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HOUSING, CONSUMPTION AND MONETARY POLICY: HOW DIFFERENT ARE THE U.S. AND THE EURO AREA?

by Alberto Musso*, Stefano Neri† and Livio Stracca‡

Abstract

This paper provides a systematic empirical analysis of the macroeconomic role of the housing market in the U.S. and the euro area. First, it establishes some stylised facts concerning key variables in the housing market on the two sides of the Atlantic, such as real house prices, residential investment and mortgage debt. Next, it presents evidence from Structural Vector Autoregressions (SVAR) by focusing on the effects of monetary policy, credit supply and housing demand shocks on the housing market and the broader economy. The analysis shows that in the housing market similarities outweigh differences. The empirical evidence suggests a stronger role for housing in the transmission of monetary policy shocks in the U.S. The evidence is less clear-cut for housing demand shocks. Finally, credit supply shocks seem to matter more in the euro area.

JEL Classification: E22, E44, E52.
Keywords: residential investment, house prices, credit, monetary policy.

Contents

1. Introduction ... 5
2. Some stylised facts: the U.S. and the euro area ... 8
   2.1 Data ... 8
   2.2 Some stylised facts on housing markets on the two sides of the Atlantic ... 9
3. The VAR evidence ... 11
   3.1 Specification and identification ... 12
   3.2 Identifying wealth and collateral channels ... 13
   3.3 Results ... 14
      3.3.1 Monetary policy shock ... 16
      3.3.2 Credit supply shock ... 17
      3.3.3 Housing demand shock ... 17
      3.3.4 Summing up the impulse response analysis ... 18
      3.3.5 Variance decomposition ... 18
4. The U.S. and the euro area in a joint model ... 19
5. Conclusions ... 21
References ... 23
Appendix ... 26
Tables and figures ... 27

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1 Introduction[1]

The role of the housing market in the business cycle, especially in the U.S., 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 much 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 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 may have been an important determinant of soaring house prices in the U.S. and elsewhere. Second, the role of the mortgage market in affecting and possibly amplifying the effect of changes in house 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.

The role of the housing market in the macroeconomy was particularly prominent in the 2007-09 financial crisis. Figure 1 shows that the drop in activity, much more so in the U.S. than in the euro area, was concentrated in residential investment, while consumption slowed down to a much lesser extent both in the U.S. and the euro area. Although there is still controversy about the precise mechanism through which the correction of U.S. housing prices triggered the crisis and the recession, it is clear that the housing market was, this time, the epicentre of the crisis.

Shocks that affect house prices and the conditions at which mortgage credit is extended are therefore at the heart of the current policy discussion. Our paper aims to shed 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 U.S. economy, it is notable that housing prices have also displayed rather strong dynamics on

[1] Our thanks to the participants in the conference "What Drives Asset and Housing Markets?", organised by the Deutsche Bundesbank and the Centre for Economic Research (ZEW), in Mannheim, 20-21 October 2008, and in particular to the discussant, Helge Berger; the participants in a seminar at the Bocconi University in Milan, 8 October 2009, in particular Tommaso Monacelli, Luca Sala, Carlo Favero, and Antonella Trigari; those in the workshop "Housing Markets and the Macroeconomy", organised at the ECB, 26-27 November 2009, in particular the discussant, Ludmila Fadejeva; as well as an anonymous referee for useful suggestions. The views expressed in the paper are those of the authors and are not necessarily shared by the European Central Bank, the Banca d'Italia or the Eurosystem.

the other side of the Atlantic in the run up to the financial crisis. Figure 2 reports the behaviour of an index of house prices in the U.S. and the euro area up to 2008. While house prices remained stable in Germany over the last decade, they increased strongly in the rest of the euro area, even more than in the U.S. In the euro area as a whole, the dynamics of house prices have been similar to the U.S.

In this respect, there are three notable differences between the euro area and the U.S. as far as the housing market is concerned. First, land availability is more abundant in the U.S. than in the euro area, which means that there should be fewer supply constraints in the former.[2] The U.S. population is also more culturally homogeneous and therefore mobile, which requires a more liquid and efficient housing market. This is supported by the evidence reported in Figure 3, showing the number of housing transactions in the U.S. and the euro area, in thousands of units. Second, the mortgage market is more developed in the U.S. 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). As reported in the latest survey of EU mortgage markets (European Central Bank, 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 U.S. has always been in the lead compared with the euro area, especially in the last decade. Towards the end of 2008, mortgage debt was about 70 per cent of GDP in the U.S., and 40 per cent in the euro area (Figure 4). Differences in the tax and legal systems on the two sides of the Atlantic may largely explain this difference (Ellis, 2010). This observation begs the question of whether the euro area is relatively more sheltered than the U.S. from housing market related shocks. Third, mortgage lending rates are mainly tied to long-term rates in the U.S., while the situation is more varied in the euro area, where for example mortgage rates are mainly variable 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 number of them are institutionally-driven and hence to a large extent exogenous. Therefore, by comparing the U.S. and the euro area there is something to be learnt about the role of housing in the business cycle more generally and the importance of institutional factors.

Against this background, the purpose of the paper is to provide a systematic empirical analysis of the role of the housing market in the macroeconomy in the U.S. and in the euro area. The analysis carried out in this paper is twofold. We first establish some stylised

[2] According to Ellis (2010), greater supply flexibility in the U.S. 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.

facts concerning key variables in the housing market on the two sides of the Atlantic, such as real house prices, residential investment and mortgage debt. We also look 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 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 U.S. and euro-area data over a sample period from 1986 to 2009 in order to obtain comparable results for the two economies. We first estimate the U.S. and euro-area models separately, and then model U.S. and euro-area variables jointly in order to analyse the international spillovers. The specification and identification of the SVAR is tailored to study the effects of some structural shocks that are of particular interest for studying the nexus between the housing market and the macroeconomy. We focus on monetary policy, (mortgage) credit supply and housing demand shocks and compare the impulse responses in the two economies to understand the similarities and the differences in a systematic manner.[3]

One advantage of the SVAR approach is that it allows us 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 enhancing an understanding of the channels of propagation of shocks. This limitation must be borne in mind in interpreting the results of this paper, as will become evident later on.[4]

Our paper refers to a small, but burgeoning literature on the effect of including housing and mortgage debt in general equilibrium; see Iacoviello (2005), Iacoviello and Neri (2010) and Calza et al. (2011). 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 U.S. and the euro area present, as noted above, important differences as regards the structure of mortgage markets, the comparative analysis that we carry out could convey some important messages for the empirical relevance of the mechanisms that lie at the core of these models. Our paper is also related to previous research showing that residential

[3] Jarocinski and Smets (2008) and Goodhart and Hofmann (2008) perform similar analyses for, respectively, the U.S. and a panel of industrialised countries. As far as monetary policy shocks are concerned, see also Calza et al. (2011). Our paper, however, is the only one focused on the trans-Atlantic differences.

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

investment is a leading indicator of, and an important contributor to, the business cycle (Leamer, 2007) and that fluctuations in house prices have significant wealth effects on consumption (Case et al., 2005).[5]

Overall, our analysis leads to five main results. First, in the descriptive analysis we find many similarities between the U.S. and the euro area as regards key housing market and macroeconomic variables, with one key difference being the cyclical correlation between real house prices and mortgage debt, which is significantly higher in the U.S., 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 shocks in the U.S. than in the euro area. Third, concerning housing demand shocks, the evidence is not fully conclusive but still suggests a larger impact of these shocks on consumption in the U.S. Fourth, we find that negative mortgage credit supply shocks affect housing market variables in the same way as negative housing demand shocks in both the U.S. and the euro area, but overall they are quantitatively much more important in the euro area. Finally, using a two-country SVAR model that includes both U.S. and euro-area variables we find that the effects of domestic shocks on domestic variables are qualitatively similar to those obtained with the closed-economy SVARs. We also find that the cross-border transmission is mainly of the "push" type, and tends to move westwards rather than eastwards, at least based on the variance decomposition analysis.

The paper is organised as follows. In Section 2 we present some stylised facts. Section 3 presents the results of the SVAR analysis. Section 4 studies the transmission of shocks across the two economies. Section 5 concludes.

2 Some stylised facts: The U.S. and the euro area

2.1 Data

We collect data for the U.S., the euro area and the five largest euro-area economies (Germany, France, Italy, Spain and the Netherlands) on a set of macroeconomic variables related to the housing market.[6] These include private consumption, residential investment, the consumer price index (CPI), real house prices (deflated using the CPI), a representative mortgage lending rate, the 3-month interbank interest rate, and mortgage debt. The

[5] Pavlidis et al. (2009) find that house prices have a wealth effect on consumption only for fluctuations in housing values that are due to bubbles. Ghent and Owyang (2010) find that the positive relation between housing and overall activity does not hold cross section at U.S. Metropolitan Areas level, which is puzzling since housing shocks are to a large extent local.

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

sources and definitions of the data are reported in the Appendix.[7] The sample period from the (quarterly) data spans from 1986:1 to 2009:2, therefore also covering the peak of the global financial crisis of 2007-09. Figure 5 shows all the key macroeconomic series used in the empirical analysis, for the U.S. and the euro area (apart from house prices, shown in Figure 2). 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 U.S. (see Figure 6). 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 most part of the U.S. Christelis et al. (2010) analyse international differences in the holdings of real and financial assets in elder households. Controlling for individual characteristics, they find that Europeans tend to hold more real estate (in particular in the form of primary residences), while Americans tend to hold more stocks.

Institutional differences among mortgage markets in individual euro-area countries are still substantial (see Calza et al., 2011). This raises the question of whether these differences matter in the transmission of key structural shocks. We take a modest step in this direction by using data for the euro area and data that excludes Germany, the country which deviates the most from the others in terms of housing market behaviour.[9] In the following section based on the SVAR analysis, therefore, we describe results for (i) the U.S., (ii) the euro area, (iii) the euro area excluding Germany.

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

We start by looking at the statistical and cyclical properties of some key macroeconomic variables related to the housing market, to set the stage for the empirical analysis that will

[7] Ideally, we 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. (2010) report an average size of 165 square meters per dwelling in the U.S., against 90 square meters in Germany and France, 92 in Italy, and 93 in Spain in the early to mid-2000s (see Table 6, p. 39).

[9] Although there are certainly differences in the housing markets amongst U.S. regions, the institutional differences in the mortgage market are probably much smaller than in the euro area.

follow later. Because the behaviour of house prices, and the housing market in general, may have specific characteristics in individual euro-area countries, we also consider the five largest euro-area countries individually.

We chose 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 Table 3.1 in Ahearne et al., 2005), although mortgage product innovation is certainly a continuous, gradual phenomenon. Moreover, we also wanted to study a relative homogeneous sample period of 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 of inflation in both the U.S. 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 2009 (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 considered (the U.S., the euro area and the five euro-area countries). Overall, the level of residential investment as a share of GDP is similar across economies (around 5 to 6 per cent) and appears to be relatively stable over time. The quarterly volatility of residential investment growth is somewhat higher in the U.S. relative to the aggregate euro area, while some heterogeneity across the largest euro area economies can be detected in this respect. The contribution of residential investment to real GDP growth is on average higher in the euro area than in the U.S., reflecting to a significant extent large average contributions from Spain. In both the euro area and the U.S. residential investment is strongly procyclical and tends to lead the business cycle (see Leamer, 2007).

Real house prices are also procyclical, but less strongly so than residential investment (see Table 2).[10] The correlation between detrended real house prices and residential investment is positive in both the U.S. and the euro area. The average annual increase in real house prices is as high in the euro area as in the U.S. 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 1997, however, the average annual increase is much larger in the U.S.

