Property Bubbles and the Driving Forces in the PIGS countries

Philipp Klotz[1]

Tsoyu Calvin Lin[2]

Shih-Hsun Hsu[3]

The PIGS countries stand in the spotlight of the current financial crisis in Europe. The boom and bust of the real estate sector was one of the major sources putting these countries into an economic downturn. This paper determines the extent to which these countries experienced property bubbles and sheds light on the role of monetary policy in the formation of bubbles.

We draw from Stiglitz's (1990) theory on asset bubbles and apply the direct capitalization approach through weighted average cost of capital (WACC) to identify real estate bubbles in the period from 1999 to 2012. In the next step we apply VAR and VECM models to investigate short- and long-run dynamics between the monetary policy of the ECB and property bubbles in the PIGS countries. Our findings indicate that Spain and Ireland experienced the largest positive bubble formation, followed by Portugal with a small bubble. In contrast to that, Greece experienced a strong negative bubble. While we find only a very weak short-run relationship between monetary policy and bubble formation in Portugal, we find both, evidence for a long- and short run relationship in the case of Ireland, Greece and Spain. The varying extent of the bubble formation and the differing impact of the monetary policy on the bubble across the PIGS countries can be mainly attributed to characteristics in the domestic financial-, fiscal- and macroprudential- system.

This paper provides strong evidence that countries with very low interest rates and low to moderate tax rate as well as high loan-to-value ratios have the potential to experience large property bubbles. Central bank's policies are crucial to trigger the boom and burst of property bubbles by manipulating the interest rate and availability of lending for house purchase. As this research only covers aggregate data for entire countries, diverging developments within each country are not captured. Future research could contribute to the literature by focusing on property market developments in specific cities or regions.

Keywords: Property Bubble, Monetary Policy, VAR, VECM, Direct Capitalization, WACC, PIGS

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[1] Ph.D. student, International Doctoral Program in Asia-Pacific Studies, National ChengChi University, Taiwan. Email: 100265504@nccu.edu.tw.

[2] Professor, Department of Land Economics, National ChengChi University, Taiwan. Email: tsoyulin@nccu.edu.tw.

[3] Assistant Professor, Department of Economics, National ChengChi University, Taiwan. Email: shhsu@nccu.edu.tw.

The authors appreciate the support from National Science Foundation of Taiwan (NSC 101-2410-H-004-203).

1 Introduction

The PIGS countries, i.e. Portugal, Ireland, Greece and Spain, stand in the spotlight of the current financial crisis in Europe. Housing prices in most of the PIGS countries surged very fast and collapsed at the end of the decade. In a recent report on house prices in 54 countries the IMF (Igan & Loungani, 2012) reported that “Price trends vary widely between countries, with Ireland, Greece, Portugal, and Spain seeing the biggest falls”. In the booming period, from the inception of a single monetary policy in the Eurozone in 1999 to the collapse in 2008, the construction industry served as a major, above EU level, driver for economic growth in these countries. Due to this strong reliance, the economy in these countries was severely hit by the downturn in the housing market. This manifested in a sharp drop of economic activity in housing-related industries.

In the case of Ireland and Spain, the real estate market was frequently identified as the most crucial factor driving these countries into an economic downturn. In contrast to that, the main drivers for the crisis in Portugal and Greece were attributed to structural issues as high government spending and an inefficient administrative system. In response to the financial crisis, various institutions reported that the boom and bust of asset price bubbles poses a serious risk for economic and financial stability and that monetary policy plays a relevant role in the formation of asset bubbles. For instance, in a report on asset price bubbles and monetary policy, the ECB (2010) pointed out that money and credit indicators help to predict booms and busts cycles in asset prices. In regard to property bubbles, a member of the Executive Board of the ECB stated that simple money and credit aggregates deviations from a trend that exceed a given threshold provide a useful predictor of costly boom and bust cycles (Praet, 2011). Another member of the Executive Board of the ECB emphasized in a speech on Ireland, that ballooning credit and spending excesses overheated the economy and misdirected resources during the booming years before the crisis (Asmussen, 2012).

This paper addresses three questions. First, to what extend did the PIGS countries experience real estate bubbles throughout the period from 1999 to 2012? Second, what is the role of the monetary policy of the ECB in the formation of property bubbles? Third, why did the single monetary policy of the ECB have a diverging effect on the formation of real estate bubbles in the PIGS countries? The remainder of this paper is grouped into five parts. In the first part, the literature review, we give a short overview on the literature on real estate bubble and the role of monetary policy. In the following two parts, we then move to the framework and data section. Here we draw from Stiglitz’s (Stiglitz, 1990) theory on asset bubbles and apply the direct capitalization approach through weighted average cost of capital (WACC) to identify real estate bubbles in the PIGS countries from 1999 to 2012. In the empirical part, we set up Vector Autoregression (VAR) and Vector Error Correction (VECM) models and apply the impulse response analysis to investigate the relationship between the monetary policy of the ECB and property bubbles in the PIGS countries. Finally, we discuss the findings from the analysis, provide answers to the questions addressed above and summarize the central arguments of this paper.

2 Literature Review

A broad range of academic literature discusses the occurrence and drivers of real estate bubbles. The definition of a bubble is simple. A bubble describes the situation where the market value is higher than the fundamental value or not justified by fundamental factors (Stiglitz, 1990).

In a paper on real estate prices and bank stability, Koetter and Poghosyan (2010) pointed to the significance of house price deviations from the fundamental value. Theoretically, deviations of house prices from the fundamental value can have two contrasting implications on bank stability. First, higher prices increase the value of collateral and net wealth of borrowers and thus reduce the likelihood of credit defaults. Second, persistent deviations from the fundamental value may foster the adverse selection of increasingly risky creditors by banks seeking to expand their loan portfolio, which, in turn, increases bank distress probabilities. The two hypotheses were tested with data on real estate markets and banks in Germany. The results indicated that deviations of house prices from its fundamental value contribute to bank instability, whereas nominal house price developments do not. In order to determine such house price deviations we have to know the fundamental value.

Although there is common consent about the definition of a bubble, the measurement of the fundamental value is a difficult task. In the academic literature there are two broad approaches on how to determine the fundamental value of real estate. The first approach interprets the fundamental value as a function of macroeconomic variables. A market price following the variations of the macroeconomic variables indicates that there is no bubble. For example, Hui and Yue (2006) applied a comparative study on housing price bubbles in Hong Kong, Beijing and Shanghai and used disposable income, the stock of vacant new dwellings and local GDP as market fundamentals. Under the second approach, real estate is regarded as an investment that produces a stream of rental income over its lifetime. In this model the fundamental value is treated as a function of the cash flow received over time. For instance, Smith and Smith (2006) defined the fundamental value as the projected net rental savings. Another example is Chan et al. (2001) defining the fundamental value as the sum of the expected present value of rental income discounted at a constant rate of return. Several studies combine elements of the two approaches. For instance, Mikhed and Zemcik (2009a) use personal income, population, house rent, stock market wealth, building costs, and mortgage rate as factors determining the fundamental value.

