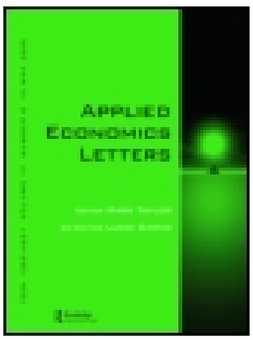

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Analysis of the impact of excess mortgages on housing prices using the cointegration test

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ABSTRACT

This article attempts to explain and predict housing prices by constructing a model based on the variables that most influence demand: the theoretical purchase effort index without tax deductions as well as a new and innovative indicator that includes the excess of mortgages granted. The Johansen methodology for cointegration analysis reveals the existence of long-run equilibrium and the model's subsequent ECM, to verify the statistical significance of the variables, confirms the validity of the model concerning this Spanish case study.

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Mortgage debt; house prices; cointegration; Spain

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I. Introduction

In reviewing the literature on this topic, many authors have centred their research on the housing bubble and the factors that influenced its formation and, in short, were able to explain the housing market's behaviour.

The objective of our work is to find the key variables that affect housing prices in order to later construct a prediction model for economic interpretation.

Through this model, we will be able to find an answer to the question that every economic player asks: when will the maximum prices from before the crisis return?

Shiller (2006) asked if it would be possible for a housing bubble to burst a year before it happened. And, if this is the case, what correction could then be made to return prices to their previous state? Would it be a harsh correction or a gradual one? In his analysis, he was more inclined towards a slow recovery process.

In this study, two key factors that have unquestionably affected housing prices have been confirmed: the progressive growth of banks through indebting families with mortgages and the continued decrease in the types of interest associated with such purchases.

The first of the two is in line with research performed by authors such as Delgado et al. (2007), who explain how, in addition to major banks, the expansion of savings banks, credit unions and smaller banks has considerably increased the amount of guaranteed loans and has enabled the extending of loans to small-scale borrowers.

In an initial analysis, it has been shown that the growth rate in the construction sector increased considerably from 1990 to 2014. Furthermore, the rate of new mortgages being granted grew at an even higher rate during the same period. Our first key variable comes from the difference between these two series, thereby quantifying the excess of mortgages granted (Figure 1). It has been shown how the progressive and accelerated growth of the provision of mortgages has affected housing demand and, therefore, formation of the housing bubble (Figure 2). The methodology employed here will help to reveal whether or not this relationship is genuine and will have long-term validity.

Other authors, such as Hofmann (2004), Gerlach and Peng (2005), Oikarinen (2009), McDonald (2011) and Zhang et al. (2015), use different methodologies to analyse the relationship between a

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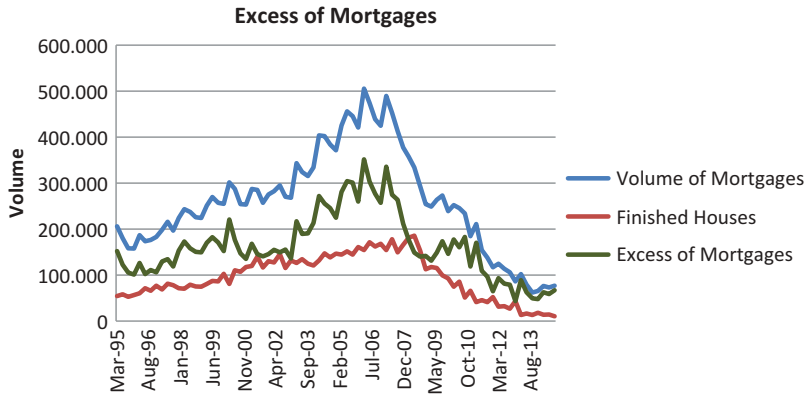

Figure 1. Excess volume of mortgage.
Source: Own elaboration from data published by Bank of Spain and Ministry of Development.

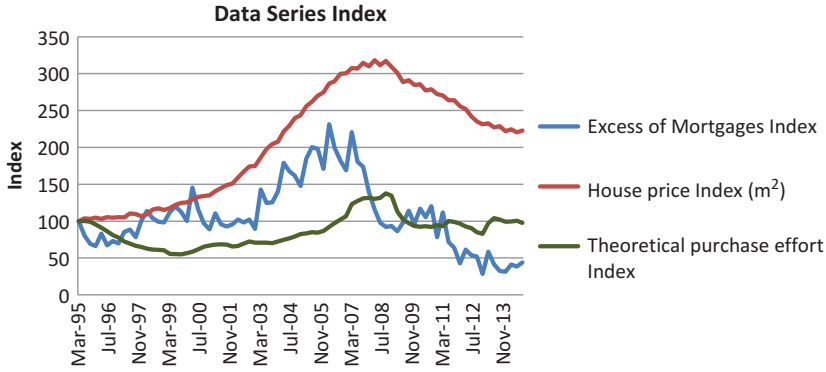

Figure 2. Key variables index.
Source: Own elaboration from data published by Bank of Spain and Ministry of Development.

number of variables, including housing prices and debt in several countries.