Table 3 reports the characteristics of euro area and U.S. mortgage debt. Mortgage debt is also procyclical in both the euro area and the U.S., with the cyclical correlation 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 (although for the period starting in 1997 they are both procyclical with correlations close to the average). An interesting difference between the U.S. and the euro area lies in the cyclical correlation

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

between mortgage debt and real house prices, which is 0.21 in the euro area and 0.77 in the U.S. This is likely to be largely due to the prevalence of home equity refinance in the U.S., 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 3-month money market rate. One interesting difference between the U.S. and the euro area is the higher lending rate compared with the 3-month interbank rate, which may partly be due to the longer maturity of mortgage debt in the U.S.[11] It is also interesting that mortgage lending rate spreads (vis-à-vis the 3-month interbank rate) are quite strongly countercyclical, especially in the U.S., 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.

To summarise, our results indicate more similarities than differences between the U.S. and the euro area as far as the housing market is concerned. In particular, residential investment, real house prices and mortgage debt are procyclical, while mortgage spreads are countercyclical, in both economies. Two interesting difference stand out, however. On the one hand, mortgage debt is more procyclical in the euro area than in the U.S. On the other hand, the correlation between real house prices and mortgage debt is considerably higher in the U.S., 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 estimate a SVAR 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 U.S.

[11] 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 and mostly variable-rate in the latter.

3.1 Specification and identification

We specify and estimate a SVAR model for the euro area and the U.S. separately, identified using short-run restrictions. The model is:

$$A_0 y_t = c + A(L) y_{t-1} + \varepsilon_t \tag{1}$$

where y is a vector of endogenous variables, c a constant, A_0 is the matrix of the contemporaneous interactions, $A(L)$ is a matrix polynomial in the lag operator L and ε is a vector of structural shocks with covariance matrix Σ. Identification of the shocks is achieved by placing suitable restrictions on the A_0 matrix.

The vector y includes the following seven variables, in this order: the log of consumer prices, the log of private consumption, the log of residential investment, the log of real house prices, the 3-month interbank rate, the representative mortgage lending rate and the log of nominal mortgage debt.

We choose a recursive (i.e. Cholesky) 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. For the housing demand shock, note that the equation for real house prices in the SVAR can be interpreted as a housing demand function, relating this variable to consumption and residential investment; we assume, however, that house prices react to changes in interest rates (in particular the mortgage lending rate) only with a quarter 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, relating to mortgage debt, can be interpreted as a mortgage demand function. We expect loan demand to depend negatively on the mortgage lending rate and positively on economic activity, and loan supply to depend positively on the lending rate.[12]

We prefer not to rely on sign restrictions to identify the shocks for two reasons. First, sign restrictions are not necessarily superior to short-run restrictions if these are able to deliver shocks that are structurally interpretable.[13] The short-run restrictions that we use do a good job in recovering shocks that are structurally interpretable, based on the

[12] See Bernanke and Blinder (1992). On the identification of the loan supply function see, for example, Brissimis and Delis (2009).

[13] Fry and Pagan (2010) state that *"It should probably not be surprising that one cannot recover the correct elasticities simply by the use of sign restrictions, since sign restrictions are very weak information. But the literature largely treats them as if they are capable of recovering accurate quantitative information. [...]*

visual analysis of the impulse responses. Second, using sign restrictions requires having a model (preferably a DSGE one) to guide us in the choice of the restrictions. While there is consensus on how to identify monetary policy and housing demand shocks (see, respectively, Uhlig, 2005 and Jarocinski and Smets, 2008) it is somewhat harder to come up with restrictions for identifying credit supply shocks. We therefore prefer to use the simplest identification scheme possible in order to allow the data to "speak for themselves" as much as possible.

It should also 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, for example, 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 drop in bank capital) should be labelled as "loan supply" and arguably 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 real house prices, and letting real house prices 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) give similar results, none of them seemed superior to the recursive identification in terms of the metric that is relevant for our analysis, i.e. achieving a clean identification of the considered structural shocks as visible in the impulse response patterns.

There is an important caveat to keep in mind when interpreting the results obtained from our analysis. 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. Indeed, we find particularly large residuals for one of the last quarters 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 may not be completely satisfactory 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 ones) as well as an independent source of shocks for the broader economy for mainly

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there is no reason to suppose that sign restrictions are better than any other way of eliciting information on impulse responses, such as provided by short run or long run restrictions."

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. Second, housing is a form of collateral for loans to households, some of which could be used for 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 (Iacoviello and Neri, 2010), a fall in house prices leads to a reduction in the quantity of mortgage debt extended, due to a borrowing constraint with a fixed down payment rate and reflecting the existence of credit-constrained households. Since borrowing is more tightly linked to house prices in the U.S., due to the possibility of refinancing existing mortgages at any time, we expect that this channel is more important in the U.S. 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., 2011). 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. Admittedly, it is not easy to disentangle these channels in the context of our SVAR analysis, but we will nevertheless try to look for signs that one or another channel may be at work, and possibly differently in the U.S. and the euro area.

3.3 Results

The reduced-form VAR is estimated consistently in levels. The sample period goes from 1986:1 to 2009:2 for both the U.S. and the euro area. We estimate the VAR using a Bayesian approach where we impose a Minnesota prior (see Doan et al., 1984) on the reduced-form coefficients, i.e. we assume that all the variables follow a random walk.[14] For the covariance matrix of the residuals, we impose a diffuse prior in order to cater for uncertainty in the estimation of the covariances.[15] We define α as the vector of coefficients of the reduced-form representation associated with the structural representation of the VAR reported in eq. (1). The prior for the coefficients in α and the variance-covariance

[14] Of course, this is not the only possible choice for the priors; see Koop and Korobilis (2010) for additional information. The usual unit root tests suggest that for some of them (the short-term interest rate and residential investment) results are actually inconclusive between the augmented Dickey-Fuller and the Phillips-Perron tests. We also consider stationary priors for these variables with a coefficient on the first lag set at 0.9 and obtain very similar results (not reported for brevity but available from the authors upon request).

[15] The results of the analysis are almost identical if we assume the covariance matrix to be fixed at the OLS estimates as in the standard Minnesota prior.

matrix of the shocks Σ are:

$$\alpha \sim N\left(\bar{\alpha}, \bar{\Sigma}^{\alpha}\right) \quad (2)$$
$$p(\Sigma) \sim |\Sigma|^{-(K+1)/2} \quad (3)$$

where $\bar{\alpha}$ denotes the mean of the prior and $\bar{\Sigma}^{\alpha}$ its variance covariance matrix. All coefficients in $\bar{\alpha}$ are equal to zero except the first own lag of the dependent variable in each equation, which is set to one. Moreover, it is assumed that the prior covariance matrix $\bar{\Sigma}^{\alpha}$ is diagonal and that the $\sigma^{\alpha}_{ij,\ell}$ element, corresponding to lag ℓ of variable j in equation i, is equal to:

$$\bar{\sigma}^{\alpha}_{ij,\ell} = \begin{cases} \frac{\phi_0}{h(\ell)} & \text{if i = j, } \forall \ell \\ \phi_0 \frac{\phi_1}{h(\ell)} \left(\frac{\sigma_j}{\sigma_i}\right)^2 & \text{if i} \neq \text{j, } \forall \ell \text{, j endogenous} \\ \phi_0 \phi_2 & \text{if j exogenous/deterministic} \end{cases}$$

The hyperparameter ϕ_0 represents the overall tightness of the prior; ϕ_1 the relative tightness of other variables, ϕ_2 the relative tightness of the exogenous variables and $h(\ell)$ the relative tightness of the variance of lags other than the first one (we assume throughout that $h(\ell) = \ell$, that is a linear decay function). The term $(\sigma_j/\ \sigma_i)^2$ is a scaling factor that accounts for the different scale of the variables of the VAR. We set $\phi_0 = 0.1$, $\phi_1 = 0.5$ and $\phi_2 = 10^5$ in our benchmark specification (see Canova, 2007), but we perform some robustness exercises on the relevance of the prior tightness to the results. Having assumed a Normal-diffuse prior, the posterior distribution of the reduced-form coefficients α and the covariance matrix Σ, is Normal-Wishart, i.e. the distribution of α conditional on Σ is Normal while the distribution of Σ^{-1} is Wishart. In order to compute the impulse responses we draw α and Σ from the posterior using the Gibbs sampling algorithm.

Figures 7-9 report the response of the variables included in the SVAR model to selected unit shocks, namely (i) the short-term interest rate, (ii) the mortgage lending rate, (iii) real house prices and (iv) residential investment shocks, respectively in the U.S. (Figure 7), the euro area (Figure 8) and the euro area excluding Germany (Figure 9). 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 U.S. 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 U.S. 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 on impact, we find that the interpretation as a monetary policy shock is an appropriate one. In the U.S. we find a large effect on housing market related variables, in particular residential investment and real house prices. This evidence is consistent with previous work showing that the largest effect of a monetary policy shock is on residential investment (see Erceg and Levin, 2006 and Vargas-Silva, 2008). This finding is consistent, in particular, with Jarocinski and Smets (2008), who also analyse the effect of monetary policy shocks on the U.S. housing market using a Bayesian VAR (see in particular Figure 4 in their paper, p. 348). The estimated impulse responses are also broadly consistent with the effect of the interest rate shock in Goodhart and Hofmann (2008). In the euro area, by contrast, we find that the effect of the shock on residential investment and real house prices are smaller. The monetary policy shock leads to a contraction of mortgage debt in both economies, which is larger in the U.S. This result is in keeping with den Haan et al. (2007), but is inconsistent with an earlier literature on the "perverse" effect of a monetary policy shock on loans (see, for example, Gertler and Gilchrist, 1993).

The response of private consumption is sluggish and muted in both economies, and it is generally stronger in the U.S.; 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 U.S., 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 pattern suggests that mortgage lending rates are sticky in the short run (see also den Haan et al., 2007), but it can also be due to the presence of term premia. This evidence seems prima facie inconsistent with the existence of a collateral channel of monetary policy at least when acting through the external finance premium; the difference between the U.S. 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 effects of the contractionary monetary policy shock on mortgage debt are significantly larger in the U.S. than in the euro area.

Overall, the evidence we present here is consistent with the view that the transmission of monetary policy shocks to the housing market and private consumption is stronger in the U.S. than in the euro area. However, it is not clear whether this is the result of a stronger collateral channel of monetary policy, or of other mechanisms.

3.3.2 Credit supply shock

A (negative) credit supply shock is defined as a 50 basis points rise in the mortgage lending rate but not in the short-term interest rate, which is followed 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.[16] It can be thought of as a small "credit crunch" i.e. a leftward shift in the supply of mortgage loans (Bernanke and Lown, 1991).[17] It is a type of shock which has 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 U.S. 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 U.S. (see Table 5).[18] The effect on real house prices is negative in both the euro area and the U.S., with - this time - a more pronounced effect in the euro area. Therefore, the adverse mortgage credit shock appears to have a similar impact to 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 U.S.; the difference, however, is not statistically significant and is even reversed once Germany is excluded from the euro area aggregate. It is difficult to assess 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 favour of non-housing consumption when conditions in mortgage credit markets become less favourable. It appears that the former effect prevails in the U.S., while the two broadly balance out in the euro area.

3.3.3 Housing demand shock

Finally, a non-monetary housing demand shock is defined in Jarocinski and Smets (2008) and Iacoviello and Neri (2010), i.e. as an increase in real house prices 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

[16] 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.