Several studies point out that monetary policy is a key driver of real estate bubbles. For example, Tsai and Peng (2011) analyzed house prices in four cities in Taiwan. The empirical result of the panel unit root and cointegration test showed that bubble-like behavior of house prices in Taiwan after 1999 was primarily related to the mortgage rates. The study concluded that expansionary policy, which leads to speculations and lower mortgage rates, is the key driver for housing bubbles. Another study (Agnello & Schuknecht, 2011) looked at the determinants of housing market booms and busts in eighteen industrialized countries from 1980 to 2007. The estimates from the Multinomial Probit model indicated that domestic credit and interest rates have a significant impact on the probability of booms and busts occurring. The evidence indicated regulatory policies that slow down money and credit growth reduce boom probabilities.

In summary, while the definition of a bubble is straightforward, it is a very difficult task to determine the fundamental value needed for the bubble calculation. In the literature, there are two broad approaches to determine the fundamental value. The first approach interprets the fundamental value as a function of macroeconomic variables. Under the second approach, real estate is regarded as an investment that produces a stream of rental income over its lifetime. The literature further indicates that housing booms and busts and the formation of bubbles are related to interest rates and credit expansion. In the subsequent analysis, we apply the second approach to determine the bubble in the PIGS countries. Only few studies of this kind take financial leverage in the definition of the bubble into account. This paper bridges this shortcoming by applying the direct capitalization approach through discounting the future rental income by WACC for the fundamental value and the subsequent bubble identification. Further, we focus on the relationship between bubble formation and the monetary policy of the ECB, the top authority controlling money supply and key interest rates in the European Monetary Union. We also intend to explore the underlying rationales to different extends of bubbles in the group of PIGS countries.

3 Framework

Bubble

An asset bubble, as defined by Stiglitz (1990), describes the situation where only investor's expectations of higher selling prices instead of the fundamental factors determine the high price today. In such a situation, investors ignore the fundamental value and bid prices up, assuming that other investors will push prices further. The bubble is created by a form of speculation which does not rely on future income streams but on expected bullish behavior of other investors. Such a situation is inherently unstable and referred to as the greater fool theory of investing. As soon as the pool of greater fools dries up, the market turns bearish and corrects towards its fundamental value. Accordingly, an asset bubble exists when the market value (MV) is higher than the fundamental value (FV).

$$\mathrm{MV} > \mathrm{FV} \tag{1}$$

We treat residential property as a cash-flow generating investment. In this case, the house value is determined by the present value of the anticipated cash flow from the investment (Mikhed & Zemcik, 2009b; Smith & Smith, 2006). A real estate investor receives rent payments and he will make a profit or loss from selling the house. Consequently, the fundamental value should be close to the flow of future rent payments discounted back by the required rate of return. Although the rent is the central factor in the calculation of the cash-flow, there are also other variables which affect the future flow of payments as transaction costs, insurance, maintenance costs, property taxes and tax savings (Smith & Smith, 2006). For simplicity, we treat the fundamental value as the discounted future rent. Most studies employ a risk-free rate of return, i.e. long-term yields of government bonds, as a proxy for the required rate of return. In practice, however, most residential properties in the Euro area is bought by individual investors financing their property via mortgage loans (ECB, 2009). The concept of weighted average cost of capital (WACC) allows us to consider this feature by incorporating both the cost of equity and debt. The loan to value ratio (L/V) adjusts the proportion of the cost of debt ($\mathrm{i_{Djt}}$) and equity ($\mathrm{i_{Ejt}}$) which is used to finance the house purchase, where the subscript j is for the country and t for the time. We use the average interest rate for deposits with agreed maturity of up to 1 year at a domestic bank as the opportunity cost of equity and the average interest rate for house purchase as the cost of debt. We use the typical loan-to-value ratio of 0.7 for the calculation of the WACC for every country.

$$\mathrm{WACC_{jt}} = \left[\frac{\mathrm{L}}{\mathrm{V}} \times \mathrm{i_{Djt}}\right] + \left[\left(1 - \frac{\mathrm{L}}{\mathrm{V}}\right) \times \mathrm{i_{Ejt}}\right] \tag{2}$$

The fundamental value of residential real estate is the rent discounted by the WACC. In the following definition $\mathrm{FV_{jt}}$ is the fundamental value, $\mathrm{RENT_{jt}}$ is the stable rent, and $\mathrm{WACC_{jt}}$ is the weighted average cost of capital.

$$\mathrm{FV_{jt}} = \frac{\mathrm{RENT_{jt}}}{\mathrm{WACC_{jt}}} \tag{3}$$

Referring back to the first formula, a positive property bubble exists when the market value of real estate is higher than the fundamental value. Thus, the bubble in percentage terms is calculated as following.

$$\mathrm{B_{jt}} = \left(\frac{\mathrm{MV_{jt}} - \mathrm{FV_{jt}}}{\mathrm{FV_{jt}}}\right) \times 100 \tag{4}$$

A positive value indicates that the market value is higher than the fundamental value and vice versa. In the following, we refer to a positive bubble when the market value is higher than the fundamental value and to a negative bubble when the market value is lower than the fundamental value.

Monetary policy and bubble formation

In this study, we take both the short-run and long-run dynamics of real estate bubbles and monetary factors into account. Real estate bubbles are linked to monetary policy through two different channels. First, house prices are sensitive to the interest on other financial assets such as bonds or deposits at a bank. Low interest rates reduce the cost of capital and provide incentives for real estate investment. While the actual need for housing for living purpose remains the same, the investment demand goes up and artificially pushes up the demand for residential real estate and housing prices. Second, interest rates and money supply affect the debt financing conditions of borrowers. Lower interest rates reduce the cost of mortgage loans, which increases, the availability and accessibility to house purchasing loans. The interplay of both channels increases the demand for housing relative to the demand for rental housing. The unbalanced development of the demand in the two markets manifests, in a widening gap, between the market and fundamental value. The relationship between property bubbles and the two channels of monetary policy can be expressed as following.

$$\mathrm{B_{jt}} = f(IR_t, HL_t) \tag{5}$$

This expression shows that the bubble $\mathrm{B_{jt}}$is a function of the Euribor IR_t and the lending for house purchase-to-GDP HL_t. Based on the description of the two channels above, we suggest that the relationship is negative between the bubble and IR_t and positive for HL_t in the short-run. In the long-run, however, we suggest that the relationship is positive between the bubble and IR_t. This is because the negative effect of the interest rate on the market value is offset by the positive effect of the interest rate on the fundamental value in the long-run. The loan-to- GDP ratio is commonly used as a measure of bank lending (Oikarinen, 2009). We use the 3-month Euribor as it is a good proxy for the key interest rate set by the ECB. The main refinancing operation is the most important monetary policy tool of the ECB. It provides liquidity through the national central banks to the domestic banking system in the member states of the Eurozone. The interest rate for this instrument is set in a tender procedure where the domestic banks make a bid and receive a short-term loan with maturity of one week. The domestic banks receive the loan and provide financial assets as a guarantee. After the transaction is completed, the domestic banks pay interest to the central bank and receive the provided collateral in return. The interest rate set in the tender procedure is subject to a minimum bid rate. The minimum bid rate is set on a monthly basis by the Governing Council of the ECB. In the tender procedure, the total amount of funds to be allocated is defined by the ECB. Domestic banks that make the highest bid are served first until the full amount is allocated. Domestic banks which are unable to obtain liquidity through this mechanism have to borrow funds in the money market. Money market interest rates as the 3-month Euribor are usually very close to the minimum bid rate of the main refinancing operations set by the ECB (ECB, 2013).

In the empirical part, we apply VAR and VECM models to analyze the short- and long- run dynamics between the bubble, Euribor and house lending-to-GDP.

