Monetary Policy Transmission and House Prices: European Cross Country Evidence*

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Preliminary Version

Abstract

This paper explores the importance of housing in European countries for the transmission of monetary policy. We use a pooled VAR model to generate impulse responses of key macroeconomic variables to a monetary policy shock taking special account of the reaction of real house prices. We cluster our sample of countries into two distinctive groups – a *strong reaction group* and a *weak reaction group* – using a novel approach, which refers to the response of real house prices to a monetary policy shock. Our results suggest that the reaction of macroeconomic variables across the groups of countries is related to the volatility of real house prices, as we find that the impact of monetary policy in the *strong reaction group* is more pronounced.

JEL classifications: C32, C33, E52

Key words: Pooled VAR model, house prices, monetary policy transmission, country clusters

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1 Introduction

Modern central banks are typically responsible for the maintenance of price stability. The pursuit of price stability requires an understanding of the transmission process of monetary policy, which comprises a variety of transmission channels that characterize the effects of monetary policy on output and inflation. Mishkin (2001) and Muellbauer and Murphy (1997) have highlighted those transmission channels that assign the housing market an important role in the propagation of monetary policy shocks.

In industrial countries, the importance of housing for the transmission of monetary policy stems from the link between the development of key macroeconomic variables and fluctuations in house prices (Mishkin, 2001). House prices are affected by a number of factors including income, the housing stock, credit availability and ultimately changes in interest rates induced by monetary policy (Muellbauer and Murphy, 2008). House price fluctuations have an impact on consumption decisions of households – via housing wealth and housing collateral effects – and residential investment – e.g. via Tobin's q by affecting the value of housing relative to construction costs (Goodhart and Hofmann, 2008). The influence of housing is related to the institutional characteristics of mortgage markets, which determine the availability of housing credit and the speed of adjustment of mortgage rates to changing money market rates. Since mortgage markets have been deregulated continuously over the past years (IMF, 2008), this suggests that the significance of housing for the propagation of monetary policy has strengthened.

This paper explores the role of housing markets in European countries for the transmission of monetary policy. We use a pooled vector autoregressive (VAR) model to generate impulse responses of key macroeconomic variables to a monetary policy shock taking special account of the reaction of real house prices. Our sample comprises 13 countries for which we use quarterly data over the period from 1995 to 2006. We select this period since the process of deregulation of mortgage markets has been accomplished mostly until the mid–1990s (Girouard and Blöndal, 2001), nevertheless certain restrictions still exist.

So far, a number of studies have employed VAR models for European countries to explore the reaction of house prices to a monetary policy shock. Iacoviello (2002), Iacoviello and Minetti (2003), Giuliodori (2005), IMF (2008) and Calza, Monacelli, and Stracca (2006) find that house prices across countries respond differently to changes in interest rates.[1] The differences in the reaction of house prices can be related to the development of mortgage markets that departs with respect to several institutional indicators such as the typical duration of mortgage contracts, the loan–to–value (LTV) ratio, the existence of equity release products and the terms of adjustment of mortgage rates. Countries where mortgage markets are more developed experience a higher volatility of house prices and a greater role for housing in the transmission of monetary policy.

Assenmacher-Wesche and Gerlach (2008) estimate a panel VAR model for a large set of OECD countries over the period from 1986 to 2006. They split their sample of countries into different groups to assess the role of institutional characteristics of mortgage markets for the transmission of monetary policy. The groups of countries are exogenously determined by using a broad range of indicators that reflect cross–country differences in the structure of mortgage financing. They conclude that institutional characteristics of mortgage markets across countries shape the response of house prices to monetary policy shocks, but the differences between the groups are quantitatively unessential.

Goodhart and Hofmann (2008) employ a panel VAR model for 17 industrial countries to assess the link between real output, monetary variables and house prices over the period from 1973 to 2006. They find a significant multidirectional relationship between these variables, which has become stronger after mortgage markets have been liberalized. They also show that in countries where house price booms emerge more frequently the relationship is more pronounced.

Overall, the evidence suggests that housing in European countries plays a certain role in the transmission of monetary policy, but identifying the cross–country differences precisely is difficult to establish. The development of mort-

[1] However since these studies estimate VAR models for single countries, a direct comparison of the effects across countries is problematic because the estimates are often imprecise due to low degrees of freedom.

gage markets is likely a source of heterogeneity, however the separation of countries by means of institutional indicators is cumbersome since (i) a general agreement on which of the indicators are most important is missing, and (ii) the classification of the indicators is often arbitrary.

We address this issue by suggesting a novel approach to cluster countries into distinctive groups taking account of the reaction of real house prices to a monetary policy shock. We split our sample of countries into two groups – a *strong reaction group* and a *weak reaction group* – that are endogenously identified by using a distance measure, which is determined by the absolute value of the difference between cumulated impulse responses. We compare the impulse responses of the two groups of countries to assess the effects of movements in real house prices after a change in interest rates.

Our results exhibit that macroeconomic variables in European countries co–move with real house prices after a monetary policy shock. Assessing heterogeneity across countries yields that significantly different cross–country effects exist. The distinction of countries into different groups shows that the impact of monetary policy in the *strong reaction group* is more pronounced.

In addition, we find that the development of mortgage markets across countries is capable to explain the divergences in the volatility of house prices after a change in interest rates, but other cross–country features such as national traditions, cultural factors, the share of the housing sector in overall economic activity, the number of employees in the construction sector, regulations regarding housing taxes and housing subsidies or transaction costs are also likely relevant. We derive this conclusion by recognizing that our grouping of countries is not strictly related to the institutional indicators that are deemed essential.

Overall, our results suggest that heterogeneity across countries reflects differences in the transmission of monetary policy, which can be explained by the amplifying effects that arise from movements in real house prices after a monetary policy shock. Since the discrepancies are sizable, we conclude that monetary policy should be concerned about the influence of house prices when setting interest rates.