[17] Sommervoll et al. (2010) find that in a model with heterogeneous agents and adaptive expectations, credit constraints on mortgagees can have large effect on the housing market.

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

additional assumption we adopt that private consumption does not react on impact to this shock should ensure that it is not a positive technology shock, including of the "positive news" type of shock. The results that we obtain are qualitatively similar to Goodhart and Hofmann (2008) and Jarocinski and Smets (2008), at least for the variables that are common with these studies.[19]

We find that a house price shock has the characteristics of a housing demand shock for the euro area, but for the U.S. it is the residential investment shock that has this structural interpretation. We cannot therefore compare the two shocks in quantitative terms and only look at possible qualitative differences. As is evident in Table 5, the housing demand shock tends to push all variables up, not only (by construction) real house prices and residential investment, but also the price level, the short-term interest rate, consumption and mortgage debt. A notable difference is, however, that the positive effect on consumption is much more short-lived than in the U.S., and ultimately turns negative in the euro area (with and without Germany). 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 U.S., since wealth effects should, if anything, be larger in the euro area than in the U.S.

3.3.4 Summing up on the impulse response analysis

Overall, the impulse responses to monetary policy shocks are in line with the conventional wisdom as well as consistent with the idea that housing and mortgage market variables play a bigger role in the U.S. than in the euro area. In particular, consumption and residential investment fall to a larger extent. As for housing demand shocks, the evidence is less clear-cut, but still points to a stronger impact of these shocks on consumption in the euro area than in the U.S., which is consistent with (though not necessarily only explained by) a stronger housing collateral channel in the U.S. Finally, we have found evidence that mortgage credit supply shocks tend to act like negative housing demand shocks in both the U.S. and the euro area.

3.3.5 Variance decomposition

To understand the quantitative importance of the three structural shocks we identified in generating fluctuations in the housing-related variables and real consumption, we compute the forecast error variance decomposition using both the U.S. and euro area SVAR models. The variance decomposition offers a somewhat different perspective in comparison with the impulse response analysis since it takes into account the size of the shocks, not only

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

of those that are shown but also of the others. 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 can be drawn.

First, it is confirmed that monetary policy shocks are more important for the housing and mortgage market variables in the U.S., although not for private consumption, especially when excluding Germany from the euro area aggregate; in particular, in the U.S. 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 real house prices (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 price level. Conversely, credit supply shocks are much more important for the euro area than for the U.S., although this may have to do with the way we measure these shocks while there are other ways to influence credit conditions - for example, through changes in credit standards - that may be particularly relevant for the U.S. In particular, mortgage debt is much less affected by lending rate shocks in the U.S. 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 U.S., 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 U.S., 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 (2010) 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 U.S. (25 per cent at 24 quarters) than in the euro area (5 per cent).

4 The U.S. and the euro area in a joint model

So far, we have analysed the results for the U.S. and the euro area obtained with closed-economy SVAR models. In this section, we relax this assumption by modelling the euro area and the U.S. jointly. This analysis has two objectives: first, it is a robustness check of the baseline analysis, aimed at understanding whether allowing for cross-country spillovers matters for the identification of domestic shocks and their propagation to domestic variables; second, it is also an analysis of the cross-country spillovers of housing market-related shocks between the U.S. and the euro area, which is interesting in its own right.[20]

[20] See Darraq Paries and Notarpietro (2008) for a first analysis of international spillovers in the housing market in the context oof a DSGE model. Beltratti and Morana (2010) find that U.S. are an important

We maintain the same recursive identification of the closed-economy SVARs and we order U.S. variables first, the euro-area variables second, which implies that euro-area shocks can impact U.S. variables only with a one quarter lag. The results are generally robust to changing the ordering, i.e. putting euro-area variables first. Overall, therefore, we estimate a Bayesian VAR model with 14 variables. In Figures 10-11, we report the responses of four shocks (the interest rate, real house prices, the lending rate and residential investment) originating in the U.S. (Figure 10) and the euro area (Figure 11) respectively, on both U.S. and euro-area variables in each graph. We report results only for the variables that are most relevant for the housing market and the household sector, namely residential investment, real house prices, the mortgage lending rate and mortgage debt. In Figures 12a-12b, we report a comparison for the impulse responses of the domestic variables to the domestic shocks between the joint model and the two separate models for the U.S. and the euro area. Results are qualitatively similar, in particular if one takes into account the posterior distribution of the responses (we do not report the posterior intervals in order to make the figure easier to read).

For shocks originating in the U.S. (Figure 10), in particular, we find that the impact of domestic shocks on domestic variables is generally the same as in the closed-economy model, but the variance of the responses is larger in some cases, on account of the bigger dimension of the model.[21] This makes it more difficult, in some cases (such as the U.S. lending rate shock), to give a clear structural connotation to the shock. While bearing this caveat in mind, a main conclusion is that the reaction of euro-area variables to U.S. shocks generally goes in the same direction as the U.S. variables, indicating that U.S. shocks mainly have a "push" effect on the euro area. An exception to this is, however, euro-area residential investment, which goes up, rather than down, following U.S. interest rate (monetary policy) and lending rate (credit supply) shocks.

Turning to shocks originating in the euro area (Figure 11), the effects on domestic (euro area) variables are similar to the corresponding ones from the euro area closed-economy model, although the statistical significance is, again, less sharp for a few variables. The effects of these shocks on U.S. variables either go in the same direction as the euro area variables, thus suggesting a "push" effect, or (more often) are surrounded by a large degree of uncertainty.

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source of fluctuations in G-7 countries not only for real activity, nominal variables and stock prices, but also for real housing prices. Costello et al. (2011) study how the the "non-fundamental" component of house prices spillovers across states in Australia.

[21] We have obtained similar results using the Litterman's circle-star approach (as implemented in Gupta and Kabundi, 2010) to estimate the cross-country spillovers. According to this approach, the prior on the reduced form coefficients of the VAR is such that only U.S. variables can influence the euro area counterparts while the latter variables cannot influence the U.S. ones.

We also reproduced the analysis reported in Table 5 for the separate models, by looking at the difference between the reaction of domestic U.S. variables to U.S. domestic shocks on the one hand, and the reaction of euro-area variables to euro-area shocks on the other.[22] The results are robust.

Perhaps the most interesting outcome of this joint modelling exercise is contained in Table 7, which reports the contribution of selected shocks to the variance of euro-area and U.S. variables at a horizon of 24 quarters. There is a striking difference between the forecast error variance of euro-area variables explained by the U.S. shocks, which is generally large, and that of U.S. variables explained by euro area shocks, which is generally small. This suggests that the cross-border transmission of housing market related shocks travels more westward than eastward across the Atlantic. Although this conclusion might partly be an artefact of the ordering of the VAR model that we have chosen, where U.S. variables come first, there is also good reason to believe that the ordering is appropriate as U.S. business cycles typically lead the euro area ones.

5 Conclusions

The paper presents a systematic empirical analysis of the role of the housing market in the macroeconomy in the U.S. and in the euro area using stylised facts and impulse responses from a Structural Vector Autoregression (SVAR) 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 U.S. and the euro area.

Impulse responses from the SVAR models suggest that the impact of monetary policy, credit supply and housing demand shocks is qualitatively similar in the U.S. 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 U.S. than in the euro area. We find no evidence, however, that the contractionary effect of monetary policy works through an increase in external finance premiums in the mortgage market, nor that this explains the stronger propagation of the monetary shock in the U.S. Overall, we find some evidence that housing markets might play a bigger role as conduits of monetary policy shocks in the U.S. than in the euro area; the evidence for housing demand and credit supply shocks is less clear-cut. 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 U.S.

[22] The results are not reported for brevity but are available from the authors upon request.

We have also analysed the effect of shocks and their international transmission in a two-country model of the U.S. and the euro area. We find that the results for domestic variables are similar to those obtained with the closed-economy models, although the results based on the two-country model are surrounded by a larger degree of uncertainty. We also find that the international transmission is mainly of a "push" type, and travels more westward than eastward.

Our analysis has several limitations which could be alleviated in future research. First, 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, for example, Kakes and Ullersma, 2010). Incorporating such non-linearities in a SVAR context would, however, be difficult from a methodological standpoint. Second, international spillovers may be important even for large closed economies such as the U.S. and the euro area (in the context of asset boom/bust cycles, see, for example, 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. Another important direction for research is the use of SVAR models with a large cross-section of potentially informative variables, such as FAVAR models, where a large number of housing market related variables could be included, as for example in Gupta et al. (2010), although data differences between the U.S. and the euro area would probably be an important obstacle to overcome.

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Appendix

Data

Definitions and 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 and Figures

Table 1 – Residential investment

1986-2009

	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

1997-2009

	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 reports 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 maximum 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

1986-2009:

	US	Euro area	DE	FR	IT	ES	NL
Average annual increase	3.0	2.8	-1.0	3.2	2.0	6.4	4.3
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

1997-2009:

	US	Euro area	DE	FR	IT	ES	NL
Average annual increase	2.4	1.2	-1.0	3.2	2.0	6.4	4.3
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 (or real residential investment) 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 - or real residential investment - , and a negative numbers indicating the numbers of quarters at which real house prices lag real GDP - or real residential investment). Cyclicality refers to the sign of the maximum 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

1986-2009:

	US	Euro area	DE	FR	IT	ES	NL
Average annual increase	6.2	6.4	6.2	4.5	10.8	15.3	7.4
Correlation with real house price	0.77	0.21	0.22	0.77	0.42	0.52	0.76
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

1997-2009:

	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 maximum 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

1986-2009:

	US	Euro area	DE	FR	IT	ES	NL
Average spread over 3-month rate	3.35	1.89	3.13	1.91	1.42	1.73	2.50
Quarterly volatility	0.45	0.34	0.38	0.58	0.73	1.07	0.38
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

1997-2009:

	US	Euro area	DE	FR	IT	ES	NL
Average spread over 3-month rate	3.08	2.56	3.13	1.91	1.42	1.73	2.50
Quarterly volatility	0.61	0.50	0.38	0.58	0.73	1.07	0.38
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 maximum 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

	US	EA	EA*	US-EA	US-EA*
Monetary policy shock					
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 2009:2. '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 the VAR models estimated separately in the US and the euro area

	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 2009:2, recursive identification. The variance decomposition is at an horizon of 24 quarters after the shocks. 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.