4 Data

In our analysis we cover the time period from the inception of the single monetary policy in the Eurozone in 1999 to the third quarter of 2012. As for the house price, we use price indices on residential property from the property price database of the ECB and the Bank for International Settlements (BIS). In the case of Ireland, there is no complete time series on house prices for the entire period available. In order to cover the full time period we use two overlapping time series and consolidate it into a single item. The rent index is sourced from the ECB and available for the entire period. For the calculation of the WACC, due to data availability, we use data from two separate datasets. Historical quarterly data on retail interest rates is sourced from Eurostat and covers the time period from 1999 to 2003. The second dataset is sourced from the monetary financial institute (MFI) database from the ECB and covers the period from 2003 to 2012. In order to allow the analysis of the full time period, we consolidate both datasets. As for the cost of debt, we use the average interest rates for housing loans. Regarding the cost of equity, we use the average interest rate on deposits of up to one year maturity. For Ireland, we use the average rate for overnight deposits as a proxy for the cost of equity as the previously mentioned interest is not available for this country. The data on the Euribor and the lending for house purchase-to-GDP is also sourced from Eurostat and available for the entire period. Figure 1 shows the bubble in the PIGS countries according to the definition in (4).

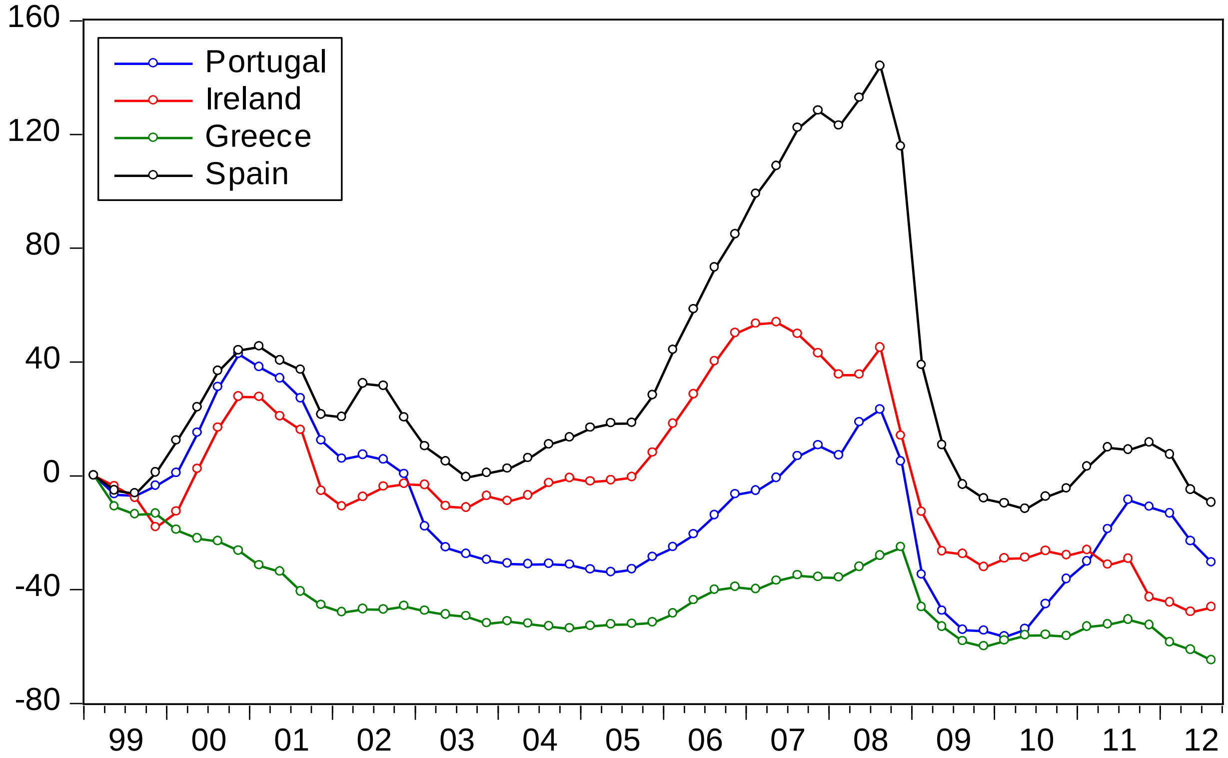

Figure 1

Bubble with WACC at 30% equity/70% debt

Portugal, Ireland and Spain experienced an increase in the bubble at the beginning of the 2000s, followed by a decrease up to 2005 in Portugal and a returning upwards trend in Ireland and Spain in

2003. In contrast to these countries, Greece experienced a constant negative trend up to 2005. Figure 2 on the WACC sheds light on the diverging development of Greece. The WACC in Greece was very high and dropped heavily from 9.53% in the first quarter of 1999 to half of its value at the end of 2001. This strong decrease of the WACC pushed up the fundamental value far above the market value, manifesting a decreasing bubble. In 2005, the WACC approached the level of the other PIGS countries and showed henceforth the same pattern. From then on, all of the countries, except for Ireland, showed a strong bubble increase up until the third quarter of 2008. In Ireland, the bubble dropped due to a decrease of the market value starting in 2007. In the third quarter of 2008, the ECB massively decreased the interest rate on the main refinancing operations, thus pushing up the fundamental value and decreasing the bubble. This triggered a strong decrease of the bubble in all of the PIGS countries.

