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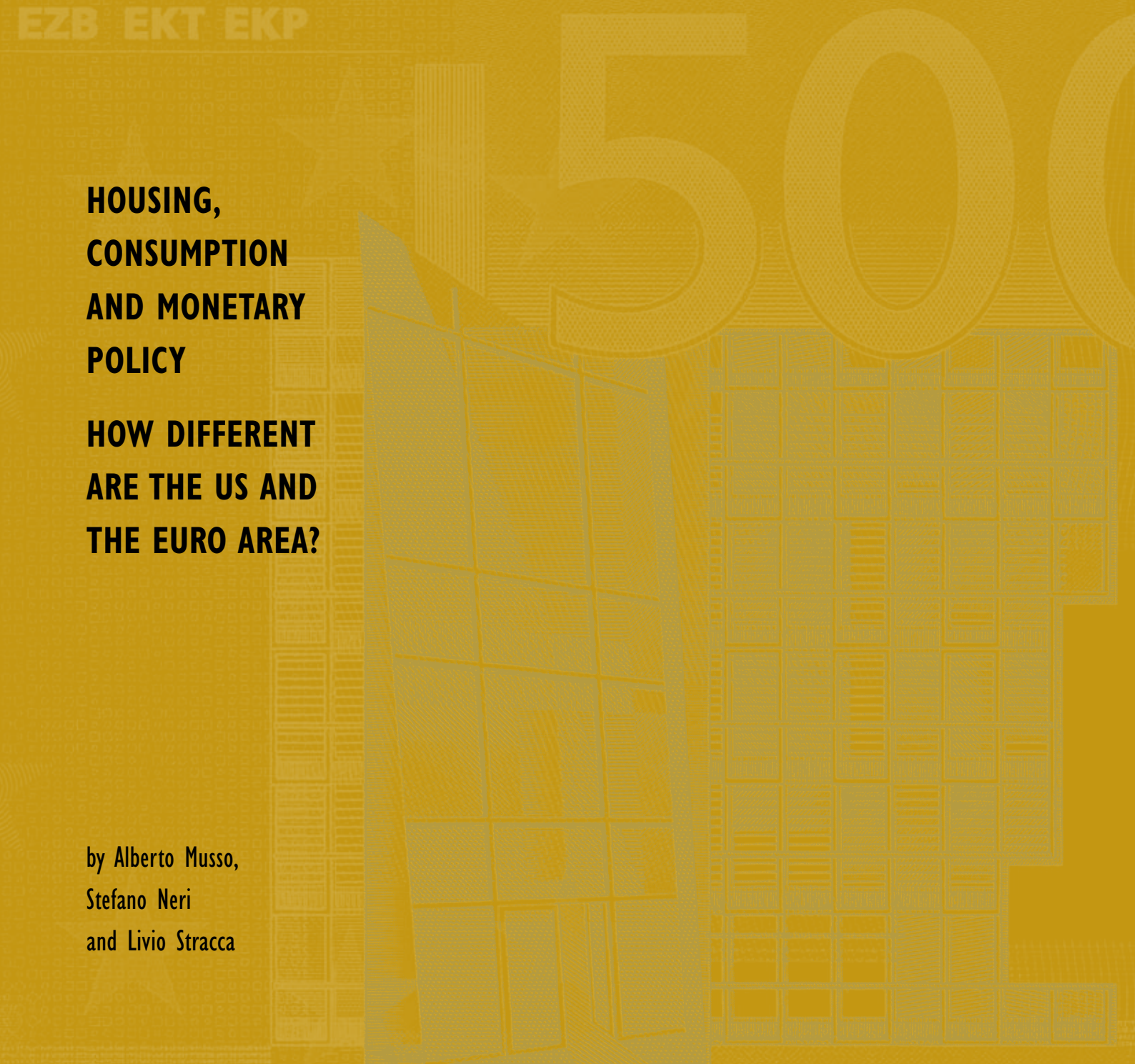

HOUSING, CONSUMPTION AND MONETARY POLICY

HOW DIFFERENT ARE THE US AND THE EURO AREA?

by Alberto Musso, Stefano Neri and Livio Stracca

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In 2010 all ECB publications feature a motif taken from the €500 banknote.

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Abstract

The paper provides a systematic empirical analysis of the role of the housing market in the macroeconomy in the US and in the euro area. First, it establishes some stylised facts concerning key variables in the housing market, such as the real house price, residential investment and mortgage debt on the two sides of the Atlantic. Then, it presents evidence from Structural Vector Autoregressions (SVAR) by focusing on the effects of three structural shocks, (i) monetary policy, (ii) credit supply and (iii) housing demand shocks on the housing market and the broader economy. We find that similarities overshadow differences as far as the role of the housing market is concerned. We find evidence pointing in the direction of a stronger role for housing in the transmission of monetary policy shocks in the US, while the evidence is less clearcut for housing demand shocks. We also find that credit supply shocks matter more in the euro area.

Keywords: Residential investment; House prices; Credit; Monetary Policy.

JEL codes: E22, E44, E52..

Non-technical summary

The role of the housing market in the business cycle has been the subject of considerable interest among academics. There are several questions that are of considerable interest for academics and policy-makers, including on the role of monetary policy in affecting the behaviour of residential investment and house prices, on the role of the mortgage market in affecting and possibly amplifying the effect of changes in housing prices on overall economic activity through some sort of financial accelerator mechanism, and on the impact of housing market corrections on financial stability in general, and bank profitability in particular.

Our paper aims at shedding some light on the transmission mechanism of housing and mortgage market related shocks on the two sides of the Atlantic. There are notable differences between the euro area and the US as far as the housing market is concerned. First, land availability is more abundant in the US than in the euro area, which may imply that there may be fewer supply constraints in the former economy. Second, the mortgage market is more developed in the US and it allows, in particular, a quicker translation of higher (lower) house prices in easier (harder) access to borrowing, notably through Mortgage Equity Withdrawal schemes. Third, mortgage lending rates are mainly tied to long-term rates in the US, while the situation is more varied in the euro area, where mortgage rates are mainly variable rate in countries such as Spain and Italy.

Against this background, the purpose of this paper is to provide a systematic empirical analysis of the role of the housing market in the macroeconomy in the US and in the euro area. The analysis carried out in this paper, in particular, is twofold. We first try to establish some stylised facts concerning key variables in the housing market, such as the real house price, residential investment and mortgage debt on the two sides of the Atlantic, also looking at lead-lag relationships with overall economic activity similar to Leamer (2007). We then carry out a more structural analysis using a Structural Vector Autoregression approach (SVAR). The same SVAR model is estimated on US and euro area data over a sample period from 1986 to 2008 in order

to obtain comparable results in the two economies. The specification and identification of the SVAR are tailored to study the effects of some structural shocks that are of particular interest in studying the nexus between the housing market and the macroeconomy. We focus, in particular, on three structural shocks: a monetary policy shock, a (mortgage) credit supply shock and a (non-monetary) housing demand shock. After standardising the size of the shock in the euro area and in the US, we compare the impulse response pattern in the two economies in order to understand similarities and differences in a systematic manner.

Overall, our analysis reaches three main results:

- First, in the descriptive analysis we find a lot of similarities between the US and the euro area as regards key housing market and macroeconomic variables, with the only key difference being confined to the cyclical correlation between the real house price and mortgage debt being higher in the US.
- Second, in the SVAR analysis we find more evidence of a role for the housing market in the transmission of monetary policy in the US than in the euro area, although the result is less clearcut when Germany is excluded from the euro area aggregate. Concerning housing preference shocks, the evidence is not conclusive in this direction but still suggests a larger impact of these shocks on consumption in the US.
- Finally, we find that negative mortgage credit supply shocks lead to a fall in real house prices and residential investment in both the US and the euro area, but appear to be quantitatively more important in the euro area.

1 Introduction

The role of the housing market in the business cycle, especially the US business cycle, has been the subject of considerable interest among academics even before, but especially in the wake of, the 2007-09 financial crisis; for example, the topic of the 2007 Jackson Hole symposium held by the Federal Reserve Bank of Kansas City was the role of the housing market in modern economies (see in particular Mishkin, 2007 and Taylor, 2007). There are several questions that are of considerable interest for academics and policy-makers, among which three tend to stand out in the debate. First, the role of monetary policy in affecting the behaviour of residential investment and house prices, as opposed to other, possibly non-fundamental factors that drive house prices up and down, such as asset price bubbles. This role is particularly relevant in the present circumstances as very low nominal and real interest rates in the first half of the decade are widely credited as having been an important determinant of excessively high house prices in the US and elsewhere. Second, the role of the mortgage market in affecting and possibly amplifying the effect of changes in housing prices (in turn due to both monetary and non-monetary factors) on consumption, residential investment and overall economic activity through some sort of financial accelerator mechanism. Third, the impact of housing market corrections on financial stability in general, and bank profitability in particular.

Shocks that affect house prices and the conditions at which mortgage credit is extended lie therefore at the heart of the current policy discussion. Our paper aims at shedding some light on the transmission mechanism of housing and mortgage market related shocks on the two sides of the Atlantic. Indeed, although much of this debate concerns the US economy, it is notable that housing prices have certainly not stayed put on the other side of the Atlantic in the run up to the financial crisis. *Figure 1* reports the behaviour of an index of the nominal house price in the US and the euro area up to 2008. While house prices have remained stable in Germany over the last decade, they have strongly increased in the rest of the euro area, even more than in the US. In the euro area as a whole, the dynamics of house prices have been similar to the US. This begs the question of whether a similar housing correction in the euro area as experienced in the US could create as much havoc on the economy in the European side of the Atlantic, in addition to the economic woes brought about by the global financial crisis.

In this respect, there are three notable differences between the euro area and the US as far as the housing market is concerned. First, land availability is more abundant in the US than in the euro area, which may imply that there may be fewer supply constraints in the former.[1] The US population is also more culturally homogeneous and therefore mobile, which translates into a more liquid and efficient housing market. This is supported by the evidence reported in *Figure 2*, showing the number of housing transactions in the US and the euro area, in thousands of units. Second, the mortgage market is more developed in the US and it allows, in particular, a quicker translation of higher (lower) house prices in easier (harder) access to borrowing, notably through Mortgage Equity Withdrawal (MEW) schemes. In the euro area MEW and other mortgage refinancing instruments are relatively underdeveloped, especially in the largest euro area countries (with the notable exception of the Netherlands).[2] As reported in the latest survey of EU mortgage markets (ECB 2009), there are even legal restrictions to mortgage securitisation in some EU countries. Looking at a synthetic measure of mortgage market development such as mortgage debt to GDP, the US has always been in the lead compared with the euro area, especially so in the last decade. At end 2008, mortgage debt was about 70% of GDP in the US, and 40% of GDP in the euro area (*Figure 3*). Differences in the tax and legal systems on the two sides of the Atlantic may largely explain this difference (Ellis 2008). This observation may beg the question of whether the euro area is relatively more sheltered than the US from housing market related shocks. Third, mortgage lending rates are mainly tied to long-term rates in the US, while the situation is more varied in the euro area, where mortgage rates are mainly variable rate in countries such as Spain and Italy. Admittedly, some of these differences in institutional characteristics may be endogenous, but it is plausible that a significant part of them are institutionally-driven and hence to a large extent exogenous.[3] Therefore, by comparing the US and the euro area there is something to be learnt about the role of housing in the business cycle more generally and

[1] According to Ellis (2008), greater supply flexibility in the US may have been a source of risk during the latest housing boom, since it implied an excess of residential investment that would otherwise not have been possible.

[2] As reported by Miles and Pillonca (2008), "overwhelmingly across Europe, a mortgage remains and nominal contract with repayments unrelated to movements in consumer or house prices". See also Table 1 in Calza et al. (2009).