Table 7 – Variance decomposition for the joint model, selected shocks

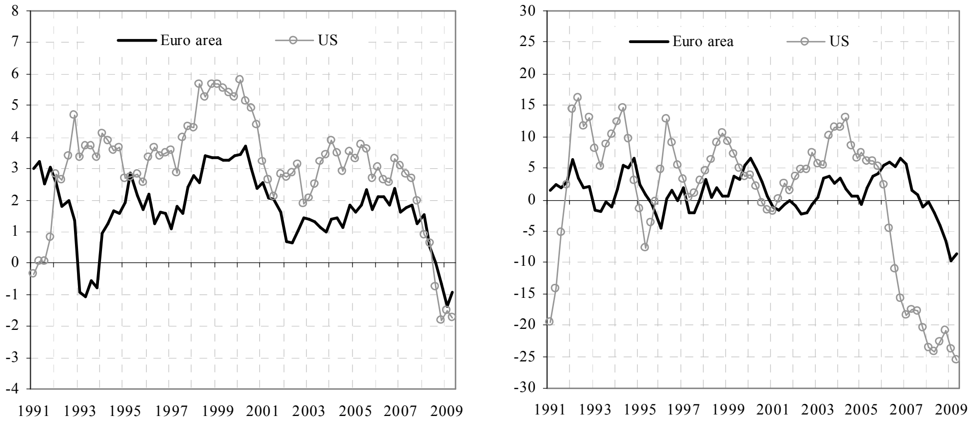
	US interest rate shock	US house price shock	US residential investment shock	US lending rate shock	EA interest rate shock	EA house price shock	EA residential investment shock	EA lending rate shock
US price level	1.1	14.8	19.6	9.7	0.1	1.2	1.8	1.4
US consumption	5.3	12.8	12.7	15.6	0.3	0.0	1.1	4.3
US residential investment	6.3	7.9	19.8	16.8	2.0	0.0	2.2	2.4
US short-term interest rate	18.0	11.9	15.4	9.3	2.7	0.4	1.0	3.3
US real house price	12.1	20.6	13.1	18.6	0.7	0.0	2.7	0.6
US mortgage lending rate	6.5	11.0	13.5	37.7	2.3	0.2	0.9	1.6
US mortgage loans	16.3	9.0	24.8	7.7	0.4	0.4	3.0	2.8
EA price level	3.8	2.1	20.2	4.0	0.2	1.7	0.2	1.0
EA consumption	4.3	2.9	13.9	4.9	0.9	0.1	0.2	7.0
EA residential investment	0.9	8.9	1.5	22.8	4.9	0.6	27.3	1.3
EA short-term interest rate	7.1	6.1	13.3	3.5	12.9	1.9	0.8	1.2
EA real house price	1.3	9.9	11.5	4.7	0.2	4.2	1.2	1.2
EA mortgage lending rate	20.7	11.6	0.8	13.7	2.4	3.2	1.2	11.1
EA mortgage loans	8.6	15.0	13.6	18.3	1.0	0.1	2.8	1.9

Note: Based on the VAR estimated from 1986:1 to 2009:2, recursive identification. The variance decomposition is at an horizon of 24 quarters after the shocks. See text for further explanations. 'EA' stays for euro area, 'US' for the United States.

Figure 1: Private consumption and residential investment growth in the euro area and the US

(percentage change)

Private consumption annual growth | Residential investment annual growth



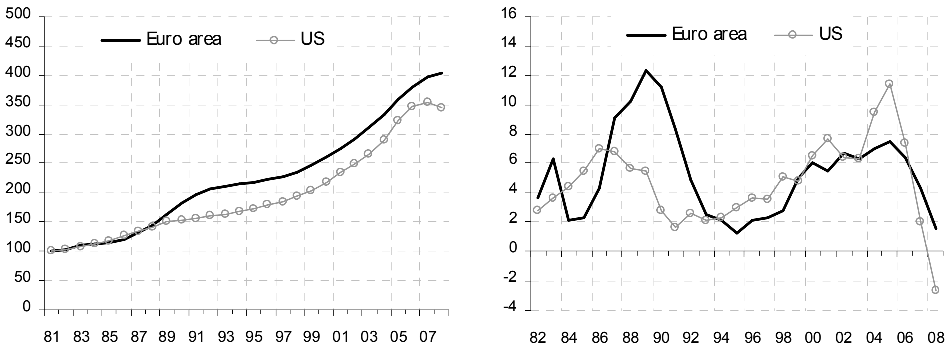
Sources: BEA and Eurostat.
Note: Annual growth rates of quarterly real indicators.

Figure 2: Residential property prices in the euro area and the US

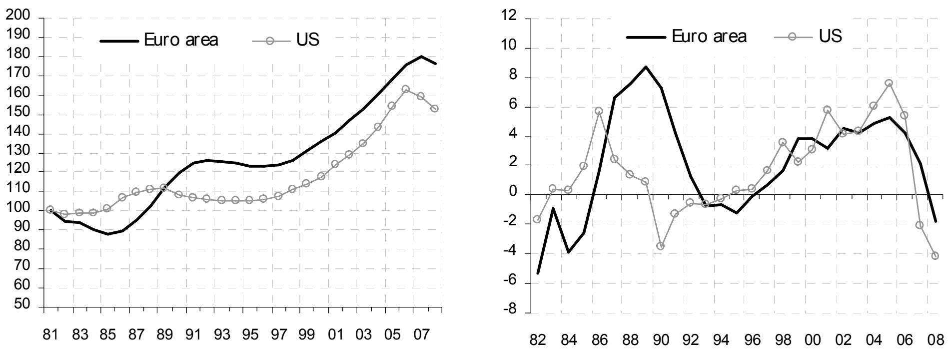
(index; percentage change)

Levels, index numbers (1980=100) | Annual growth

nominal

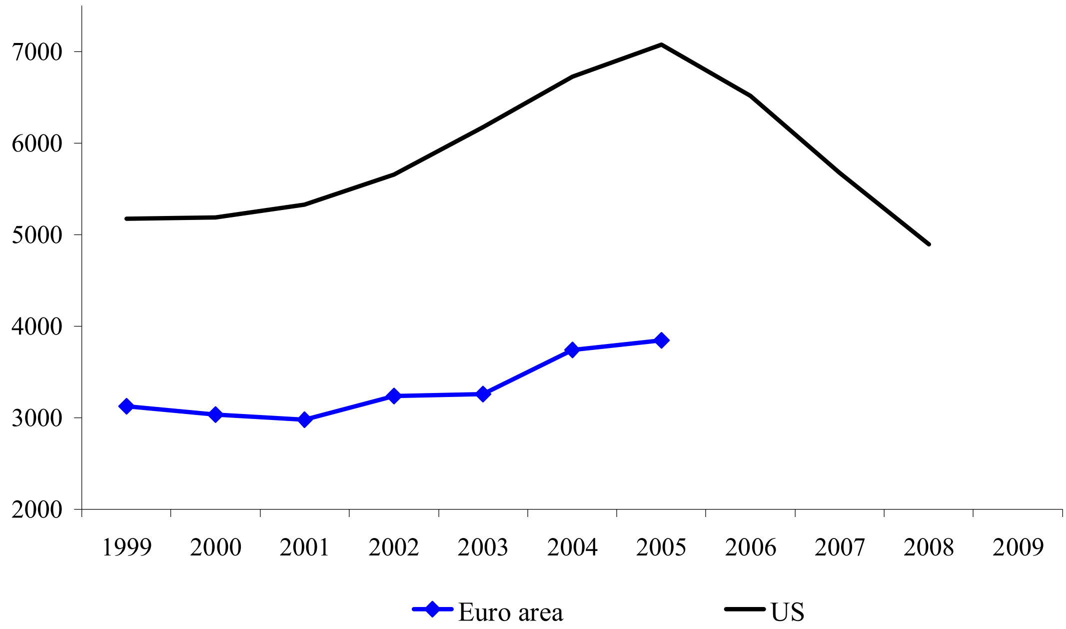


real (deflated by the HICP/CPI)



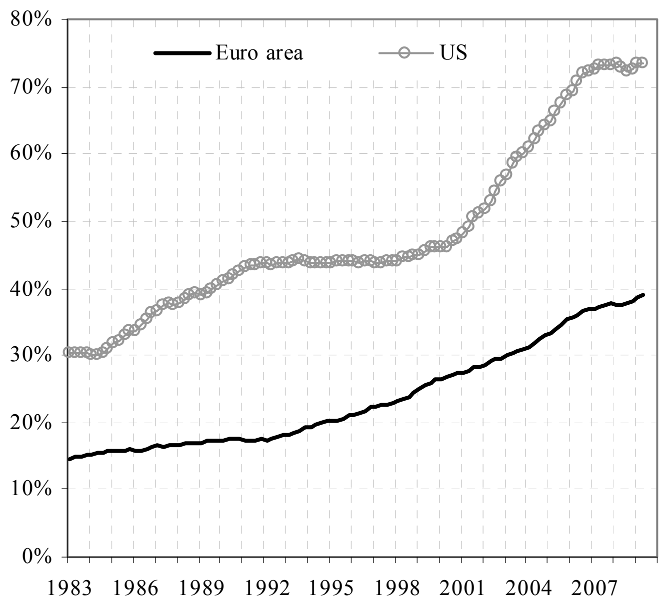
Sources: ECB and OECD.
Note: Annual data. Indices normalised such that 1981=100.

Figure 3 – Housing transactions
(thousands of units)



Sources: ECB Structural housing indicators and Bank for International Settlements.

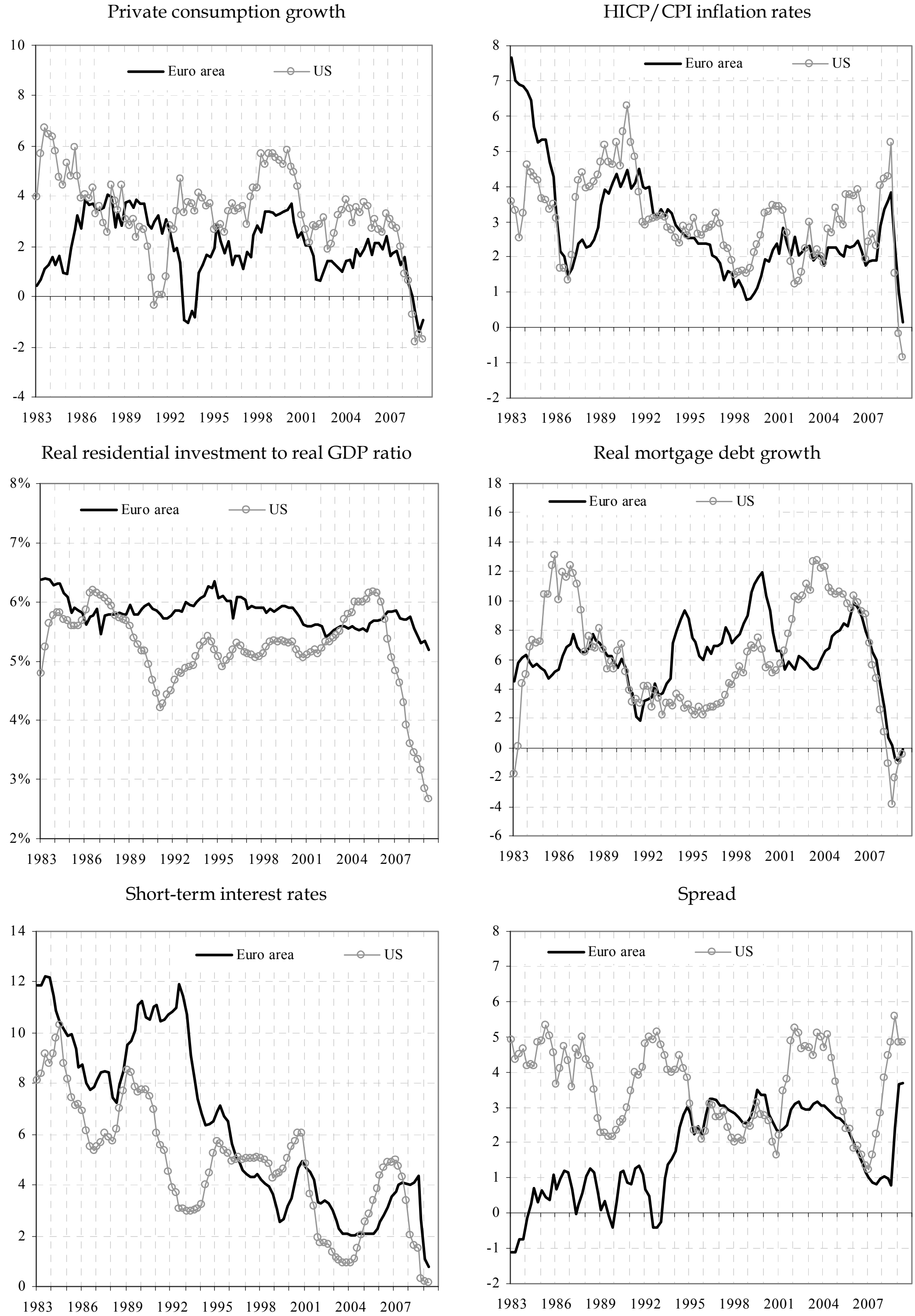
Figure 4: Mortgage debt to GDP in the euro area and the US
(percentages)