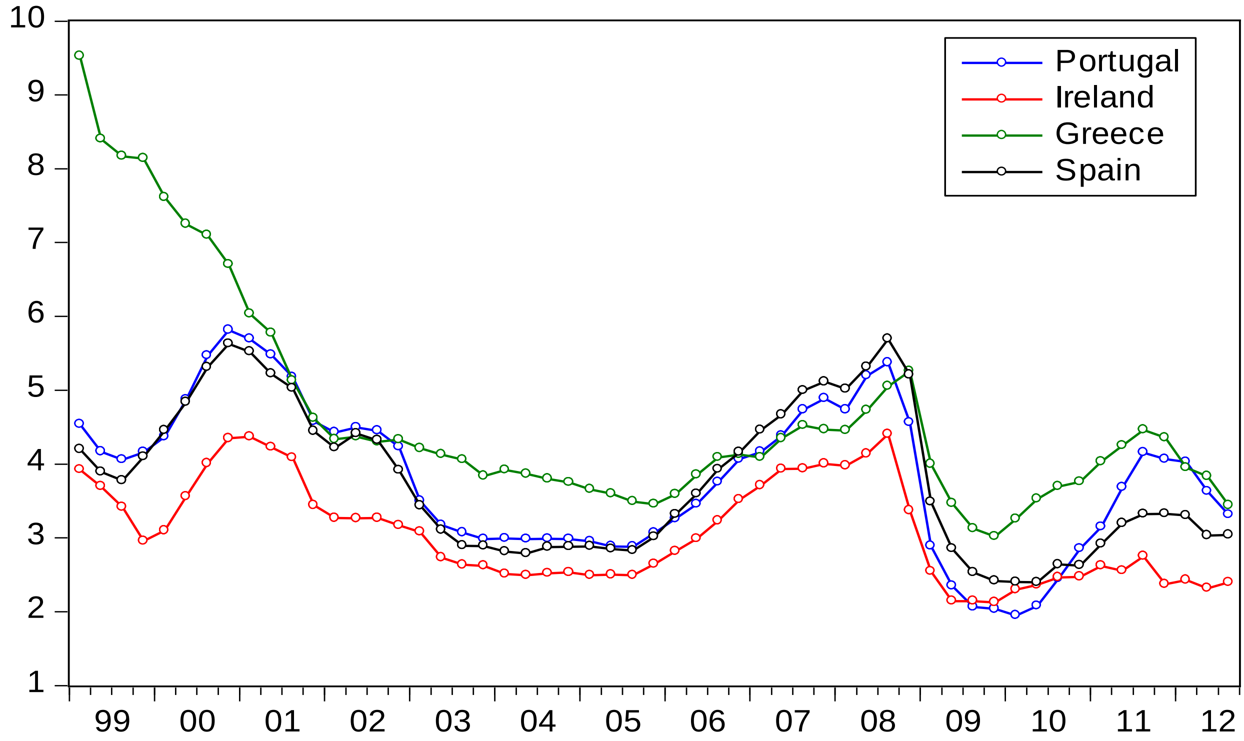

Figure 2
WACC at 30% equity/70% debt

In figure 3, the left panel contrasts the minimum bid rate for main refinancing operations set by the ECB with the 3-month Euribor money market interest rate. It is obvious that the money market rate is closely related to the key interest rate of the ECB. In the subsequent analysis we use the 3-month Euribor as proxy for the interest rate for the main refinancing operations of the ECB. The right panel shows the ratio of lending volume for house purchase-to-GDP of the quarterly GDP in the Eurozone.

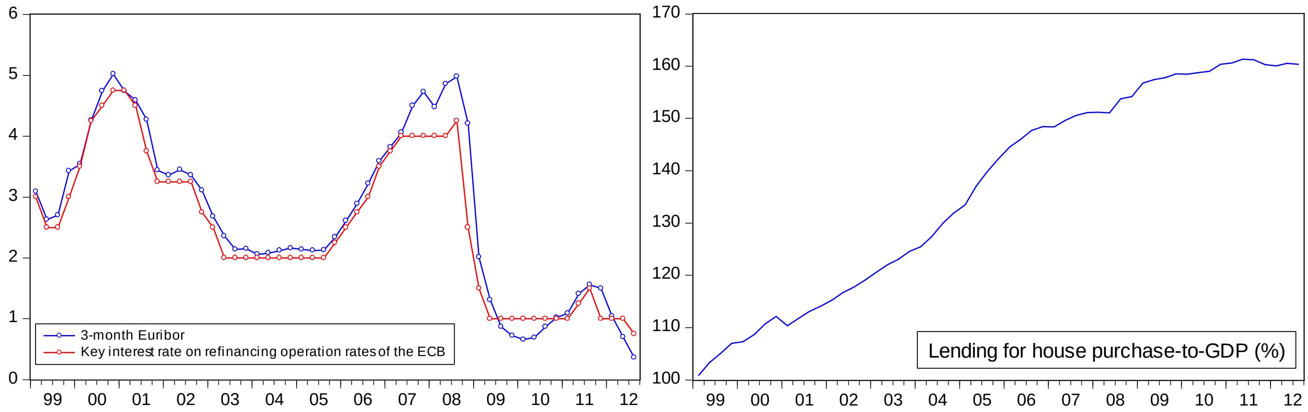

Figure 3

Interest Rates and Lending for House Purchase-to-GDP

In order to select the appropriate model for the following analysis, we apply the Augmented Dickey Fuller (ADF) test to determine the order of integration of our variables. A variable is said to be integrated of order n, when it achieves stationarity after taking its n-th difference. As shown in the table below, the ADF test statistic indicates at a significance level of 5% that all of the variables in its level contain a unit root, except for the bubble in Portugal. However, the bubble in Portugal indicates a unit root at 10% level of significance. The first difference of all variables is stationary at 5% level of significance. Thus we conclude that all of the variables are integrated of order one, I(1) say.

Table 1

ADF Unit Root Test

	Level			Difference			
Variable	t-value	p-value	Lags	t-value	p-value	Lags	Result
HL^{ti}	1.07	1.00	0	-5.44	0.00	0	I(1)
IR^{c}	-1.85	0.35	1	-3.89	0.00	0	I(1)
$B_{Portugal}{}^{c}$	-2.78	0.07	1	-3.51	0.01	0	I(1)
$B_{Ireland}{}^{c}$	-1.84	0.36	1	-4.15	0.00	0	I(1)
$B_{Greece}{}^{c}$	-1.86	0.35	1	-5.39	0.00	0	I(1)
$B_{Spain}{}^{c}$	-2.61	0.10	1	-3.52	0.01	0	I(1)

Note: The number of lags included in the ADF test is decided by the automatic lag length selection criteria based on SIC with maximum lag length of 10. ^{c} indicates that a constant term and ^{ti} indicates that a constant term as well as a linear time trend have been included in the model.

5 Empirical Analysis

Long-run dynamics

Engle and Granger (1987) showed that a linear combination of two or more non-stationary variables may be stationary. Such a linear combination of non-stationary variables is referred to as cointegration. Following the definition, the components of the vector $x_t = x_{1t}, x_{2t}, \ldots, x_{nt}$ are said to be cointegrated if all components of x_t are I(1) and a vector $\beta = \beta_1, \beta_2, \ldots, \beta_n$ exists such that the linear combination $\beta x_t = \beta_1 x_{1t} + \beta_2 x_{2t} + \ldots + \beta_n x_{nt}$ is stationary, I(0) say. The stationary linear combination is the cointegration equation and may be interpreted as the long-run relationship among the variables in the model.

We apply the Johansen Methodology illustrated by Enders (2010) to test for cointegration amongst the variables in each system. In the first step, we use the undifferenced data and estimate a separate VAR for each country in our sample to determine the appropriate maximum lag length for each VAR. We choose the maximum lag length on the basis of the sequential modified LR test statistic. Including four lags in the lag specification, the tests indicate a lag length of two for Portugal and Greece, and four for Ireland and Spain.

In the next step we estimate the third model considered by Johansen (1995) to determine the rank of integration. This model allows the time series to have linear deterministic trends and includes an intercept but no trend in the cointegration equation. The cointegration vector in this model removes the linear deterministic trend of the time series as it removes the unit roots so that the cointegration equation does not contain any trend. A cointegration equation without a linear trend is close to the idea of the cointegrating vector defining an equilibrium relationship. There are two possible test statistics, considering different alternative hypotheses, to determine the number of cointegraion relationships, i.e. the rank of cointegration (r). Table 2 presents the corresponding results.

Both test statistics indicate on a significance level of 5% that the variables in the model of Ireland, Greece and Spain are cointegrated of order one. In the case of Portugal neither the trace nor the maximum eigenvalue test statistics shows cointegration. Thus, we conclude that there is a long-run relationship between the bubble in Ireland, Greece and Spain and the two variables representing monetary policy. However, in the case of Portugal, we find no such relationship.

