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Juan Carlos Cuestas

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House prices and capital inflows in Spain during the boom: evidence from a cointegrated VAR and a Structural Bayesian VAR*

Juan Carlos Cuestas

Economics and Research Department

Eesti Pank (Bank of Estonia)

Department of Finance and Economics

Tallinn University of Technology

Abstract

House prices in Spain escalated rapidly in the run up of the financial crisis. In addition, capital inflows may have influenced the amount of credit available for private use, and in particular for the purchase of real estate. The aim of this paper is to analyse the relationship between foreign capital flows and house prices in Spain. Based on a cointegrated VAR and a structural Bayesian VAR, it is found that both capital inflows and house price shocks have influenced each other in the run up of the Great Moderation.

Key words: house prices; capital inflows; leveraging; CVAR; structural Bayesian VAR.

JEL code: C22, F15.

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Corresponding author; email: juan.carlos.cuestas@eestipank.ee; address for correspondence: Research Unit, Economics and Research Department, Eesti Pank, Estonia pst. 13, 15095, Tallinn, Estonia; tel: +3726680645

1 Introduction

Since the collapse of Lehman Brothers in 2008, the world economy stumbled. However, the negative effects of the collapse were aggravated in many countries with inflated markets, in particular housing markets.[1]

In Europe, and more precisely in southern Europe, Spain can be considered as a case study since house prices increased by a greater amount in Spain after 2001 than anywhere else in Europe, and suffered the sharpest drop around 2012. It is also important to understand of house price dynamics and its determinants since, as Iacoviello (2014) show, there is a strong connection between house prices and consumption. Hence, the results we obtain here can be of policy relevance and can provide insights in order to boost consumption.

The empirical literature on the determinants of house prices is extensive (see Adams and Füss, 2010, amongst many others). However, for Spain to the best of our knowledge, only Gimeno and Martínez-Carrascal (2010) provide a thorough analysis of the main determinants of housing prices and their relationship to consumption. In Gimeno and Martínez-Carrascal's paper, the authors estimate a vector error correction model (VECM) to explain the interaction between house prices, nominal interest rates, labour income and housing loans.[2] They focus on the period 1984:Q1 to 2009:Q1. However, the role of capital inflows is neglected. During the final years of the Great Moderation, Spain in addition to other European countries of the periphery, experienced high levels of leveraging, both domestic –private, and foreign. Excess leveraging, when the main collateral price does not correspond to the fundamentals, may exacerbate the

[1] It is not within the scope of this paper to discuss rational bubbles. See for instance Cunado et al. (2005) amongst many others.

[2] Anundsen and Jansen (2013) also provide evidence of the bidirectional causality between credit and house prices.

Fisher deflation effect. As a consequence, the reaction of selling assets to reduce leveraging and pay outstanding debt may create an excess of supply and a sudden drop in prices. In this line of research, Cuestas and Staehr (2014) analyse the relation between private credit and net foreign liabilities in Greece, Italy, Ireland, Portugal and Spain. They show that domestic private credit and capital inflows have fed each other in the case of Spain in the run-up of the housing boom period.[3] Their results differ compared to the other countries analysed since the direction of causality only runs from foreign capital to domestic credit in the remainder. Hence, the case of Spain is of particular interest.

The main hypothesis we test in this paper is that capital inflows affect house prices and that house prices can attract more foreign capital. With excess savings coming from oil producers and Asia and low interest rates all over the world, booming housing markets can be appealing for international investors looking for fast returns. Hence, not only Spanish banks may have sought the necessary liquidity to satisfy the demand for credit, but also foreign investors may have invested massively in housing during this period.

The contribution of this paper is twofold; first, to test for the effect of capital inflows on housing prices in Spain, and vice versa with a focus on the years before the ignition of the crisis and after the physical introduction of the euro, i.e. 2001Q1-2008Q4. Given the shortage of the sample period, the second novelty is related to the use Bayesian VAR (BVAR) to obtain impulse-response functions based on a structural BVAR (SBVAR). However, following the existing literature we also estimate a cointegrated VAR (CVAR) as a preliminary analysis. The focus on that particular period is motivated by the years when Spain experienced the highest growth of house prices, together with the physical introduction of the euro and the increase of real estate operations against money laundering.

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[3] Similar results are found in Tillman (2013) for the case of Asia. For the case of Europe, Gupta et al. (2015) also find that the lack of house price comovement for some countries may be due to capital inflows.

The remainder of the paper is organised as follows. Section 2 summarises the econometric methods applied in this empirical analysis. Section 3 presents the data, Section 4 presents the results of the CVAR and SBVAR models and the last section concludes the paper.

2 Methodology

In this paper we apply first cointegration analysis and estimate a VECM or CVAR model (Johansen, 1988, 1991) of the following form:

$$\Delta X_t = \alpha\beta' X_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta X_{t-i} + \mu + \varepsilon_t \qquad (1)$$

where X_t is a vector of non-deterministic variables, α is a matrix of loading parameters or adjustment coefficients, β' is a vector containing the long run coefficients, γ_i represents the parameters of the short run or dynamics, μ is a deterministic component, a drift in this case, and ε_t is the vector of errors.