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

Figure 5: Main variables used in the empirical analysis

(percentage changes; percentages; percentage points)

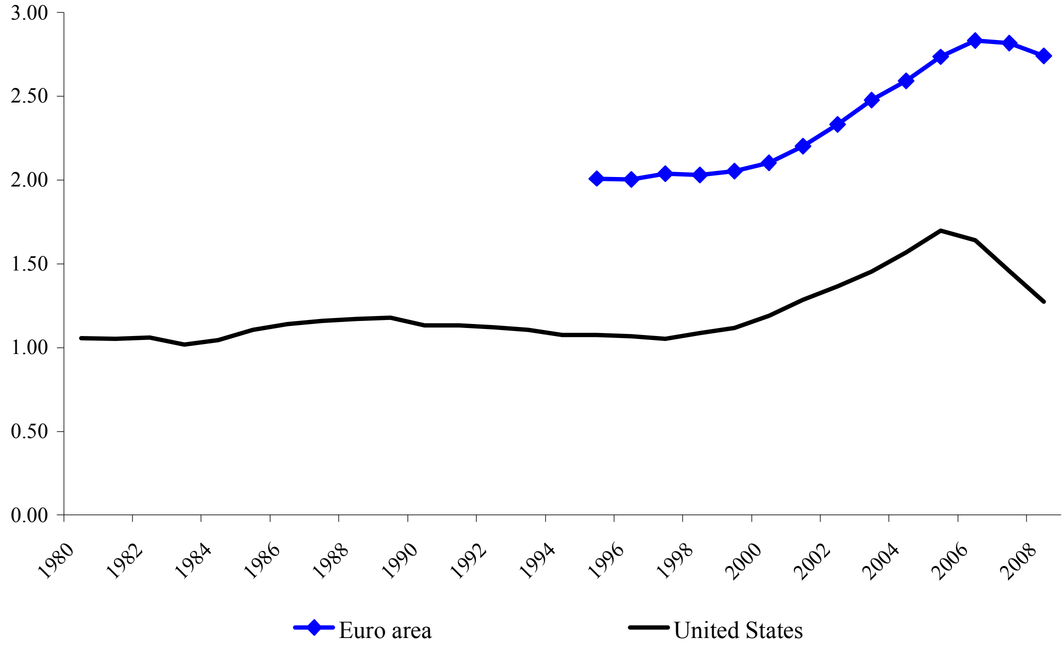


Sources: BEA, ECB, Eurostat.

Note: Annual growth rates of quarterly real indicators, except for real residential investment to real GDP ration (percentages) , short-term interest rates (percentages) and the spread (percentage points). The spread refers to the spread between the mortgage lending rate and the short-term interest rate (3-month rate).

Figure 6 – Housing wealth

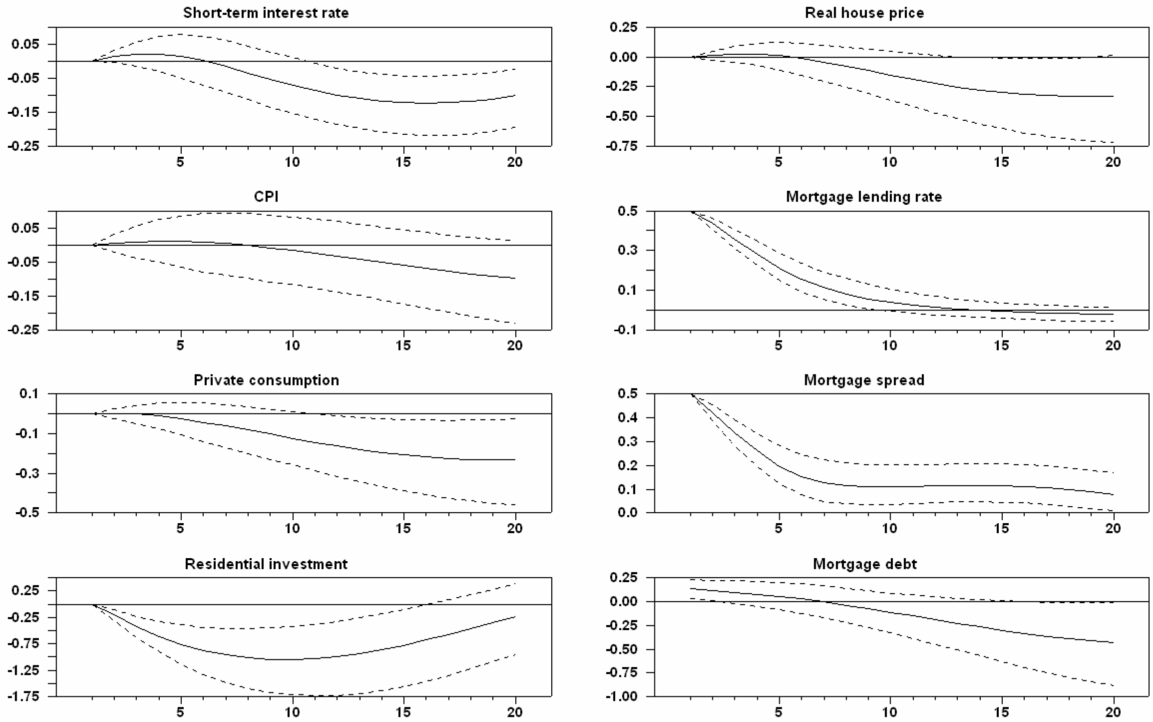
(percentages)



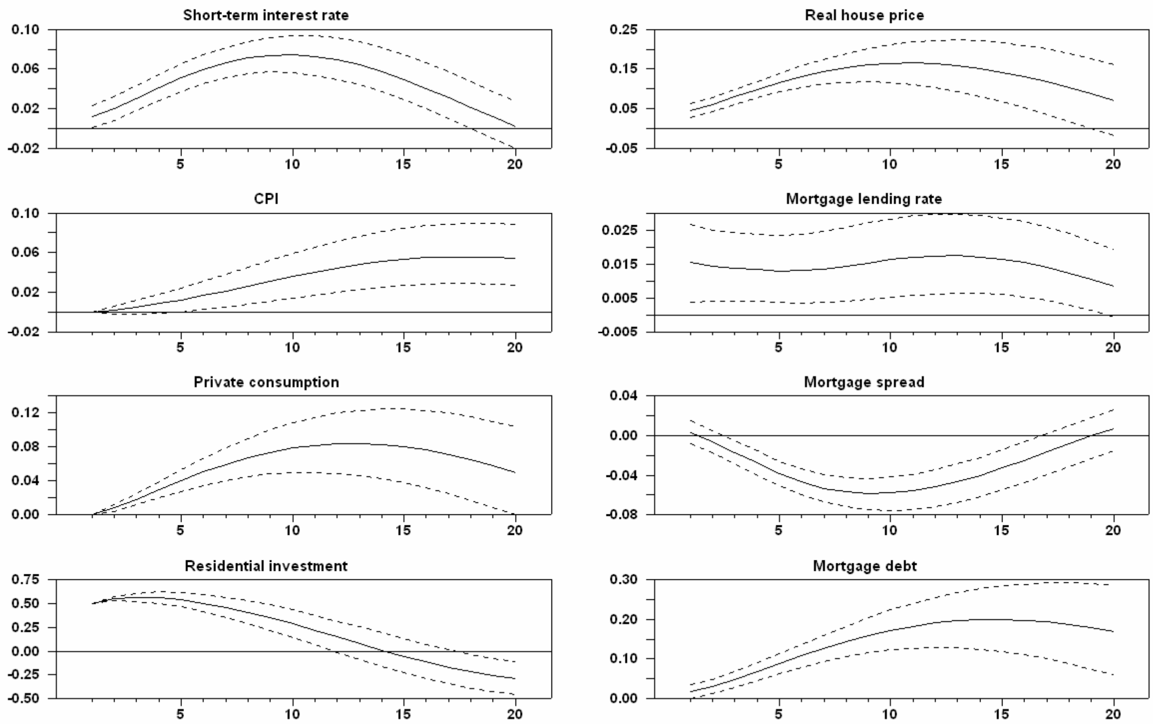
Sources: ESA national accounts for the euro area and Haver for the United States.
Note: Data are ratios to nominal GDP.