[3] See Crook and Hochguertel (2007) on the institutional roots of cross country differences in household debt.

the importance of institutional factors.

Against this background, the purpose of the this paper is to provide a *systematic* empirical analysis of the role of the housing market in the macroeconomy in the US and in the euro area. The analysis carried out in this paper, in particular, is twofold. We first try to establish some stylised facts concerning key variables in the housing market, such as the real house price, residential investment and mortgage debt on the two sides of the Atlantic, also looking at lead-lag relationships with overall economic activity similar to Leamer (2007). This part of the analysis could be considered as the unconditional one, namely without regard to the structural shocks that are behind the observed developments. We then carry out a more structural analysis using a Structural Vector Autoregression approach (SVAR), which is conditional on the identification of a restricted number of structural shocks. The same SVAR model is estimated on US and euro area data over a sample period from 1986 to 2008 in order to obtain comparable results in the two economies. The specification and identification of the SVAR are tailored to study the effects of some structural shocks that are of particular interest in studying the nexus between the housing market and the macroeconomy. We focus, in particular, on three structural shocks: a monetary policy shock, a (mortgage) credit supply shock and a (non-monetary) housing demand shock. After standardising the size of the shock in the euro area and in the US, we compare the impulse response pattern in the two economies in order to understand similarities and differences in a systematic manner.[4]

An advantage of the SVAR approach is that it allows to identify the effect of structural shocks while imposing relatively loose identification restrictions that allow the researcher to remain relatively agnostic as to the outcome of the analysis. At the same time, the SVAR cannot be as useful as a fully fledged dynamic stochastic general equilibrium (DSGE) model in allowing an understanding of the channels of propagation of shocks. This limitation has to be kept in mind in interpreting the results of this paper, as will become evident later on.[5]

[4] Jarocinski and Smets (2008), Cardarelli et al. (2008) and Goodhart and Hofmann (2008) perform similar analyses for, respectively, the US and a panel of industrialised countries. As far as monetary policy shocks are concerned, see also Calza et al. (2009). Our paper, however, is the only one focused on the trans-Atlantic differences.

[5] Darracq Paries and Notarpietro (2008) estimate a two-country DSGE model of the euro area and the US featuring a housing sector and analysing housing-related disturbances. The focus of that paper, however, is not to systematically compare the US and the euro area.

Our paper relates to a small, but burgeoning literature on the effect of including housing and mortgage debt in general equilibrium; see Iacoviello (2005), Iacoviello and Neri (2009), Campbell and Hercowitz (2005) and Calza et al. (2009). In these papers, the bulk of the effect of changes in house prices on the macroeconomy happens through a collateral mechanism, as credit-constrained households are allowed to borrow only against housing equity. Given that the US and the euro area present, as noted above, important differences as regards the structure of mortgage markets, the kind of comparative analysis that we carry out could convey some important message for the empirical importance of the mechanisms that lie at the core of these models.

Overall, our analysis has four main results. First, in the descriptive analysis we find many similarities between the US and the euro area as regards key housing market and macroeconomic variables, with one key difference being the cyclical correlation between the real house price and mortgage debt, which is significantly higher in the US especially on account of a particularly low correlation in Germany. Second, in the SVAR analysis we find more evidence of a role for the housing market in the transmission of monetary policy in the US than in the euro area. Third, concerning housing preference shocks, the evidence is not conclusive in this direction but still suggests a larger impact of these shocks on consumption in the US. Finally, we find negative mortgage credit supply shocks impact on housing market variables in the same way as negative housing demand shocks in both the US and the euro area, but are overall quantitatively much more important in the latter economy.

The paper is organised as follows. In Section 2 we present preliminary empirical evidence and stylised facts. Section 3 contains the SVAR analysis, and Section 4 some sensitivity analysis. Section 5 presents some discussion of the results. Section 6 concludes.

2 Some stylised facts: the US and the euro area

2.1 Data

We collect data for the US, the euro area and the five largest euro area countries (Germany, France, Italy, Spain and the Netherlands[6]) on a set of macroeconomic variables

[6] These countries collectively cover around 90 per cent of the euro area economy, if measured by real GDP.

that are related to the housing market. These include private consumption, residential investment, the consumer price index (CPI), the real house price (deflated using the CPI), a representative mortgage lending rate, the 3-month interbank interest rate, and mortgage debt. The sources and definitions of the data are reported in the Annex.[7] The sample period from the data spans from 1986:1 to 2008:4, therefore also covering the peak of the global financial crisis of 2007-09. *Figure 4* contains all the key macroeconomic series used in the empirical analysis, for the US and the euro area. Data on mortgage delinquencies or other measures of mortgage default are not available for the euro area as a whole, and are therefore not used in the analysis.

As a preliminary observation it is interesting to note that, contrary to the common perception (notably that Americans live in bigger and more expensive houses than Europeans[8]), housing wealth is larger in the euro area, as a share of GDP, than in the US (see *Figure 5*). Although there may be statistical issues involved, the difference is so large that it is unlikely to be determined by statistical factors alone. In Europe, housing is the chief form of wealth for many households, who are traditionally less inclined to invest in financial markets, in particular stock markets, and see housing as a "safe haven" asset. Moreover, population concentration probably makes land more valuable in Western Europe than in large part of the US. Christelis et al. (2009) analyse international differences in the holdings of real and financial assets in elder households, finding that - controlling for individual characteristics - Europeans tend to hold more real estate (in particular in the form or primary residence), while Americans tend to hold more stocks.

2.2 Some stylised facts on housing markets on the two sides of the Atlantic

We start by taking a look at the statistical and cyclical properties of some key macroeconomic variables related to the housing market, in order to set the stage for the empirical analysis that will follow later. As already pointed out in the Introduction, this part of the analysis should be considered as the unconditional one, not taking any stance on the kind

[7] Ideally, one would have liked to collect consumption data split by durable and non-durable goods. Unfortunately, data for this decomposition do not exist for the euro area.

[8] Christelis et al. (2009) report an average size of 165 square meters per dwelling in the US, against 90 square meters in Germany and France, 92 in Italy, and 93 in Spain in the early to mid 2000s (see Table 6, page 39).

of structural shocks that may be behind observed developments. In the following Section we then impose more structure and condition on a number of identified structural shocks using an SVAR approach.

Because the behaviour of house prices, and generally the housing market, may have peculiar characteristics in individual euro area countries, we also consider the five largest euro area countries individually. We choose the start of the sample period to be 1986. This reflects the fact that major episodes of deregulation and financial innovation in the mortgage markets took place in the early 1980s (see e.g. Table 3.1 in Ahearne et al. 2005), although mortgage product innovation is certainly a continuous, gradual phenomenon. Moreover, we also want to study a sample period of relative homogeneity in terms of monetary policy regime, and 1986 is appropriate since it comes after the Great Disinflation of the early 1980s and marks a period of relative stability in the inflation rate in both the US and the euro area. In order to test for the robustness to changes in the sample period, we report results for the whole sample as well as for the most recent period from 1997 to 2008 (which is also the period in which the euro area can be roughly considered as a monetary union).

Table 1 reports key characteristics of *residential investment* in the seven economies (the US, the euro area and the five individual euro area countries). Overall, the level of residential investment as a share of GDP (around 5%) as well as the quarterly volatility and the contribution to real GDP growth are similar, though the former is significantly higher in the US and the latter in Spain and the Netherlands. Residential investment is strongly pro-cyclical (the maximum correlation is 0.68 in the United States and 0.61 in the euro area; as high as 0.73 in France) and tends to lead the business cycle (see also Leamer 2007).

The *real house price* is also procyclical, but less strongly so than residential investment (see *Table 2*).[9] Interestingly, the relationship with real GDP is clearly lagging in the US, but is slighly leading in the euro area. The correlation with residential investment, detrended, is positive in both the US and the euro area. It is also interesting to observe that the average annual increase in the real house price is as high in the euro area as in the US for the whole sample period, though this masks considerable heterogeneity across countries, with Germany standing out as an outlier; for the sample period starting from

[9] See Ahearne et al. (2005) for a similar result for 18 major industrial countries.

1997, however, the average annual increase is mch larger in the US. It should be kept in mind, however, that house price statistics are not harmonised across countries, not only between the US and the euro area but to some extent also within the euro area itself.

Table 3 reports the characteristics of euro area and US *mortgage debt*. The average annual growth of real mortgage debt is very similar across economic areas, at around 6%, though it is lower in France and higher in Italy and Spain; in the post-1997 sample, it is significantly higher in the US. Mortgage debt is also pro-cyclical in both the euro area and the US, with the cyclical correlation being higher in the euro area in both sample periods. It is, however, significantly less procyclical in Italy and especially in Germany, where it is even countercyclical. An interesting difference between the US and the euro area is in the cyclical correlation between mortgage debt and the real house price, which is 0.21 in the euro area and 0.77 in the US. This is likely to be due to a large extent to the prevalence of home equity refinance in the US, which creates a link between house prices and mortgage debt. At the same time, the result for the euro area is very much influenced by Germany, which displays a similarly low correlation. Moreover, the result does not hold for the most recent sample period, starting in 1997.

In *Table 4* we report key characteristics of the *mortgage lending rate*, as a spread over the interbank 3-month rate. One interesting difference between the US and the euro is the higher level of the lending rate compared with the interbank 3-month rate, which may partly be due to the longer maturity of mortgage debt in the US.[10] It is also interesting that mortgage lending rate spreads (vis-a-vis the 3-month interbank rate) are quite strongly counter-cyclical, especially in the US, and are somewhat lagging the business cycle. Because our measure of mortgage spreads can reflect both term premia and "pure" external finance premia, the interpretation of this result is not straightforward; see, among others, Aksoy et al. (2009) for a structural explanation of the counter-cyclical behaviour of banking spreads.

To summarise, our results indicate more similarities than differences between the US and the euro area as far as the housing market is concerned. In particular, residential investment, the real house price and mortgage debt are pro-cyclical, while the mortgage spread is counter-cyclical, in both economies. Two interesting difference stand out, how-

[10] Among the euro area countries, the difference in average spreads between, on the one hand, Germany and the Netherlands and, on the other, Italy and Spain is most likely due to the fact that mortgage contracts are predominantly fixed rate in the former countries and mostly variable rate in the latter.

ever. On the one hand, mortgage debt is more procyclical in the euro area than in the US. On the other hand, the correlation between real house prices and mortgage debt is considerably higher in the US, though this difference seems to be largely driven by Germany and partly Italy and much less so by the other main euro area countries; moreover, the difference is not visible in the period after 1997.

3 The VAR evidence

In this section we move to estimate a VAR model in order to give a more structural interpretation to the set of stylised facts introduced in the previous Section. In particular, we will analyse the reaction of key variables to three structural shocks, maintaining the same identification for the euro area and the US data.

3.1 Specification and identification

We specify and a Structural Vector Autoregressive model (SVAR) for the euro area and the United States separately, identified using short run restrictions. The model is defined as

$$Ay_t = c + B(L)y_{t-1} + \Sigma\varepsilon_t \tag{1}$$

where y is a vector of endogenous variables, c a constant, A is the matrix of the contemporaneous interactions and ε is a vector of structural shocks, with Σ the covariance matrix. The identification is achieved by placing suitable restrictions on the A matrix.

The vector y includes the following seven variables, in this order: the log CPI p, log private consumption c, log residential investment ri, the log real house price hpr, the 3-month interbank interest rate R, the representative mortgage lending rate R^l and log nominal mortgage debt b, hence

$$y_t = [p, c, ri, R, hpr, R^l, b]_t \tag{2}$$

Each VAR model also includes a constant term.[11]

[11] Note that a few variables appear to be I(1) according to standard tests, but these are not the same in the US and the euro area. Partly for this reason (since we want to impose exactly the same structure in the US and euro area models) and partly because we are not interested in long run relations in this paper, we choose to estimate a model directly in log levels and do not directly test and impose the presence of one or more cointegrating vectors in a VECM framework.