The remainder of the paper is organized as follows. In Section 2, the baseline pooled VAR model for our sample of countries is presented. We generate impulse responses to a monetary policy shock to explore the reaction of real house prices to an innovation in interest rates. Section 3 sets out our approach of identifying distinctive groups of countries. We discuss the institutional characteristics of mortgage markets across countries, describe our methodology applied and comment our findings. In Section 4, we compare impulse responses of the groups of countries to a monetary policy shock to assess the influence of movements in real house prices. Section 5 provides concluding remarks.

2 Benchmark VAR Model

Consider a pooled VAR model in reduced form:

$$X_t = c + \sum_{j=1}^{n} A_j X_{t-j} + \varepsilon_t, \tag{1}$$

where X_t is a stacked vector of endogenous country variables, A is a matrix of autoregressive coefficients, c is a matrix of country specific constant terms, n is the number of lags and ε_t is a stacked vector of country error terms. The stacked vector X_t comprises four variables:

$$X_t = [y'_{it} \;\; p'_{it} \;\; s'_{it} \;\; (hp)'_{it}]', \tag{2}$$

where (y_{it}) denotes real GDP, (p_{it}) is the price level, measured by the GDP deflator, (s_{it}) is the nominal short–term interest rate, which serves as the policy instrument of the central banks and (hp_{it}) are real house prices – i.e. nominal house prices deflated with the GDP deflator. The index i reflects the number of countries considered, i.e. $i = 1, ..., 13$.

The VAR model is estimated via Bayesian methods using quarterly data for 13 European countries taken from the OECD over the period from 1995Q1 to 2006Q4.[2] Our sample of countries comprises Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain,

[2] Appendix A provides a detailed description of the data. Since mortgage markets in European countries experienced an extensive phase of liberalization (IMF, 2008), which started in the early 1980s and ended in the mid 1990s (Girouard and Blöndal, 2001), we decided to focus on the period after the process of deregulation has been accomplished.

Sweden and the United Kingdom. All variables are in logs – except for the nominal short–term interest rate, which is expressed in percent – and linearly de–trended. The matrix of constant terms c comprises individual country dummies that account for possible heterogeneity across the units. We use a lag order of $n = 3$, which ensures that the residuals are free of first–order serial correlation.[3]

2.1 Basic Estimation Results

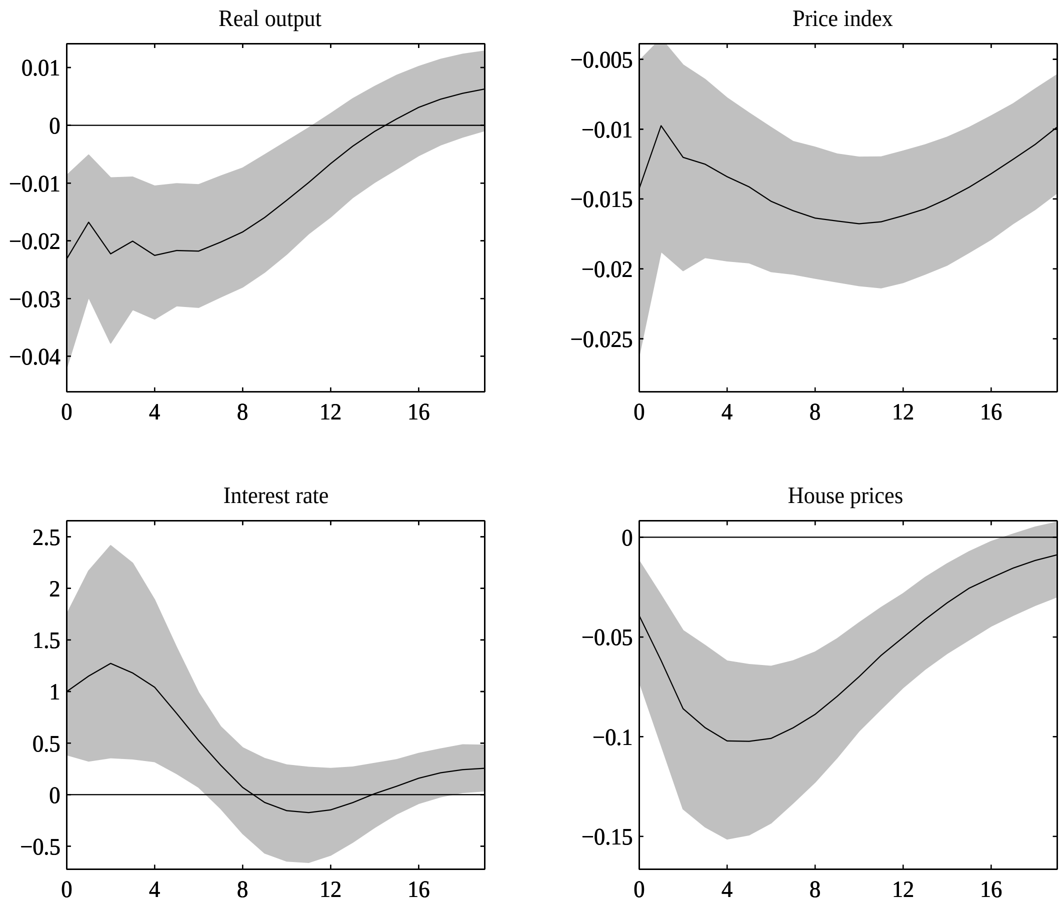
Based on the VAR model (1) we generated impulse responses of the variables to a monetary policy shock. As in Uhlig (2005), Canova and de Nicolo (2002) and Peersman (2005) we identify the shock by imposing sign restrictions that incorporate the notion that a contractionary monetary policy shock has a non–positive impact on real output (y_t), prices (p_t) and real house prices (hp_t) as well as a non–negative impact on the short–term interest rate (s_t). While the restrictions imposed on real output, the price level and the short–term interest rate are standard (Peersman, 2005), the restriction imposed on real house prices follows from theoretical considerations by Iacoviello (2005) which show that real house prices should decline on impact after a monetary contraction rather than rise. For all variables the time period over which the sign restrictions are binding is set equal to two quarters. The restrictions are imposed as $\leq$ or $\geq$.