Figure 7 – Impulse responses for the United States

Lending rate shock

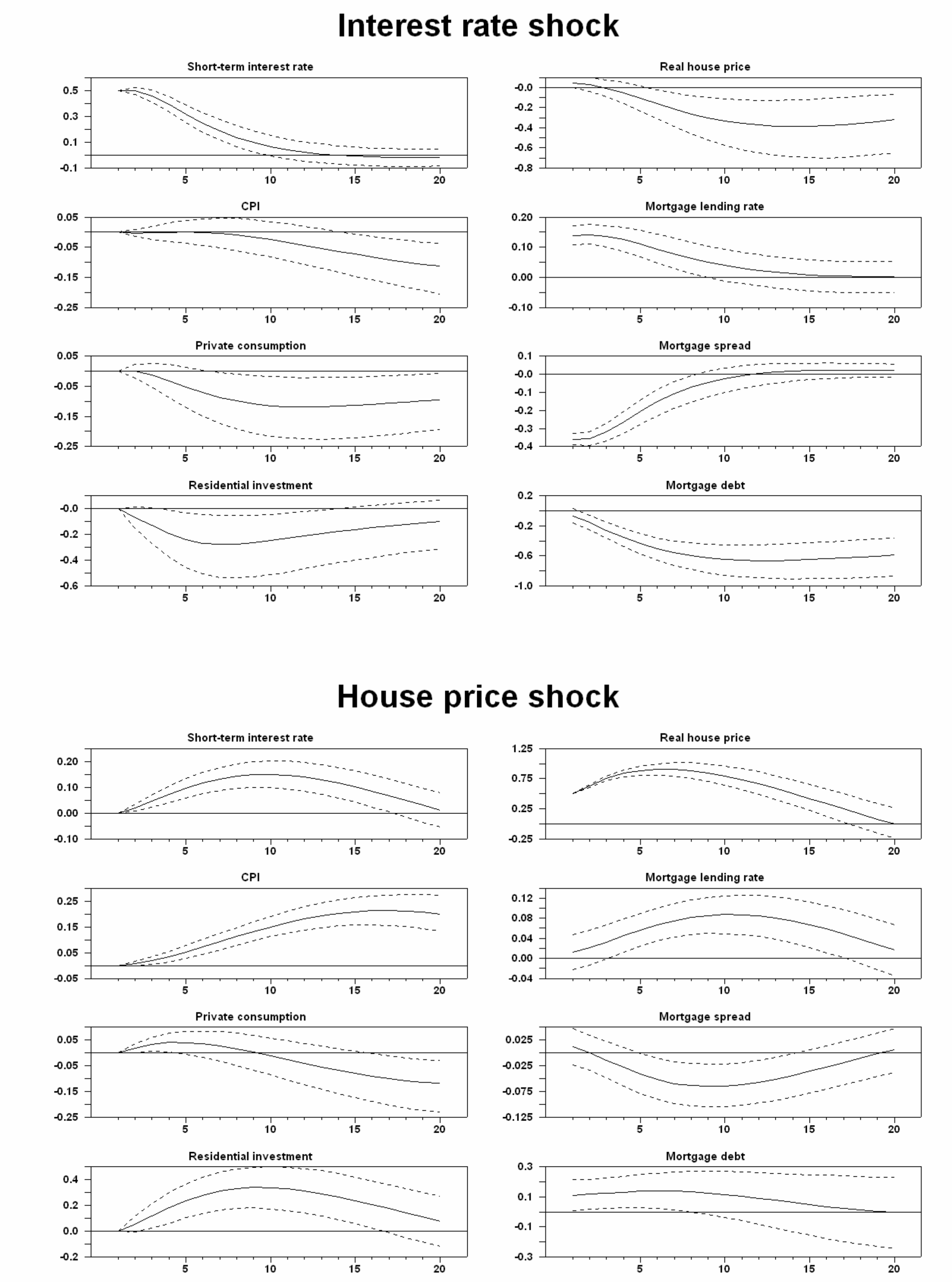


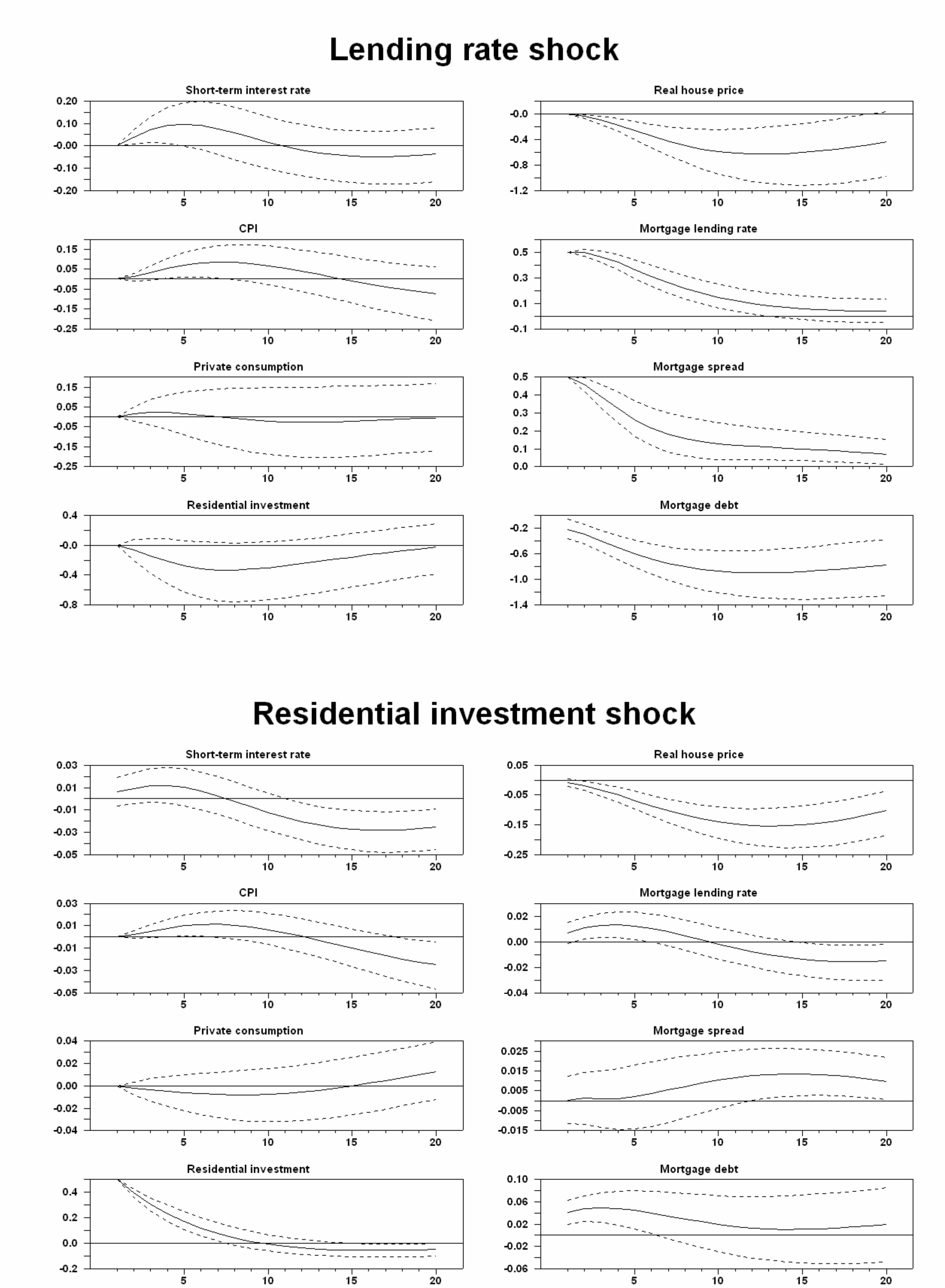
Residential investment shock



Note: Impulse responses based on the baseline VAR model for the U.S. (see text for further explanations), estimated on the sample period 1986:1 to 2009:2. Confidence bands are based on the 68% significance level.

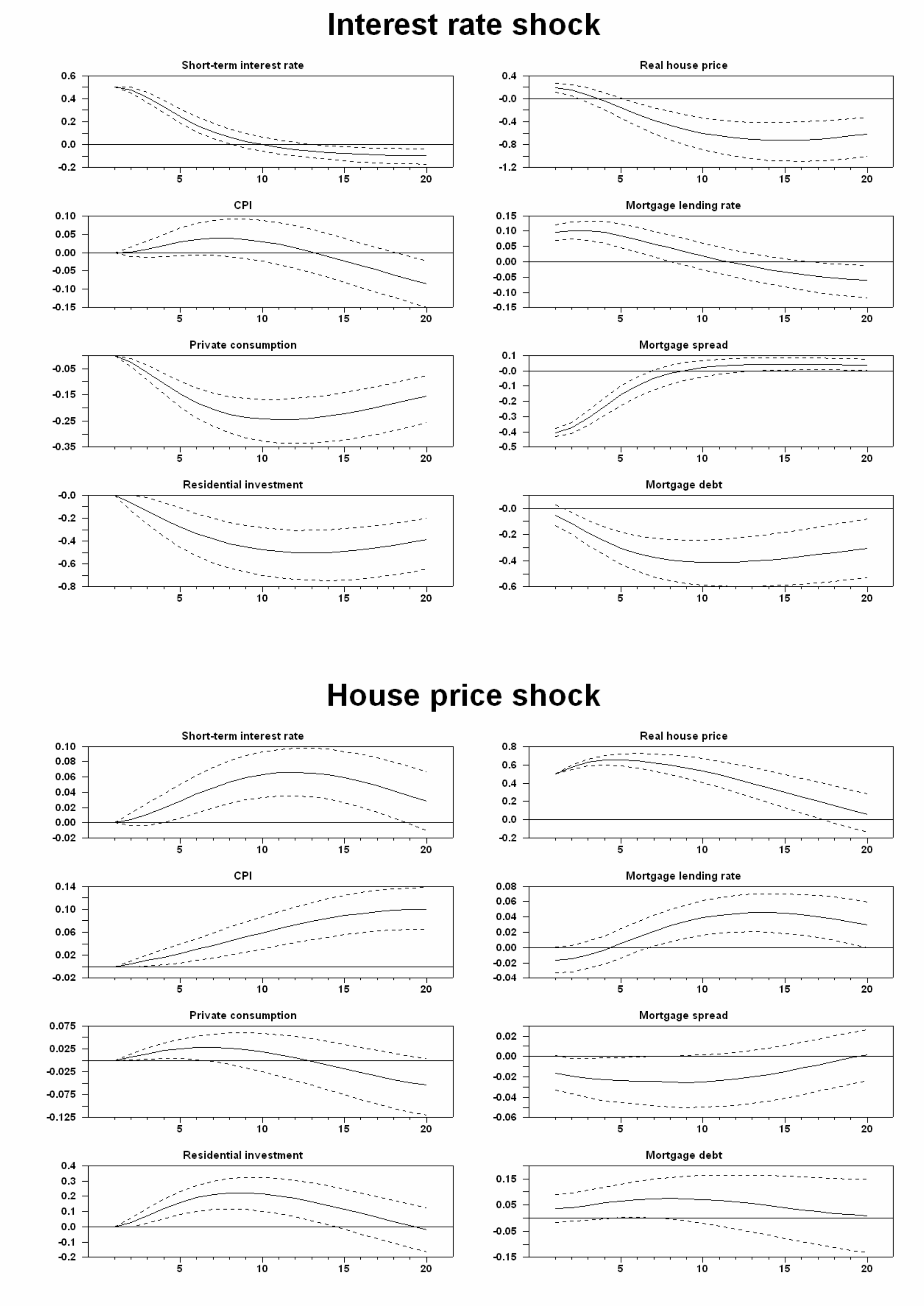
Figure 8 – Impulse responses for the euro area



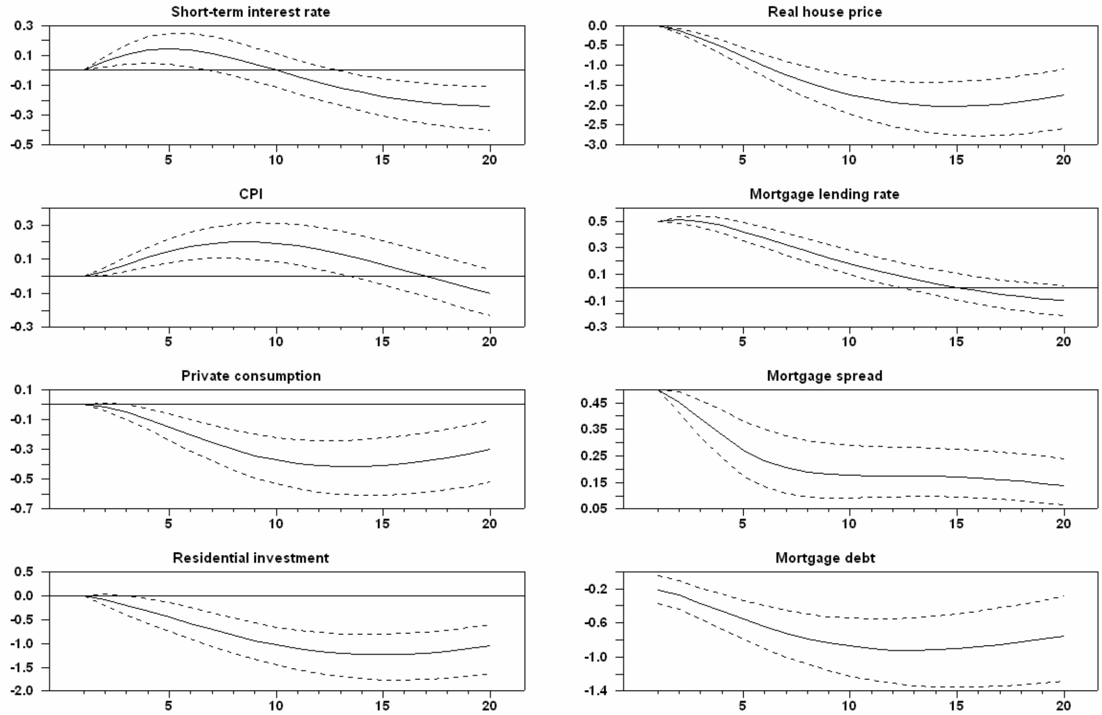


Note: Impulse responses based on the baseline VAR model for the euro area (see text for further explanations), estimated on the sample period 1986:1 to 2009:2. Confidence bands are based on the 68% significance level.

