THE RELATIONSHIP BETWEEN MORTGAGE MARKETS AND HOUSE PRICES: DOES FINANCIAL INSTABILITY MAKE THE DIFFERENCE?

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Abstract:

During the late 1990s and up to 2007 several countries experienced sharp increases in house prices. These episodes are usually mentioned among the causes of the recent world's economic and financial turmoil. The dramatic growth in bank lending during this period has been broadly held responsible for these market dynamics. However, the empirical relationship between mortgage credit and house prices remains largely unexplained. This paper analyses the relationship between house prices and mortgage credit in Spain, a country where house prices and mortgage credit have experienced a high growth in recent years prior to the financial crisis. We employ a quarterly database from 1988Q4 to 2008Q4. Using cointegration analysis and Vector-Error-Correction (VEC) models, we find that both house prices and mortgage credit interact in the short- and in the long-run. The results also suggest that there were a regime shift in mortgage lending in Spain in 2001 –where mortgage credit securitization substantially grew- that increased the economic significance of the impact of mortgage lending on house prices.

JEL Classification: R21, G12, G21

Keywords: house prices, mortgages, banks

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"The proximate cause of the crisis was the turn of the housing cycle in the United States and the associated rise in delinquencies on subprime mortgages, which imposed substantial losses on many financial institutions and shook investor confidence in credit markets. However, although the subprime debacle triggered the crisis, the developments in the U.S. mortgage market were only one aspect of a much larger and more encompassing credit boom whose impact transcended the mortgage market to affect many other forms of credit."

Ben Bernanke (Chairman, Board of Governors of the Federal Reserve System) at the Stamp Lecture, London School of Economics, London, England. January 13, 2009

It is generally agreed that the trigger for the turmoil was a myriad of problems associated with the US housing market correction (…) the period preceding the current financial turmoil shares many of the characteristics of previous historical episodes – a so-called "Minsky moment" whereby there is a sudden recognition and recoil from underlying credit whose quality was in fact worsening for years.

Jean-Claude Trichet (President of the European Central Bank) at the Policy Discussion "Global Economic Policy Forum 2008", New York University, New York, 14 April 2008.

1. INTRODUCTION

What are the causes of the sharp increases in house prices that many industrialized countries have experienced in recent years? Is the high growth in mortgage credit to blame? In the U.S., the dramatic rise in subprime lending has been broadly blamed for these market dynamics. However, recent evidence has shown that subprime credit activity does not seem to have had much impact on subsequent house price returns, although there is strong evidence of a price-boosting effect as the Government Sponsored Enterprises –such as Fannie Mae and Freddie Mac- were displaced in the market by private issuers of new mortgage products (Coleman *et al.*, 2009). In Europe, the growth in house prices has been particularly noticeable in some countries such as Spain, the UK and Ireland -where house prices have increased by more than 180% only between 1997 and 2007- the largest growth among major industrialised countries. Mortgage financing has also been the focus of the debate in Europe although the actual dynamics of the relationship between mortgage credit and house prices are not, so far, well-known.

Even if the correlation between house prices and mortgage credit can be observed in most countries experiencing sharp increases in house prices, the direction of causality (if any) is not that clear. Econometric analysis has an important role in the definition of this relationship, both in the short and in the long term. This paper aims to shed some light on the relationship between house prices and mortgage credit in Spain. Cointegration analysis and vector error correction models are employed to assess the short-run and long-run dynamics of mortgage credit and house prices in Spain. We use quarterly data for the 1988Q4-2008Q4 period. Together with house prices, we also employ a house price/rent (P/R) indicator which proxies the magnitude of the over-valuation of house prices during this period. The paper is divided into three sections following this introduction. Section 2 surveys the main studies that have examined the relationship between house prices and mortgage credit. In section 3 we develop an empirical study of the relationships between house prices and mortgage lending using cointegration analysis and error correction models. The paper ends with a summary of the main results and conclusions in section 4.

2. HOUSE PRICES AND MORTGAGE FINANCING: A REVIEW

House price modelling has received increasing attention in the economic literature in the last thirty years[1]. With regard to the role of lending in this context, it should be pointed out that explicit consideration of mortgage credit as a central variable in house-price models is not, in most cases, endowed within theoretical grounds. Therefore, even assuming the existence of a relationship between both variables, the main theoretical studies have considered mortgage credit and house prices separately.

