0.33
2002	0.0656	0.39	0.66	0.0803	0.20	0.56	0.1519	0.40	0.23	0.1036	0.11	0.31	0.2453	0.42	0.13	0.0822	0.17	0.47
2003	0.1142	0.45	0.49	-0.1265	0.74	0.35	0.1271	0.42	0.25	0.0911	0.13	0.36	0.0987	0.48	0.54	-0.0200	0.48	0.85
2004	0.1108	0.43	0.46	-0.0410	0.51	0.77	0.0531	0.42	0.59	0.0611	0.18	0.49	0.1324	0.43	0.27	0.0844	0.13	0.41
2005	0.1269	0.44	0.32	0.1943	0.01	0.10	0.0867	0.45	0.36	0.1084	0.07	0.22	0.0773	0.40	0.40	0.0644	0.15	0.47
2006	0.1029	0.40	0.45	0.0857	0.17	0.51	0.1062	0.40	0.34	0.0885	0.12	0.35	0.1262	0.45	0.33	0.1022	0.10	0.33
2007	0.1006	0.38	0.48	0.0600	0.22	0.61	0.1002	0.40	0.35	0.0610	0.19	0.51	0.1093	0.35	0.43	0.0044	0.39	0.96

Table 4: Results of LSV Herding Measure for Loans Outstanding (cont.)

The table presents the results of Lakonishok, Schleifer and Vishny (1992) (LSV) herding measure, given by equation (11), for the period 1995-2007 for the EU-15 countries. The LSV herding measures are based on the total amount of loans outstanding and weight of loans outstanding to the five different classes of bank assets, which is based on the banks' exposure to: (1) sovereigns and other governmental authorities, (2) nonfinancial corporations, (3) financial institutions, (4) residential property and (5) other counterparties (see Acharya *et al*. 2006). The "**LSV Total**" column refers to the value of the sample means of LSV herding measures over the five different classes of banks assets. The "**LSV House**" column refers to the residential property loans asset class LSV herding measure. For both LSV herding measures are presented their *t*-statistic and Chi-square statistic *p-values*. Data were obtained from BANKSCOPE. Only were selected for analysis, banks whose specialization is one of the following: "commercial banks", "cooperative banks", "real estate & mortgage", "bank holdings & holding companies", "savings banks" and "investment banks".

	Spain						**Sweden**						**United Kingdom**					
Year	**LSV Total**	***p-value***		**LSV House**	***p-value***		**LSV Total**	***p-value***		**LSV House**	***p-value***		**LSV Total**	***p-value***		**LSV House**	***p-value***	
		t	***Chi^2***		***t***	***Chi^2***		***t***	***Chi^2***		***t***	***Chi^2***		***t***	***Chi^2***		***t***	***Chi^2***
1996	0.1263	0.35	0.35	0.1484	0.00	0.01	0.2107	0.41	0.38	-0.3200	0.89	0.10	0.1037	0.45	0.17	0.1332	0.00	0.01
1997	0.1798	0.49	0.19	0.2248	0.00	0.00	0.2590	0.40	0.23	0.1762	0.07	0.32	0.1669	0.51	0.16	0.1797	0.00	0.00
1998	0.1948	0.48	0.19	0.2404	0.00	0.00	0.1219	0.42	0.59	-0.1333	0.66	0.44	0.0874	0.54	0.29	0.1752	0.00	0.00
1999	0.2006	0.38	0.36	0.2478	0.00	0.00	0.2933	0.37	0.12	0.2444	0.00	0.09	0.0859	0.40	0.06	0.1771	0.00	0.02
2000	0.2177	0.40	0.00	0.1956	0.00	0.00	0.2188	0.39	0.20	0.1682	0.03	0.18	0.0898	0.49	0.24	0.1093	0.01	0.03
2001	0.2138	0.40	0.00	0.1851	0.00	0.00	0.0752	0.40	0.62	0.0727	0.21	0.61	0.0851	0.52	0.20	0.1022	0.01	0.04
2002	0.2335	0.40	0.00	0.2005	0.00	0.00	0.2161	0.41	0.15	0.1529	0.06	0.23	0.0282	0.46	0.68	-0.0164	0.56	0.79
2003	0.2284	0.40	0.00	0.2145	0.00	0.00	0.0638	0.40	0.65	0.0405	0.28	0.73	0.0675	0.41	0.50	0.0434	0.20	0.48
2004	0.1069	0.53	0.15	0.1908	0.00	0.00	0.2299	0.41	0.10	0.2126	0.01	0.07	0.0644	0.53	0.15	0.1553	0.00	0.00
2005	0.0816	0.47	0.21	0.1061	0.00	0.02	0.1060	0.43	0.43	0.1633	0.04	0.17	0.0621	0.48	0.29	0.0967	0.02	0.07
2006	0.1253	0.56	0.06	0.1709	0.00	0.00	0.1257	0.45	0.27	0.1592	0.02	0.13	0.1256	0.39	0.33	0.2060	0.00	0.00
2007	0.1838	0.54	0.10	0.2298	0.00	0.00	0.1087	0.38	0.45	0.0794	0.17	0.50	0.0590	0.47	0.48	-0.0456	0.73	0.47

Table 5: One-Sample *t* Test Results

The table presents the results of the *t*-statistic for the difference between the LSV herding measure over the five different classes of bank assets (sample mean) and the LSV herding measure for the residential property loans over the period, by country. For this purpose is computed the means one-sample *t* test for the LSV herding measures. "**LSV Total**" refers to the value of the sample mean of LSV herding measure over the five different classes of bank assets. "**LSV House**" refers to the LSV herding measure for the residential property loans. *p-values* of means one-sample *t* test are presented in last column . [a, b, c] indicate the existence of statistical significance of 1%, 5% and 10%, respectively.

Country	***t*-test**	***p-value***
	LSV Total – LSV House	
Austria	0.0319	0.005[a]
Belgium	0.0246	0.118
Denmark	-0.0203	0.083[c]
Finland	0.0091	0.652
France	0.0386	0.000[a]
Germany	0.0515	0.006[a]
Greece	-0.0258	0.059[c]
Ireland	-0.0956	0.000[a]
Italy	0.0490	0.000[a]
Luxembourg	0.0498	0.105
Netherlands	0.0084	0.307
Portugal	0.0840	0.000[a]
Spain	-0.0418	0.039[b]
Sweden	0.0856	0.1215
United Kingdom	-0.0310	0.042[b]

Table 6: Correlations between Herding Measures and House Price Bubble Term

The table shows the correlations between Lakonishok, Schleifer and Vishny (1992) herding measures over the five different classes of bank assets (sample mean) and for the residential property loans and the house price bubble term over the period 1995 to 2007, for EU-15 countries. "**Bubble**" refers to the house price bubble term. "**LSV Total**" refers to the value of LSV herding measures over the five different classes of bank assets (sample mean). "**LSV House**" refers to the value of LSV herding measures for the residential property loans. In parentheses are presented the values of *t*-statistic. [a, b, c] indicate the existence of statistical significance of 1%, 5% and 10%, respectively.