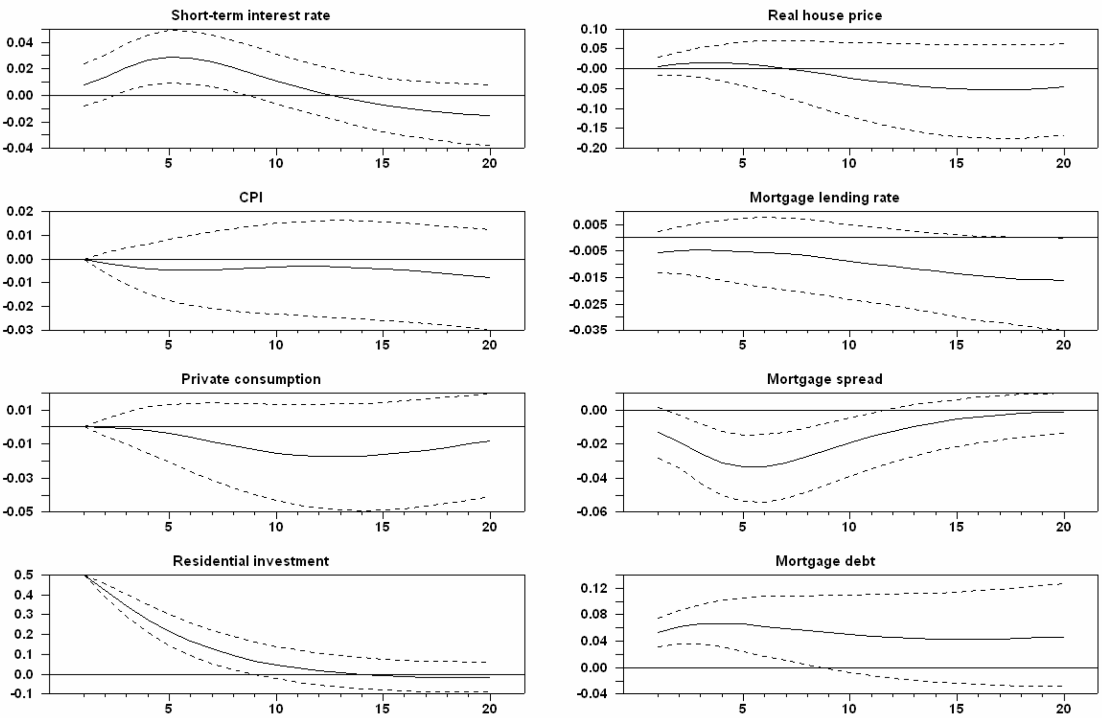
Figure 9 – Impulse responses for the euro area excluding Germany



Lending rate shock

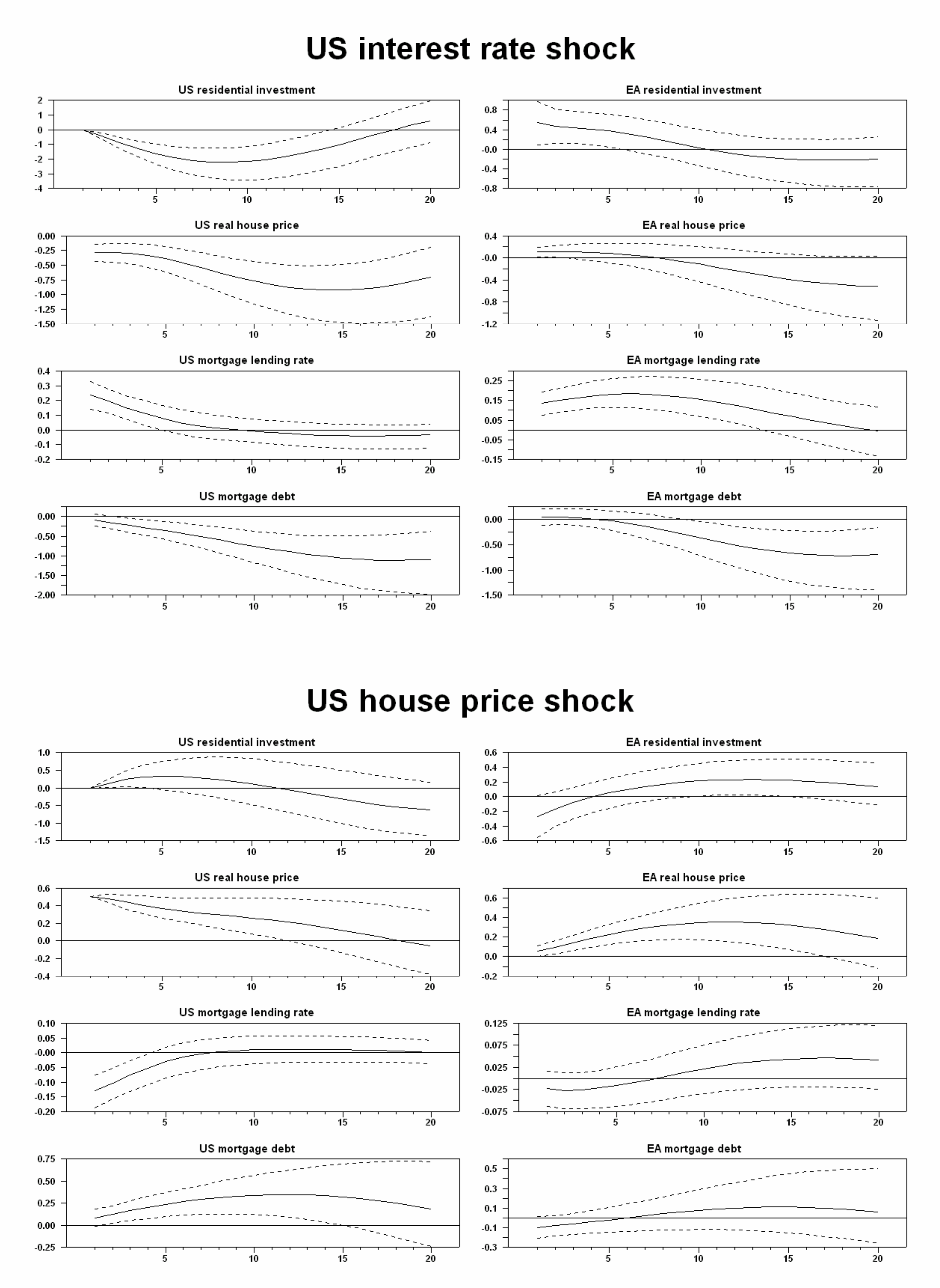


Residential investment shock

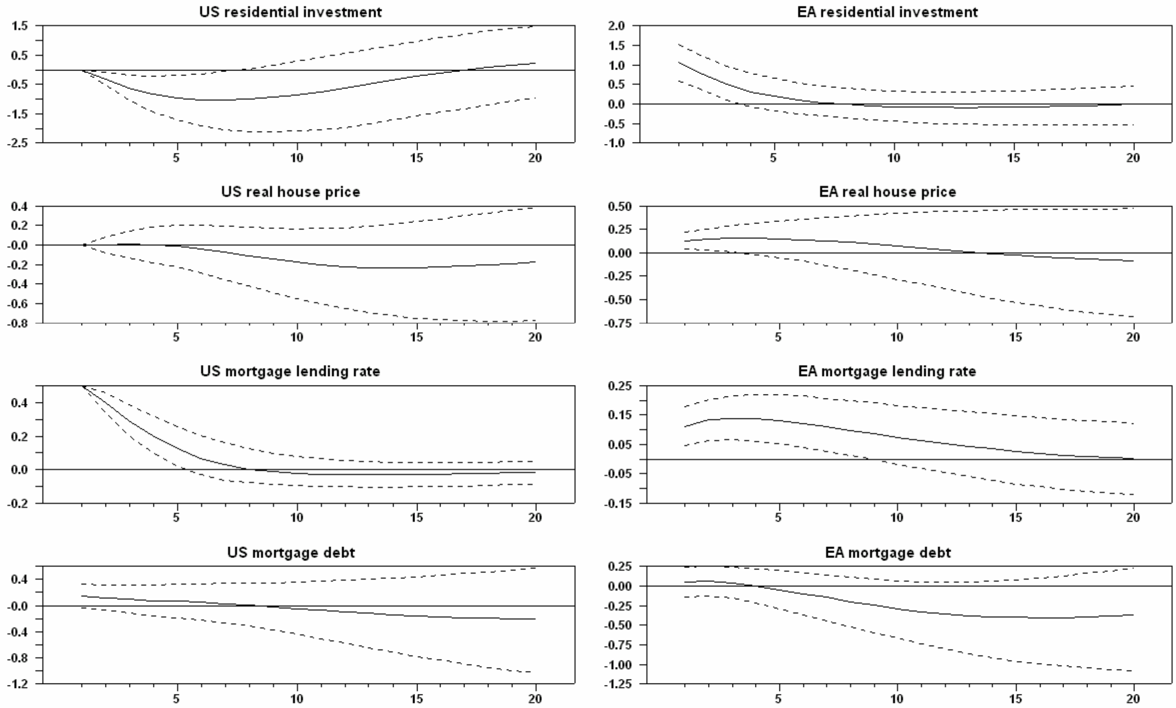


Note: Impulse responses based on the baseline VAR model for the euro area excluding Germany (see text for further explanations), estimated on the sample period 1986:1 to 2009:2. Confidence bands are based on the 68% significance level.

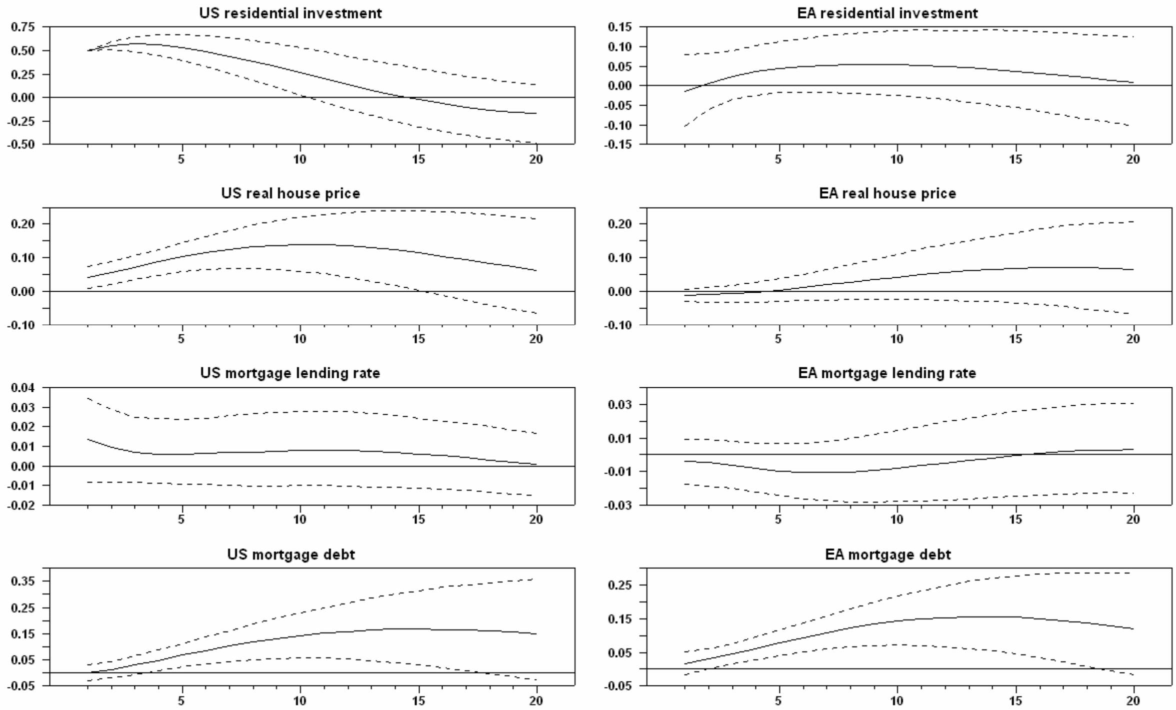
Figure 10 – Impulse responses for US and euro area housing variables to US shocks (joint US and euro area model, with US variables ordered first)