Given the focus of this paper on a short period of time, we additionally use the BVAR approach. The advantage of Bayesian econometrics in this context has to do with the use of prior information with a probability distribution, jointly with the likelihood function obtained from the sample to (by means of the Bayes theorem) obtain the posterior distribution for any parameter. This posterior distribution is the key for obtaining probability distributions for the autoregressive parameters in the VAR. The posterior probabilistic distribution can be expressed as,

$$\pi(\delta|Y) = \frac{f(Y|\delta)\pi(\delta)}{f(Y)} \qquad (1)$$

where δ is a vector of autoregressive parameters in the VAR, $\pi(\delta|Y)$ is the posterior distribution conditional to the sample information contained in the vector Y, $f(Y|\delta)$ is the likelihood function, $\pi(\delta)$ is the prior distribution about the parameters and $f(Y)$ is simply the density function of the data in the sample. This latter function is only used as a means to standardise. Hence, equation (1) is commonly written as,

$$\pi(\delta|Y) \propto f(Y|\delta)\pi(\delta) \tag{2}$$

We must also bear in mind that inference is not made by means of standard t-statistics and frequentist asymptotic theory, hence the order of integration of the variables is not a problem in this case.

In the framework of VAR using Bayesian econometrics, it is customary to use the Minnesota prior (full VAR) (Litterman, 1986). The analysis carried out in this paper follows this approach as it has been done before in the context of housing markets (Gupta and Das, 2008). The cornerstone is the distribution of δ which is assumed to be $N(\delta_0,\Omega_0)$. Litterman (1986), following the general wisdom that macro-variables appear to be unit roots, assumes that for each variable in the model, the autoregressive parameter is set to be equal to 1, and 0 for the rest. The variance of the parameters is given by

$$\sigma^2_{\delta_{ii}} = \left(\frac{\lambda_1}{l^{\lambda_3}}\right)^2 \tag{3}$$

$$\sigma^2_{\delta_{ij}} = \left(\frac{\sigma_i^2}{\sigma_j^2}\right)\left(\frac{\lambda_1\lambda_2}{l^{\lambda_3}}\right) \tag{4}$$

where, σ_i^2 and σ_j^2 refer to the ordinary least squares residual variance for the autoregressive models for variables i and j, l is the lag for the coefficient, λ_1 is the own lag variance (overall tightness), and λ_3 is a scaling constant which controls the speed of convergence to 0 for the coefficients of lags greater than 1. Following the standards in the literature for BVARs these are set as $\lambda_1 = 0.2$, $\lambda_2 = 0.5$, $\lambda_3 = 1$.

The structural model is based on the following equation;

$$\delta_0 Y_t = \delta(L) Y_t + \varepsilon_t \tag{4}$$

where δ_0 is the matrix of contemporaneous restrictions, δ is a matrix of coefficients for the lagged variables, and L is the lag operator in polynomial form. In the next section we provide more detail on the identification of shocks for the purposes of this paper.