Country	Bubble vs LSV House	Bubble vs LSV Total
Austria	-0.3042 (-0.903)	-0.3721 (-1.133)
Belgium	0.2181 (0.707)	-0.0789 (-0.250)
Denmark	0.6757[b] (2.898)	0.2088 (0.675)
Finland	0.2894 (0.956)	0.2552 (0.834)
France	0.4450 (1.491)	0.0376 (0.112)
Germany	0.2209 (0.716)	0.1254 (0.399)
Greece	0.5823[c] (0.058)	0.0079 (0.023)
Ireland	0.7274[a] (3.353)	-0.3688 (-1.255)
Italy	0.2178 (0.706)	0.2552 (0.834)
Luxembourg	0.1643 (0.527)	-0.0977 (-0.311)
Netherlands	-0.1476 (-0.472)	-0.4699 (-1.677)
Portugal	0.2298 (0.746)	-0.2418 (-0.788)
Spain	0.6887[b] (3.004)	-0.0917 (-0.291)
Sweden	0.5075[c] (0.092)	0.0861 (0.790)
United Kingdom	0.8269[a] (4.649)	-0.4498 (-1.592)

Table 7: Granger Causality Tests

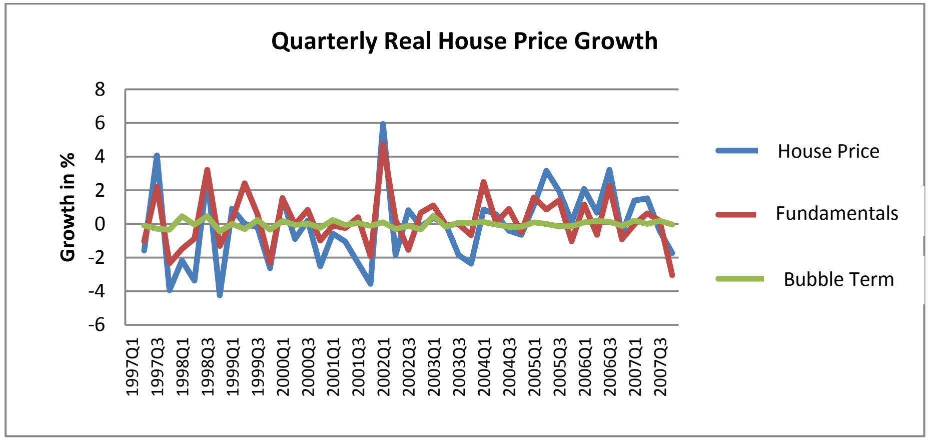
The table shows the Granger Causality Tests results between the herding measure of Lakonishok, Schleifer and Vishny (1992) for the residential property loans and the house price bubble term over the period 1995 to 2007, for EU-15 countries. "**Bubble**" refers to the house price bubble term. "**LSV House**" refers to the value of LSV herding measures for the residential property loans. X => Y means the null hypothesis that *X* does not Granger causes *Y*. **Y** means the rejection of the null hypothesis and **N** means the acceptance of the null hypothesis. For each country is given the respective *p-values* of the *F-statistic* test. In the last column of the table come the Granger causality tests results obtained for each country.

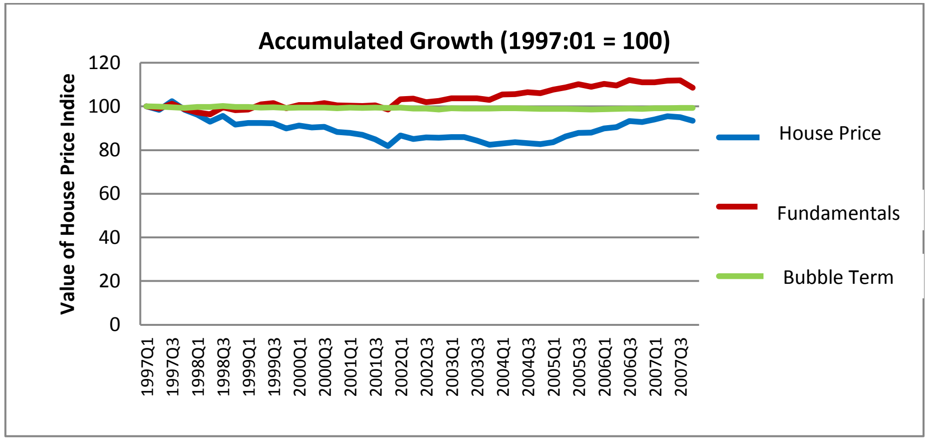
Country	**Bubble => LSV House**			**LSV House => Bubble**			**Granger Causality**
	F-Statistic	*p-value*	Result	*F-Statistic*	*p-value*	Result	
Austria	2.0739	0.272	N	2.4785	0.232	N	Independence
Belgium	1.0063	0.429	N	0.1209	0.888	N	Independence
Denmark	14.7351	0.064	Y	1.6315	0.401	N	Bubble => LSV House
Finland	0.2604	0.781	N	0.6140	0.577	N	Independence
France	0.9880	0.448	N	1.2790	0.372	N	Independence
Germany	0.7153	0.533	N	0.6719	0.552	N	Independence
Greece	0.7707	0.521	N	0.1631	0.854	N	Independence
Ireland	19.3250	0.031	Y	0.1303	0.881	N	Bubble => LSV House
Italy	0.5304	0.618	N	0.1206	0.889	N	Independence
Luxembourg	0.5867	0.590	N	2.4828	0.178	N	Independence
Netherlands	0.6353	0.567	N	0.6012	0.584	N	Independence
Portugal	0.6376	0.567	N	0.4636	0.654	N	Independence
Spain	16.2168	0.058	Y	1.0411	0.524	N	Bubble => LSV House
Sweden	45.0882	0.021	Y	2.6607	0.285	N	Bubble => LSV House
United Kingdom	15.3283	0.060	Y	0.8002	0.500	N	Bubble => LSV House
Global	3.2472	0.042	Y	1.415	0.246	N	Bubble => LSV House