[1] In this section we basically survey the literature analysing the relationship between house prices and mortgage financing. In any case, there is a wide range of approaches that pay particular attention to the determinants of other variables rather than financing. In this respect, recent studies such as of Glaeser *et. al.* (2005) have shown the importance of both building costs and land availability and regulation as two of the key factors that explain the evolution of house prices.

As for the studies on the specific relationship between house prices and mortgage financing can be classified in two main approaches: the financial-type or asset market approach and the macroeconomic approach. The asset market approach (Brown *et al.*, 1997; Holly and Jones, 1997; Ayuso and Restoy, 2006, 2007) is based either on inter-temporal equilibrium conditions, or on the weaker requirement of absence of arbitrage opportunities. Financial market imperfections are excluded, but specific rigidities on the supply side of the economy may be encountered. Most models following this approach seek to obtain an equilibrium equation for the ratio of the house price to the rental price, which serves to ascertain whether the current price is misaligned, or inflated by speculative bubbles.

In the macroeconomic-type models (Poterba 1984; Égert and Mihaljek, 2007), house price dynamics are expressed as a function of the variables which determine the supply of and demand for housing. Empirical literature using this macroeconomic-type framework include both cross-country studies (Hofmann, 2001; Annett, 2005; Girouard et al, 2006; Sutton, 2002; Terrones and Otrok, 2004; Tsatsaronis and Zhu, 2004) and individual country studies (Martínez Pagés and Maza 2003; Fitzpatrick and McQuinn, 2004; Gerlach and Peng, 2005; and Gimeno and Martínez-Carrascal, 2010). The present paper borrows from these macro-type models. Importantly, information asymmetries play an important role as consumers do not have all the information that they would like with regard to the availability of credit (Bernanke and Gertler, 1989). This friction confers great significance to expectations in the study of the interaction between mortgage credit and house prices. In order to approximate these asymmetries, together with the volume of credit, these studies include other important variables for expectations such as interest rates or lagged house price values. Yet, as pointed out by Hass and Greef (2000), consumers may not obtain as much mortgage credit as may be

indicated merely by the equilibrium interest rate. In this context, mortgage credit rationing appears as a factor that may cause disequilibrium in the mortgage credit market and, consequently, in the housing market. In some studies, therefore, the stock of mortgage loans has been used as a proxy variable for credit rationing (Hendry, 1984). In other studies, such as Muellbauer and Murphy (1997), the growth rate of that stock is used alternatively.

Another important factor to study the interaction between house prices and mortgage financing is the cyclical behaviour of both variables, which usually determines the use of time trends and the identification of cointegration relationships between these two magnitudes. The cyclical component of mortgage credit and its interaction with property prices has been underscored, amongst others, by Goodhart (1995) for the United Kingdom, Borio and Lowe (2002) for a broad sample of industrialised countries, Coleman *et al.* (2009) for the US or Oikarinen (2009) for Finland. However, as shown in some of these studies, it is unclear that it is mortgage credit what causes growth in house prices. Rather the contrary, some other factors –such as, *inter alia*, the inelastic supplies of owner-occupied housing- are identified as the main causes of house price increases (Goodman and Thibodeau, 2009). Furthermore, the consideration of the house as collateral in loan operations and the effects of monetary policy through the "bank lending channel" have also concentrated a great deal of attention in recent literature. In this respect, Aoki *et al.* (2004) introduce the housing stock (as loan collateral) in the general financial accelerator model in monetary policy transmission mechanisms[2], showing that a rise in house prices increases collateral value for consumers. This increase has a positive impact on consumption and also permits

[2] See the general scheme of Bernanke, Gertler and Gilchrist (1999).

greater recourse to credit financing, although at the same time it amplifies the cyclical effects of lending and consumption, thereby increasing risk.

As for the specific relationship between financing and house prices, Gimeno and Martínez Carrascal (2010) carry out an application to the Spanish case and this represents the first explicit approach to the interaction between financing and house prices in Spain. Their results show that growing imbalances in the mortgage credit market tend to bring down house prices in the long run, whereas in the short term increases in mortgage credit appear to bring about a rise in house prices. Similarly, Martínez Pagés and Maza (2003) analysed the Spanish case, using an error correction model, where real income and nominal interest rates are posited as the main variables explaining the evolution of house prices.