We choose a recursive identification scheme as the baseline, in order to identify the three shocks we are interested in, namely (i) a monetary policy shock, (ii) a housing demand shock, and (iii) a credit supply shock. For the monetary policy shock, we assume that the short term interest rate does not react to mortgage market variables in the same quarter, which appears to be realistic. As to the housing demand shock, note that the equation for the real house price can be interpreted as a housing demand function, relating the real house price to consumption and residential investment; we assume, however, that house prices react to changes in interest rates (in particular the mortgage lending rate) sluggishly, i.e. only with a quarterly lag. We interpret the equation for the mortgage interest rate as a loan supply function, whereby financial intermediaries set the interest rate on mortgage debt as a function of the short term interest rate, the key macroeconomic variables (the price level and private consumption) as well as the housing market related variables. The last equation, relative to mortgage debt, can be interpreted as a mortgage loan demand function. We would expect loan demand to depend negatively on the mortgage lending rate and positively on economic activity; loan supply rather to depend positively on the lending rate.[12]

It should be recalled that the identification of credit demand and supply functions based on time series data is traditionally considered as problematic due to the risk of simultaneity, to the point that most researchers use panel (often bank-level) data to sort them out (see e.g. Kashyap and Stein 2000). In this paper we look carefully at the impulse responses to check whether the structural characterisation of these shocks can be upheld. In particular, shocks that affect banks' ability to provide mortgage loans and lending conditions (say a fall in bank capital as in Santos and Winton 2009) should be labelled as 'loan supply' and lead to a *rise* in lending spreads accompanied by a *fall* in mortgage lending.

We have tried alternative, non recursive identification schemes; for example by imposing a zero reaction in the same quarter for the nominal short-term interest rate to the real house price, and letting the real house price react contemporaneously to the mortgage lending rate. While results for these alternative identification schemes (which are not reported for brevity but are available from the authors upon request) lead to similar results,

[12] See Bernanke and Blinder (1992). On the identification of the loan supply function see e.g. Brissinis and Delis (2009).

none of them seemed superior to the recursive identification in terms of the metric that is relevant for our analysis, i.e. having a clean identification of the considered structural shocks as visible in the impulse response patterns.

There are several caveats to keep in mind when interpreting our analysis, and two of them are particularly noteworthy. First, we consider the euro area and the US separately in each VAR, and do not model any international spill-over effect. While this is a restrictive assumption, and in fact we find that the VAR residuals in the US and the euro area are correlated for some variables, the focus of our paper is on shocks that have, at least to a large extent, a domestic nature.[13] Moreover, it is not easy to control for cross-country spillovers without extending the model significantly and therefore overly reducing the available degrees of freedom. Finally, it is very difficult to ascertain the direction of causality in the cross-country spillovers when two large economies are involved, meaning that it is also difficult to specify a fully "neutral" model with international interdependencies.

Second, our model has a linear structure, while some of the phenomena that we are modelling (we refer in particular to credit risk, credit conditions and house price movements) may entail non-linear dynamics, especially in times of crisis.[14] Indeed, we find particularly large residuals for the last quarter in our sample period (2008:4) which is associated with the peak of the global financial crisis, implying either the influence of an omitted variable or that the linear structure of the model is unsatisfactory in such extreme circumstances.

3.2 Identifying wealth and collateral channels

The housing market can act as a conduit for the transmission of shocks (such as monetary policy shocks) as well as an independent source of shocks for the broader economy due to essentially two reasons. First, housing is an important form of wealth and changes in house prices can conceivably have aggregate wealth effects, although it is not clear that changes in house prices represent net wealth for the economy as a whole.[15] Second, housing is a form of collateral for loans to households, some of which could be used for

[13] See, however, International Monetary Fund (2008) on possible cross country housing market spillovers.
[14] Iacoviello (2000).
[15] See among others Buiter (2008).

consumption purposes. Changes in house prices can therefore affect the tightness of the collateral constraint and, more broadly, credit supply conditions for the household sector. In some models (such as Aoki et al. 2004) a, say, fall in house prices brings about a rise in mortgage lending rates and in the external finance premium for households due to its impact on household net worth. In other models (e.g. Iacoviello and Neri 2009), a fall in house prices leads to a reduction in the quantity of mortgage debt extended, due to a borrowing constraint with a fixed downpayment rate and reflecting the existence of credit-constrained households. Since borrowing is more tightly linked to house prices in the US, due to the possibility to refinance existing mortgages at any time, one can surmise that this channel is more important in the US than in the euro area; in other words, changes in house prices should have a bigger impact on credit supply conditions (see Calza et al. 2009). On the other hand, wealth effects may be stronger in the euro area due to the larger importance of housing wealth in overall household wealth and net worth. It is admittedly not easy to disentangle these channels in the context of our VAR analysis, but we will nevertheless try to look for signs that one or another channel may be at work, and possibly differently in the US and the euro area.

3.3 Results

As noted, the reduced form VAR is estimated consistently in levels relying on the results in Sims, Stock and Watson (1990). The sample period goes from 1986:1 to 2008:4 for both the U.S. and the euro area. We estimate the VAR using a Bayesian approach where we impose a standard Minnesota prior (see Doan, Litterman and Sims 1984) on the reduced-form coefficients, i.e. assuming that all the variables follow a random walk. For the covariance matrix of the residuals, we impose a diffuse prior.

Institutional differences among mortgage markets in individual euro area countries are still substantial (see Calza et al. 2009), and this begs the question of whether these differences matter in the transmission of key structural shocks. We take a modest step in this direction by analysis the difference between the euro area results and a euro area aggregate excluding Germany, the country which is the most deviant from the others in terms of housing market behaviour, as evident in the descriptive analysis.[16] In the

[16] Although there certainy are differences in the housing markets amongst US regions, the institutional differences in the mortgage market are probably much smaller than in the euro area.

following, therefore, we describe results for (i) the US, (ii) the euro area, (iii) the euro area excluding Germany.

Figures 6-8 report the response of the variables included in the SVAR model to selected unit shocks, namely (i) interest rate, (ii) mortgage lending rate, (iii) house price and (iv) residential investment shocks, respectively in the US (Figure 6), the euro area (Figure 7) and the euro area excluding Germany (Figure 8). Note that in addition to the mortgage lending rate we also report the spread between this rate and the short-term interest rate; this can be interpreted as an "external finance premium" in the housing market, although it also reflects the behaviour of term premia given the longer maturity of most mortgages, especially in the US. We summarise the results in *Table 5*, which reports not only the signs of the impulse responses to identified *structural* shocks, but also the signs of the *differences* in the impulse responses (whenever statistically significant) between the US and the euro area (with and without Germany).

3.3.1 Monetary policy shock

Starting from an interest rate shock that increases the short-term interest rate by 50 basis points in impact, we find that the interpretation as a monetary policy shock is an appropriate one. In the US we find a large effect on housing market related variables, in particular residential investment and the real house price. This evidence is consistent with previous work showing that the largest effect of a monetary policy shock is on residential investment (Bernanke and Gertler 1995; Erceg and Levin 2006; McCarthy and Peach 2002; Vargas-Silva 2008). Also note that the US results for a monetary policy shock are consistent, in particular, with Jarocinski and Smets (2008), who also analyse the effect of monetary policy shocks on housing market related variables using a Bayesian VAR (see in particular Figure 4 in their paper, p. 348); they are also broadly consistent with the effect of the interest rate shock in Goodhart and Hofmann (2008), although in their case the response of the price level to the interest rate shock is positive, not negative in the post-1985 sample period (see their Figure 4, p. 195). In the euro area, by contrast, we find that the effect of the shock on residential investment and the real house price is smaller. The monetary policy shock leads to a contraction of mortgage debt in both economies, but especially so in the US. This latter result is consistent with the results of den Haan et al. (2007), but is inconsistent with an earlier literature on the "perverse" effect of a

monetary policy shock on loans (see e.g. Gertler and Gilchrist 1993).

The reaction of private consumption is sluggish and muted in both economies, but is generally stronger in the US; this difference is statistically significant (see Table 5) and is quite consistent with the literature on the so-called "output composition puzzle" (Angeloni et al. 2003). Note, however, that this result is reversed when Germany is excluded from the euro area (see Table 5, last column). There is evidence of a price puzzle in the short term in the US, but not in the euro area. The rise in the nominal interest rate also leads to a rise in mortgage lending rates but to a smaller extent, suggesting a *drop* in the mortgage spread in the short term. This is likely to be an indication that mortgage lending rates are sticky in the short term (see also den Haan et al. 2007), but can also reflect term premia. This evidence seems prima facie inconsistent with the existence of a collateral channel of monetary policy (see Iacoviello and Minetti 2008) at least when acting through the external finance premium; the difference between the US and the euro area is statistically significant (Figure 8), but largely reflects the dynamic adjustment to the short rate following the monetary policy shock. We find, however, that the impact of the contractionary monetary policy shock on mortgage debt is significantly larger in the US than in the euro area, though this could reflect both credit demand and supply effects.

Overall, the evidence we present here is consistent with the view that the transmission of monetary policy shocks onto the housing market and private consumption is stronger in the US than in the euro area. It is however not immediately evident that this comes from a stronger collateral channel of monetary policy, or from other mechanisms.

3.3.2 Credit supply shock

A (negative) credit supply shock is defined as a rise by 50 basis points in the mortgage lending rate but not of the short rate (to rule out a monetary policy shock) which is accompanied over time by a contraction of mortgage debt. This shock can be interpreted as a worsening of the conditions at which mortgage credit is extended to households.[17] One can think of a small "credit crunch", i.e. a leftward shift in the supply of mortgage loans (Bernanke and Lown 1991). It is, for self-evident reasons, a type of shock which has

[17] Note that in order not to confuse the identification of the shock with a monetary policy shock, in the identification scheme we set the contemporaneous response of the nominal short-term rate at zero.

received enormous attention in the public debate in the current financial crisis, so it may be particularly interesting to take a close look at its effects within our model.

We find that for both the US and the euro area a shock to the mortgage lending rate can be interpreted as a negative credit supply shock. The effect of the shock is, first and foremost, a fall in residential construction activity in both economies, but again larger in the US, though only marginally statistically significantly so (see Table 5).[18] The effect on the real house price is negative in both the euro area and the US, with - this time - a more pronounced effect in the former. Therefore, the adverse mortgage credit shock appears to have a similar impact as a negative housing demand shock as far as residential construction and house prices are concerned, which is a reasonable result. The effect on consumption is somewhat divergent as the shock does not move consumption in the euro area while it leads to a decline in the US; the difference however is not statistically significant and is even reversed once Germany is excluded from the euro area aggregate. It is difficult to state whether this is a surprising result or not. On the one hand, one could imagine a model in which there is some negative spill-over from the fall in residential construction activity and house prices on consumption, e.g. via employment, collateral or wealth effects; on the other hand, there could be some substitution away from construction activity in favor of non-housing consumption when conditions in mortgage credit markets get less favourable. It appears that the former effect prevails in the US, while the two balance out in the euro area.