Table 2
Johansen Cointegration Test

		Trace Test				Maximum-Eigenvalue Test				
Country	**Lag**	**H0**	**λtrace**	**5% critical value**	**p-Value**	**H0**	**λmax**	**5% critical value**	**p-Value**	**Result**
Portugal	2	r=0	19.93	29.80	0.43	r=0	13.89	21.13	0.37	r=0
		r≤1	6.04	15.49	0.69	r=1	4.30	14.26	0.83	
Ireland	4	r=0	60.54	29.80	0.00	r=0	46.17	21.13	0.00	r=1
		r≤1	14.37	15.49	0.07	r=1	10.83	14.26	0.16	
Greece	2	r=0	36.26	29.80	0.01	r=0	35.14	29.80	0.01	r=1
		r≤1	10.55	15.49	0.24	r=1	13.36	15.49	0.10	
Spain	4	r=0	36.26	29.80	0.01	r=0	25.71	21.13	0.01	r=1
		r≤1	10.55	15.49	0.24	r=1	7.81	14.26	0.40	

Note: r is the rank of cointegration. λtrace is the Trace statistic, testing the null hypotheses r=0 and r≤1 against the alternative hypotheses r>0 and r>1. λmax is the Maximum-Eigenvalue statistic, testing the null hypothesis r=0 and r=1 against the alternative hypotheses r=1 and r=2.

The analysis of the estimated cointegration relation helps us to understand the direction and magnitude of the long-run relationship in the three countries where we found cointegration. The upper panel of table 3 summarizes the results. The normalized cointegration coefficients of the Euribor and the bubble indicate a positive relationship in all of the three countries, where a one percentage increase in the Euribor leads to a 38.21% increase in the bubble in the case of Spain, to an increase of 26.31% in the case of Ireland and to a 7.54% increase in the case of Greece. The relationship between HL and the bubble in the three countries is also positive, but not significant for Greece. A one percent increase of the lending for housing-to-GDP ratio leads to a 1.9% increase in the bubble in Spain and to a 0.98% increase in Ireland. The positive relationship between the Euribor and the bubble in three countries matches our expectation outlined in the framework where we suggest that the negative effect of the interest rate on the market value is offset by the positive effect of the interest rate on the fundamental value in the long-run.

Table 3
Estimated Cointegration Relation

	Ireland			Greece			Spain		
	B	**IR**	**HL**	**B**	**IR**	**HL**	**B**	**IR**	**HL**
Coefficient	1	-26.31*	-0.98*	1	-7.54*	-0.18	1	-38.21*	-1.90*
Std. error		-1.09	-0.07		-1.40	-0.11		-1.51	-0.10
t-statistic		-24.22	-14.31		-5.39	-1.61		-25.27	-19.61
Adj. speed	0.37*	0.02*	0.07*	-0.20*	0.00	0.01	0.10	0.01	0.07*
Std. error	0.13	0.01	0.02	0.07	0.01	0.02	0.22	0.01	0.02
t-statistic	2.86	3.80	4.27	-2.97	-0.07	0.70	0.44	1.33	3.92

Note: * denotes significance at the 95% confidence interval. The critical value for the t-test is 1.96. Coefficient is the normalized cointegration coefficient; Adj. speed is the speed-of-adjustment coefficient and Std. error the respective standard error.

Short-run dynamics

In the next step, we are interested in the short-run dynamics between the variables in the models. In the case of Portugal, the Johansen cointegration test indicated no cointegration relationship, thus, we set up a traditional VAR model in first differences as specified below. x_t is the n×1 vector of the three variables included in our model. A_0 is the n×1 vector of intercept terms, A_i the n×n matrix of coefficients and ε_t the n×1vector of error terms.

$$\Delta x_t = A_0 + A_1 \Delta x_{t-1} + \cdots + A_p \Delta x_{t-p} + \varepsilon_t \quad (6)$$

In the case of Ireland, Greece and Spain we use the same model for the Johansen cointegration test. The model includes a constant but no trend in the cointegration vector. This model removes the linear deterministic trend of the time series as it removes the unit roots so that the cointegration equation does not contain any trend. This specification is close to the idea of the cointegrating equation defining an equilibrium relationship. The model is specified below where x_t is the n×1 vector of the variables included in the model, $A_0$is a n×1vector of constant terms, $(\beta_0 + \beta' y_{t-1})$ the cointegrating equation, α the speed-of-adjustment, A_i the n×n matrix of coefficients and ε_t the n×1vector of error terms.

$$\Delta x_t = A_0 + \alpha(\beta_0 + \beta' x_{t-1}) + A_1 \Delta x_{t-1} + \cdots + A_{p-1} \Delta x_{t-p+1} + \varepsilon_t \quad (7)$$

The speed-of-adjustment coefficient indicates how the variables adjust to any discrepancies from the long-run equilibrium relationship. Given the positive value of the cointegrating equation, a positive coefficient indicates that the variable will go up and a negative coefficient indicates that the variable will decrease. The lower panel of table 3 shows the estimates. In the short-run, the bubble in Ireland responds with an increase and the bubble in Greece with a decrease to a deviation from the long-run equilibrium; it means that, in the short-run, the bubble tends to depart from the long-run equilibrium in Ireland but tends to approach the long-run equilibrium in Greece. In the case of Spain, the speed-of-adjustment coefficient is not significant at the 5% level of significance.

Based on the VAR for Portugal and the VECM for the other PIGS countries, we analyze the dynamic effect of innovations of lending for house purchase-to-GDP and the money market interest rate on the bubble by computing orthogonalised impulse responses. Hereby we use the standard Choleski decomposition (Sims, 1980) to derive the impulse responses. The ordering used is B-HL-IR and aligned to the specification used by Hofmann (2004) and Oikarinen (2009). Following the ordering, we assume that the Bubble does not respond contemporaneously to innovations in lending for house purchase-to-GDP and the Euribor. The lending for house purchase does not respond contemporaneously to a shock in the interest rate, and the interest rate is rather flexible because the

ECB and the domestic banking system can respond immediately with an interest rate change to alterations of the former two variables, thus it may be affected within a quarter by the other two variables. The chosen ordering of the variables is standard in the literature on monetary policy transmission and reflects the common assumption that interest rate changes are transmitted to the economy with a lag. The following figures illustrate the impulse responses up to 20 quarters from the shock. As outline above, we use differenced data in the case of Portugal and data in its levels for the other three countries. Therefore the results of the following analysis cannot be compared directly with the other three countries. The first figure shows the response of the Bubble to the Euribor and the lending for house purchase-to-GDP in Portugal. The impulse response function of Portugal reveals that the bubble responds positively and only slightly to a positive innovation of the two variables. The effect vanishes after 10 quarters.

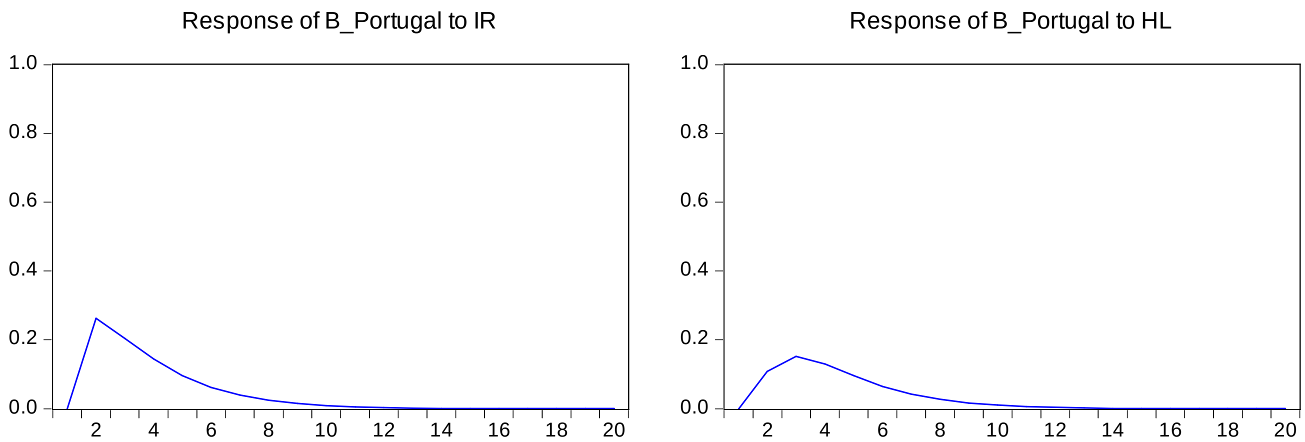

Figure 4

Impulse Response Function- Portugal

As illustrated in figure 5, the response of the bubble to a one standard deviation shock of both, the Euribor and the lending for house purchase-to-GDP is slightly positive in Greece. The effect of the two variables increases up to lag five and remains from then on at around the same level.