In any case, the empirical contribution that comes closest to the aims of this paper is Gimeno and Martínez-Carrascal (2010) that analyses recent developments in house purchase loans and house prices in Spain and the linkages between them showing that both variables are interdependent in the long-run[3]. The main difference between the approach in our study and that of Gimeno and Carrascal (2010) is that the addition of the default ratio (as an *ex-post* measure of the quality of lending) and of an alternative model that considers the price to rent ratio.

Gerlag and Peng (2005) also offered a similar approach as they examine the long and short-term relationship between house prices and mortgage credit on the basis of approximation of the cointegration relations between both aggregates[4]. With an application to the Hong Kong housing market, their results show that the increases in house prices are positively and significantly related to growth in long-term mortgage loans but credit is not found to significantly affect house prices.

[3] As in Gimeno and Martínez Carrascal (2009) we find two-cointegration relationships for these variables.
[4] It must be pointed out, in any case, that Gerlach and Peng (2005) use private lending as a proxy for mortgage credit.

As far as the Spanish case is concerned, most empirical studies have followed the intertemporal asset market model. Ayuso and Restoy (2006, 2007) also developed an intertemporal asset pricing model in order to determine empirically the level of overvaluation of house prices in Spain, the United Kingdom and the United States. Their results suggest that part of the rise in house prices in Spain since 1998 may be attributed to a correction for an earlier underpricing, although in recent years the growth in house prices appears to be mainly due to substantial demand shocks.

3. AN EMPIRICAL APPROACH TO THE RELATIONSHIP BETWEEN HOUSE PRICES AND MORTGAGE FINANCING

The empirical methodology aims to explore the relationship between house prices and mortgage lending in Spain. Importantly, some recent studies have highlighted that house price macroeconomic-type models usually do not work well empirically for two main reasons (Cameron et al., 2006): i) due to the existence of structural breaks in the sample period analyzed; ii) due to classic omitted variable bias and, in particular, to the general fact that these models do not take account of changing credit conditions/standards. As shown by Gallin (2008) many home price models lack data on credit standards facing (and regional housing stocks) that may account for the absence of a long-run relationship between home prices, interest rates, and income. This role of credit conditions on house prices has been also demonstrated in the theoretical contribution of Kim (2007) within a house price to rent framework. It is interesting, then, to study if credit conditions may have an influence on the determination of house prices and, in particular, on "house price to rent" ratios since easier credit has been found to drive up the house price to income. This is also particularly relevant considering the role of lax credit conditions on lending growth in the years prior to the

financial crisis starting in 2007. Along with house prices, this empirical exercise attempts to approximate the relationship between mortgage financing and the actual market valuation. This valuation is approximated through the relationship between the asset price and the rental revenues as a house price-rents ratio (P/R).

We incorporate such omitted data into house price models which yield stable long-run relationships, more precisely estimated income and interest rate coefficients, reasonable speeds of adjustment, and improved model fits."Therefore, our specification will consider structural breaks (as a robustness check) and the cointegration tests include credit quality (mortgage lending default rates) as a proxy for changes in credit conditions[5].

3.1. Data and description of the sample

We use quarterly that comprise the period 1988Q4-2008Q4. The variables employed and the statistical sources are described as follows:

- *Mortgage credit per household in real terms*: it comprises lending for house purchase and renovation (which refers in over 90% to mortgage guarantee lending) in relation to the number of household (source: Banco de España and Instituto Nacional de Estadística [INE]).
- *House price in real terms*: logarithm of the square metre price of new and second-hand housing (source: Ministerio de Fomento y Ministerio de Vivienda).
- *House P/R*: The housing rental revenues index has been calculated from the respective rental component of the Consumer Price Index (source: INE).

[5] Most of the empirical models including changes in credit conditions include the loan-to-value (LTV) ratio. In our case, the Bank of Spain only offers data on LTV ratios from 2005 onwards although the correlation between this variable and our mortgage credit default rate during 2005-2008 is -0.97.