Figure 1: Real House Prices, Market Fundamentals and Bubble Term

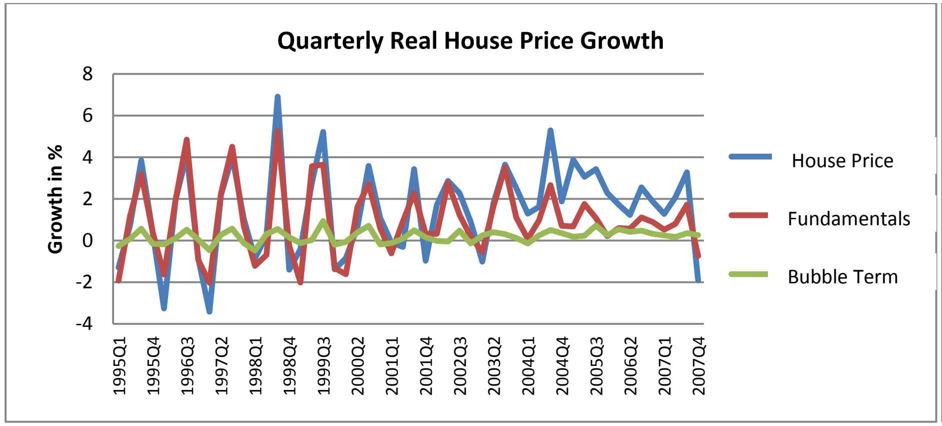
The following graphs show the real house price movements, the house price market fundamentals and the house price bubble term, for the EU-15 countries, based on equations (19), (20), (21) and (22). For each country are presented two charts: one with the quarterly growth in real house prices and its two components (fundamentals and bubble terms) and another with the accumulated growth in real house prices and its two components.

1. Austria





2. Belgium



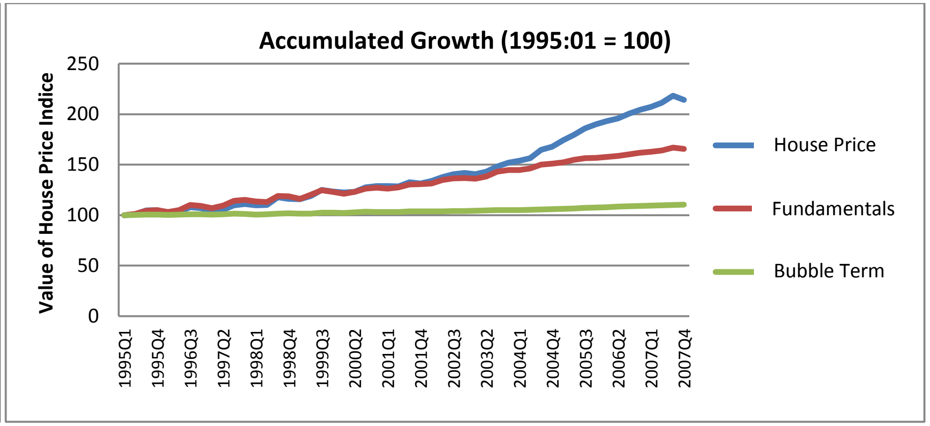
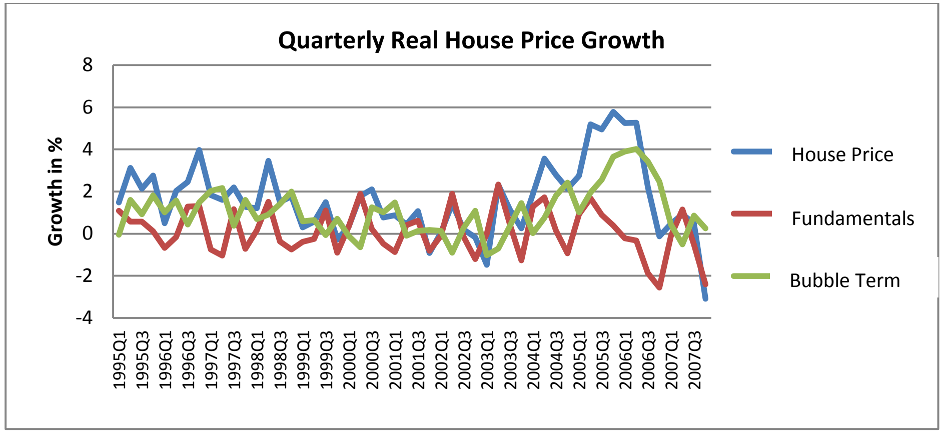
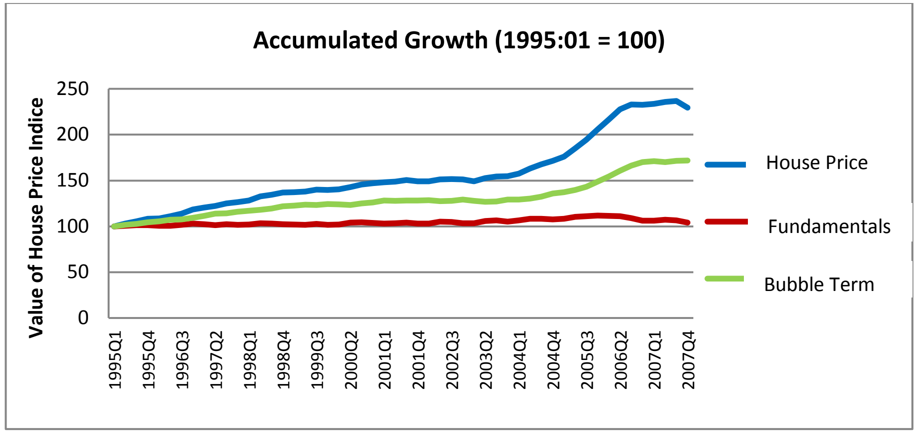


Figure 1: Real House Prices, Market Fundamentals and Bubble Term (cont.)

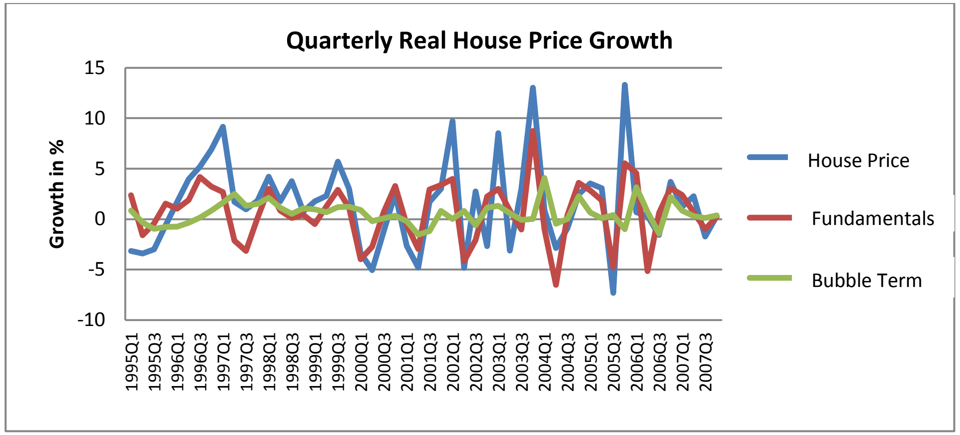
The following graphs show the real house price movements, the house price market fundamentals and the house price bubble term, for the EU-15 countries, based on equations (19), (20), (21) and (22). For each country are presented two charts: one with the quarterly growth in real house prices and its two components (fundamentals and bubble terms) and another with the accumulated growth in real house prices and its two components.