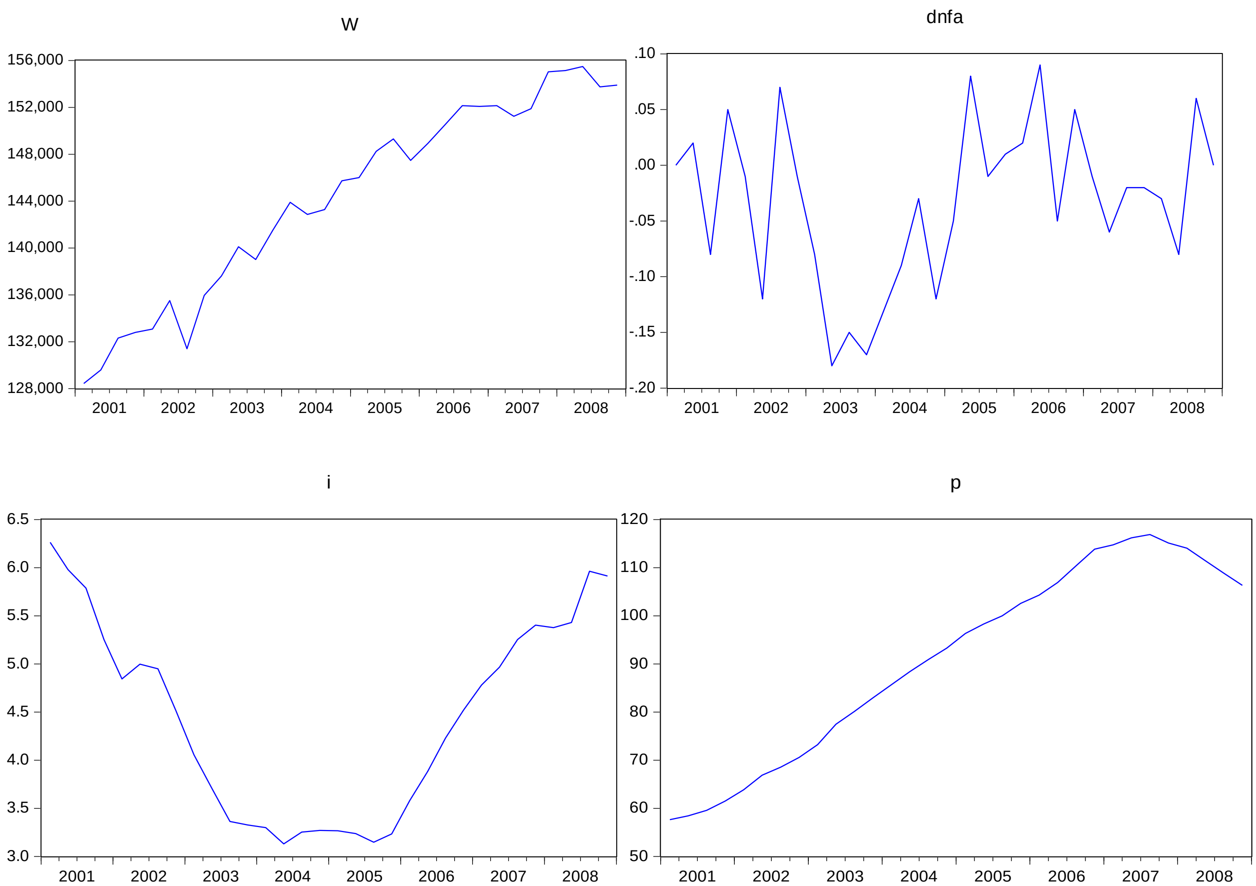
3 Data

As in Gimeno and Martínez-Carrascal (2010), the focus of this paper is on the analysis of the relationship between real house prices, nominal interest rates, real labour income, and net capital flows, the latter as a proxy forcredit volumes, for the period 2001Q1-2008Q4. The real house price index, p_t, has been obtained from the *OECD.Stat* database, nominal interest rates for house purchase, i_t, have been obtained from the *ECB Statistical Data Warehouse*, labour income (compensation of employees), and net foreign assets, have been deflated by the harmonised index of consumer price and have been downloaded from *Eurostat,* yielding the real variables of labour income, w_t, and net foreign assets, nfa_t. Real income and real net foreign assets have been seasonally adjusted using the Census X-13 procedure. To account for the flow of capital (net capital outflows), real net foreign assets have been transformed into first differences, $dnfa_t$. Since, according to Cuestas and Staehr (2014) capital inflows and credit may be highly correlated, the latter is not included in our model.

In Figure 1, we show the plots of the time series. The relatively high correlation between house prices and real income is immediately obvious. In addition, capital flows change sign quite frequently during the sample, although on average they are negative indicating net capital inflows. It is interesting to note how interest rates for home purchase reverted in 2005.

It is then expected that house prices depend positively on real income and capital inflows, but negatively on the interest rate. In addition, it is expected that capital inflows depend positively on house prices.

Figure 1: Data graphs



4 Econometric analysis

To estimate a CVAR, we need to test for the order of integration of the variables. In Table 1, we provide the results of the Ng and Perron (2001) unit root tests, with both trend and intercept. According to these results, all variables are unit root processes. The anomaly is the house price index, which appears to be stationary. However this is quite implausible. To clarify this issue we have also applied the ADF test for this variable, confirming that the house price index is actually an I(1) process.[4]

Table 1: Ng and Perron (2001) results with intercept and trend

Variable		MZa	MZt	MSB	MPT
dfna		-4.24	-1.45	0.34	21.44
i		-3.47	-1.16	0.33	23.57
p		-65396***	-180***	0.002***	0.002***
w		-7.03	-1.63	0.23	13.21
Asymptotic critical values:	1%	-23.80	-3.42	0.14	4.03
	5%	-17.30	-2.91	0.16	5.48
	10%	-14.20	-2.62	0.18	6.67

*Note: Critical values obtained from Ng and Perron (2001). Lag length obtained by the Modified Akaike Information Criterion. The symbol *** indicates rejection of the null at the 1% level.*

Given our relatively short sample, we estimate a CVAR with only two lags and an unrestrictied constant. The Trace and Lambda test for the number of cointegrating vectors are shown in Table 2. According to these results, the Trace test indicates full rank, which is implausible as that would imply that all variables are stationary. However, the Lambda test indicates only one cointegrating vector. Hence, our CVAR estimation will be based upon this choice.

Table 3 and 4 display some specification tests. According to these there are no specification problems as in both cases the null hypotheses of no autocorrelation and normality of the residuals cannot be rejected. Also, the heteroscedasticity test is satisfactory (Chi-sq.=177, df=180, p-value=0.53).

[4] Results available upon request from the author.

Table 2: Trace and lambda tests

r	Eigenvalue	Trace Statistic	0.05 Critical Value	P-value
None	0.62	69.63	47.85	0.00
At most 1	0.49	38.56	29.79	0.00
At most 2	0.26	16.98	15.49	0.03
At most 3	0.19	7.12	3.84	0.01

r	Eigenvalue	Lambda Statistic	0.05 Critical Value	P-value
None	0.62	31.07	27.58	0.02
At most 1	0.49	21.57	21.13	0.05
At most 2	0.26	9.86	14.26	0.22
At most 3	0.19	7.12	3.84	0.01

Table 5 displays the estimated coefficients of the cointegrating vector, the loading matrix and the dynamics. According to this table, and focusing now on the coefficients of the cointegrating vector, house prices depend positively on real income with a significant effect and negatively on interest rates, also with a significant effect, as expected. However, capital outflows do not appear to enter the cointegrating vector at conventional significance levels. This implies that our hypothesis that capital inflows affect house prices does not hold. Also, from Table 3 we can gather information about the weak-exogeneity of the variables which is measured by the significance of the α parameters. The implication is that house prices and capital outflows react to deviations from their long run equilibrium, whereas interest rates and real income appear to be weakly-exogenous. Hence, the latter two variables do not seem to be caused by the long run relationship. These results are in line with Cuestas and Staehr (2014) in the sense that capital inflows and housing market conditions seem to cause each other. In other words, according to this specification the evolution of the housing market may be an attractor for capital inflows and vice versa, at least in the short run.