- *Nominal mortgage credit interest rate*: average mortgage credit interest rate (source: Banco de España).
- *Real salary per employee*: ratio of gross salary to the number of households (source: INE).
- *Credit quality:* mortgage credit default rate (source: Banco de España)

Figure 1 shows the main trends in house prices and mortgage credit in Spain between 1988Q4 and 2008Q4. House prices have gone through four differentiated stages in this period. As of the late 1980s and early 1990s a substantial rise in house prices took place in real terms, followed by certain stability between 1993 and 1998 and a subsequent significant resurgence thereafter. After the US subprime crisis in August 2007, house prices have then progressively declined and, in particular, during 2008. Mortgage credit, however, increased constantly (in per capita terms) throughout the period analysed. However, the intensity of this growth has been markedly higher during 1987-1990 and 2001-2007 periods. The evolution of the house P/R and average mortgage interest rates are shown in Figure 2. During the first half of the period considered, the house P/R followed a similar path to house prices. However, between 2001 and 2007, the P/R ratio increased considerably, suggesting a significant overvaluation of house prices above market fundamentals. The house P/R and has only fallen from 2007Q3 onwards when the growth in house prices in Spain has progressively fallen. As for interest rates, they have been significantly lower from 1995 onwards even if they have slightly risen from 2006 to 2008. Table 1 shows the Augmented Dickey-Fuller (ADF) integration order test. In accordance with the critical values, the series analysed are integrated of order 1, so their first differences were sufficient to achieve stationarity.

3.2. Long-term cointegration and analysis

The cointegration model employed stems from the vector autoregression methodology (VAR) proposed by Johansen (1988, 1991, 1995), which is basically expressed as:

$$x_t = \beta_1 x_{t-1} + ... + \beta_k x_{t-k} + \mu + \delta\tau_{\partial t} + \varepsilon_t \quad (1)$$

where x is a vector of endogenous variables, μ is a vector of constant terms, τ is a deterministic time trend and ε is a vector of "white noise" error terms. The equation in (4) may be expressed as a vector error correction (VEC) model, which is a restricted VAR especially appropriate for analysing long-term behavior so that the endogenous variables converge on their cointegration relations:

$$\Delta x_t = C_1 \Delta x_{t-1} + ... + C_{k'1} \Delta x_{t-k+1} + C_0 \Delta x_{t-1} + \mu + \varepsilon_t \quad (2)$$

where C represents the matrix of coefficients for each variable. In particular, C_0 is a matrix that may be factorized as $C_0 = \alpha\beta'$, where β is a long-term vector of cointegration coefficients and α is the vector of coefficients that measure the rate of adjustment in the long run. The Johansen's trace test methodology consists, precisely, of analysing the range of the matrix C_0, which indicates the number of long-term cointegration relationships within the set of endogenous variables. In the empirical estimation mortgage credit per household in real terms, house price in real terms, nominal interest rates and mortgage lending default rates were introduced as endogenous variables[6]. The number of lags in this analysis was four, there being no significant lags of a superior order to this. Since the data frequency is quarterly, we

[6] The inclusion of the housing stock and the cost of use of housing among the set of variables, as put forward in the general theoretical model expressed in equation (3), generated numerous inconsistencies in the estimation and, therefore, they were not included in the final specification.

include quarterly dummy variables to control for the seasonality of the data. The final estimations correspond to a filtered restricted model where the usual house price and mortgage credit normalisation restrictions are imposed.

The results of the cointegration test are shown in Table 2 (restricted model 1). The trace test values, including those corrected for small-size samples, indicate that two cointegration relationships exist. Alternatively, we constructed a second model (restricted model 2), where, instead of house prices, the house P/R is included. The results of the trace test for this model are shown in Table 3 and they also show the existence of two cointegration relationships. Both house prices and mortgage lending seem to interact in the long-run.