3. Denmark





4. Finland



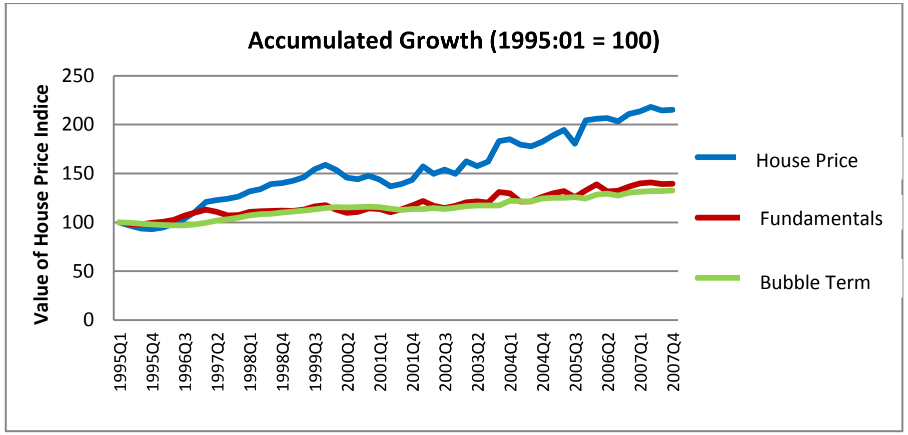
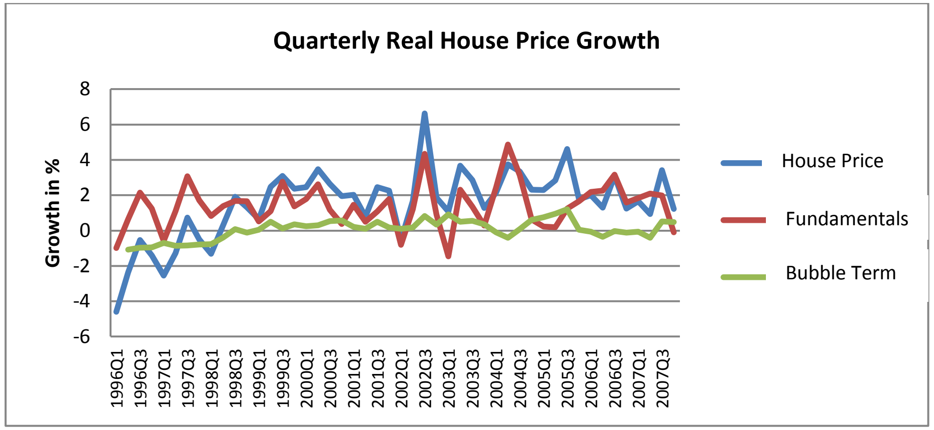
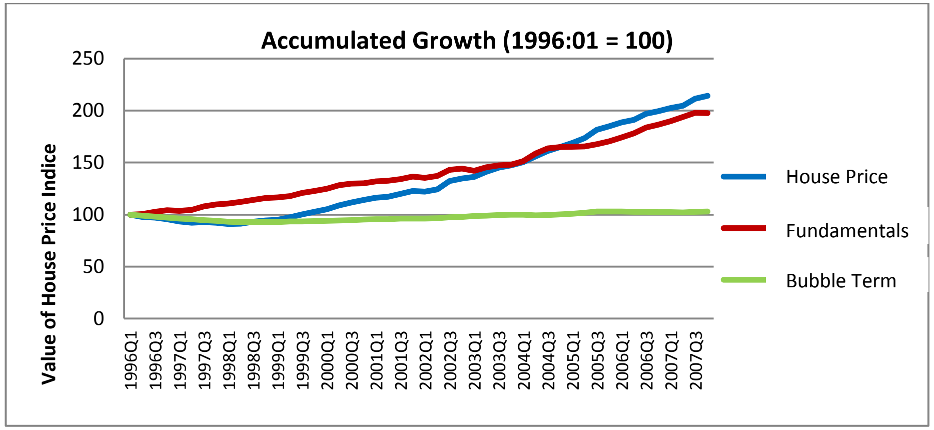


Figure 1: Real House Prices, Market Fundamentals and Bubble Term (cont.)

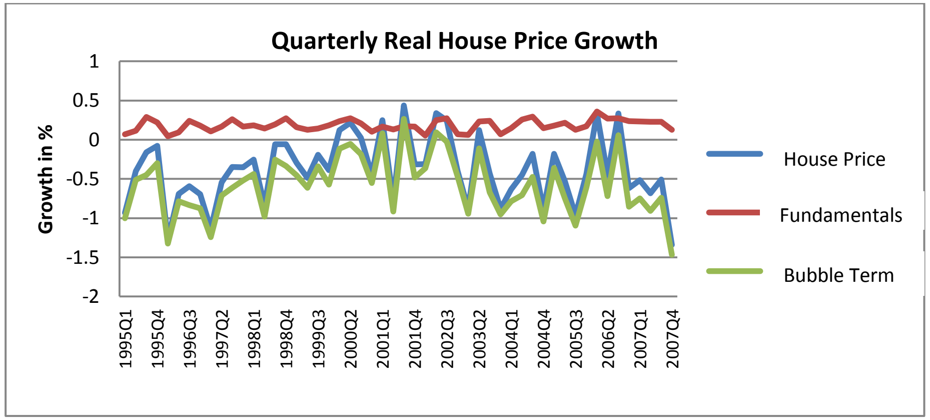
The following graphs show the real house price movements, the house price market fundamentals and the house price bubble term, for the EU-15 countries, based on equations (19), (20), (21) and (22). For each country are presented two charts: one with the quarterly growth in real house prices and its two components (fundamentals and bubble terms) and another with the accumulated growth in real house prices and its two components.