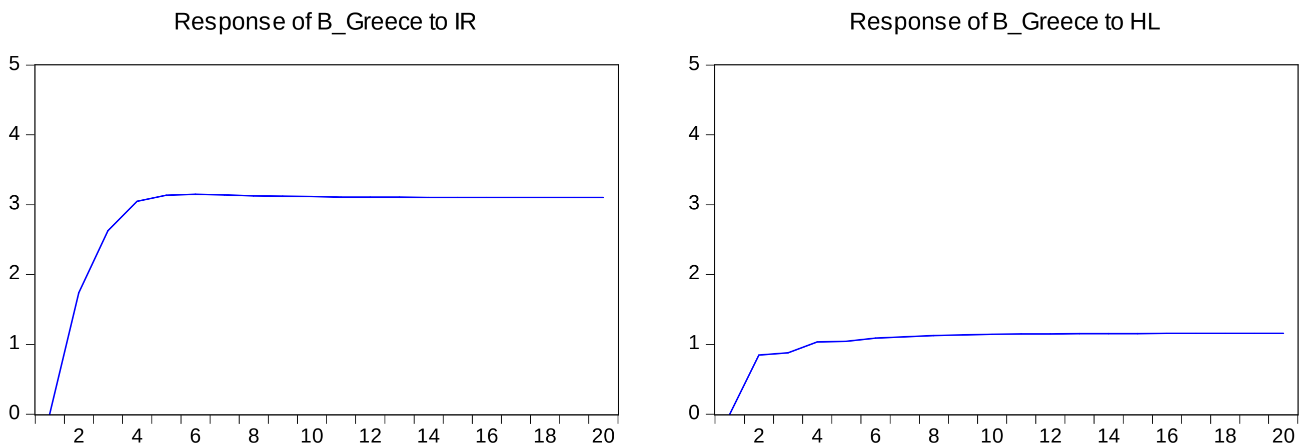

Figure 5

Impulse Response Function- Greece

As shown in figure 6 and 7, a positive one standard deviation shock in the Euribor has temporarily no effect in Ireland and a slightly positive effect in Spain before turning strongly negative. The initially positive response of Spain and the continuous positive response of Greece to a positive shock in the Euribor can be explained by the effect of the WACC on the fundamental value and bubble. An increase in the Euribor leads to an increase in the WACC. With an increase in the WACC, the fundamental value decreases, the gap to the market value widens and the bubble increases. The response of the bubble in Spain to a positive innovation in the Euribor turns strongly negative and is negative in Ireland because the demand side of real estate is affected by the higher interest rate.

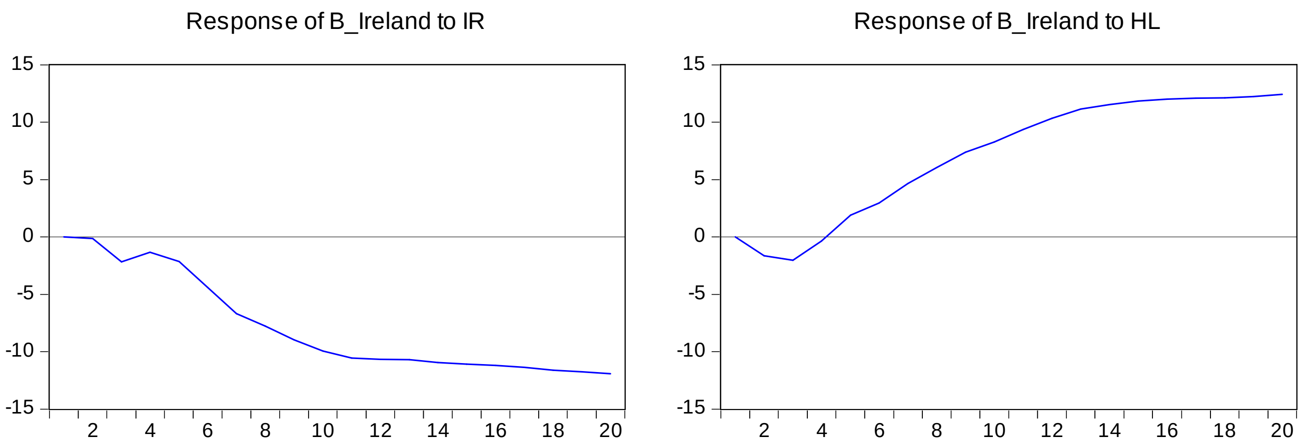

Figure 6

Impulse Response Function- Ireland

Here in the case of a positive interest rate shock, mortgage borrowers become increasingly overwhelmed by the debt burden, and in the worst case default on their mortgage loans. Investors loose interest in real estate and start to switch to other assets where interest rates increase. This decreases the demand and market price for property, thus resulting in a decreasing bubble.

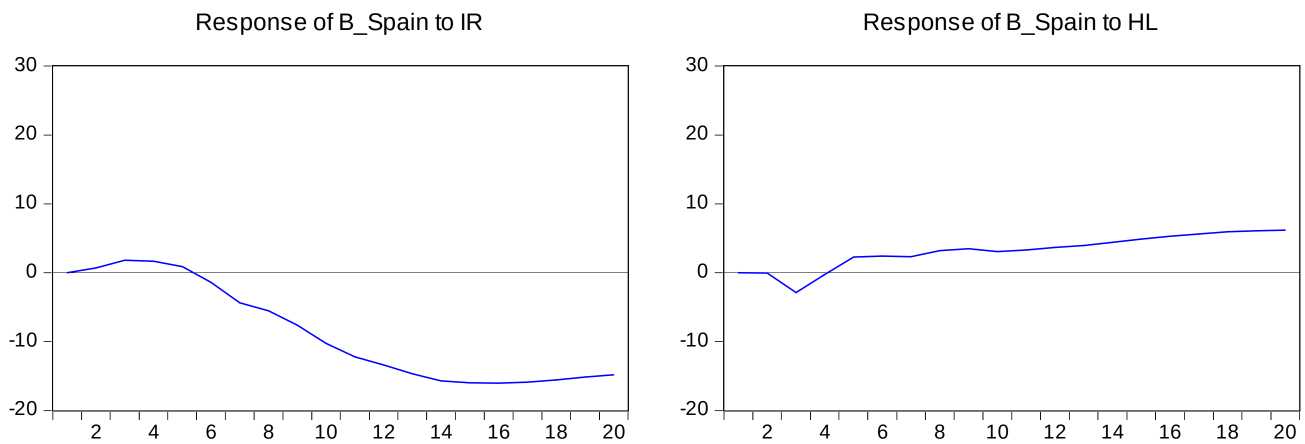

Figure 7

Impulse Response Function- Spain

As the Bubble in Portugal and Greece, also the bubble in Ireland and Spain responds positively to a positive shock in the lending for house purchase-to-GDP. In contrast to the former two countries, Ireland's as well as Spain's bubble respond much stronger and with a lag to an innovation in HL.