Table 4 presents the cointegration vectors for each of the two restricted models, including the adjustment rate parameters[7]. All the adjustment rate parameters have been annualised. First of all, in restricted model 1 we observe that the elasticity of mortgage credit to house prices is 0.85, while the long-term elasticity of lending to interest rates is 8.00. The elasticity of house prices to mortgage credit, real salary and credit quality are 0.62, 1.79 and 2.12 respectively. These parameters present similar values to those obtained by Gimeno and Martínez Carrascal (2010) for a broad range of alternative cointegration model specifications. As for the adjustment rate parameters, they measure the dynamics of the return to long-term equilibrium. In this respect, the first restricted model shows that when the mortgage credit per household lies above its long-term equilibrium level, its return to equilibrium takes place by way of three sources: firstly, by means of reductions of 10.4% per year in mortgage loans; in addition, by means of reductions of 4.9% per year in the house price, by means of reductions of 2.5% per year

[7] As in Gimeno and Martinez-Carrascal (2010) we impose a normalization restriction on mortgage credit in Model 1 and a unitary elasticity of this credit with respect to real salary. In the house price (and the house P/R) a zero coefficient is imposed on interest rates along with normalization restriction on house prices.

in nominal interest rates and, lastly, by improvements in credit quality of 2,7%. Similarly, house prices adjust (when they lie above their equilibrium level) by means of reductions of 3.0% in mortgage lending, 5.4% in the actual prices and increases of 2.6% in the nominal interest rate and 3.6% on credit quality.

Table 4 also shows the long-term correction and adjustment rate parameters for restricted model 2, where the house P/R is included instead of house prices. In this case we observe that the elasticities of mortgage credit to the house P/R, interest rates and credit quality are 0.28 and 2.98 and 3.52 respectively. The elasticity of the actual P/R to mortgage credit is 0.41 and to salary per worker is 2.44, whereas the elasticity of the P/R to credit conditions is 3.26. As for the long-term adjustment, when lending for housing purchases is above its equilibrium level, it is estimated that the return to equilibrium takes place by means of yearly reductions in the actual mortgage credit of 8.1%, reductions in the house P/R of 4.3%, reductions in the interest rate of 2.9% and improvements in credit quality of 1,9%. Introduction of the house P/R enables us to make an interesting additional analysis: how the adjustment dynamics take place when the house is overpriced (above its equilibrium level). The results also indicate that the return to house pricing equilibrium takes place by means of yearly reductions in mortgage lending of 3.2%, reductions of the actual P/R of 5.5%, increases in interest rates of 3.6%[8] and an improvement in credit quality of 4,8%.

In short, the results of the cointegration tests underline the importance of the relationships between mortgage credit and house prices in the determination of their long-term equilibrium. They also show the importance of interest rates as a correction mechanism both for the disequilibrium in the mortgage credit market and in house prices.

[8] Naturally, this adjustment refers to a variation of 2.9% in respect of the interest rate at the time and, under no circumstance, to a net increase of 2.9 percentage points in the interest rate.

3.4. Short-term analysis

Cointegration analysis allows us to make a more stringent estimation of the short-term dynamics of house prices and mortgage credit. In particular, it is possible to obtain ordinary least squares estimates of the short-term dynamics of mortgage credit per household in real terms, house prices in real terms, and the house P/R. The error correction term in these estimates is determined by two lagged cointegration (*CI*) vectors of mortgage credit and house prices (or house P/R), respectively[9].

Five equations were estimated and their results are shown in Table 5. In the basic model (equation (I)), the short-term determinants of mortgage credit per household are analysed in real terms. The explanatory variables – which are introduced in differences - included as many as four actual dependent variable lags, as well as the actual values and four house price lags, the real salary and the nominal interest rates. In accordance again with the "general-to-specific" approach, only the coefficients of significant variables are shown. In this first equation we observe a short-term positive and significant effect of house prices on mortgage credit. Interest rates, however, have a negative impact on the variation in short-term mortgage credit, while real salary (as a proxy for income expectations) is positively and significantly related to mortgage credit. The lag in the correction for disequilibrium in the mortgage credit market (*CI(ΔMortgage credit per household in real terms*) also acts as a mechanism for correction of actual long-term mortgage credit, whereas the lag in the correction for house price disequilibrium (*CI(ΔHouse prices in real terms*) appears to have no impact on short-term mortgage credit.

[9] These estimates could present considerable biases due to the simultaneity between house prices and mortgage credit. However, the application of Hausman's test for an auxiliary regression of mortgage credit where residuals of an additional house price regression are included does not reject the null hypothesis of unbiased ordinary least square estimates.