Table 3: Autocorrelation tests

Lags	LM-Stat	p-value
1	22.34	0.13
2	17.56	0.35
3	16.55	0.41
4	11.34	0.78
5	15.34	0.49
6	15.012	0.52

Table 4: Jarque-Bera normality tests

Component	Skewness	Chi-sq	df	p-value
p	0.47	1.22	1	0.26
dfna	0.64	2.18	1	0.13
i	0.41	0.93	1	0.33
w	-0.25	0.34	1	0.55
Joint		4.68	4	0.32
Component	Kurtosis	Chi-sq	df	p-value
p	3.15	0.03	1	0.85
dfna	3.10	0.01	1	0.90
i	4.42	2.70	1	0.10
w	2.43	0.43	1	0.51
Joint		3.19	4	0.52
Component	Jarque-Bera	df	Prob.	
p	1.25	2	0.53	
dfna	2.20	2	0.33	
i	3.64	2	0.16	
w	0.78	2	0.67	
Joint	7.87	8	0.44	

Table 5: CVAR estimates

Coint. vector (t-1)	β			
p	1.00			
dnfa	-16.26 (12.35) [-1.31]			
i	2.63 (1.13) [2.32]			
w	-0.001 (0.000) [-15.88]			
	Δp_t	$\Delta dnfa_t$	Δi_t	Δw_t
α	-0.13 (0.04) [-2.92]	-0.01 (0.00) [-2.38]	0.02 (0.01) [1.79]	96.19 (94.36) [1.02]
Δp_{t-1}	0.57 (0.17) [3.23]	-0.02 (0.01) [-1.33]	0.03 (0.04) [0.63]	334.85 (354.57) [0.94]
Δp_{t-2}	0.30 (0.17) [1.68]	0.01 (0.01) [0.93]	-0.00 (0.04) [-0.08]	-110.87 (357.74) [-0.30]
$\Delta dnfa_{t-1}$	-3.16 (2.42) [-1.30]	-0.88 (0.20) [-4.32]	-0.20 (0.64) [-0.32]	9045.45 (4834.81) [1.87]
$\Delta dnfa_{t-2}$	2.87 (2.54) [1.12]	-0.71 (0.21) [-3.35]	1.03 (0.67) [1.53]	4117.91 (5071.60) [0.81]
Δi_{t-1}	-0.11 (0.82) [-0.13]	0.11 (0.06) [1.63]	0.52 (0.21) [2.39]	-3061.79 (1650.91) [-1.85]
Δi_{t-2}	1.42 (0.94) [1.51]	0.09 (0.07) [1.18]	-0.30 (0.24) [-1.21]	368.23 (1874.29) [0.19]
Δw_{t-1}	-0.00 (0.00) [-1.05]	-5.16E-06 (1.0E-05) [-0.49]	-3.09E-05 (3.3E-05) [-0.93]	-0.23 (0.24) [-0.93]
Δw_{t-2}	2.59E-05 (0.00) [0.21]	-1.25E-05 (1.0E-05) [-1.21]	1.82E-05 (3.2E-05) [0.56]	-0.18 (0.24) [-0.74]
C	0.17 (0.30) [0.59]	0.03 (0.02) [1.19]	-0.04 (0.08) [-0.54]	812.08 (597.25) [1.35]
Adj. R-squared	0.80	0.40	0.37	0.14

Note: Standard errors are displayed in parentheses, whereas t-statistics appear in brackets.

As mentioned above, frequentist econometrics tests may suffer from a number of problems in short samples. Hence, we now present the results of the SBVAR analysis. It is based on four lags, as quarterly data is used and we can afford to include more lags to pick up the dynamics as the set of information is expanded with the inclusion of prior information. A constant is also included as the deterministic component. For the identification of shocks to house prices we have used Cholesky factorisation with the following ordering: real income, capital outflows, real house prices and interest rates.[5] This means that house prices can be affected contemporaneously by real income and international capital movement shocks, but the effect of interest rate shocks is set to zero in the contemporaneous period. Similar ordering has been followed by Hofmann (2004), Goodhart and Hofmann (2008) and Oikarinen (2009).

In Figure 2, we display the impulse response functions for the reaction of house prices to shocks to the other variables; as one can see from the figure, real income innovations do not have an effect on house prices as the posterior distribution has hardly shifted. This result is in line with the findings by Gimeno and Martínez-Carrascal (2010). Capital outflows have a negative impact on house prices, or, in other words, capital inflow shocks have a positive impact on house prices with permanent effects. These results corroborate now our hypothesis that capital inflows can influence house prices through an increase in liquidity and credit availability. Finally, as expected, interest rate innovations have a negative effect on house prices, as an increase in the cost of borrowing decreases the demand of housing.

In Figure 3, we analyse whether foreign capital may be attracted by increasing housing prices, real income and interest rates in Spain. To identify these shocks, the following ordering of the variables has been used; real income, house prices, capital outflows and interest rates. The key here is that capital outflows are allowed to be affected