3.3.3 Housing demand shock

Finally, a non-monetary housing demand shock is defined similar to Jarocinski and Smets (2008) and Iacoviello and Neri (2009), i.e. as an increase in the real house price that leads to a rise in residential investment over time and is not associated with a fall in the nominal short-term interest rate, in order to rule out an expansionary monetary policy shock. The assumption that private consumption also does not react on impact should also rule out a positive technology shock, also of the "positive news" shock type. The results that we obtain for this shock are qualitatively similar to Cardarelli et al. (2008) as well as Goodhart and Hofmann (2008) and Jarocinski and Smets (2008), at least for

[18] Moreover, the difference is insignificant once Germany is excluded.

the variables that are common with these studies.[19]

We find that an house price shock has the characteristics of an housing demand shock in the euro area, but in the US VAR it is rather the residential investment shock that has this structural interpretation. We therefore cannot compare the two shocks in quantitative terms and only look at possible *qualitative* differences. As evident in Table 5, the housing demand shock tends to push all variables up, not only (by construction) the real house price and residential investment, but also the CPI, the short term interest rate, consumption, and mortgage debt. A notable difference is that, however, the positive effect on consumption is much more short lived (and ultimately turns negative) in the euro area (with and without Germany) than in the US. Although as noted a quantitative comparison is not possible for this shock, we are tempted to conclude that a possibly more positive effect of the housing demand shock on consumption reflects a stronger collateral channel in the US, since wealth effects should if anything be larger in the euro area than in the US.

3.3.4 Summing up on the impulse response analysis

Overall, the comparison of the responses to the monetary shock are generally in line with the conventional wisdom as well as consistent with the idea that housing and mortgage market related variables play a bigger role in the US than in the euro area. Consumption and residential investment fall more, in particular. As just noted, the evidence for a housing demand shock is less clearcut, but still points to a stronger impact of these shocks on consumption in the euro area than in the US, which is consistent with (though not necessarily only explained by) a stronger housing collateral channel in the US. Finally, we have found evidence that the mortgage credit supply shock tends to act like a negative housing demand shock in both the US and the euro area.

3.3.5 Variance decomposition

In order to understand the quantitative importance of the three structural shocks we have identified in generating fluctuations in the housing related variables and real consumption, we compute the forecast error variance decomposition for both the US and euro area models. The variance decomposition offers a somewhat different perspective in comparison

[19] See in particular Figure 3 in Jarocinski and Smets (2008), p. 347.

with the impulse response analysis since it takes into account the size of the shocks, not only of those that are shown but also of the other shocks. *Table 6* reports the median of the three shocks to the forecast error variance at two different horizons of the full set of variables. Based on this analysis, three interesting conclusions may be reached.

First, it is confirmed that monetary policy shocks are more important for the housing and mortgage market related variables in the US, although not for private consumption, especially when excluding Germany from the euro area aggregate; in particular, in the US monetary policy shocks explain some 20 per cent of residential investment at 24 quarters (8 per cent in the euro area), 18 per cent of the real house price (2 per cent in the euro area) and 32 per cent of mortgage debt (15 per cent in the euro area), but only less than 10 per cent of the variability of the CPI. Conversely, credit supply shocks are much more important for the euro area than for the US, although this may have to do with the way we measure these shocks (as a shock to the mortgage lending rate) while there are other ways to influence credit conditions - for example credit standards - that may be particularly relevant for the US. In particular, mortgage debt is much less affected by lending rate shocks in the US than in the euro area. Third, and perhaps most notably, we find that housing demand shocks (respectively the house price shock in the euro area and the residential investment shock in the US, as noted above) have a limited, but non-negligible impact on non-housing variables; for example, they explain 11 per cent of consumption variability at 24 quarters horizon in the US, and 10 per cent in the euro area. This is significantly in excess of what is typically found in DSGE models, as for example in Iacoviello and Neri (2009) and Darracq Paries and Notarpietro (2008), where housing demand shocks have a very limited spillover on non-housing variables. Mortgage debt appears to be much more affected by housing demand shocks in the US (25 per cent at 24 quarters) than in the euro area (5 per cent).

4 Conclusions

The paper offered a systematic empirical analysis of the role of the housing market in the macroeconomy in the US and in the euro area using stylised facts and impulse responses from a Vector Autoregression (VAR) by focusing on the effects of monetary policy, credit supply and housing demand shocks on the housing market and the broader economy.

All in all, our results indicate more similarities than differences between the US and the euro area as far as the housing market is concerned, at least from a qualitative standpoint. In both economies residential investment, the real house price and mortgage debt are procyclical, and the spread between the representative mortgage lending rate and the short-term interest rate is countercyclical.

Impulse responses from the SVAR models suggest that the impact of monetary policy, credit supply and housing demand shocks is qualitatively similar in the US and the euro area. At the same time, the SVAR evidence suggests that the transmission of *monetary policy* shocks to the housing market is stronger in the US than in the euro area. We find no evidence, however, that the contractionary effect of monetary policy works through an increase in external finance premium in the mortgage market, nor that this explains the stronger propagation of the monetary shock in the US.

Mortgage *credit supply* shocks have significant effects on residential investment and mortgage loans, while the effects on real consumption seem to be more limited. *Housing demand* shocks have positive effects on all variables, but the effect on consumption appears stronger and more persistent in the United States. Overall, we find some evidence that housing markets might play a bigger role as conduits of monetary policy shocks in the US than in the euro area; the evidence for housing demand and credit supply shocks is less clearcut.

Our analysis has several limitations which could be alleviated in future research. As already mentioned, one is that our empirical setting is a linear one, while there may be reason to believe that housing booms and busts may have disproportionate (and hence non-linear) effects, as investigated in recent papers (see e.g. Kakes and Ullersma 2005). Incorporating such non-linearities in an SVAR context would, however, not be easy from a methodological standpoint. Second, international spillovers may be important even for large closed economies such as the US and the euro area (in the context of asset boom/bust cycles, see e.g. Alessi and Detken 2009; from a DSGE modelling perspective, see Darracq Paries and Notarpietro 2008). Making progress on these two dimensions while maintaining a structural interpretation of the underlying shocks seems a promising, although challenging, avenue for future research.

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Annex – Data and stylised facts

Sources of data

Data	Definition	Source
House prices		
euro area	Residential property prices, New and existing dwellings (quarterly data derived by interpolation of annual data)	ECB
US	Residential property prices, Existing houses	Federal Housing Finance Agency (FHFA)
Private consumption		
euro area	Real Private Consumption Expenditure	ECB and Eurostat
US	Real Personal Consumption Expenditures	Bureau of Economic Analysis
Residential investment		
euro area	Gross fixed capital formation, housing	ECB and Eurostat
US	Real Private Residential Fixed Investment	Bureau of Economic Analysis
Consumer prices		
euro area	Harmonised index of consumer prices	ECB
US	Consumer price index	OECD Economic Outlook data
Short term interest rates		
euro area	EMU 3-month EURIBOR up to 1998, 3-month Euro Repo from 1999 onwards	OECD Main Economic Indicators (from 1994) + AWM (before 1994) + ECB (from 1999)
US	3-Month Treasury Bill: Secondary Market Rate	Bureau of Economic Analysis
Mortgage loans		
euro area	Loans to households for house purchasing	ECB
US	Home mortgages liabilities of households	Flow of Funds Accounts of the United States, Board of Governors of the Federal Reserve System
Mortgage lending rates		
euro area	Mortgage lending rate	ECB
US	Mortgage lending rate	IMF International Financial Statistics (IFS)

Table 1 – Residential investment

1986-2008

	US	Euro area	DE	FR	IT	ES	NL
Residential investment/GDP	5.2%	5.8%	6.4%	5.9%	4.7%	5.8%	6.0%
Quarterly volatility	3.06	1.78	3.14	1.94	2.12	3.23	8.14
Contribution to real GDP growth	0.01	0.03	0.02	0.02	0.01	0.06	0.05
Cyclicality	procycl	procycl	procycl	procycl	procycl	procycl	procycl
Lead/lag relation with real GDP	+2	+2	+2	-1	-1	0	+8
Maximum correlation with real GDP	0.68	0.61	0.52	0.73	0.38	0.69	0.40

1997-2008

	US	Euro area	DE	FR	IT	ES	NL
Residential investment/GDP	5.2%	5.6%	6.2%	5.3%	4.5%	6.6%	5.8%
Quarterly volatility	3.23	1.24	2.19	1.38	2.38	3.33	3.23
Contribution to real GDP growth	-0.01	0.02	-0.02	0.03	0.02	0.07	0.02
Cyclicality	procycl	procycl	procycl	procycl	procycl	procycl	procycl
Lead/lag relation with real GDP	+3	+3	+2	-1	0	+4	0
Maximum correlation with real GDP	0.62	0.84	0.79	0.86	0.46	0.46	0.79

Note: Quarterly volatility is represented by the standard deviation of the quarter-on-quarter growth rates. Contribution to real GDP growth report the average contribution to the quarter-on-quarter real GDP growth. The cyclical properties (cyclicality, lead/lag relation and maximum correlation) are based on filtered data (obtained by applying the Baxter-King band- pass filter with standard cut-off frequencies) and are derived by selecting the highest correlations among those computed by shifting the reference series between minus eight quarters and plus eight quarters. The lead/lag relation with real GDP indicates the shift of the reference series found for the maximum correlation (with a positive number indicating the numbers of quarters at which residential investment leads real GDP, and a negative numbers indicating the numbers of quarters at which residential investment lags real GDP). Cyclicality refers to the sign of the correlation coefficient of residential investment with real GDP: if positive, residential investment is classified as procyclical ("procycl"), while if negative, residential investment is classified as countercyclical ("counterc"). Cyclical properties based on annual growth rates are very similar.

Table 2 – Real house prices

1986-2008:

	US	Euro area	DE	FR	IT	ES	NL
Average annual increase	3.0	2.8	-0.9	4.1	3.5	7.0	5.2
Quarterly volatility	0.94	0.73	0.60	1.37	1.37	2.60	1.15
Cyclicality	procycl	procycl	procycl	procycl	procycl	procycl	procycl
Lead/lag relation with real GDP	-5	+1	0	-1	-8	0	-8
Maximum correlation with real GDP	0.41	0.52	0.71	0.65	0.66	0.65	0.31
Lead/lag relation with real res. inv.	0	0	-2	+2	0	0	-1
Maximum correlation with real res. inv.	0.65	0.41	0.58	0.70	0.56	0.52	0.51

1997-2008:

	US	Euro area	DE	FR	IT	ES	NL
Average annual increase	2.4	1.2	-2.0	7.1	3.2	7.2	5.6
Quarterly volatility	0.87	0.44	0.37	1.25	0.94	1.44	1.28
Cyclicality	procycl	procycl	procycl	procycl	procycl	procycl	procycl
Lead/lag relation with real GDP	0	+3	+2	+2	-8	+8	-3
Maximum correlation with real GDP	0.13	0.22	0.68	0.48	0.61	0.34	0.81
Lead/lag relation with real res. inv.	0	0	-1	+2	-8	0	-2
Maximum correlation with real res. inv.	0.79	0.04	0.45	0.63	0.63	0.34	0.43

Note: Quarterly volatility is represented by the standard deviation of the quarter-on-quarter growth rates. The cyclical properties (cyclicality, lead/lag relation and maximum correlation) are based on filtered data (obtained by applying the Baxter-King band- pass filter with standard cut-off frequencies) and are derived by selecting the highest correlations among those computed by shifting the reference series between minus eight quarters and plus eight quarters. The lead/lag relation with real GDP indicates the shift of the reference series found for the maximum correlation (with a positive number indicating the numbers of quarters at which real house prices lead real GDP, and a negative numbers indicating the numbers of quarters at which real house prices lag real GDP). Cyclicality refers to the sign of the correlation coefficient of real house prices with real GDP: if positive, real house prices are classified as procyclical (“procycl”), while if negative, real house prices are classified as countercyclical (“counterc”). Cyclical properties based on annual growth rates are very similar.