Figure 1 shows the impulse responses of the variables to a contractionary monetary policy shock, which is normalized to unity. The solid lines display the median of the impulse responses and the shared areas are the $84th$ and $16th$ percentile error bands. The simulation horizon covers 20 quarters. Notice that the immediate responses of all variables are constrained after the impact so that little interpretation need be given to the sign of the adjustment for the first two quarters.

Real output falls after the monetary policy shock and remains below the baseline value for around 16 quarters. The decline in prices holds on constantly. The short–term interest rate remains above baseline for around 10 quarters and reverts to it afterwards. Real house prices display a humped–shaped response – which is consistent with the findings of e.g. Assenmacher-Wesche and Gerlach

[3] See Appendix B for the results of tests for first–order autocorrelation.

Figure 1: Baseline VAR Model: Impulse Responses to a Monetary Policy Shock



Notes: The solid lines denote impulse responses, ... The shaded areas are 84% and 16% percentile error bands.

(2008), Iacoviello and Minetti (2003) and Calza, Monacelli, and Stracca (2006) – and return gradually to the baseline value after around 20 quarters. Considering the responses of prices and real house prices two remarks are in order. First, nominal house prices decline in reaction to a contractionary monetary policy shock. Second, the adjustment of nominal house prices is more flexible than the adjustment of prices over the simulation horizon, which means that nominal house prices are less sticky.

Table 1: Forecast Error Variance due to a Monetary Policy Shock

	Real output	Price level	Interest rate	House prices
Horizon				
1	16.03	12.85	12.69	11.99
2	15.63	12.37	10.62	17.21
3	15.90	13.18	10.43	21.47
4	16.53	14.30	10.65	23.66
6	18.51	17.71	10.83	27.62
8	19.51	22.16	11.33	30.41
10	20.29	27.08	11.37	33.27
12	19.66	31.46	11.70	34.18
14	18.99	35.09	11.83	34.34
16	18.55	37.22	11.84	34.47
18	18.44	38.34	12.02	34.88
20	18.87	39.19	12.19	34.45

Notes: For all variables in the pooled VAR model the figures display the percent of the variance in the reduced form innovation at different horizons attributable to a monetary policy shock.

The forecast error variance decomposition presented in Table 1 provides some additional information on the quantitative impact of the monetary policy shock. Regarding the volatility of real output the monetary policy shock explains a share of around 18% over the simulation horizon (corresponding to the median impulse response function). Movements in prices are accounted for by the monetary policy shock in a sizable fraction, starting with 13% immediately after the occurrence of the shock and continuously increasing up to 39%. Moreover, regarding the volatility of real house prices the monetary policy shock explains a share of 12% on impact of the shock, with a continuous increase to 34% at the end of the simulation horizon. We interpret this figure as a remarkable fraction, given that real house prices should be also affected by real output and price level innovations.

2.2 Alternative Identification Scheme

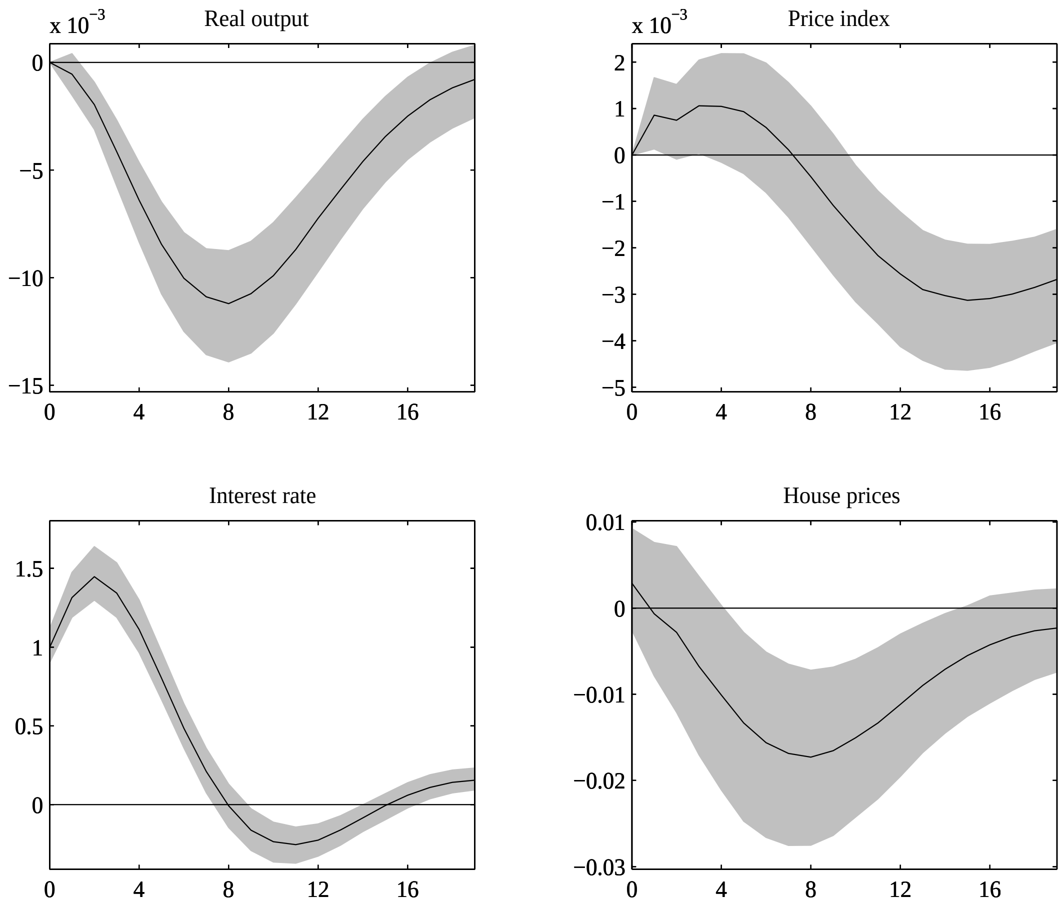
We check robustness of our results by generating impulse responses of the variables to a monetary policy shock, which is identified by imposing a triangular orthogonalization (Sims, 1980).[4] The ordering of variables in the stacked vector X_t implies that real output and prices are hit by an innovation in the nominal short–term interest rate with a lag of one quarter, while real house prices are affected contemporaneously. The impulse responses of the variables are shown in Figure 2 together with the corresponding error bounds.