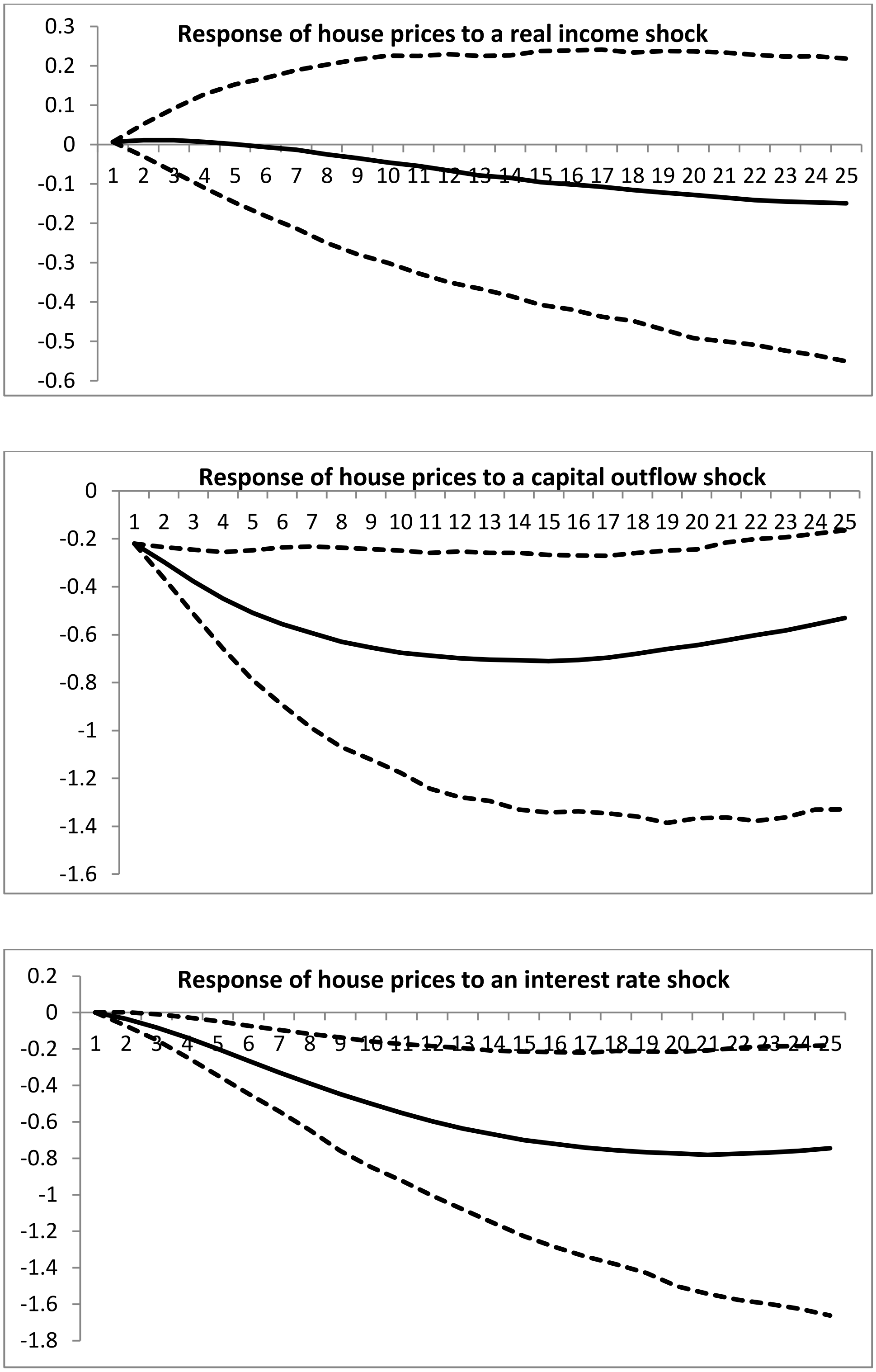
[5] Structural shocks are reported in the Appendix.

contemporaneously by house price shocks. As it can be depicted from Figure 3, both an increase in real income and an increase in house prices act as attracting factors of foreign capital. The effect of an interest rate shock is not significant. These results confirm the findings obtained by Cuestas and Staehr (2014), i.e. *pull* factors are important when analysing house market conditions.

In Figure 4, we reproduce the part of the fluctuations of each of the two main variables, due to the other variables, or forecasted error variance decomposition. It is noticeable that the contribution of foreign capital flow shocks on the forecast error variance of house prices is the highest of all three variables. It is also noticeable that real income shocks have little effect on house price - a finding which corroborates our previous results. With respect to the contribution of real income, house price and interest rate shocks on capital flows, it can be said that real income acts as the strongest attractor. However, the effect of house price shocks also seems to contribute between 10 and 50% to the capital outflows forecast error variance.

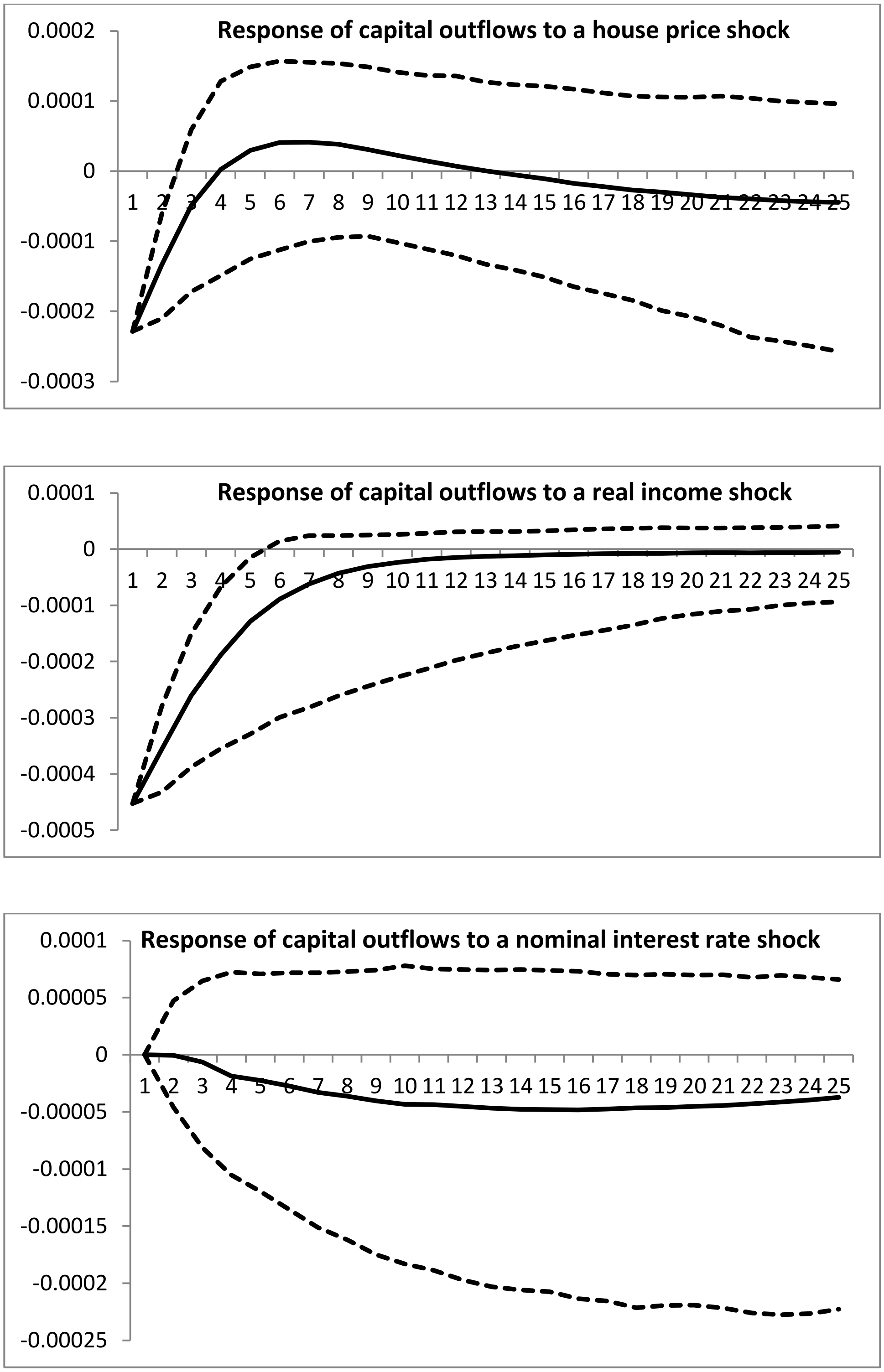
All in all, the results found here confirm our initial hypotheses: (1) foreign capital flow shocks have influenced house prices, (2) not only real income, but also the evolution of the housing market conditions have acted as attractors to foreign capital. These results highlight the importance of macroprudential policies to control the final destination of foreign capital as banks may be inclined to self-finance themselves from foreign markets in order to pump liquidity into a booming housing market.