Table 3 – Real mortgage debt

1986-2008:

	US	Euro area	DE	FR	IT	ES	NL
Average annual increase	6.2	6.4	5.4	4.7	11.1	15.6	8.1
Correlation with real house price	0.77	0.21	0.28	0.81	0.47	0.51	0.75
Quarterly volatility	0.89	0.77	2.26	1.11	2.15	1.74	1.86
Cyclicality	procycl	procycl	counterc.	procycl	procycl	procycl	procycl
Lead/lag relation with real GDP	+3	+3	-8	0	+4	+2	+3
Maximum correlation with real GDP	0.20	0.81	-0.56	0.63	0.24	0.57	0.39

1997-2008:

	US	Euro area	DE	FR	IT	ES	NL
Average annual increase	8.2	6.9	1.7	7.6	13.3	15.7	8.0
Correlation with real house price	0.64	0.66	0.63	0.56	0.12	0.29	0.85
Quarterly volatility	0.80	0.79	1.19	0.95	2.11	1.83	1.97
Cyclicality	procycl	procycl	procycl	procycl	procycl	procycl	procycl
Lead/lag relation with real GDP	+5	+3	+2	0	+4	-1	-3
Maximum correlation with real GDP	0.60	0.93	0.83	0.91	0.71	0.51	0.76

Note: Correlation with real house prices refers to the contemporaneous correlation between real mortgage debt and real house prices. Quarterly volatility is represented by the standard deviation of the quarter-on-quarter growth rates. The cyclical properties (cyclicality, lead/lag relation and maximum correlation) are based on filtered data (obtained by applying the Baxter-King band- pass filter with standard cut-off frequencies) and are derived by selecting the highest correlations among those computed by shifting the reference series between minus eight quarters and plus eight quarters. The lead/lag relation with real GDP indicates the shift of the reference series found for the maximum correlation (with a positive number indicating the numbers of quarters at which real mortgage debt leads real GDP, and a negative numbers indicating the numbers of quarters at which real mortgage debt lags real GDP). Cyclicality refers to the sign of the correlation coefficient of real mortgage debt with real GDP: if positive, real mortgage debt is classified as procyclical ("procycl"), while if negative, real mortgage debt is classified as countercyclical ("counterc"). Cyclical properties based on annual growth rates are very similar.

Table 4 – Mortgage lending rates

1986-2008:

	US	Euro area	DE	FR	IT	ES	NL
Average spread over 3-month rate	3.35	1.89	2.98	2.22	2.03	1.92	2.47
Quarterly volatility	0.45	0.34	0.57	0.61	0.82	0.88	0.47
Cyclicality	counterc.	counterc.	counterc.	counterc.	counterc.	counterc.	counterc.
Lead/lag relation with real GDP	-2	-3	-5	-2	-3	+8	0
Max/min correlation with real GDP	-0.71	-0.47	-0.59	-0.47	-0.25	-0.23	-0.35

1997-2008:

	US	Euro area	DE	FR	IT	ES	NL
Average spread over 3-month rate	3.08	2.56	2.97	2.43	2.38	1.74	2.57
Quarterly volatility	0.61	0.50	0.69	0.77	0.64	0.46	0.62
Cyclicality	counterc.	counterc.	counterc.	counterc.	counterc.	counterc.	counterc.
Lead/lag relation with real GDP	-2	-2	-4	-2	+7	+8	-4
Max/min correlation with real GDP	-0.73	-0.70	-0.66	-0.80	-0.60	-0.30	-0.55

Note: Calculations are based on the spread between the mortgage lending rate and the short term interest rate (3-month rate). Quarterly volatility is represented by the standard deviation of the quarterly changes in the spread. The cyclical properties (cyclicality, lead/lag relation and maximum correlation) are based on filtered data (obtained by applying the Baxter-King band- pass filter with standard cut-off frequencies) and are derived by selecting the highest correlations among those computed by shifting the reference series between minus eight quarters and plus eight quarters. The lead/lag relation with real GDP indicates the shift of the reference series found for the maximum correlation (with a positive number indicating the numbers of quarters at which the spread leads real GDP, and a negative numbers indicating the numbers of quarters at which the spread lags real GDP). Cyclicality refers to the sign of the correlation coefficient of the spread with real GDP: if positive, the spread is classified as procyclical (“procycl”), while if negative, the spread is classified as countercyclical (“counterc”). Cyclical properties based on annual growth rates are very similar.

Table 5 – Signs of the impulse responses to selected structural shocks

Monetary policy shock					
	US	**EA**	**EA***	**US-EA**	**US-EA***
Short-term interest rate	+,-	+	+	+,-	+,-
Real house price	-	-	-	-	-
CPI	+,-	-	-	+	+,-
Mortgage lending rate	+,-	+	+	+	
Consumption	-	-	-	-	+
Residential investment	-	-	-	-	-
Mortgage debt	-	-	-	-	-
Credit supply shock					
Short-term interest rate	-	+	+,-	0	-,+
Real house price	-	-	-	+	+
CPI	-	+	+	0	-
Mortgage lending rate	+	+	+	-	-
Consumption	-	0	-	0	+
Residential investment	-	0	-	-	0
Mortgage debt	-	-	-	+	+
Housing demand shock					
Short-term interest rate	+	+	+	NA	NA
Real house price	+	+	+	NA	NA
CPI	+	+	+	NA	NA
Mortgage lending rate	+	+	+	NA	NA
Consumption	+	+,-	+,-	NA	NA
Residential investment	+	+	+	NA	NA
Mortgage debt	+	+	+	NA	NA

Note: '+' and '-' are reported if the impulse response of the corresponding variable is above or below the baseline for at least 2 quarters at a significance level of 68%. The impulse responses are derived from the baseline VAR model, estimated over the sample period 1986:1 to 2008:4. 'EA' stays for euro area, 'US' for United States, and 'US-EA' is the difference between the impulse responses in the US VAR and the euro area VAR.

* Euro area excluding Germany.

Table 6 – Variance decomposition

For 12 quarters:

	Interest rate shock			House price shock			Residential investment shock			Lending rate shock			Other shocks		
	EA	EAexDE	US	EA	EAexDE	US	EA	EAexDE	US	EA	EAexDE	US	EA	EAexDE	US
CPI	12.0	0.5	0.7	31.6	5.1	1.7	2.3	0.5	1.7	7.2	20.3	1.9	47.0	73.6	94.0
Private consumption	17.6	20.4	6.8	10.1	3.5	4.7	9.7	15.0	10.6	1.8	8.8	0.2	60.9	52.2	77.7
Residential investment	9.6	8.8	32.3	15.2	12.6	10.5	32.0	17.4	42.0	7.5	10.3	1.8	35.7	51.0	13.3
Short-term interest rate	26.6	26.3	31.9	19.2	4.7	9.3	12.5	15.5	33.1	8.1	13.7	3.1	33.5	39.8	22.6
Real house price	2.1	1.9	23.3	52.5	39.9	14.3	35.1	5.0	45.3	1.8	25.1	1.3	8.5	28.1	15.8
Mortgage lending rate	6.9	5.2	22.9	20.5	6.3	7.1	5.1	1.8	12.5	31.3	63.8	27.7	36.2	22.8	29.8
Mortgage loans	15.0	6.9	19.5	6.2	12.8	6.7	17.6	3.0	28.9	20.9	43.4	0.4	40.3	34.0	44.4

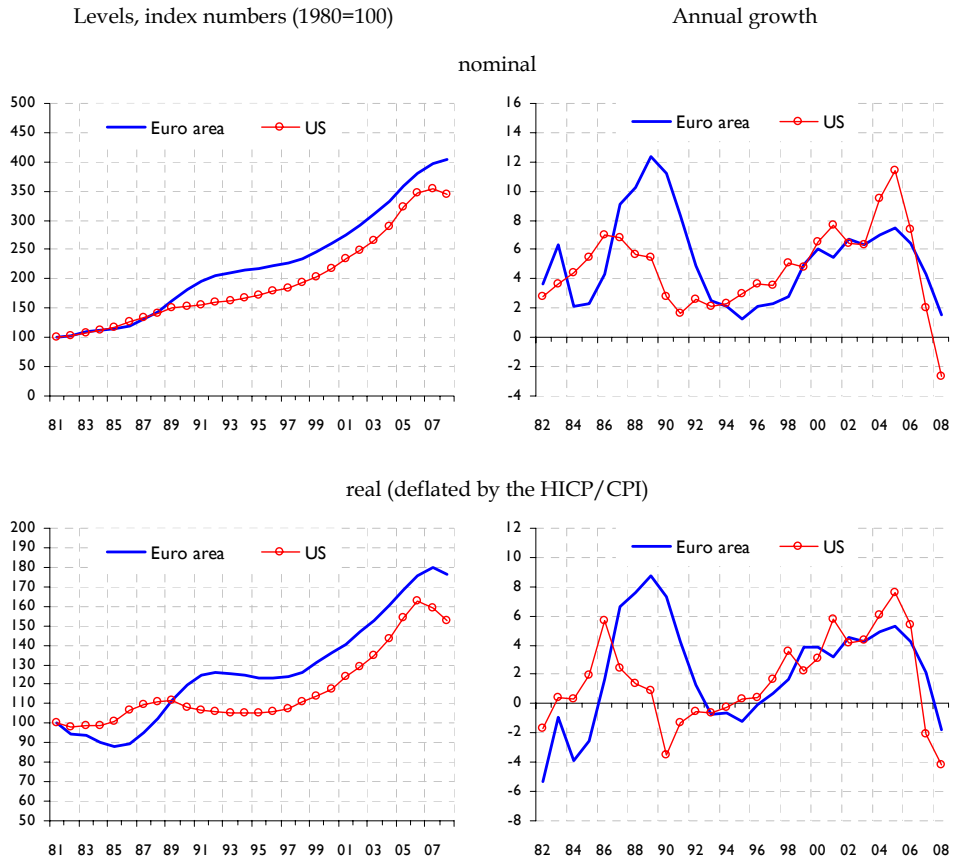
For 24 quarters:

	Interest rate shock			House price shock			Residential investment shock			Lending rate shock			Other shocks		
	EA	EAexDE	US	EA	EAexDE	US	EA	EAexDE	US	EA	EAexDE	US	EA	EAexDE	US
CPI	14.3	2.8	9.5	35.9	22.5	1.6	23.0	3.0	8.3	5.9	14.9	1.0	20.8	56.9	79.6
Private consumption	18.2	16.4	9.4	9.7	5.2	3.9	13.8	15.5	11.0	3.9	11.3	0.2	54.4	51.6	75.5
Residential investment	7.9	8.1	20.5	12.6	11.7	8.7	31.2	15.1	41.8	12.1	13.1	0.6	36.2	52.1	28.5
Short-term interest rate	16.9	20.9	23.5	14.8	8.1	10.1	21.4	14.0	27.9	15.7	13.0	1.1	31.1	44.1	37.3
Real house price	1.7	2.3	17.5	39.1	31.9	7.0	42.2	4.7	25.1	3.6	28.1	1.4	13.4	33.0	49.1
Mortgage lending rate	5.3	4.5	23.3	15.7	10.2	9.2	15.5	4.9	18.6	31.0	51.0	20.0	32.6	29.3	28.8
Mortgage loans	14.6	5.5	32.5	4.7	10.6	4.2	19.1	2.4	24.8	16.6	39.8	0.5	45.0	41.7	38.0

Note: Based on the VAR estimated from 1986:1 to 2008:4, recursive identification. See text for further explanations. ‘EA’ stays for euro area, ‘EaexDE’ for the euro area excluding Germany, and ‘US’ for the United States. Note that totals may not sum up exactly to 100.0 due to rounding.