5. France





6. Germany



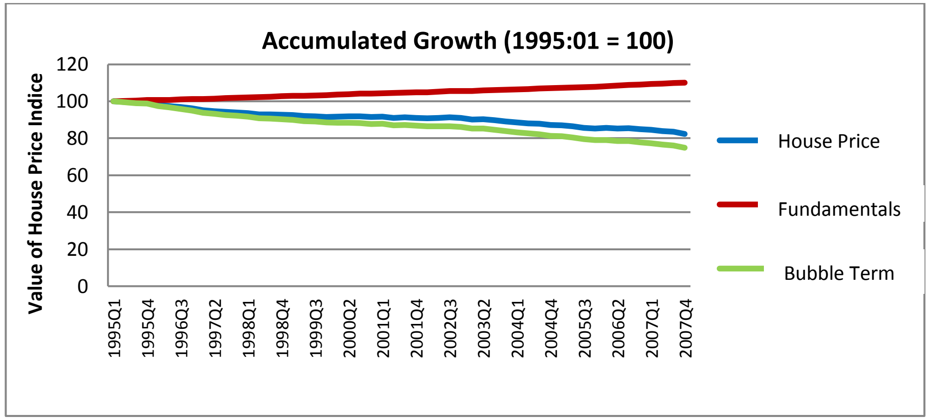
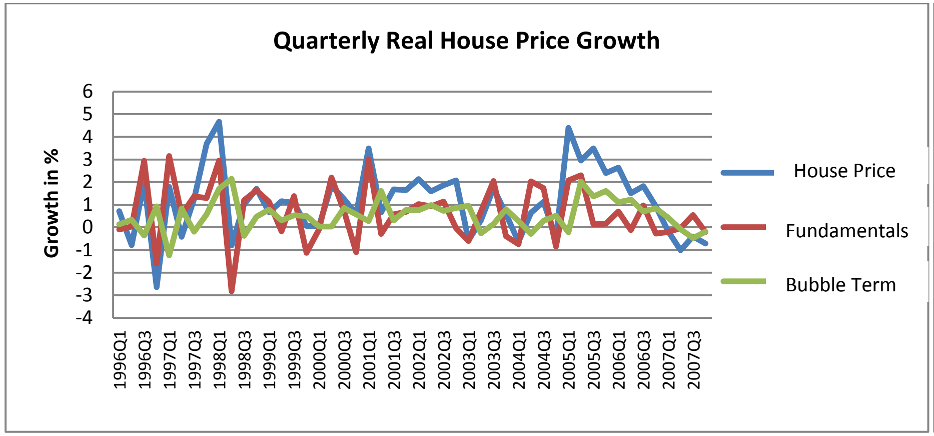
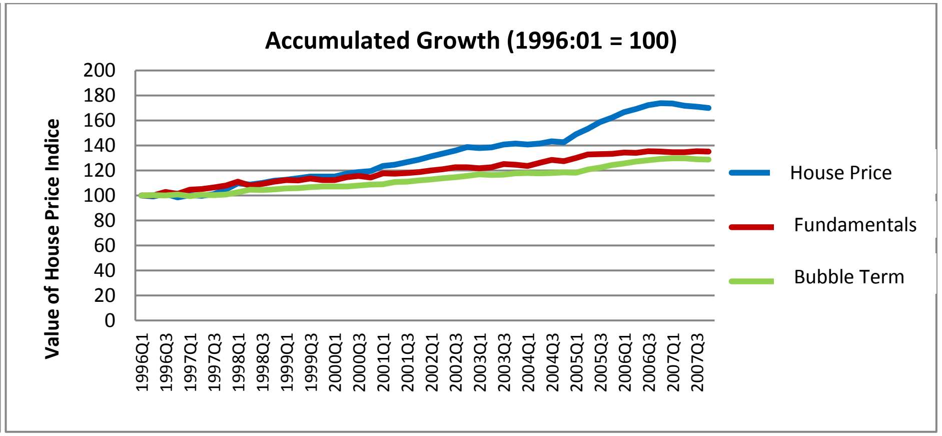


Figure 1: Real House Prices, Market Fundamentals and Bubble Term (cont.)

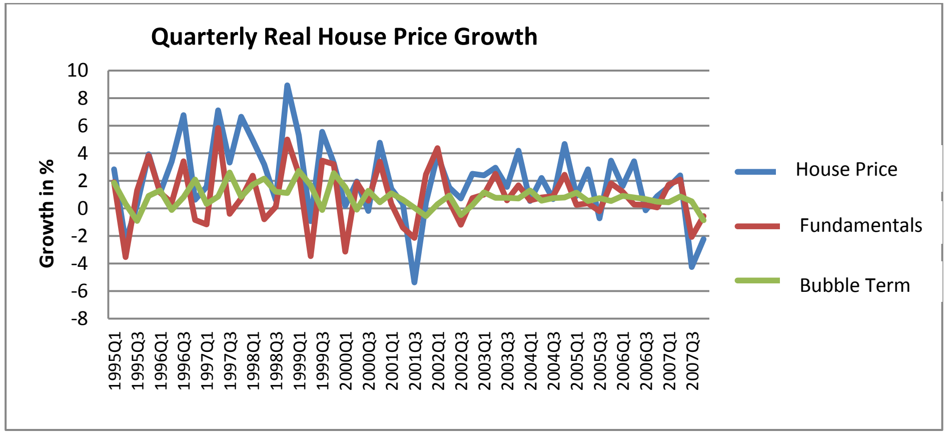
The following graphs show the real house price movements, the house price market fundamentals and the house price bubble term, for the EU-15 countries, based on equations (19), (20), (21) and (22). For each country are presented two charts: one with the quarterly growth in real house prices and its two components (fundamentals and bubble terms) and another with the accumulated growth in real house prices and its two components.