The variance decomposition in table 4 shows that almost no variance of Portugal's bubble can be explained by the short-run dynamics of the Euribor and the lending for house purchase-to-GDP. In Ireland, both, IR and HL explain a large proportion of the variance in the bubble. For instance, at lag 10 IR explains around 31% and HL around 41% of the variance in the bubble. At lag twenty the explanatory power of IR decreases to 26% and increases up to 63% for HL. In Greece and Spain, most of the variance in the bubble is explained by IR and only a small portion by HL. At lag ten 30% of the variance in Greece's bubble and around 16% in Spain's is explained by the Euribor. The explanatory power of IR increases to 32% in Ireland and to 39% in Spain at lag twenty. The major observation here is that IR and HL does not substantially drive the bubble in Portugal. Ireland is substantially driven by the two variables and Greece as well as Spain primarily by the Euribor.

Table 4

Decomposition of variance for Bubble

	Portugal		Ireland		Greece		Spain	
Period	**ΔIR**	**ΔHL**	**IR**	**HL**	**IR**	**HL**	**IR**	**HL**
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.09	0.01	0.15	2.39	8.36	1.98	0.00	0.10
3	0.13	0.04	3.79	3.13	15.42	2.31	0.00	2.17
4	0.15	0.06	4.30	2.47	20.71	2.75	0.08	2.19
5	0.15	0.07	5.68	4.45	24.05	3.01	0.30	1.82
6	0.16	0.07	10.73	8.90	26.22	3.24	1.37	1.59
7	0.16	0.07	18.81	16.38	27.64	3.42	4.04	1.41
8	0.16	0.07	24.76	24.92	28.64	3.57	7.27	1.23
9	0.16	0.07	28.46	33.13	29.37	3.70	11.32	1.19
10	0.16	0.07	30.85	39.54	29.93	3.80	16.22	1.25
11	0.16	0.07	31.77	44.95	30.36	3.88	21.14	1.44
12	0.16	0.07	31.28	49.64	30.71	3.96	25.29	1.75
13	0.16	0.07	30.16	53.44	31.00	4.02	28.76	2.09
14	0.16	0.07	29.16	56.17	31.25	4.07	31.54	2.40
15	0.16	0.07	28.31	58.19	31.45	4.12	33.61	2.67
16	0.16	0.07	27.62	59.78	31.63	4.16	35.13	2.89
17	0.16	0.07	27.12	61.04	31.79	4.19	36.28	3.05
18	0.16	0.07	26.82	62.00	31.92	4.22	37.19	3.18
19	0.16	0.07	26.63	62.78	32.05	4.25	37.95	3.28
20	0.16	0.07	26.45	63.46	32.16	4.28	38.66	3.36

Before moving on to the discussion part, we apply the residual Portmanteu-test for autocorrelations to each model. The null hypothesis of this test is that the residuals exhibit no autocorrelations up to a specified lag. We choose a maximum lag length of 20 and perform the test for the model of each country. At 5% level of significance, the null hypothesis in Portugal, Greece and Spain cannot be rejected. In Ireland, the null hypothesis cannot be rejected on 10% level of significance. Thus, we conclude that the estimated models are robust.

6 Discussion

The analysis of the real estate market in the PIGS countries showed that Spain and Ireland experienced the largest positive bubble in the period between the implementation of the single monetary policy under the ECB in 1999 and 2012, followed by Portugal with a very small bubble. In contrast to that, Greece experienced a strong negative bubble trend. This decrease was due to a very strong decrease of interest rates up to 2001, which pushed the fundamental value far above the market value, resulting in a decreasing bubble.

The major bubble boom, starting between 2003 and 2005 was followed by the burst at the end of 2008, when interest rates of the ECB reached its second peak. The empirical analysis confirmed that there is a significant long- and short-run relationship between monetary policy and the bubble formation. We found strong evidence that the bubble in Ireland, Greece and Spain is positively related to both the Euribor and the house lending-to GDP in the long-run. In Portugal, however, we found no long-term relationship between the variables. As for Portugal, the impulse response analysis showed only a weak positive relationship between the two variables and the bubble. In Greece, the analysis showed a stronger positive relationship between the two variables and the bubble than in Portugal. In contrast to that, we found that the bubble in Ireland and Spain, the countries with the largest bubble, is negatively related with the Euribor in the short-run. Further, the analysis showed that the bubbles in these two countries are positively related to lending for house purchase-to-GDP. Although we found some similarities in the long- and short- rung relationship between the bubble and the variables, (i.e. the monetary policy), there are still differences across the PIGS countries. These differences can be attributed to the characteristics of the financial system, fiscal and macroprudential policies in each country.

First, the monetary policy of the ECB is transmitted differently through the interest rate and credit channel to the countries in the Eurozone (ECB, 2009). The interest channel describes the process of how key interest rates set by the ECB impact the interest rates at banks at the national level. In this regard, Sorenson and Lichtenberger (2007) pointed out that although the ECB sets the key interest rate for the entire Eurozone, the interest rates on mortgages are heterogeneous across countries. The credit channel describes the process how monetary policy affects the supply of money on the national level. In this regard, Ciccarelli et al. (2010) showed that a monetary policy shock of the ECB has a significant impact on credit availability. Further, they demonstrate that there are differences between size and timing of the impact across borrowers and economic regions. As a result of the differences in the interest rate and credit channel, the monetary policy of the ECB has a varying impact on domestic deposit and lending conditions of banks. The following table on the interest rates of housing loans and deposits shows the diverging interest rates across the PIGS countries. Looking at the interest rates for housing loans, it is noteworthy that the two countries with the largest bubble had, most of the time, up to the burst of the bubble in 2008 the lowest interest rate. Further, the interest rate in Greece decreased rapidly from 1999 and its level remained still the highest among the PIGS countries up to the mid-2000s. The rapid decrease of the interest rate manifested in the initially strongly decreasing bubble in Greece.

Table 5
Interest Rates on Housing Loans and Deposits

	Average interest rate for housing loans				Average interest rate on deposits*			
	Portugal	Ireland	Greece	Spain	Portugal	Ireland	Greece	Spain
1999	5.02	4.94	8.51	4.79	2.40	0.13	8.68	2.13
2000	6.03	5.19	7.62	5.79	3.04	0.40	6.12	3.36
2001	6.04	5.59	6.28	5.84	3.35	0.40	3.32	3.22
2002	5.02	4.58	5.01	4.85	2.96	0.12	2.76	2.75
2003	3.71	3.73	4.77	3.54	1.95	0.52	2.41	2.01
2004	3.49	3.40	4.49	3.21	1.82	0.45	2.30	1.97
2005	3.40	3.40	4.11	3.23	1.88	0.52	2.25	2.10
2006	4.08	4.14	4.32	4.14	2.61	0.81	2.96	2.83
2007	4.88	5.00	4.47	5.15	3.76	1.33	4.09	4.01
2008	5.34	5.07	4.85	5.65	4.10	1.41	4.93	4.52
2009	2.56	2.93	3.79	3.03	1.82	0.62	2.50	2.34
2010	2.54	3.16	3.64	2.52	1.84	0.64	3.36	2.51
2011	3.86	3.40	4.28	3.41	3.53	0.64	4.26	2.67
2012	3.78	3.28	3.20	3.21	2.88	0.48	4.80	2.70

* Deposits with agreed maturity of up to 1 year. In the case of Ireland there is no data on this rate available, therefore we show the interest rate for an overnight deposit.