The findings show that real output falls after a monetary policy shock, exhibiting a humped–shaped response, and returns to the baseline value subsequently. Prices initially increase for about 8 quarters before they start to fall. The initial rise of prices reflects the presence of a *price puzzle* (Sims, 1992), which is also reported in related studies – see e.g. Goodhart and Hofmann (2008) – that employ a Choleski decomposition for the identification of the shock.[5] Real house prices slightly increase on impact after a monetary policy shock, but the rise is statistically insignificant. Real house prices decline afterwards and return to the baseline value subsequently. Overall, the impulse responses resulting from the triangular orthogonalization are qualitatively similar to those stemming from the sign restrictions with the exception that the reaction of real house prices appears to be slightly more pronounced.

[4]In addition we checked robustness by considering alternative model specifications, where we included nominal house prices instead of real house prices, or alternatively included the real effective exchange rate or the mortgage interest rate as an additional variable. Overall, we find that our findings are robust against these modifications. The results are not reported here but are available upon request.

[5]Notice that the avoidance of the price puzzle is the main reason we choose to use sign restrictions to identify the monetary policy shock.

Figure 2: Alternative Identification Scheme



Notes: The solid lines denote impulse responses, ... The shaded areas are 84% and 16% percentile error bands.

3 Heterogeneity Across Countries

So far, we have estimated the VAR model (1) for our sample of countries by assuming that systematic cross–country differences can be explained by country–specific intercepts. In the following, we proceed by splitting the countries into distinctive groups to reveal whether the economies are heterogeneous in the reaction of real house prices to a monetary policy shock.

3.1 Characteristics of Mortgage Markets

Following Maclennan, Muellbauer, and Stephens (1998) the institutional characteristics of mortgage markets across European countries constitute a source of heterogeneity for the role of housing in the transmission of monetary policy. Some key characteristics are summarized in Table 2, which depicts a number of institutional indicators that potentially have a bearing on the sensitivity of house prices to a change in interest rates (Calza, Monacelli, and Stracca, 2006).

Heterogeneity in the depth of mortgage markets across European countries is reflected by the volume of mortgage credit relative to GDP, which varies considerably. In the Netherlands, the United Kingdom and Denmark the ratios are relatively high, ranging between 111% and 67%, while Italy, Austria and France report the lowest ratios.

Table 2: Institutional Characteristics of Mortgage Markets

	Mortgage Debt (% of GDP)	Average Typical Term (years)	Typical LTV Ratio (in %)	Mortgage Equity Withdrawal	Refinancing (fee–free prepayment)	Interest Rate Adjustment	Mortgage Market Index
Austria	20	25	60	No	No	Mainly Fixed	0.31
Belgium	31	20	83	No	No	Mainly Fixed	0.34
Denmark	67	30	80	Yes	Yes	Mainly Fixed	0.82
Finland	38	17	75	Yes	No	Mainly Variable	0.49
France	26	15	75	No	No	Mainly Fixed	0.23
Germany	52	25	70	No	No	Mainly Fixed	0.28
Ireland	53	20	70	Limited	No	Mainly Variable	0.39
Italy	15	15	50	No	No	Mainly Fixed	0.26
Netherlands	111	30	112	Yes	Yes	Mainly Fixed	0.71
Portugal	53	28	75	No	–	Mainly Variable	–
Spain	46	20	80	Limited	No	Mainly Variable	0.40
Sweden	54	25	85	Yes	Yes	Mainly Variable	0.66
United Kingdom	73	25	70	Yes	Limited	Mainly Variable	0.58

Sources: IMF (2008), Calza, Monacelli, and Stracca (2006) and Tsatsaronis and Zhu (2004).

The access of households to mortgage credit depends on several factors (IMF, 2008), such as the standard length of mortgage loan contracts, the typical loan–to–value (LTV) ratio, the ability of mortgage equity withdrawals and the capability to prepay mortgages without fees. Longer mortgage debt contracts keep the ratio between debt services and income affordable. High LTV ratios allow households to take out more debt, while the ability to borrow against accumulated home equity allows households to tap their housing wealth directly. The possibility of early repayment enables households to refinance their mortgage debt in the event of interest rates decline. Finally, the composition of mortgages as between variable–rate and fixed–rate is also potentially important (Tsatsaronis and Zhu, 2004). Mortgage debt contracts designed with variable mortgage rates lower the debt burden of households when short–term interest rates decline, but at the expense of a higher burden when short–term interest rates rise.

The IMF (2008) distinguishes the development of mortgage markets across countries by means of a synthetic mortgage market index to exploit the diversity in explaining the role of housing for the transmission of monetary policy.[6] The index is constructed as a simple average of several institutional indicators and lies between 0 and 1, yielding that higher values reflect a high degree of development, while lower values indicate that the development is minor.[7]

According to the IMF (2008), mortgage markets in Denmark, Sweden and the Netherlands appear most developed, which suggests a high potential role for housing in the transmission of monetary policy. In these countries the standard length of mortgage debt contracts is around 30 years, the typical LTV ratios are about 80% and mortgage products specifically designed for equity withdrawals are widely marketed. In contrast mortgage markets in Austria, France, Germany and Italy appear less developed, as the typical LTV ratios ranges only between 50% to 70% and the ability of mortgage equity withdrawals is widely missing.

[6]Our discussion on the separation of countries refers mainly to the results of the IMF (2008), but we are aware of a number of studies – see Giuliodori (2005), Tsatsaronis and Zhu (2004) and Calza, Monacelli, and Stracca (2006), among others – that proceed along similar lines. These studies classify countries into homogenous groups taking account of several institutional indicators. Compared to the results of the IMF (2008), the outcome is akin.