Equation (2) in Table 5 shows the short term dynamics of house prices in real terms. Not only the interest rate, but also the correction for long-term disequilibrium – both in house prices and in mortgage credit – have a negative and significant effect on house prices in the short term. In the equation (3), house price is replaced by the house P/R as the dependent variable. Again, interest rates and the two cointegration corrections have a negative impact[10].

In order to compare our results with those of Gimeno and Carrascal (2010) and Ayuso and Restoy (2006), Figure 3 shows the evolution of the error correction terms for the sample period (1998-2008). Consistently with those studies, our results show that the higher gaps in housing prices and mortgage lending took place in the early 1990s, the late 1990s, and 2008.

3.5. Stability of short-term dynamics and the regime shift in mortgage credit

As shown in Figure 1, mortgage credit significantly increases from 2001 to 2007. Various factors may have caused a shift in the mortgage credit regime from 2001 onwards. First of all, a significant increase in mortgage securitization took place in those years, in part due to the approval of new securitization regulations in 1999 that increase the range of securitization products. In any event, as noted by Almazan et al. (2008), even if the new regulation was implemented in 1999, the rise in securitization is noticeable from 2001 onwards. House prices also increased considerably from 2001 and real interest rates were set at the lower levels of the period analysed. All in all, these trends may have caused a shift in mortgage credit regime. This shift may have had a significant impact on the estimated long-run and short-run impact of house prices on mortgage credit. We include a series of tine dummies multiplied by the error-correction

[10] We also test alternative specifications where we use per capita GDP instead of real salary per worker and real interest rates instead of nominal interest rate. The results were found to be robust to these changes in specification and are not shown for simplicity.

term of the OLS regressions to check whether there has been a structural break in the cointegration relationship. The results suggest that this term is not significant.

We also employ a dummy to capture if there is a short-run change in mortgage credit regime in 2001. The dummy variable takes the value of zero up to 2000Q4 and that of unity thereafter. The OLS equations are then re-estimated with an interaction of mortgage credit multiplied by this dummy. What this term effectively does is to adjust the coefficient of mortgage credit in line with a regime shift in this credit in 2001. The term is shown to be statistically significant and, therefore, we expect the short-term dynamics of mortgage credit to vary from 2001 onwards. To analyse this regime shift, the OLS regressions in section 3.4 for mortgage credit are run for two sub-periods: 1988Q4-2000Q4 and 2001Q1-2008Q4. The results are shown in Table 6. Comparing the results for the equations of mortgage credit in the two sub-periods, we find that the magnitude of the coefficients of house prices and interest rates exhibit a much larger effect on mortgage credit during 2001Q1-2008Q4. The latter may reveal that the relationship between house prices and mortgage credit may have been exacerbated in those years.

4. CONCLUSIONS

House prices have been the main focal point of economic and social debate in recent times in many developed countries. The rise in house prices in the Spanish case has been has been one of the most striking in the international perspective. There are many factors affecting house prices, although the influence of any of these factors and the possible interactions between them require a long-term analysis of these influences

over time. Amongst these factors, and with the advent of the financial crisis beginning in August 2007, the relationship between mortgage financing and prices has concentrated a big deal of attention in this context.

In this paper we follow various empirical methodologies to analyse the relationship between mortgage financing and house prices in Spain using quarterly data from 1988Q4 to 2008Q4. We also include a house price/rent (P/R) indicator in order to analyse the magnitude of the overvaluation of house prices. The results in this paper suggest that in Spain mortgage lending and house prices dynamics have mutually interacted in the long- and short-run although the short-term impact of mortgage lending on house prices may have significantly increased from 2001Q1 onwards. We speculate that this shift in the impact of mortgage lending may be related to securitization trends. In any event, it is observed that lending may have been excessive in the years prior to the financial crisis, at least as far as house prices are concerned. Besides, the interaction between both variables may have contributed to financial instability. Not surprisingly, some recent research has suggested that capital adequacy requirements on mortgage lending should be related to housing appreciation (Goodhart and Hofmann, 2007). In any event, further research is needed to analyse to what extent other sources of credit such as credit for construction and real estate companies may have had an influence on house prices.