The methodology applied in the cointegration analysis for the variables in this study has been used by other authors, including Martínez-Pagés and Maza (2003), who analyse the cointegration relationship between housing prices and real estate stock in Spain. Martínez-Carrascal and del Río (2004) also study the long-term equilibrium model between family consumption and debt. Similarly, Gimeno and Martínez-Carrascal (2010) show the links between mortgage debt and, in this case, long-term housing prices in Spain. Finally, Berisha, Meszaros, and Olson (2015) use the Johansen and Engle–Granger tests and the consequent short-term model through ECM, used by Pesaran, Shin, and Smith (2000), to determine the cointegration of family debt and income inequality in the United States.

The results obtained confirm the existence of cointegration between the variables analysed here and housing prices in Spain during the period in question. Moreover, it has been possible to create short-term model through ECM, which shows statistical significance in the key variables that have different lags. Therefore, empirical evidence exists to answer the question: when will prices return to their previous maximum levels?

The rest of this article is structured as follows: Section II presents the data series and the methodology used, in Section III the results obtained are explained and finally, Section IV concludes the article.

II. Data series and methodology

In this section, the existence of cointegration is analysed, in other words, the genuine, long-term relationship between housing prices and the explanatory variables used in the model. Initially, the theoretical purchase effort for housing without deductions and

the excess volume of mortgages granted have been included as explanatory variables. The latter of the two has been calculated based on the difference between the number of total mortgages and the number of finished homes. All of the variables have been expressed in quarterly terms and the period is understood to extend from first quarter of 1995 through to the last quarter of 2014.

To analyse the relationship between house prices and excess mortgages, we estimate a three-order uVAR with the constant unrestricted. The general model[1] has been expressed as follows:

$$\Delta X_t = \prod X_{t-1} + \sum_{j=1}^{q-1} \Gamma \Delta X_{t-j} + \varepsilon_t,$$

where X_t is a vector including house price per m^2 (HP), excess of mortgages granted (EM) and theoretical purchase effort without deductions (TE).

Using this model, a Johansen test was performed to prove the existence of cointegration vectors based on the range of the corresponding matrix. In the first case, the null hypothesis implies that no cointegration exists, that is to say, that the matrix range is zero, and the alternative hypothesis expresses that at least one cointegration vector exists. In the next test, the null hypothesis implies that at least one cointegration vector exists or that the matrix range is one, against the alternative hypothesis that no cointegration vector exists, or in other words, that the matrix range is not one. Following this reasoning the maximum number of vectors can be reached, this being equal to the number of explanatory variables.

The test was carried out with unrestricted constant. The variables are introduced for four lags due to the quarterly periodicity of the series. This test uses the method of maximum likelihood estimation.

Once the existence of cointegration has been proved, following the same methodology that was used by Pesaran, Shin, and Smith (2000) a short-term equilibrium model was created by means of the ECM. The coefficients of the variables are estimated by using the method of maximum likelihood.

III. Estimation results

The matrix range at the corresponding statistically significant levels has resulted to be greater than zero, and consequently, there is at least one cointegration vector. In the following tests, the null hypothesis is not rejected; therefore, the existence of cointegration is accepted as being a maximum of one long-run equilibrium vector.

Table 1 shows the results based on the Johansen test of the period analysed:

In Table 2 the long-term model is constructed using the long-term matrix, where both the positive correlation between housing prices and the number of mortgages and the negative correlation between the former and the indicator of the financial effort that the families need to make to buy a home were proven. The value of this effort indicator[2] will depend on the acquisition cost of a property in relation to the income of the home and on the buyer's ability to obtain credit for the purchase.

Where HP is the housing price per m^2, EM is the excess of mortgages granted and TE is the indicator for theoretical purchase effort without deductions for buying a home.

Finally, Table 3 the short-term equilibrium model or vector correction model (VECM) has been calculated using the ECM. The model is presented with variables in differences with the lags necessary in order to resolve any issues with autocorrelation in the initial estimation.

VECM[3] is estimated by using the method of maximum likelihood:

In the model, the results have shown the coefficients of the explanatory variables to be significant, at levels of 1%, 5% and 10% with a prediction precision of 77.1997%, taking the adjusted R^2 variance into account. There have also been included explanatory variables that are not statistically significant;

[1]Data published by Bank of Spain and Ministry of Development. EM is own elaboration from data of Bank of Spain and Ministry of Development.
The variables have been deseasonalized using Tramo Seats methodology (TSW). The housing price variable has been deflated by using the CPI.
The rate of correlation between the variables, which might cause multicollinearity problems, has been analysed.
Ramsey's reset test was used to verify that the functional form is adequate.
The Breusch–Godfrey test was used to analyse whether or not there were any problems with autocorrelation, the autoregressive conditional heteroskedasticity (ARCH) test was used to analyse heteroscedasticity, and the Jarque–Bera test was used to analyse normality.