[7]See IMF (2008) for details on the construction of the mortgage market index.

Nevertheless the distinction of countries by means of institutional indicators is disputable (Assenmacher-Wesche and Gerlach, 2008). First, the selection of the indicators is subjective. Vagueness prevails in the decision on which of the indicators are relevant. Second, the indicators are compiled arbitrarily. For instance a considerable degree of judgement is required – see ECB (2003) – to decide on the relevant LTV ratios (using the average ratio or the maximum ratio), to assess whether restrictions on early repayment fees are implemented or to evaluate whether mortgage rates are variable or fixed because both terms often coexist. Since the separation of countries on the basis of institutional indicators suffers from these shortcomings, we decide to proceed by using an alternative approach.

3.2 Country Clusters

We split our sample of countries into two distinctive groups – a *strong reaction group* and a *weak reaction group* – by focusing on the response of real house prices to a monetary policy shock. Since our approach is novel, we describe the methodology applied more explicitly.

3.2.1 Methodology

The separation of countries proceeds in three steps.

1. Step: Distance Measure We start by estimating pooled VAR models for all possible pairs of country groups, which contain at least three units to ensure enough degrees of freedom.[8] Overall the number of pairs of country groups amounts to 4005.[9] For all pairs of country groups we generate impulse responses to a monetary policy shock, which is identified by imposing our sign restrictions.

[8]As before the VAR models contain the same set of variables – real output, prices, the short–term interest rate and real house prices – and a lag length of 3.

[9]Notice that in our sample of countries the total number of different pairs of country groups amounts to 4096 ($= 2^{13}/2$). Given that we consider only pairs of country groups containing at least three units, this reduces the number of pairs to 4005, since there are 13 combinations with only one unit and 78 combinations – $(12 \times 13)/2$ – with two units.

For each pair of country groups, we compare the reaction of real house prices to a monetary policy shock by applying the following distance measure:

$$d = \left| \sum_{i=1}^{q} \alpha_{1i} - \sum_{i=1}^{q} \alpha_{2i} \right| , \tag{3}$$

where α_{1i} and α_{2i} are the median responses of real house prices of the respective groups i periods after the occurrence of the shock. We consider the responses of up to two lags $q = 2$, which corresponds to the time period over which the sign restrictions are binding.

The distance measure in expression (3) reflects the absolute value of the difference between the cumulated impulse responses. Choosing the pair of country groups with the largest realization of the distance measure would be straightforward. But there exists a great number of pairs with very similar distance measures, which means that using the maximum distance pair only would contaminate the choice by a considerable portion of randomness.

2. Step: Selected Pairs of Country Groups Therefore, we identify all pairs of country groups that exhibit a significant distance measure, where significance is detected as follows. Assume that the estimated impulse response coefficients $\widehat{\alpha}_{1i}$ and $\widehat{\alpha}_{2i}$ asymptotically follow a normal distribution. Then the sums of the coefficients considered for the distance measure, denoted by $\widehat{s}_1 = \sum_{i=1}^{q} \widehat{\alpha}_{1i}$ and $\widehat{s}_2 = \sum_{i=1}^{q} \widehat{\alpha}_{2i}$, are also asymptotically normal. Under the null hypothesis that all pairs of country groups are alike and have the same sum of population coefficients $\widehat{s} = \sum_{i=1}^{q} \widehat{\alpha}_i$, their only systematic difference in the estimation results is the size of the panel from which they are estimated.

The sums of the estimated coefficients should be approximately distributed as:

$$\widehat{s}_1 - s \sim N\left(0, \sigma^2/(N_1 T)\right) \tag{4}$$

$$\widehat{s}_2 - s \sim N\left(0, \sigma^2/(N_2 T)\right) , \tag{5}$$

where N_1 is the size of the first panel, N_2 is the size of the second panel, T is the number of observations and σ^2 is the population variance that is assumed constant across countries. Furthermore, assuming that the countries are independent, we can apply a classical difference test using the statistic: $d = \widehat{s}_1 - \widehat{s}_2$. Under the null hypothesis, the statistic is approximately normally distributed with mean zero and variance:

$$\mathrm{Var}(d) = \sigma^2/(N_1 T) + \sigma^2/(N_2 T) = (1/N_1 + 1/N_2)\,\sigma^2/T. \tag{6}$$

Since σ^2 is unknown, we estimate the population variance from expression (6) by noting that:

$$\sigma^2 = T\mathrm{Var}(d)/\left(1/N_1 + 1/N_2\right), \tag{7}$$

where the sample variance of the distance measure $\mathrm{Var}(d)$ is calculated from the numerous realizations of d. Given the estimate of σ^2, we construct a t–statistic and compare it with the corresponding 95% critical value of the t–distribution.

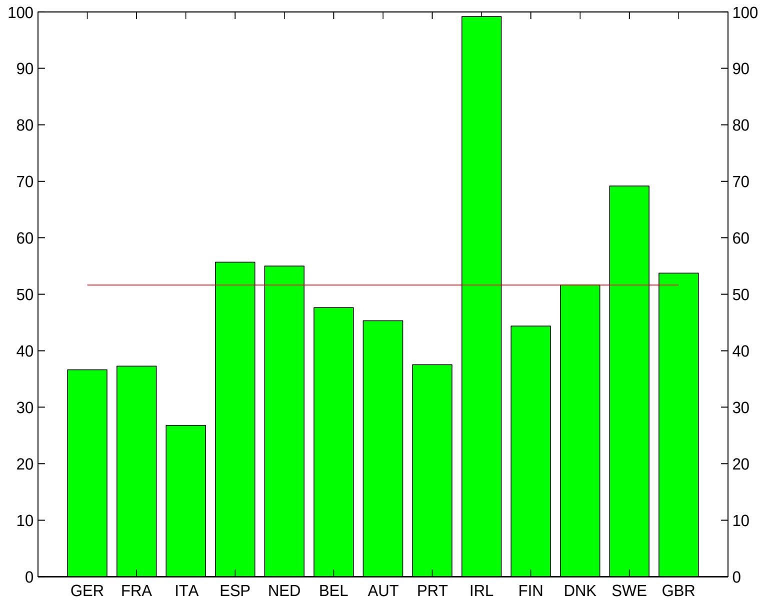
3. Step: Selection of the Country Groups We continue by calculating the frequency that a single country belongs to the group with a significantly stronger reaction of real house prices to a monetary policy shock. Under the null hypothesis that all countries are equal, this resembles a random experiment in which for each pair of country groups the countries are sampled without replacement. Accordingly, for a given country group size, the frequency x – that a particular country is found to be in the *strong reaction group* – follows a hypergeometric distribution: $f(x; M, K, n)$, where M denotes the total number of countries considered, i.e. $M = 13$, K is the size of each country group, which takes one of the values between $3, 4, ..., 10$ because there is a minimum of at least three units per group, and n denotes the number of different combinations, which show a significant distance for a given group size, $n = n(K)$.