Figure 2: Impulse response functions, reaction of house prices



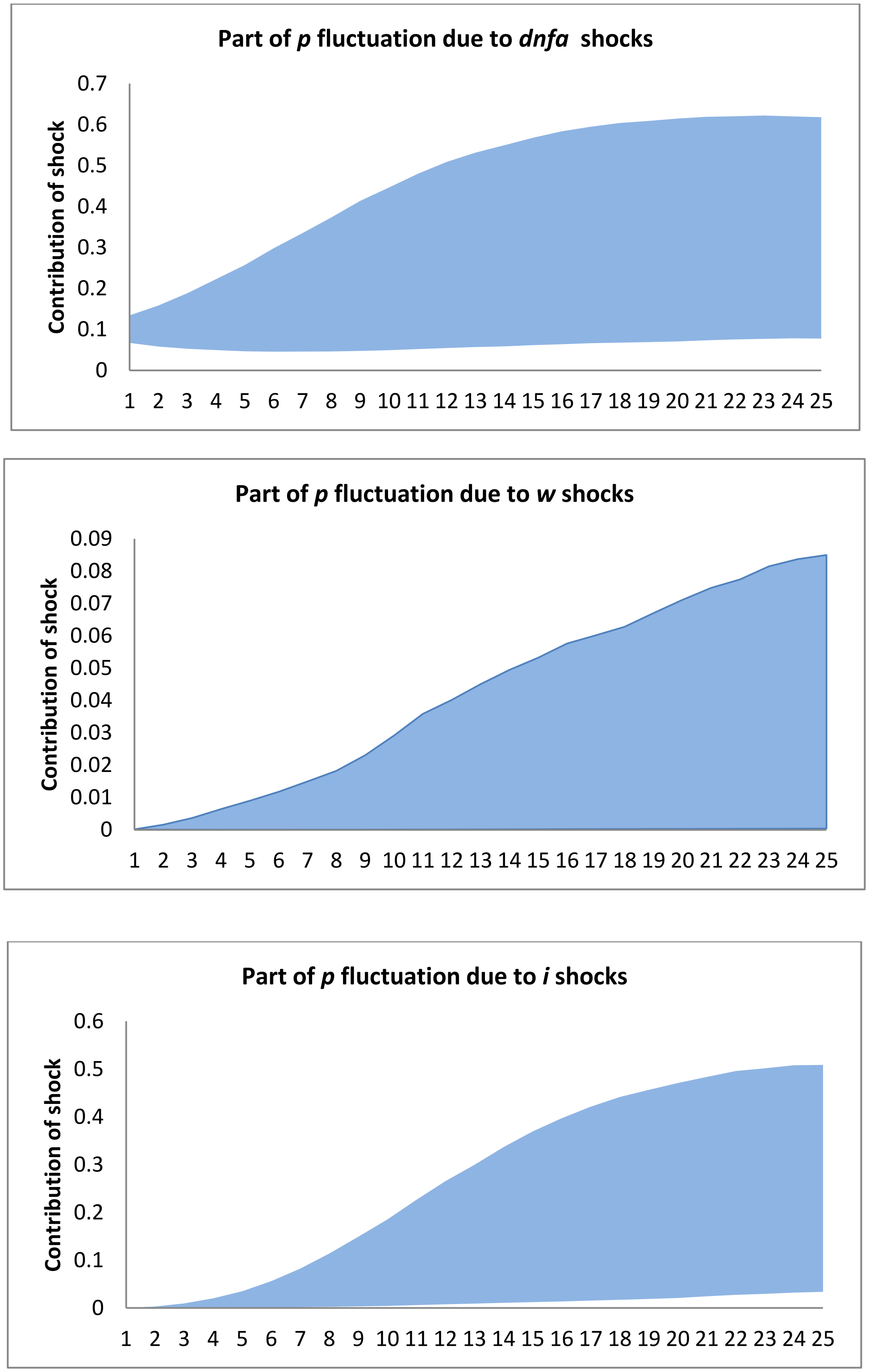
Notes: Dotted lines represent 95% credible set. Dark line represents the median. The vertical axis measures the reaction to a one standard deviation shock.