Figure 1: Nominal residential property prices in the euro area and the US

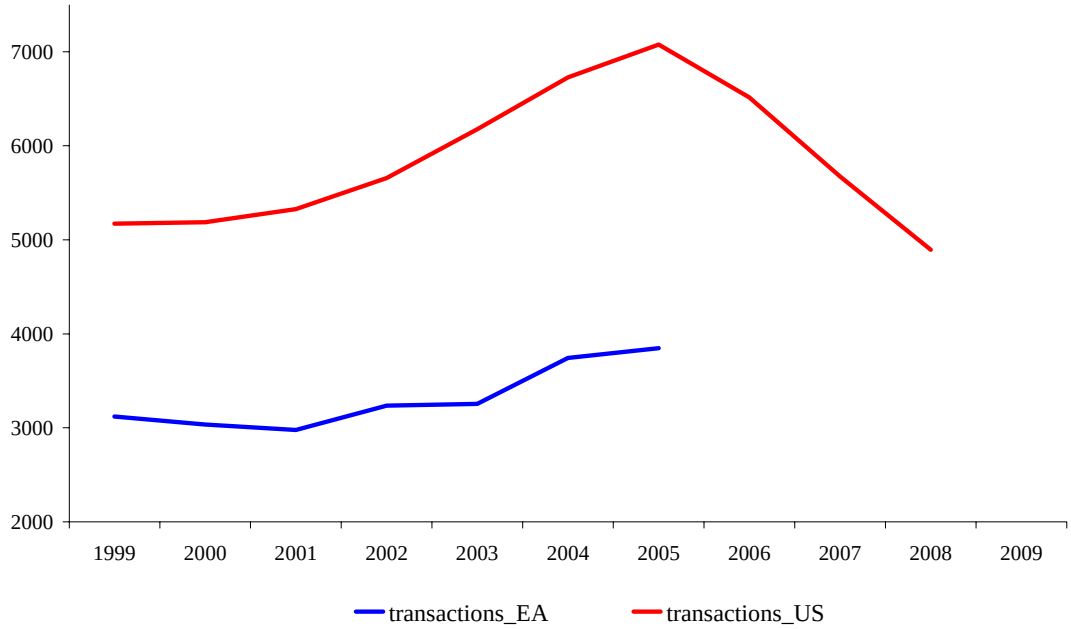
(index; percentage change)



Sources: ECB and OECD.

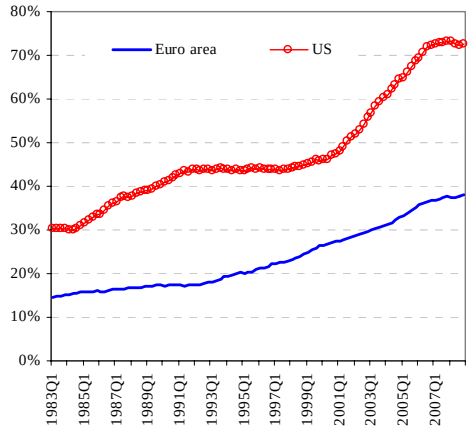
Note: Annual data. Indices normalised such that 1981=100. For the US index of prices of existing houses.

Figure 2 – Housing transactions



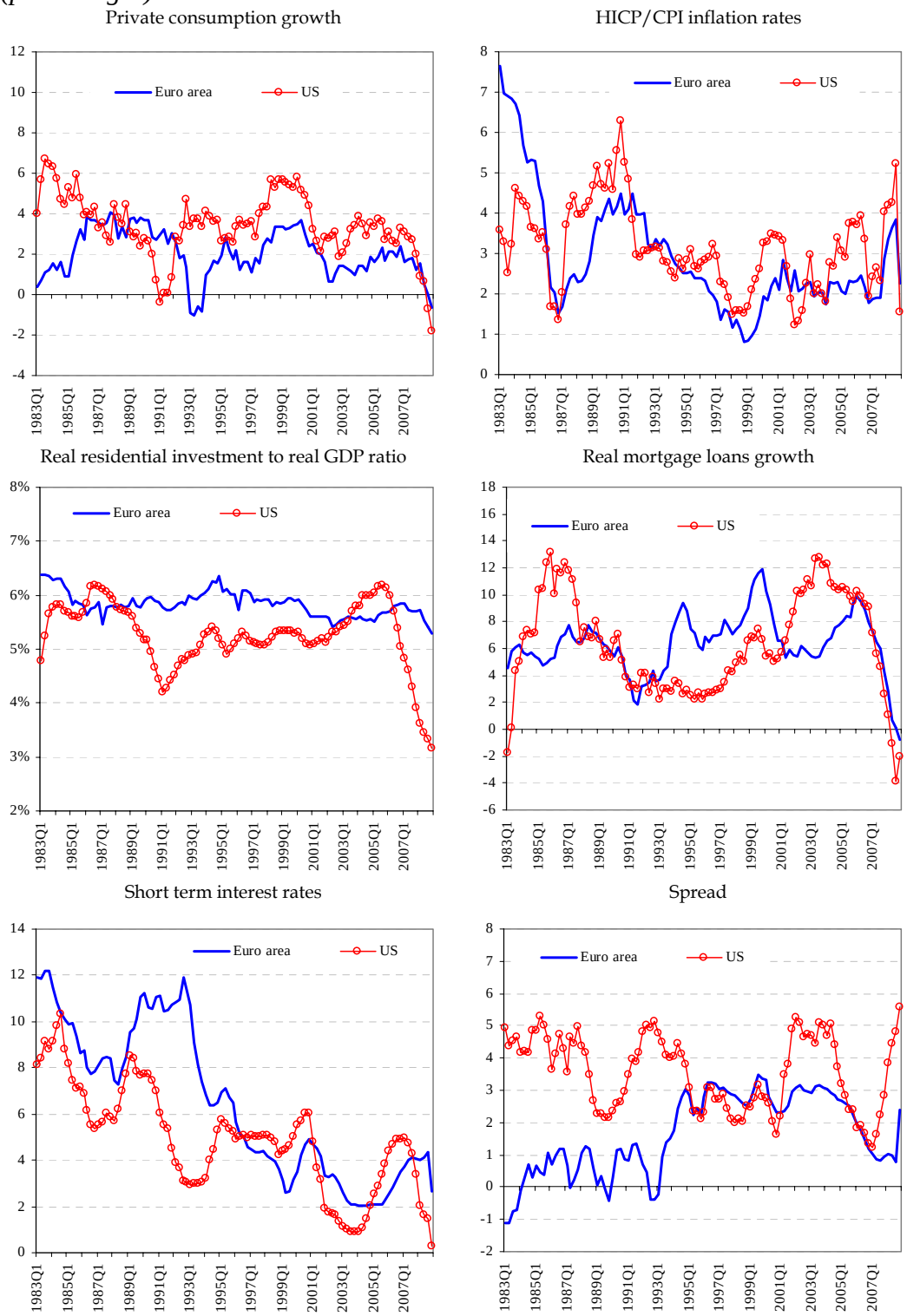
Sources: ECB Structural housing indicators and Bank for International Settlements. Data are in thousands of units.

Figure 3: Mortgage debt to GDP in the euro area and the US
(percentages)



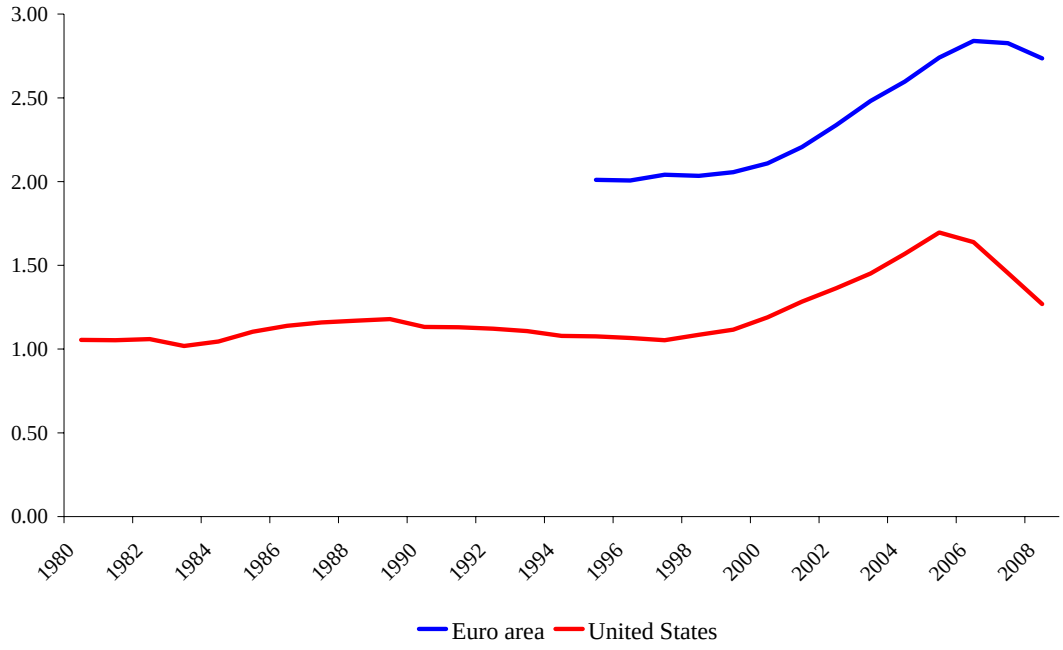
Sources: BEA, Board of Governors, ECB, Eurostat.
Note: Nominal mortgage loans to nominal GDP ratio.

Figure 4: Main variables used in the empirical analysis
(percentages)



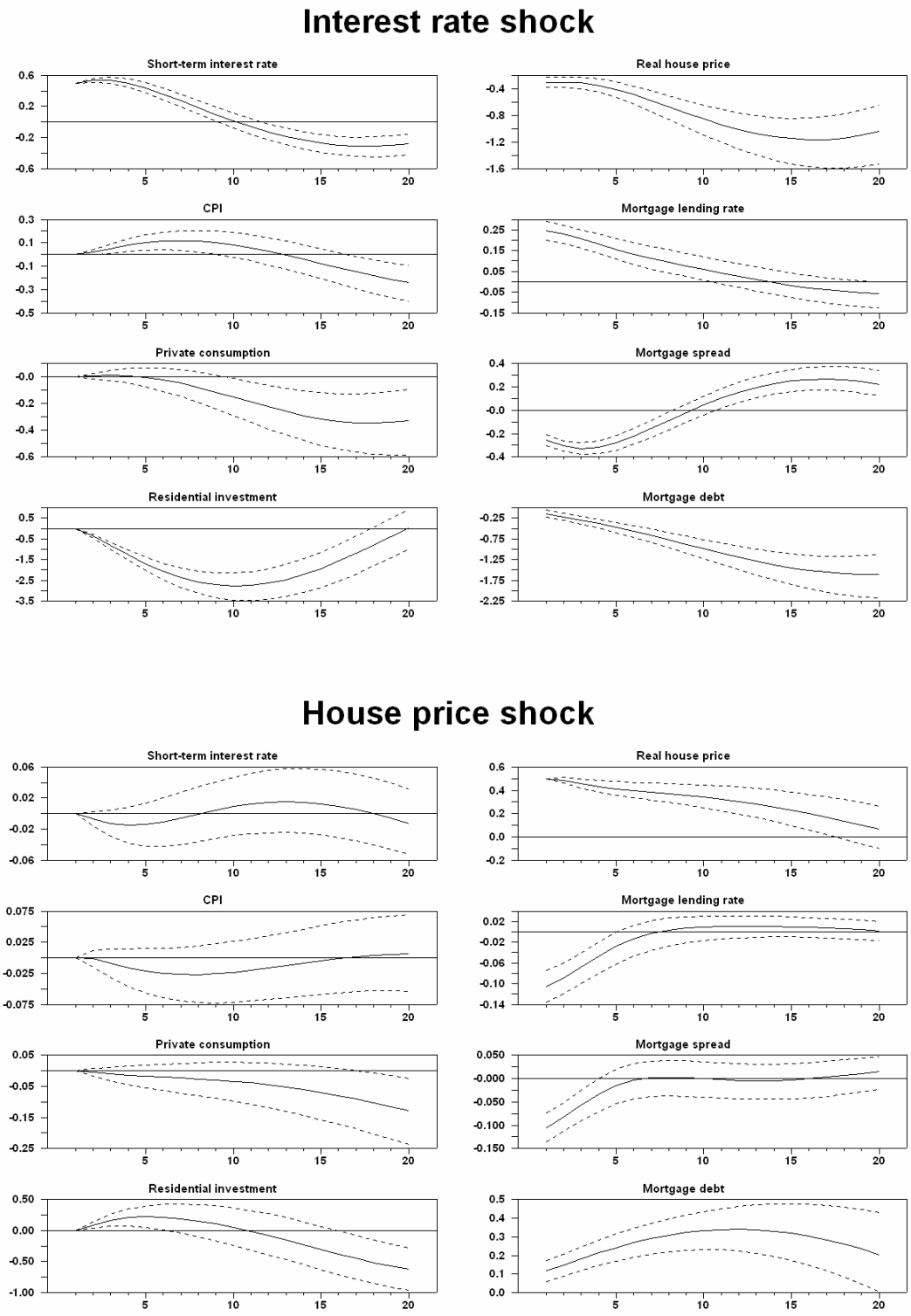
Sources: BEA, ECB, Eurostat.