7. Greece





8. Ireland



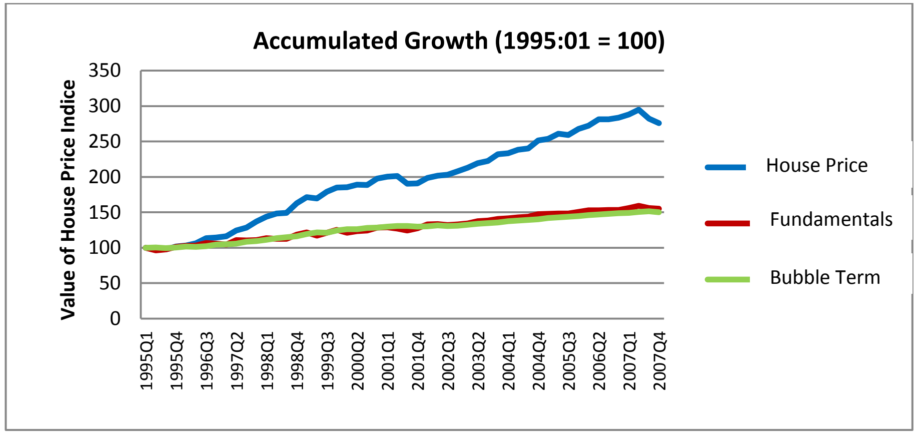
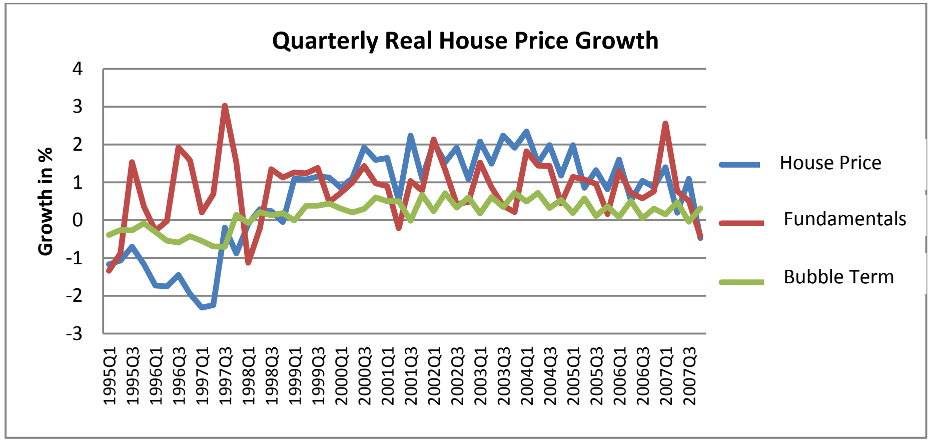
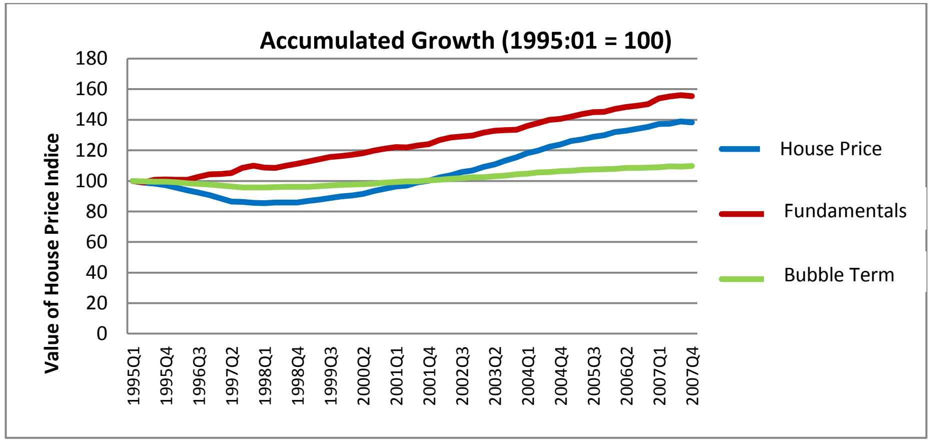


Figure 1: Real House Prices, Market Fundamentals and Bubble Term (cont.)

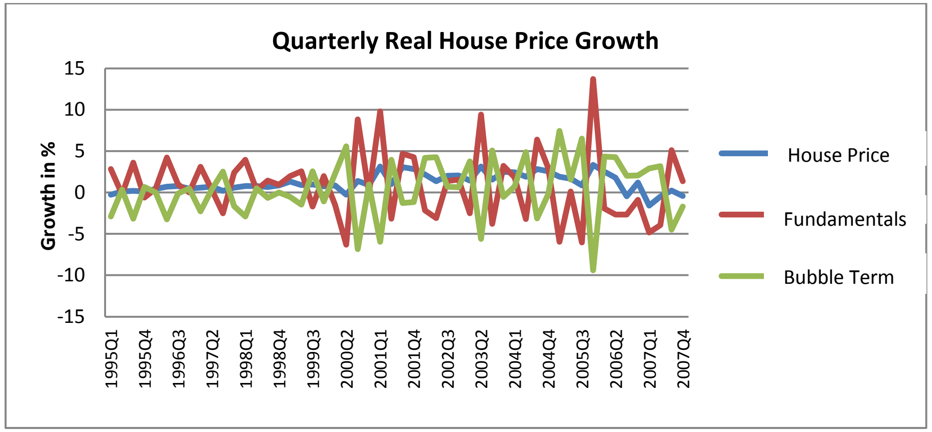
The following graphs show the real house price movements, the house price market fundamentals and the house price bubble term, for the EU-15 countries, based on equations (19), (20), (21) and (22). For each country are presented two charts: one with the quarterly growth in real house prices and its two components (fundamentals and bubble terms) and another with the accumulated growth in real house prices and its two components.

9. Italy





10. Luxembourg



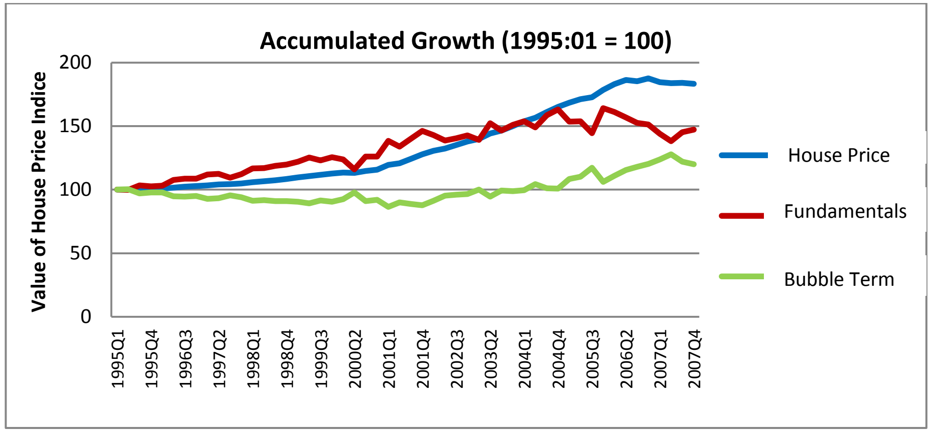
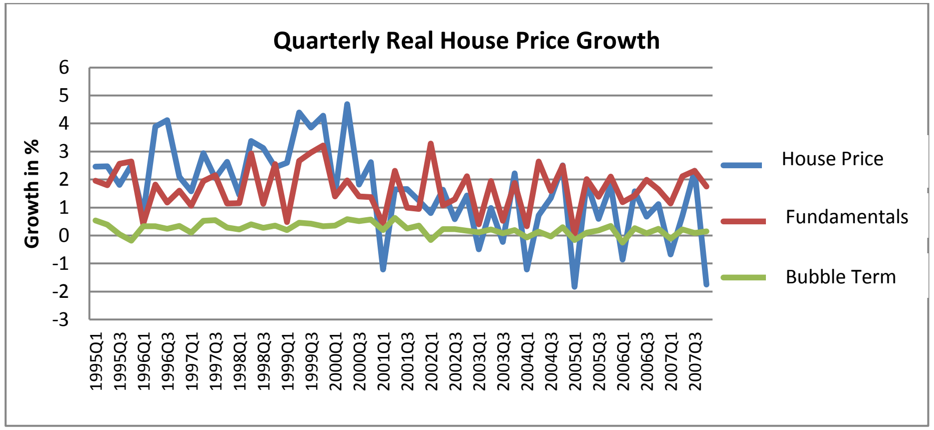
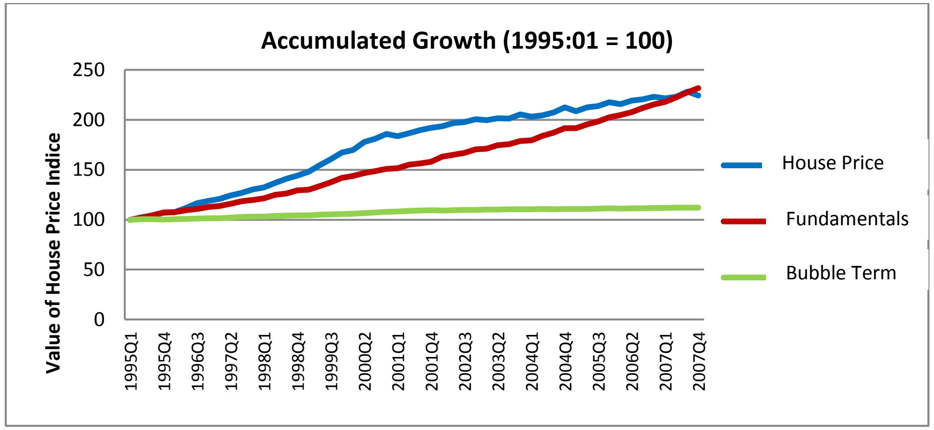