Finally, from the hypergeometric distribution we derive a 95% critical value for the frequency that a particular country belongs to the *strong reaction group*. If a country is selected more often, the null hypothesis that all countries are equal can be rejected.

3.2.2 Identified Country Groups

The separation of countries according to the above steps leads to two distinctive groups that depart in the reaction of real house prices to a monetary policy shock. Figure 3 plots the relative frequency of belonging to the *strong reaction group* and the *weak reaction group* – as measured by means of the cumulative impulse responses of real house prices over two lags – together with the average critical value of the hypergeometric distribution, which amounts to 0.516.

Figure 3: Selected Groups of Countries



Notes:

The classification of countries yields that Ireland, Sweden, Spain, the Netherlands, the United Kingdom and Denmark are settled in the *strong reaction group*, as in these countries the reaction of real house prices to a monetary policy shock is significantly more pronounced. In contrast Austria, Belgium, Finland, France, Germany, Italy and Portugal belong to the *weak reaction group* because their relative frequency is below the critical value.[10]

[10] Our approach leads to the following ranking of countries as measured by the respective relative frequency: Ireland (0.99), Sweden (0.69), Spain (0.56), the Netherlands (0.55), the United Kingdom (0.54), Denmark (0.52), Belgium (0.48), Austria (0.45), Finland (0.44), Portugal (0.38), France (0.37), Germany (0.36) and Italy (0.27). Notice that the 95% critical value of belonging to the *strong reaction group* is 0.516.

Our distinction of countries is roughly in line with the mortgage market index of the IMF (2008), however some important differences are in order. First, the ranking departs. We obtain for Ireland the highest relative frequency, followed by Sweden and Spain, while the mortgage market index assigns Denmark the highest value, followed by the Netherlands and Sweden. Second, the composition differs. We find that Ireland and Spain are settled in the *strong reaction group*, although both countries obtain relatively low values in the mortgage market index. In turn, Finland obtains a relative high value in the mortgage market index, although this country belongs to the *weak reaction group*.

We interpret our findings as an indication that the development of mortgage markets across countries is important in shaping the reaction of house prices to a monetary policy shock, but additional country–specific characteristics – see ECB (2003) – such as national traditions, cultural factors, the share of the housing sector in overall economic activity, the number of employees in the construction sector, regulations regarding housing taxes and subsidies or transaction costs might also be relevant.

4 Assessing Heterogeneity across the Groups of Countries

4.1 Baseline VAR models

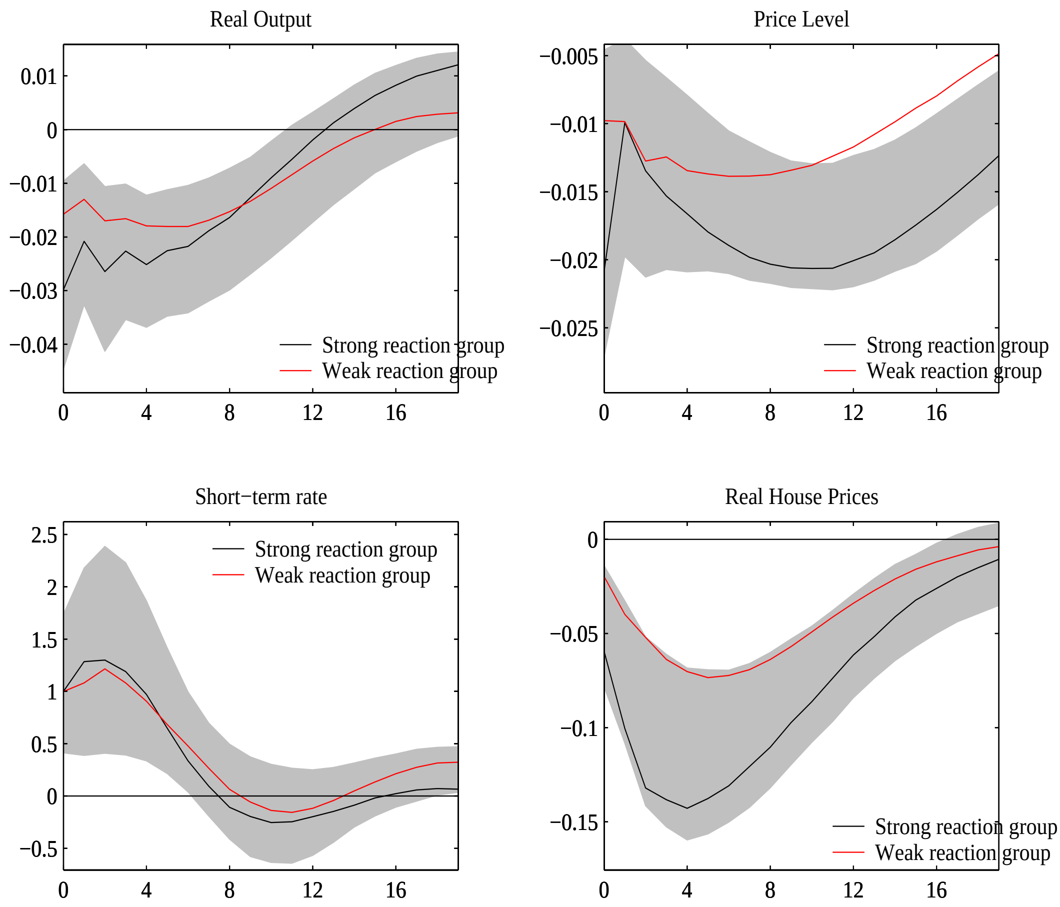
Next, we re–estimate a pooled VAR model for every group of countries separately.[11] For both groups, we compare the responses of the variables to a monetary policy shock, which is identified by imposing our previous sign restrictions.