Figure 5 – Housing wealth

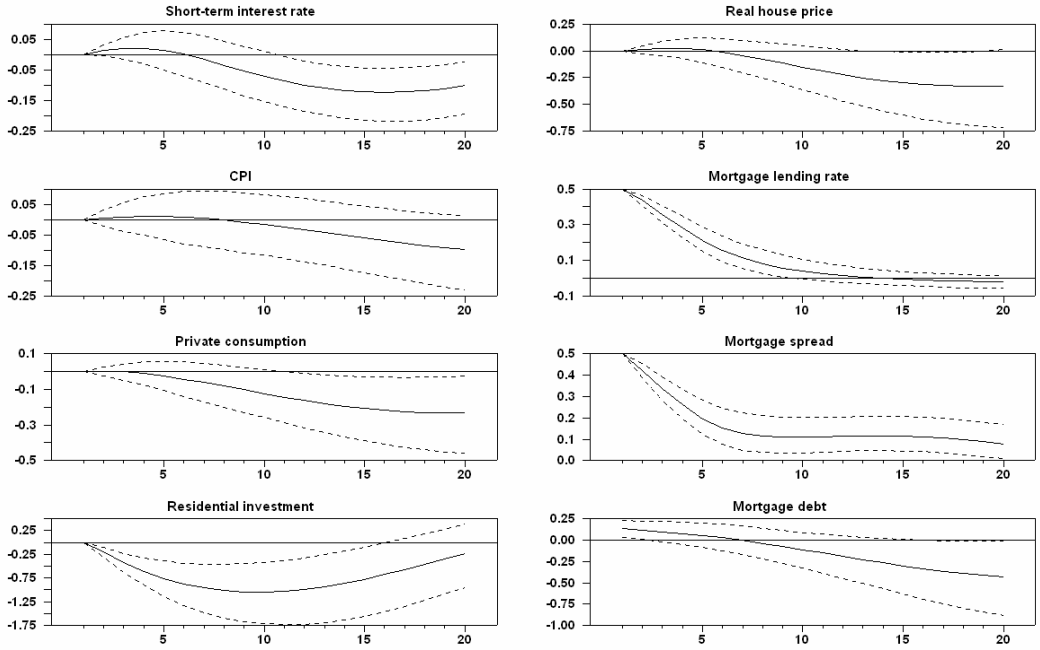


Sources: ESA national accounts for the euro area and Haver for the United States. Data are ratios to nominal GDP.

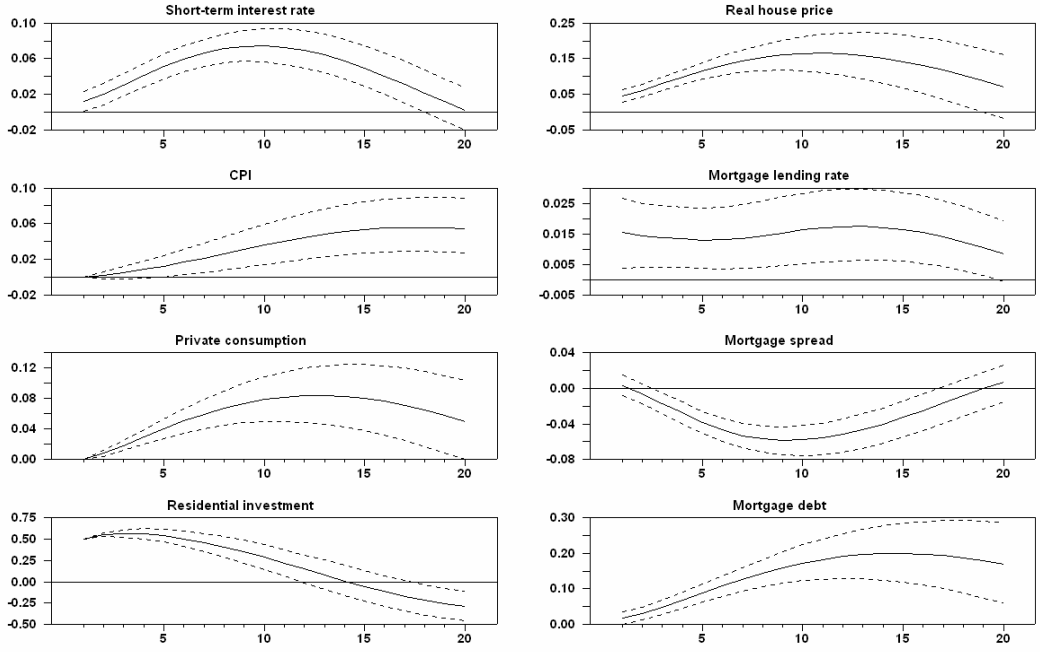
Figure 6 – Impulse responses for the United States



Lending rate shock

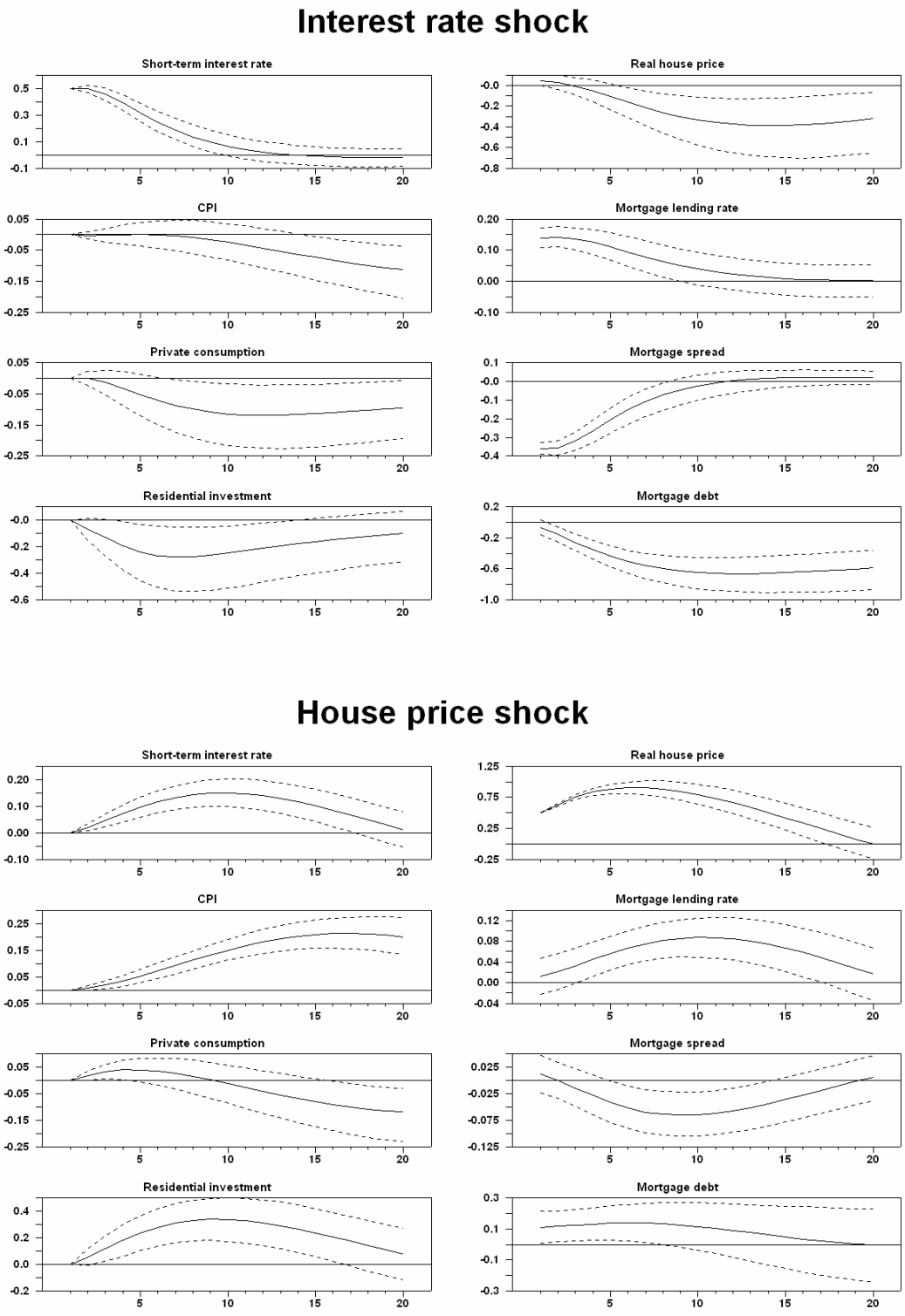


Residential investment shock

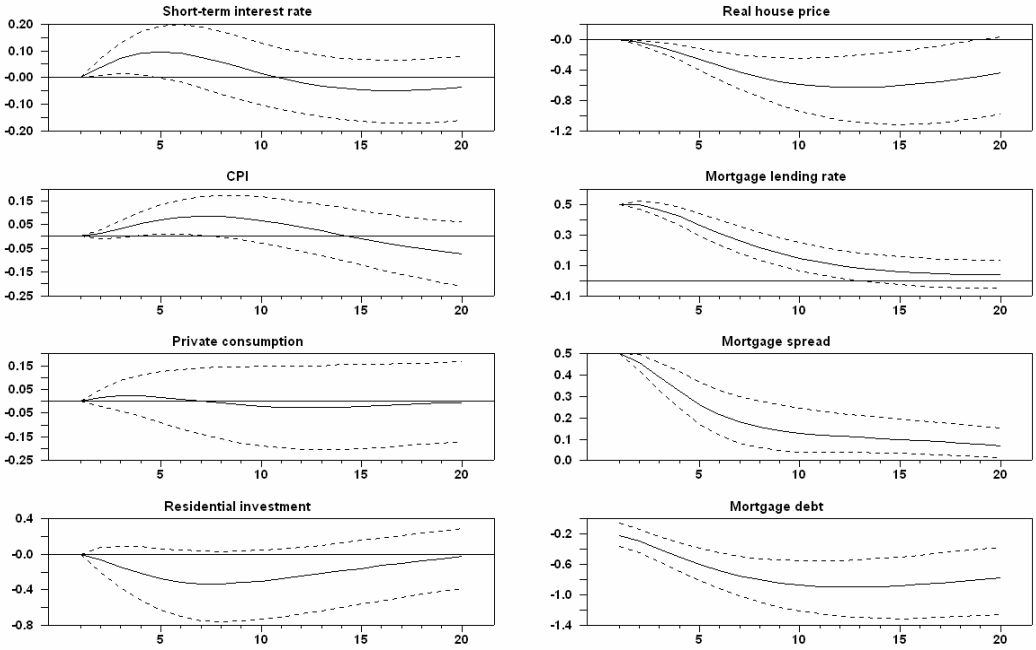


Note: Impulse responses based on the baseline VAR model (see text for further explanations), estimated on the sample period 1986:1 to 2008:4. Confidence bands are based on the 68% significance level.