Figure 3: Impulse response functions, reaction of capital outflows



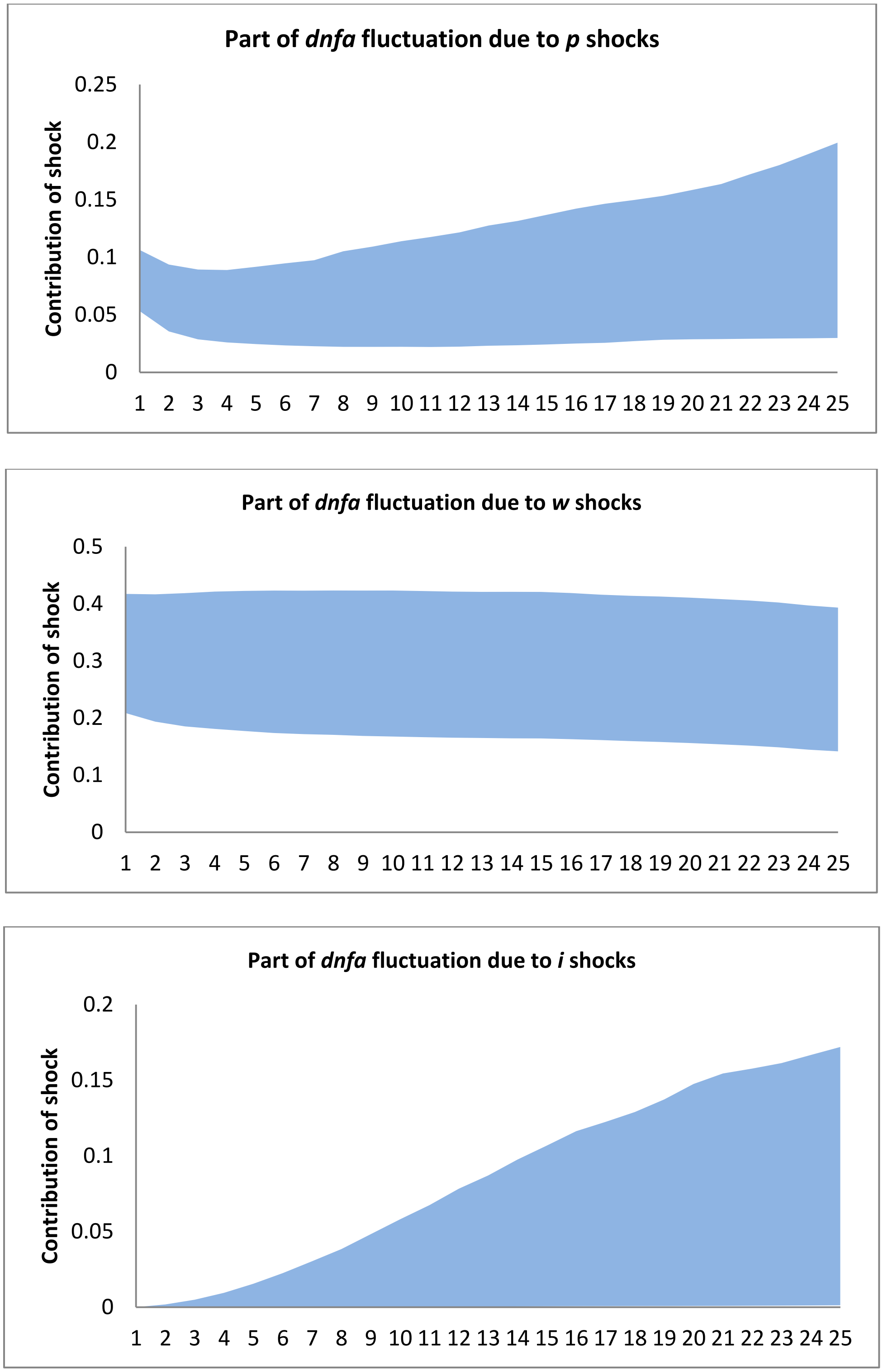
Notes: Dashed lines represent 95% credible set. Dark line represents the median. The vertical axis measures the reaction to a one standard deviation shock.

Figure 4: Forecasted error variance decomposition, shocks to house prices



Notes: Shadowed area represents 95% credible set.