Figure 4 reports the impulse responses of the variables in both groups of countries – the *strong reaction group* and the *weak reaction group* – together with the confidence regions of the responses stemming from the full–sample baseline specification, which are marked by the shaded areas. Notice that for every group of countries the reaction of the short–term interest rate is almost

[11] Again, every VAR model contains a lag length of $n = 3$.

alike, which means that both groups are hit by an identical monetary policy shock.[12]

Figure 4: Impulse responses of country groups



Notes: The solid lines denote impulse responses, ... The shaded areas are 84% and 16% percentile error bands.

The impulse responses indicate that real output in both groups of countries falls in tandem after the monetary policy shock, but the reaction in the *strong reaction group* is on impact more pronounced. The fall of prices in both groups is significantly different, showing that the decline in the *strong reaction group* is more distinctive and permanent than in the *weak reaction group*. The reaction

[12]As before the monetary policy shock is normalized to unity.

of real house prices in both groups of countries also differs substantially as the drop in the *strong reaction group* is much more pronounced on impact and longer–lasting.

Table 3: Forecast Error Variance due to a Monetary Policy Shock

	Real output		Price level		Interest rate		House prices	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Horizon								
1	15.08	12.77	17.07	7.20	10.80	16.66	14.11	7.58
2	16.35	11.35	14.75	9.14	9.20	14.32	22.49	13.11
3	17.33	11.97	15.43	12.21	8.63	12.82	27.25	15.66
4	17.92	12.54	16.64	14.24	8.74	11.81	29.91	18.12
6	18.47	14.72	20.62	19.01	9.25	10.58	33.48	21.55
8	18.18	16.74	25.36	22.90	9.81	10.20	34.41	23.50
10	17.55	17.25	29.90	26.00	10.92	10.59	34.79	24.74
12	16.96	16.95	33.54	28.46	11.59	10.92	34.58	25.35
14	16.63	16.07	36.09	30.55	12.23	11.23	34.34	25.92
16	16.79	15.64	37.41	31.26	12.54	11.48	33.94	25.66
18	17.50	15.37	38.00	32.18	12.83	11.69	33.85	25.61
20	18.59	15.40	38.59	32.44	12.99	12.08	33.88	26.05

Notes: For all variables the figures display the percent of the variance in the reduced form innovation at different horizons attributable to a monetary policy shock. (1) forecast error variance of the *strong reaction group.* (2) forecast error variance of the *weak reaction group.*

For both groups of countries, Table 3 summarizes the forecast error variance decompositions, which provide an additional insight into the different quantitative impact of the monetary policy shock. Movements of real output in every group are almost equally accounted for by the monetary policy shock, starting with 15% in the *strong reaction group* and 13% in the *weak reaction group* on impact of the shock and increasing up to 18% and 15%, respectively, at the end of the simulation horizon. Regarding the volatility of prices between the groups notable differences are observable, as the monetary policy shock explains a share of 17% and 7% immediately after the occurrence of the shock, with a continuous increase to 39% and 32%. Likewise, movements in real house prices are more accounted for by the monetary policy shock in the *strong reaction group* than in the *weak reaction group*, starting with 14% and 8% on impact of the shock and increasing up to 34% and 26%, respectively, at the end of the simulation horizon.

The findings exhibit that the adjustment of the variables in both groups of countries depart – to some extent even substantially – after a monetary policy shock. The heterogeneity across countries seems to reflect the differences in the transmission of monetary policy, which can be related to the amplifying influence of house prices in propagating monetary policy shocks. We interpret the discrepancy in the adjustment as sizable enough to conclude that monetary policy should be concerned about movements in real house prices when setting interest rates.

4.2 Extended VAR Models

Finally, we estimate an extended pooled VAR model for every group of countries, which includes an additional variable that potentially plays a role for the transmission of monetary policy. The vector of endogenous variables is given by:

$$X_t = [y'_{it} \;\; p'_{it} \;\; s'_{it} \;\; (hp)'_{it} \;\; z'_{it}]' \,, \tag{8}$$

where (z_{it}) is the additional variable of interest, which is either given by real private consumption, real residential investment, the mortgage rate or the real effective exchange rate. The variables summarized by (z_{it}) are expressed in logs – except for the mortgage rate that is in percent – and linearly detrended.

The inclusion of private consumption by households follows from the idea that spending plans are likely affected by movements in house prices due to housing wealth and housing collateral effects (Muellbauer and Murphy, 2008). Households may increase their consumption expenditures in response to an increase in housing wealth induced by a shift of house prices.[13] Additionally,

[13]However it is important to note that an increase in housing wealth is different from a rise in financial wealth, because housing fulfills a dual role, serving as both a real asset and a commodity yielding service, an increase in the value of housing assets causes a redistribution of wealth within the household sector. Therefore the impact on consumption expenditure arising through wealth effects should be limited (Quelle).

households may rise their consumption expenditures because of an easier access to credit, since an increase in house prices extends the value of collateral, which loosens credit constraints. The strength of both effects depends – inter alia – on the sensitivity of house prices to a change in interest rates.