Figure 1: Real House Prices, Market Fundamentals and Bubble Term (cont.)

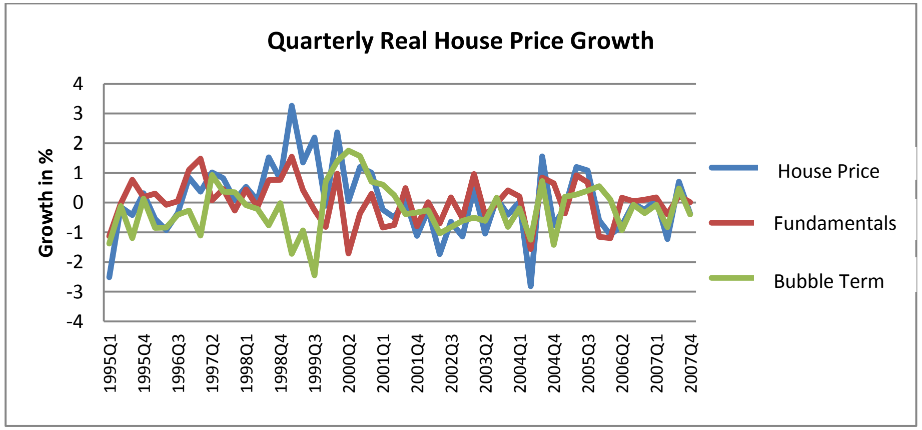
The following graphs show the real house price movements, the house price market fundamentals and the house price bubble term, for the EU-15 countries, based on equations (19), (20), (21) and (22). For each country are presented two charts: one with the quarterly growth in real house prices and its two components (fundamentals and bubble terms) and another with the accumulated growth in real house prices and its two components.

11. Netherlands





13. Portugal



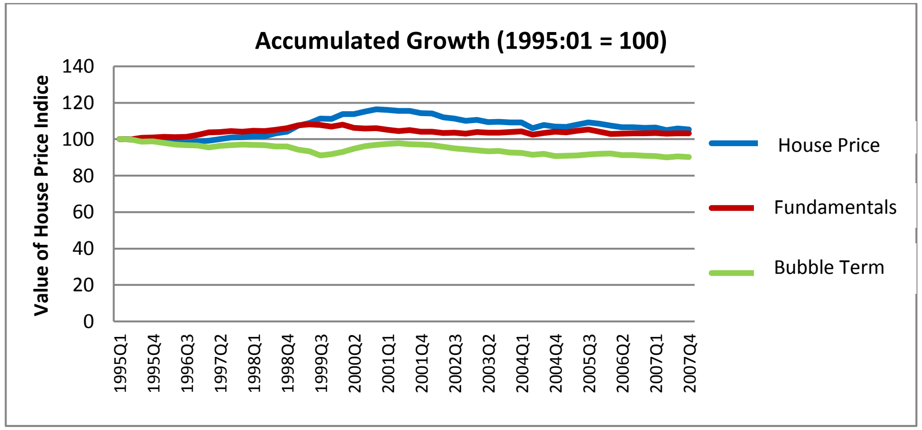
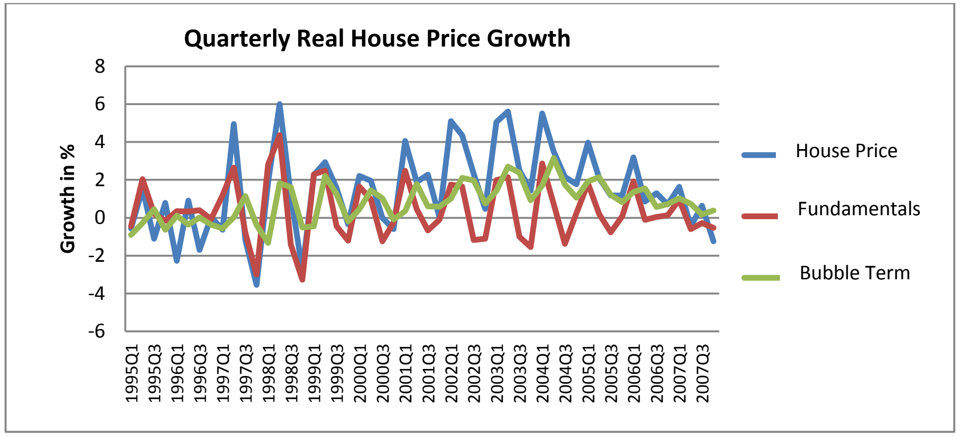
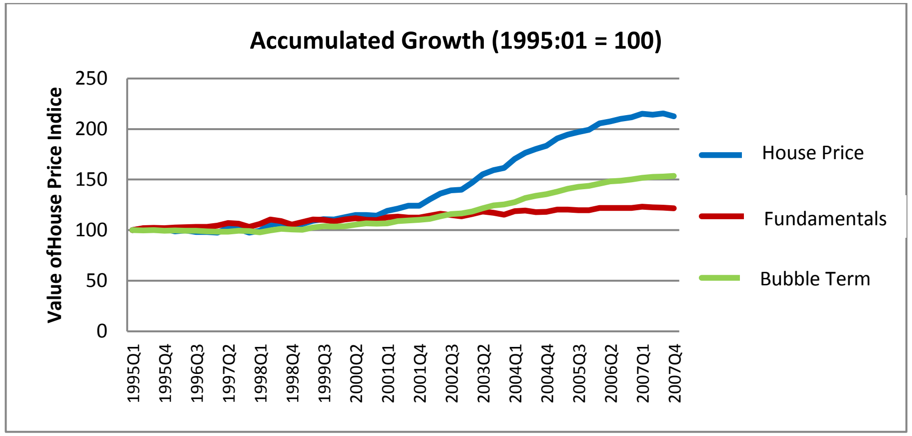


Figure 1: Real House Prices, Market Fundamentals and Bubble Term (cont.)