Figure 5: Forecasted error variance decomposition, shocks to capital outflows



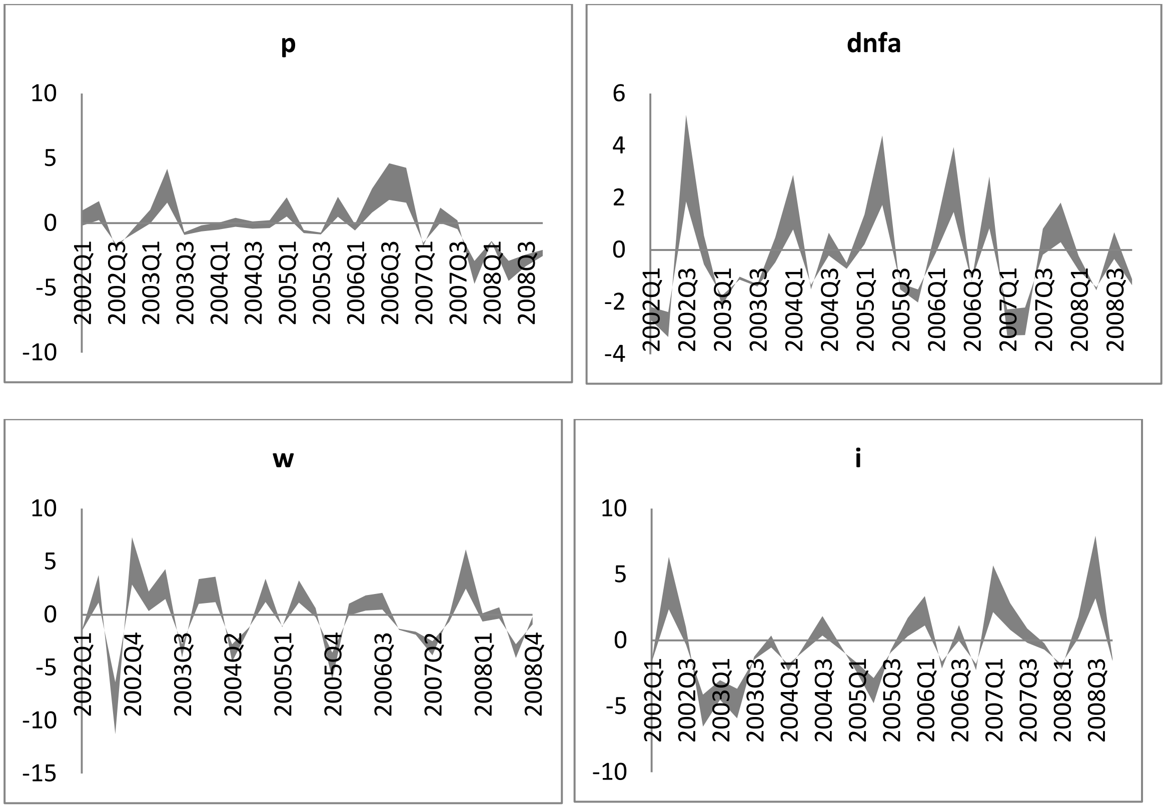
Notes: Shadowed area represents 95% credible set.

5 Conclusions

Acknowledging the fact that house prices in Spain were influenced by external factors can be of policy interest in order to avoid future overheating in the housing market, which contributed to the financial crash in 2008.

This paper sheds light on the relationship between house prices and foreign capital flows. By substituting the amount of credit for house purchases by changes in net foreign assets, we find that house prices are positively affected by foreign capital inflows, and, as expected, negatively by interest rates. However, the effect of real income innovations on house prices is not significant. In addition, we find that house prices and real income acted as attractors for foreign capital in Spain during the period analysed.

Appendix: structural shocks



Notes: Shadowed area represents 95% credible set.

References

Adams, Z., and R. Füss (2010): "Macroeconomic determinants of international housing markets," *Journal of Housing Economics*, vol. 19, pp. 38-50.

Anundsen, A. K., and E. S. Jansen (2013): "Self-reinforcing effects between housing prices and credit," *Journal of Housing Economics*, vol. 22, pp. 192-212.

Cunado, J., L. A. Gil-Alana and F. Pérez de Gracia (2005): "A test for rational bubbles in the NASDAQ stock index: A fractional integrated approach," *Journal of Banking and Finance,* vol. 29, pp. 2633-2654.

Cuestas, J. C. and K. Staehr (2014): "The great (De)leveraging in the GIIPS countries. Domestic credit and net foreign liabilities 1998–2013," Bank of Estonia Working Papers wp2014-4

Hofmann, B. (2004): "The Determinants of Bank Credit in Industrialized Countries: Do Property Prices Matter?" *International Finance*, vol. 7, pp. 203–234

Gimeno, R., and C. Martínez-Carrascal (2010): "The relationship between house prices and house purchase loans: The Spanish case," *Journal of Banking and Finance*, vol. 34, pp. 1849-1855.

Goodhart, C., and B. Hofmann (2008): "House prices, money, credit, and the macroeconomy," *Oxford Review of Economic Policy*, vol. 24, pp. 180-205.

Gupta, R., C. Andre and L. Gil-Alana (2015): "Comovement in Euro area housing prices: A fractional cointegration approach," *Urban Studies*, vol. 52, pp. 3123-3143.

Gupta, R. and S. Das (2008): "Spatial Bayesian methods of forecasting house prices in six metropolitan areas of South Africa," *South African Journal of Economics*, vol. 76, pp. 298-313.

Iacoviello, M. (2004): "Consumption, house prices, and collateral constraints: a structural econometric analysis," *Journal of Housing Economics*, vol. 13, pp. 304-320.

Johansen, S. (1988): "Statistical analysis of cointegrated vectors", *Journal of Economic Dynamic and Control*, vol. 12, pp. 231-254.

Johansen, S. (1991): "Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models", *Econometrica*, vol. 59, pp. 1551-1580.

Litterman, R. (1986): "Forecasting with Bayesian Vector Autoregressions – Five years of experience", *Journal of Business and Economic Statistics,* vol. 4, pp. 25-38.

Oikarinen, E. (2009): "Interaction between housing prices and household borrowing: The Finnish case," *Journal of Banking and Finance*, vol. 33, pp. 747-756.

Tillmann, P. (2013): "Capital inflows and asset prices: Evidence from emerging Asia," *Journal of Banking and Finance*, vol. 37, pp. 717-729.