Residential investment may be stimulated by an increase in house prices, primarily because the value of housing rises relative to construction costs. Including the mortgage rate accounts for the speed debt contracts conditions adapt to a change in interest rates, while considering the real effective exchange rate allows to control for the effects arising through open economies influences that might also have a bearing on the transmission of monetary policy.

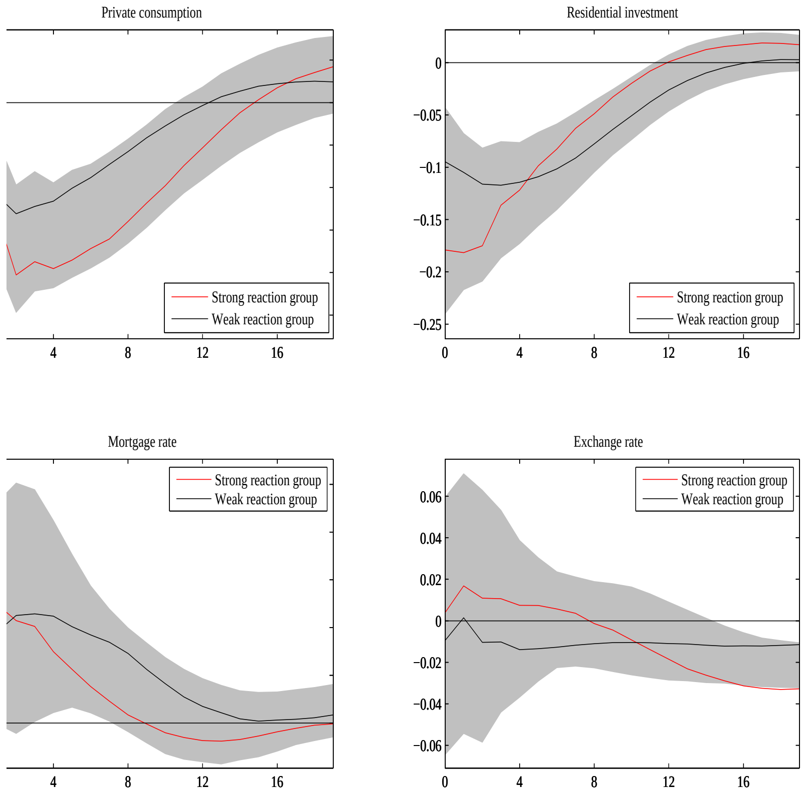
We assess heterogeneity across the groups of countries by focusing on the reaction of the additional variables to a monetary policy shock.[14] The impulse responses are plotted in Figure 5, together with the confidence regions of the responses resulting from the extended full–sample baseline specifications, which are marked by the shaded areas.

The findings exhibit that real private consumption in both groups of countries responds differently to a monetary policy shock, as the fall in the *strong reaction group* is more pronounced. This suggests that the reaction of private consumption is affected by the volatility of real house prices due to wealth and collateral effects. The response of real residential investment in both groups of countries seems to be alike, except for the initial reaction on impact after the shock, which is more vigorous in the *strong reaction group* than in the *weak reaction group*.

Mortgages rates in both groups of countries move differently. The shift of mortgage rates in the *strong reaction group* is more pronounced on impact of the shock, while the adjustment in the *weak reaction group* is more persistent. The discrepancy in the adjustment of mortgage rates might be attributable to diverging debt contract terms, however in both groups both forms of variable–rate and fixed–rate contracts co–exist (see Table 2). Finally, the real effective

[14]To be consistent with the reaction of real output, we decided to include sign restrictions on the reaction of consumption and residential investment, which hold for two quarters. In contrast, the responses of the mortgage rate and the real effective exchange rate are left unrestricted.

Figure 5: Extended VAR Model Specifications



Notes: The solid lines denote impulse responses to a monetary policy shock, ... The shaded areas are 84% and 16% percentile error bands.

exchange rate hardly moves in both groups after the monetary policy shock.

5 Concluding Remarks

We explore the role of housing in European countries for the transmission of monetary policy. We estimate a pooled VAR model to generate impulse responses of key macroeconomic variables to a monetary policy shock taking special account of the reaction of real house prices. Our sample comprises 13 countries for which we use quarterly data over the period from 1995 to 2006.

We find that key macroeconomic variables in European countries co–move with real house prices after a monetary policy shock. Assessing heterogeneity across countries we split our sample into two distinctive groups – a *strong reaction group* and a *weak reaction group* – using a novel approach that refers to the reaction of real house prices to a monetary policy shock. We compare the impulse responses of the two groups to assess the effects of movements in real house prices after a change in interest rates.

Assessing heterogeneity across the groups of countries, we find that notable differences exist. The reaction of macroeconomic variables in the *strong reaction group* are more pronounced than in the *weak reaction group*, which suggests that real house prices play an amplifying role in the propagation of monetary policy shocks. As regards the discrepancy across our groups of countries, we conclude that monetary policy should take account of the volatility of real house prices when setting interest rates.

Appendices

A Data Base

We use data for 13 European countries taken from the OECD over the period from 1995Q1 to 2006Q4. The sample of countries includes Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden and the United Kingdom. The data comprises:

1. Real GDP: Gross domestic product, volume, market prices, seasonally adjusted.
2. Prices: Gross domestic product, deflator, market prices, seasonally adjusted. An exception is Ireland where the consumer price index is used, since the GDP deflator exhibits ... (?)
3. Short–term interest rate: Short-term interest rate in percent.
4. Real house prices: Nominal house prices provided by the OECD, deflated with the GDP deflator, seasonally adjusted.
5. Real private consumption: Private final consumption expenditure, volume, seasonally adjusted.
6. Real residential investment: Private residential fixed capital formation, volume, seasonally adjusted. Since residential investment is not available for Austria, Portugal and Spain, we used the gross fixed capital formation, volume, seasonally adjusted, instead.
7. Mortgage rates: Mortgage rates taken from the European Central Bank (www.ecb.org).
8. Real effective exchange rate: Real Effective Exchange Rate Index, EUR.

B Tests for Serial Correlation

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