[2]The Bank of Spain develops this indicator based on the quotient between the cost during the first year of a fixed-rate mortgage, those currently being used, with a term of 15 years and which allow 80% of the price of an average home to be financed, and the average annual salary. An average home is considered to be a property of 93.75 m^2 built space (approximately 75 m^2 of usable floor space).

[3]The Breusch–Godfrey test was used to analyse whether or not there were any problems with autocorrelation, the ARCH test was used to analyse heteroscedasticity.

Table 1. Cointegration test.

Johansen test
Number of equations = 3
Lag order = 4
Estimation period: 1996:01–2014:04 (T = 77)
Unrestricted
constant
Log-likelihood = −1121.2 (Including a constant term: −1339.72)

Range	Eigen values	Trace statistic	*p*-Value	Max statistics, Log-likelihood	*p*-Value
0	0.40232	52.975	[0.0000]	39.632	[0.0000]
1	0.10938	13.343	**[0.1026]**	8.9197	**[0.2998]**
2	0.055830	4.4236	[0.0354]	4.4236	[0.0354]

Corrected for sample size (gl = 64)

Range	Trace statistic	*p*-Value
0	52.975	[0.0000]
1	13.343	**[0.1108]**
2	4.4236	[0.0393]

Note: *p*-values are given in brackets denote rejection of the hyphotesis at 10%, 5% and 1% levels.
Source: Own elaboration.

Table 2. Long-term matrix.

(alpha * beta)

	HP	EM	TE
HP	0.0022957	0.00016209	−1.6509
EM	25.556	−0.033010	−2382.2
TE	0.0016005	1.4289e-005	−0.16415

Source: Own elaboration.

Table 3. Vector error correction model.

VECM	ΔHousing price	
range	05:01–15:04	Lags: 4
	Coefficient	*p*-Value
ΔHP_{t-1}	0.149628	0.1615
ΔHP_{t-2}	0.215492	0.0493**
ΔHP_{t-3}	0.0970643	0.36
ΔHP_{t-4}	0.679851	4.59e-08***
ΔTE_{t-1}	165125	0.3319
ΔTE_{t-2}	−489956	0.0107**
ΔTE_{t-3}	0.498012	0.8006
ΔTE_{t-4}	−325008	0.0680*
ΔEM_{t-1}	−3.68389	0.7322
ΔEM_{t-2}	0.622671	0.9577
ΔEM_{t-3}	−7.97912	0.4984
ΔEM_{t-4}	9.74745	0.3693
EC1	0.0155175	0.0346**
	Adjusted R^2	**0.771997**

Source: Own elaboration.
*, ** and *** denote significance at 10%, 5% and 1% levels, respectively.

however they are relevant to the economic interpretation of the model, in this case, excessive mortgages.[4] The coefficient for the remainder variable with one tag reveals the quantity of error correction that is produced with current conditions in order to regain equilibrium. The quarterly portion of correction indicates that 1.55% of correction occurs quarterly; consequently, it will take approximately 64.5 quarters, in other words, a minimum of 16 years to return housing prices to their maximum 2006 levels.

IV. Conclusions

In a preliminary descriptive analysis, similar trends are observed in housing prices and in the volume of mortgages allocated by financial entities in Spain. Furthermore, the higher rate of growth that begins in 2002 in the second series, which deals with credit, is noteworthy when compared to the volume of finished houses. This is the period when property prices underwent their greatest increase. Consequently, the impact of the variable that represents the excess of mortgages granted on the formation of the real estate bubble has been analysed. The results of the Johansen test have confirmed the existence of cointegration in each of the models analysed. Furthermore, by using the error correction mechanism, a short-term prediction model has been established, which explains and estimates with great precision, approximately 77% in the R^2 adjusted estimate, as well as provides information on the correction for each period. Based on this correction a return to equilibrium in a period of 16 years has been calculated, that is to say that it will take sixteen years in order to reach the maximum housing prices from the year 2006. Therefore, by taking into consideration only the analysed explanatory variables, the pace of recovery will be slow, which coincides with Shiller (2006). Although a regular review of the model will be necessary, the statistical significance of these variables and their high quality in prediction speak to the importance of this model, which should be taken into account in the future. It seems very interesting to study the variable the excess of granted mortgages as, keeping a long-term balance with housing prices; it is statistically significant in the VECM with longer lags.

Disclosure statement

No potential conflict of interest was reported by the authors.

[4]Due to the peculiarity of the real estate market which works at slower pace, the same test has been performed with eight lags, with the same result of long-term equilibrium. On the subsequent estimate for ECM the explanatory variable mortgage excess with longer lags has resulted in high levels of significance.

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