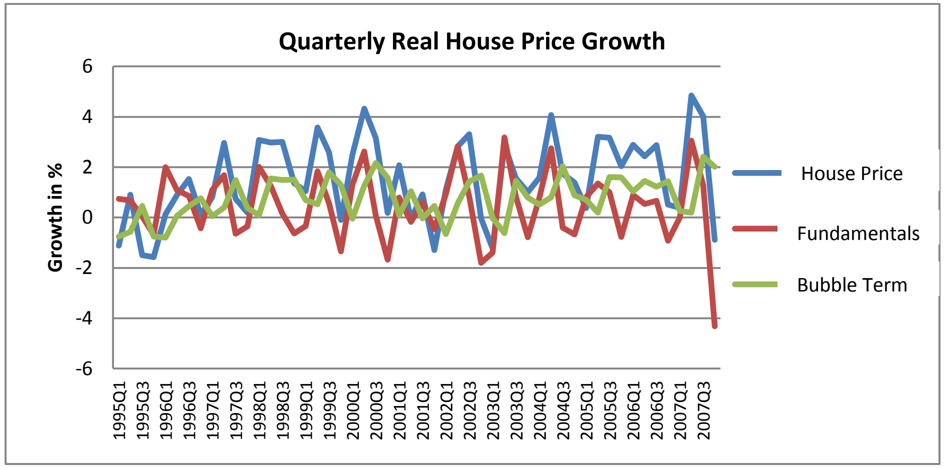
The following graphs show the real house price movements, the house price market fundamentals and the house price bubble term, for the EU-15 countries, based on equations (19), (20), (21) and (22). For each country are presented two charts: one with the quarterly growth in real house prices and its two components (fundamentals and bubble terms) and another with the accumulated growth in real house prices and its two components.

13. Spain





14. Sweden



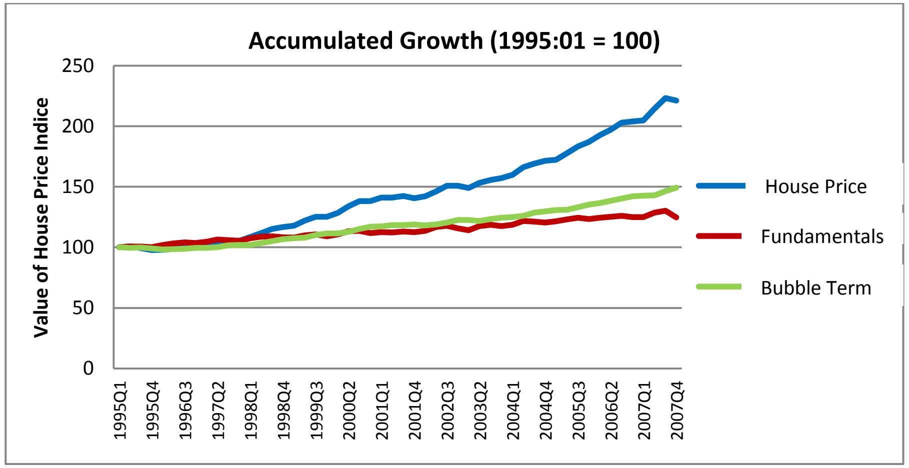
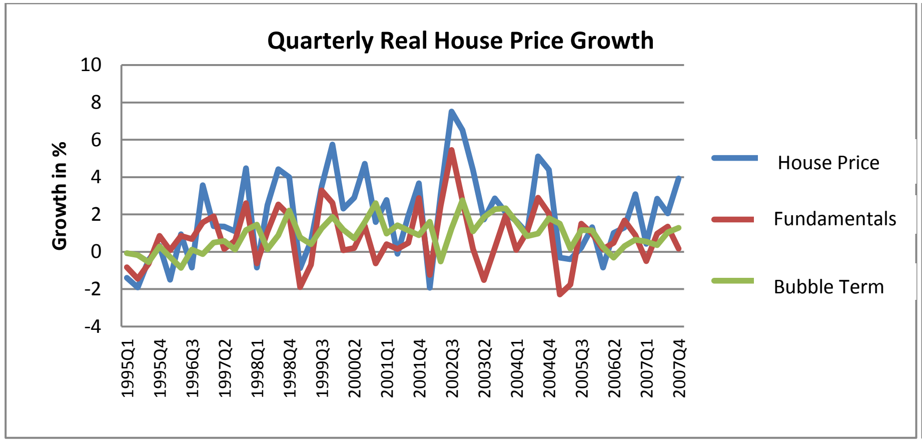


Figure 1: Real House Prices, Market Fundamentals and Bubble Term (cont.)

The following graphs show the real house price movements, the house price market fundamentals and the house price bubble term, for the EU-15 countries, based on equations (19), (20), (21) and (22). For each country are presented two charts: one with the quarterly growth in real house prices and its two components (fundamentals and bubble terms) and another with the accumulated growth in real house prices and its two components.

15. United Kingdom



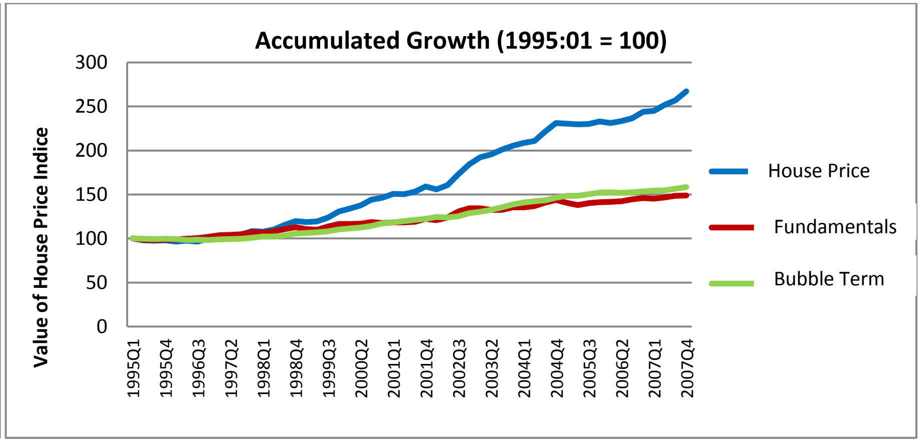


Figure 2: Percentage of Outstanding Loans to Residential Property

The following graph shows the percentage of outstanding loans to residential property over the sample period (1995-2007), by country. The series was obtained from national central banks and ECB – "Oustanding stock of housing lending" databases.