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Table 1. Augmented Dickey Fuller (ADF) unit root test for the set of variables analysed

	Levels	**First differences**
	ADF	**ADF**
Mortgage credit per household in real terms	-3.6894	-3.8693**
House price in real terms	-1.8652	-3.7057**
House P/R	-0.1421	-5.6850***
Nominal mortgage credit interest rate	-2.4864	-3.8756**
Real salary per worker	-1.4536	-4.6419***
Credit quality (mortgage lending default rate)	-2.6952	-4.2636***

*** Rejection of the null hypothesis of unit roots at the 10% significance level**
**** Rejection of the null hypothesis of unit roots at the 5% significance level**
***** Rejection of the null hypothesis of unit roots at the 11% significance level**

Test 2. Johansen's cointegration test (restricted model 1)

Endogenous variables: mortgage credit per household in real terms, house price in real terms, nominal interest rates and mortgage lending default rates.
Restricted variable: real salary per worker

H_0: range=r	Trace (statistical t)	Small-size sample correction
r=0	58.14***	50.11***
$r \leq 1$	30.44***	25.13***
$r \leq 2$	11.09	10.55

* Cointegration exists at 10% significance
** Cointegration exists at 5% significance
*** Cointegration exists at 1% significance

Table 3. Johansen's cointegration test (restricted model 2)

Endogenous variables: mortgage credit per household in real terms, house P/R, nominal interest rates and mortgage lending default rates.
Restricted variable: real salary per worker

H_0: range=r	Trace (statistical t)	Small-size sample correction
r=0	98.88***	88.27***
$r \leq 1$	56.46***	45.10***
$r \leq 2$	15.23	13.26

* Cointegration exists at 10% significance
** Cointegration exists at 5% significance
*** Cointegration exists at 1% significance

Table 4. Long-term relationships, cointegration vectors (β) and adjustment rate (α)

All the adjustment rates parameters have been annualised
(standard errors in parentheses)

	Restricted model 1				**Restricted model 2**			
	Vector	Adjustment rate	Vector	Adjustment rate	Vector	Adjustment rate	Vector	Adjustment rate
Mortgage credit per household in real terms	1	-0.104 (0.031)	-0.619 (0.127)	-0.030 (0.011)	1	-0.086 (0.026)	-0.417 (0.087)	-0.032 (0.010)
House price in real terms	-0.848 (0.145)	-0.049 (0.016)	1	-0.054 (0.017)	-	-	-	-
House PER (prices/rent)	-	-	-	-	-0.286 (0.064)	-0.040 (0.013)	1	-0.055 (0.016)
Nominal mortgage credit interest rate	8.00 (0.418)	-0.025 (0.008)	0.000	0.026 (0.006)	2.586 (0.293)	-0.032 (0.011)	0.000	0.036 (0.012)
Real salary per worker	-1	-	-1.792 (0.209)	-	-1	-	-2.448 (0.286)	-
Credit quality (mortgage lending default rates)	3.641 (0.314)	-0.027 (0.004)	2.128 (0.255)	-0.036 (0.007)	3.920 (0.327)	-0.019 (0.002)	3.263 (0.306)	-0.048 (0.08)

Note: All variables are expressed in logs excepting interest rates. Model adjusted for the cases in which the adjustment rate parameters proved statistically significant, at 5% at least.

Table 5. Short-term equations. Ordinary least square estimates with error correction (1988Q4-2008Q4)

(standard errors in parentheses)

	Correction for restricted model 1		**Correction for restricted model 2**	
	(I)	*(II)*	*(III)*	*(IV)*
	Δ Mortgage credit per household in real terms	*ΔHouse price in real terms*	*Δ Mortgage credit per household in real terms*	*ΔHouse PER (prices/rent)*
ΔHouse price in real terms	0.1441*** (0.007)	-	0.1781*** (0.006)	-
ΔHouse PER (prices/rent)	-	-	-	-
Δ Mortgage credit per household in real terms	-	0.1205*** (0.002)	-	0.1617*** (0.002)
ΔNominal mortgage credit interest rate	-0.6038*** (0.014)	-0.0481** (0.002)	-0.6823** (0.011)	-0.0372** (0.003)
ΔReal salary per worker	0.2362*** (0.009)	-	0.1980*** (0.006)	-
CI (ΔMortgage credit per household in real terms)	-0.2451*** (0.018)	-	-0.1971** (0.011)	-
CI(ΔHouse price in real terms)	0.0739** (0.006)	-0.1204*** (0.008)	0.0556** (0.007)	-
CI(ΔHouse P/R)				-0.4588*** (0.011)
	Diagnostic tests for the residuals			
LM test	0.459 (0.79)	0.447 (0.81)	0.428 (0.86)	0.525 (0.64)
Normality test	0.504 (0.81)	0.486 (0.85)	0.514 (0.81)	0.894 (0.53)
ARCH test	0.771 (0.43)	0.446 (0.71)	0.727 (0.46)	0.628 (0.50)
Heterocedasticity	0.297 (0.97)	0.280 (0.99)	0.284 (0.97)	0.272 (0.99)
R^2	0.78	0.72	0.75	0.68