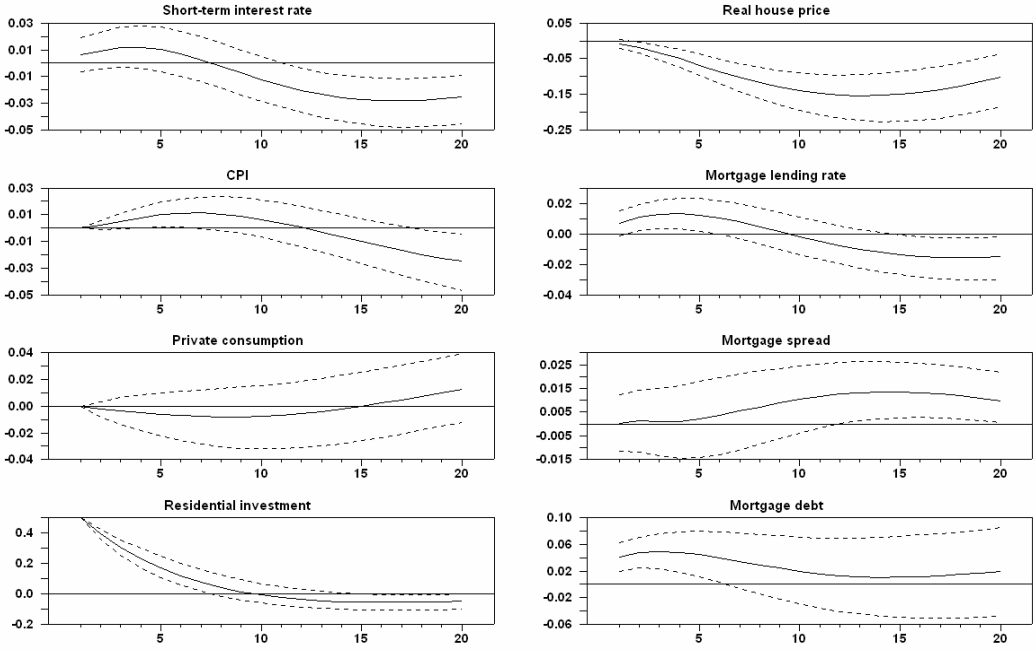
Figure 7 – Impulse responses for the euro area



Lending rate shock

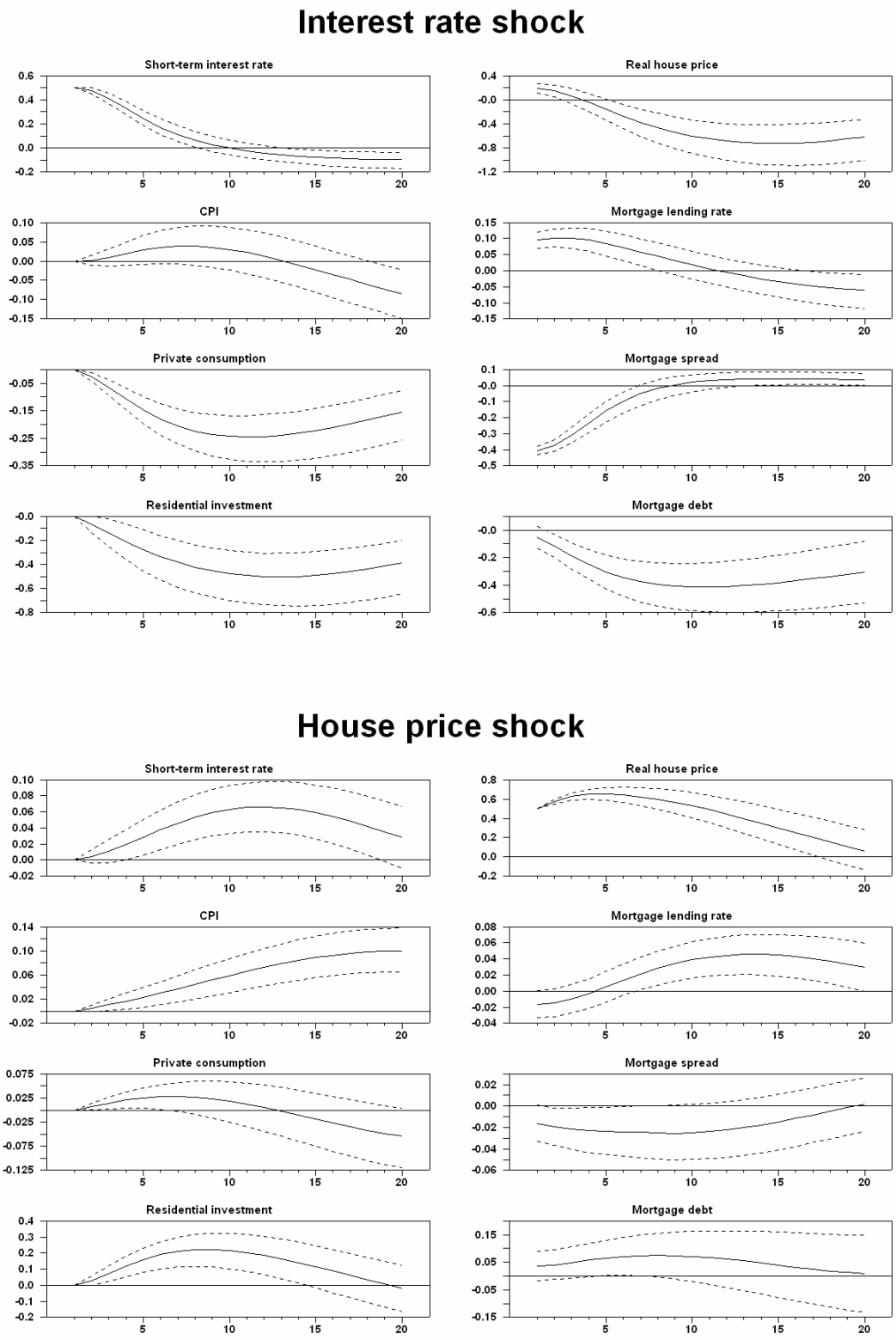


Residential investment shock

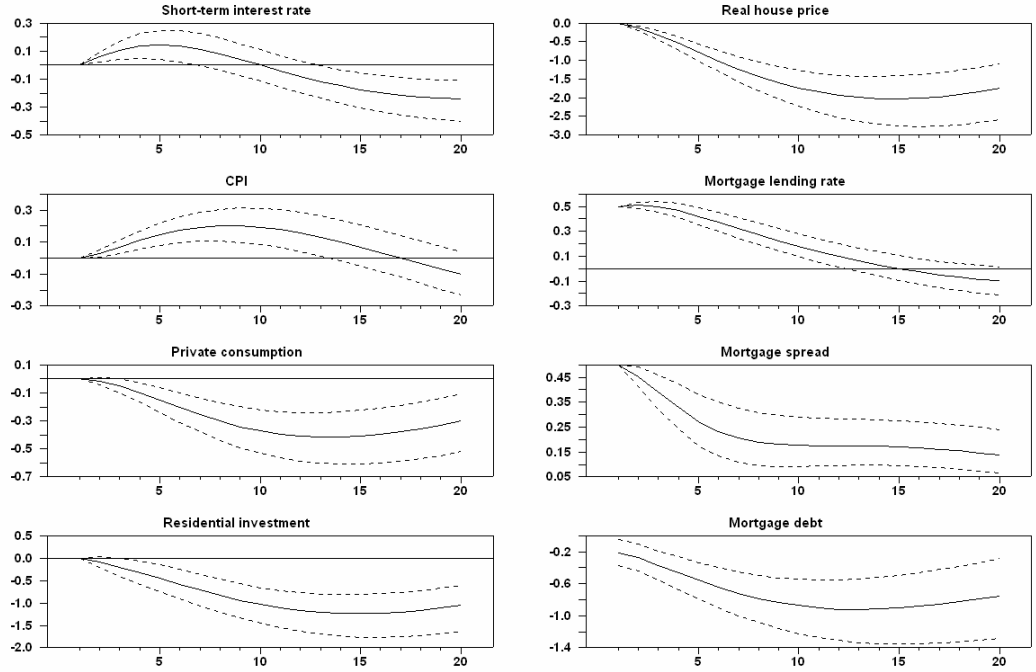


Note: Impulse responses based on the baseline VAR model (see text for further explanations), estimated on the sample period 1986:1 to 2008:4. Confidence bands are based on the 68% significance level.

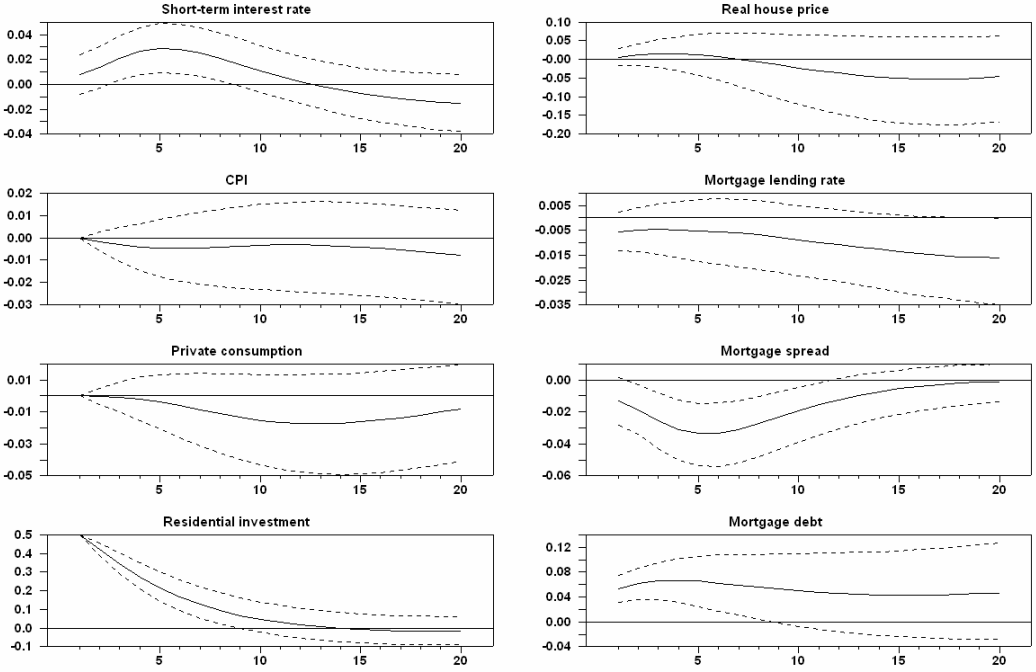
Figure 8 – Impulse responses for the euro area excluding Germany



Lending rate shock



Residential investment shock



Note: Impulse responses based on the baseline VAR model (see text for further explanations), estimated on the sample period 1986:1 to 2008:4. Confidence bands are based on the 68% significance level.