Second, fiscal policies in the Eurozone vary from country to country. These policies include, for instance, tax deductibility of interest payments on mortgage loans, capital gains taxes, inheritance tax, wealth tax, real estate property tax and transaction taxes. A report from the ECB (2009) shows that tax rates in 2008 varied strongly throughout the Eurozone and the PIGS countries. To give an example, the maximum tax rate applicable on capital gains in Greece is zero if capital gains have been or will be reinvested in another permanent residence within certain time limits. In Spain the maximum rate is 18%, in Ireland 20% and in Portugal 42%. Third, in regard to the macroprudential policies as loan-to-value ratios, the report shows large differences among the PIGS countries in 2007. In the group of the PIGS countries, Ireland had the highest average loan-to-value ratio of 83% for first-time house buyers, followed by Greece with 73%, Spain with 72.5% and Portugal with 71%.

The combination of these three factors gives a strong indicator why Portugal experienced a moderate bubble and why Ireland and Spain experienced a strong bubble. In Portugal, relatively high interest rates in the boom period combined with a high tax rate and comparatively low average loan to value ratio discouraged investors and speculators to move into real estate. In contrast, very low interest rates and moderate tax rates as well as relatively high loan-to-value ratios in Ireland and Spain encouraged investors to move into real estate, thus pushing up the market value and the bubble.

As this research only covered aggregate data for the PIGS countries, diverging developments within each country were not captured. Future research could bridge this gap by analyzing property market developments in specific cities or regions within each country. Further, other variables influencing the calculation of the bubble as occupancy rates, maintenance cost and tax were not considered in this paper. The inclusion of these factors would help draw a more detailed picture about the bubble and its drivers. Further, a more detailed analysis of credit expansion, fiscal and macroprudential policies on the national level in relation to the bubble could give useful insights for investors and policymakers.

7 Conclusion

Overvalued property prices pose a serious risk for economic and financial stability. This analysis showed that Spain and Ireland experienced the largest positive bubble formation in the period between 1999 and 2012, followed by Portugal with a very small bubble. In contrast to that, Greece experienced a strong negative bubble, which was due to a rapid decrease of interest rates between 1999 and 2001, resulting in a fundamental value far above the market value. The major bubble boom, starting between 2003 and 2005, was followed by the burst at the end of 2008 when the interest rates of the ECB reached its peak.

Results of the empirical analysis on the long- and short run relationship between the monetary policy of the ECB and the bubble in the PIGS countries indicate a very strong relationship in Ireland and Spain. In the long-run, the bubble is positively related to both an increase in the money market interest rate and the lending for house purchase-to-GDP. In the short-run, however, we found strong evidence for a negative relationship of the bubble with the Euribor and a strong positive relationship with the lending for house purchase-to-GDP. In the case of Greece, we found a weak positive long- and short- run relationship between the two variables and the bubble. As for Portugal, we found no long- and only a very weak short-run relationship. The varying extent of the bubble formation and the differing impact of the monetary policy on the bubble across the PIGS countries can be mainly attributed to the characteristics in the domestic financial-, fiscal- and macroprudential- system.

This paper provides strong evidence that countries with very low interest rates and low to moderate tax rates as well as high loan-to-value ratios have the potential to experience large property bubbles. Central bank’s policies are crucial to trigger the boom and burst of property bubbles by manipulating the interest rate and availability of lending for house purchase.

References

Agnello, L., & Schuknecht, L. (2011). Booms and Busts in Housing Markets: Determinants and Implications. *Journal of Housing Economics, 20*, 171-190.

Asmussen, J. (2012). The Irish Case from an ECB Perspective, from http://www.ecb.int/press/key/date/2012/html/sp120412.en.html

Chan, H. L., Lee, S. K., & Woo, K. Y. (2001). Detecting Rational Bubbles in the Residential Housing Markets of Hong Kong. *Economic Modelling, 18*, 61-73.

Ciccarelli, M., Maddaloni, A., & Peydro, J.-L. (2010). Trusting the Bankers: A New Look at the Credit Channel of Monetary Policy. *ECB Working Paper Series*(1228).

ECB. (2009). Housing Finance in the Euro Area. *European Central Bank Structural Issues Report*.

ECB. (2010). Asset Price Bubbles and Monetary Policy Revisted. *ECB Monthly Bulletin, November 2010*, 71-83.

ECB. (2013). Monetary policy, from http://www.ecb.europa.eu/mopo/html/index.en.html

Enders, W. (2010). *Applied Econometric Time Series*: John Wiley & Sons.

Engle, R. F., & Granger, C. W. J. (1987). Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica, 55*(2), 251-276.

Hofmann, B. (2004). The Determinants of Private Sector Credit in Industrialized Countries: Do Property Prices Matter? *International Finance, 7*, 203-234.

Hui, E. C. M., & Yue, S. (2006). Housing Price Bubbles in Hong Kong, Beijing and Shanghai: A Comparative Study. *J Real Estate Finan Econ, 33*, 299-327.

Igan, D., & Loungani, P. (2012). Global House Prices Still Showing Down Trend. *IMF Survey Magazine: IMF Research*, from http://www.imf.org/external/pubs/ft/survey/so/2012/res091712a.htm

Johansen, S. (1995). *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models*. New York: Oxford University Press.

Koetter, M., & Poghosyan, T. (2010). Real Estate Prices and Bank Stability. *Journal of Banking & Finance, 34*, 1129-1138.

Mikhed, V., & Zemcik, P. (2009a). Do House Prices Reflect Fundamentals? Aggregate and Panel Data Evidence. *Journal of Housing Economics, 18*, 140-149.

Mikhed, V., & Zemcik, P. (2009b). Testing for Bubbles in Housing Markets: A Panel Data Approach. *J Real Estate Finan Econ, 38*, 366-386.

Oikarinen, E. (2009). Interaction Between Housing Prices and Household Borrowing: The Finnish Case. *Journal of Banking & Finance, 33*, 747-756.

Praet, P. (2011). Housing Cycles and Financial Stability - The Role of the Policymaker, from http://www.ecb.europa.eu/press/key/date/2011/html/sp111124.en.html

Sims, C. (1980). Macroeconomics and Reality. *Econometrica, 48*, 1-48.

Smith, M. H., & Smith, G. (2006). Bubble, Bubble, Where's the Housing Bubble? *Brookings Papers on Economic Activity*(1).

Sorensen, C. K., & Lichtenberger, J.-D. (2007). Mortgage Interest Rate Dispersion in the Euro Area. *ECB Working Paper Series*(733).

Stiglitz, J. E. (1990). Symposium on Bubbles. *The Journal of Economic Perspectives, 4*(2), 13-18.

Tsai, I. C., & Peng, C.-W. (2011). Bubbles in the Taiwan Housing Market: The Determinants and Effects. *Habitat International, 35*(2), 379-390.