Note: All variables are expressed in logs excepting interest rates. The LM test is the Godfrey test for autocorrelation. For normalitiy the Doornik and Hansen test is used. Arch test is for autoregressive conditional heteroscedasticity test. The heterocedasticity test is a White test. In these diagnostic tests, p-values are in brackets.

* Statistically significant at 10%

** Statistically significant at 5%

*** Statistically significant at 1%

Table 6. Short-term equations with a regime shift in 2001. Ordinary least square estimates with error correction: 1988Q4-2000Q4 and 2001Q1-2008Q4

(standard errors in parentheses)

Corrections for restricted model 1

	1988Q4-2000Q4	**2001Q1-2008Q4**
	Δ Mortgage credit per household in real terms	*ΔMortgage credit per household in real terms*
ΔHouse price in real terms	0.0597*** (0.001)	0.1902*** (0.001)
ΔHouse PER (prices/rent)	-	-
ΔNominal mortgage credit interest rate	-0.3654*** (0.008)	-0.4252*** (0.010)
ΔReal salary per worker	0.2019*** (0.005)	0.2305*** (0.005)
CI (ΔMortgage credit per household in real terms)	-0.4671*** (0.007)	-0.3610*** (0.009)
CI(ΔHouse price in real terms)	0.1699** (0.004)	0.2003** (0.005)
$\mathbf{R^2}$	0.75	0.73

Note: All variables are expressed in logs excepting interest rates.

* Statistically significant at 10%

** Statistically significant at 5%

*** Statistically significant at 1%

Figure 1. House prices and mortgage credit growth rates in Spain (1988Q4-2008Q4)
Quarterly data

Figure 2. House P/R and mortgage interest rates in Spain (1988Q4-2008Q4)
Quarterly data

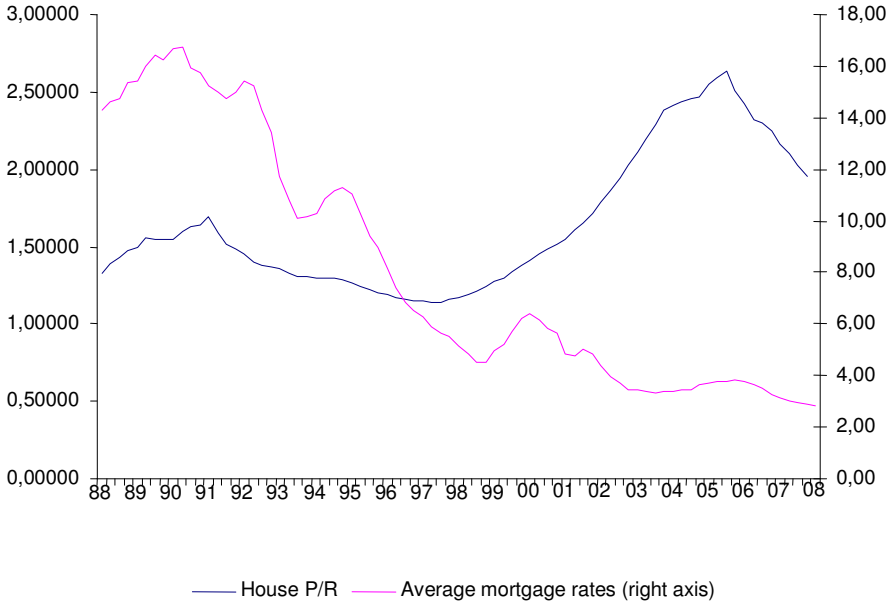

Figure 3. Mortgage credit per household, house price and house P/R: evolution of the error correction terms