US lending rate shock

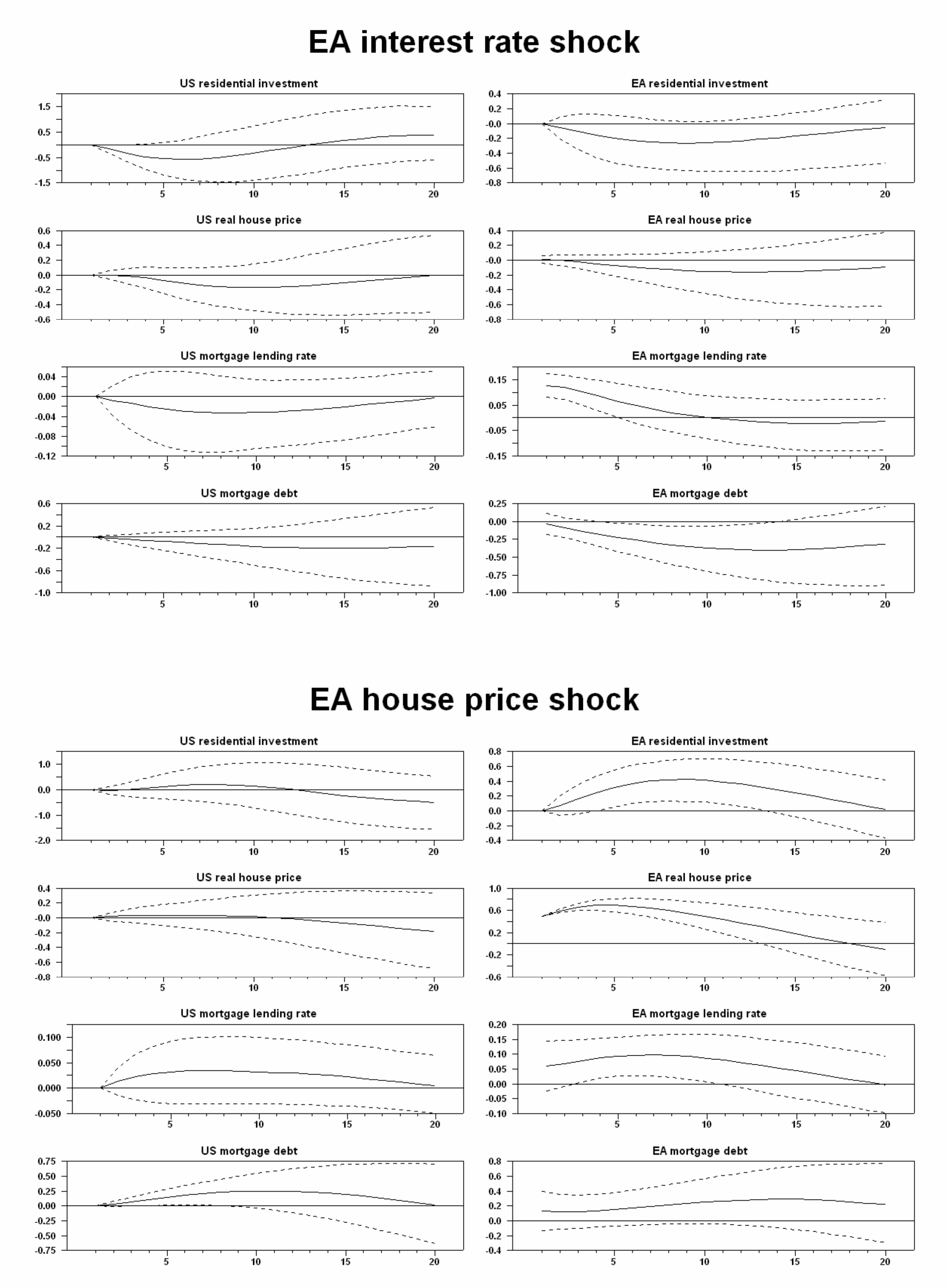


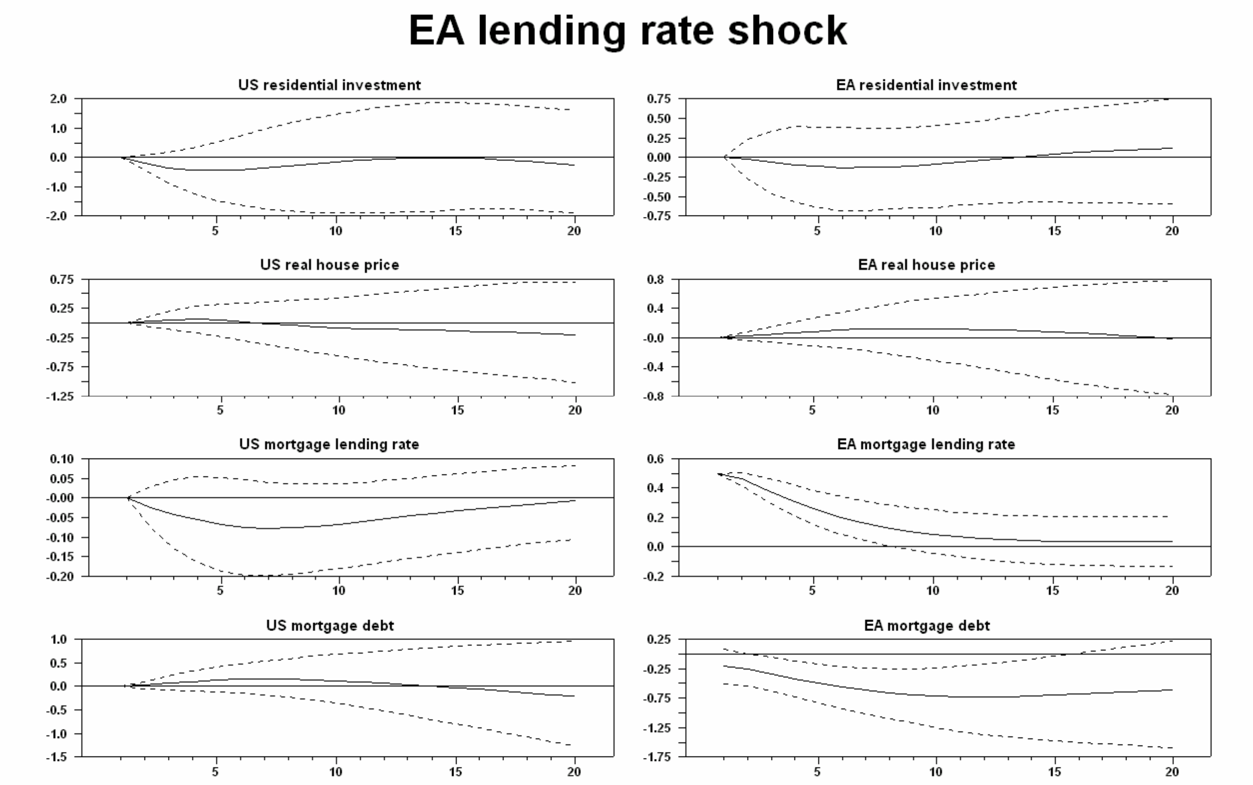
US residential investment shock

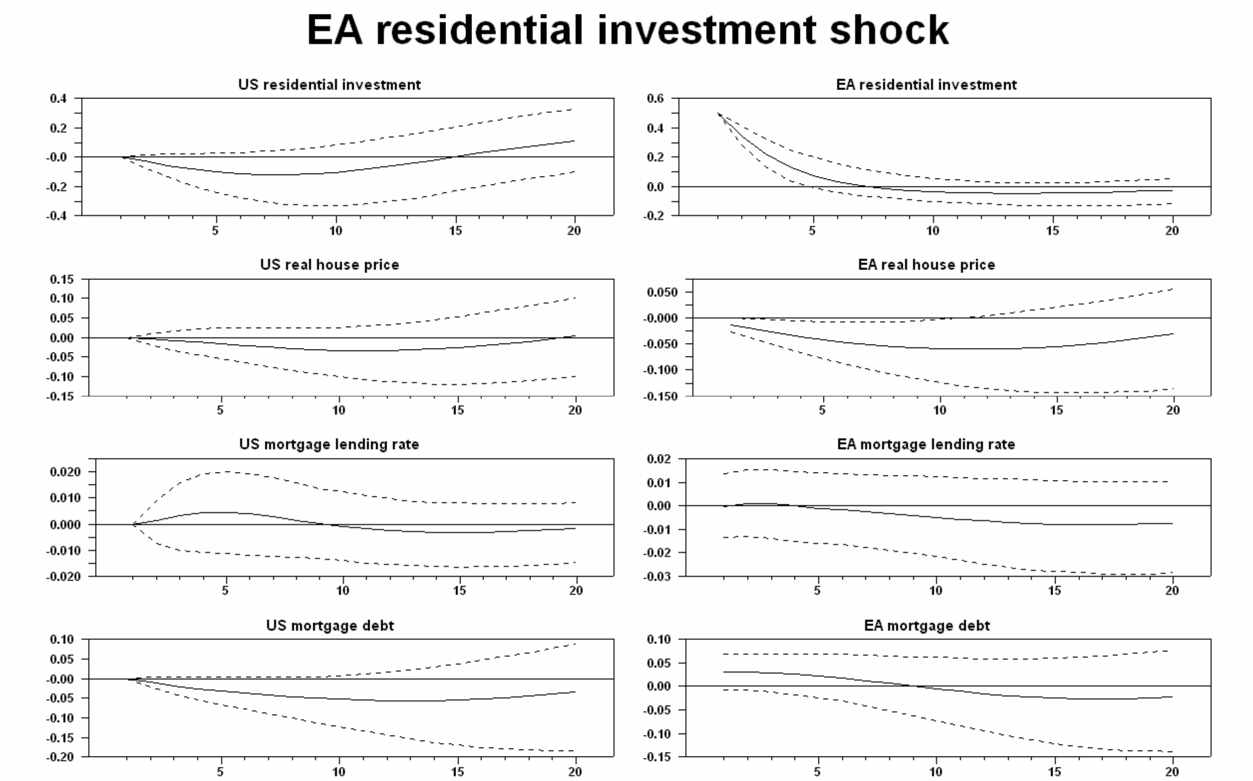


Note: Impulse responses to U.S. shocks based on the joint VAR model (see text for further explanations), estimated on the sample period 1986:1 to 2009:2. Confidence bands are based on the 68% significance level.

Figure 11 – Impulse responses for US and euro area housing variables to euro area shocks (joint US and euro area model, with US variables ordered first)

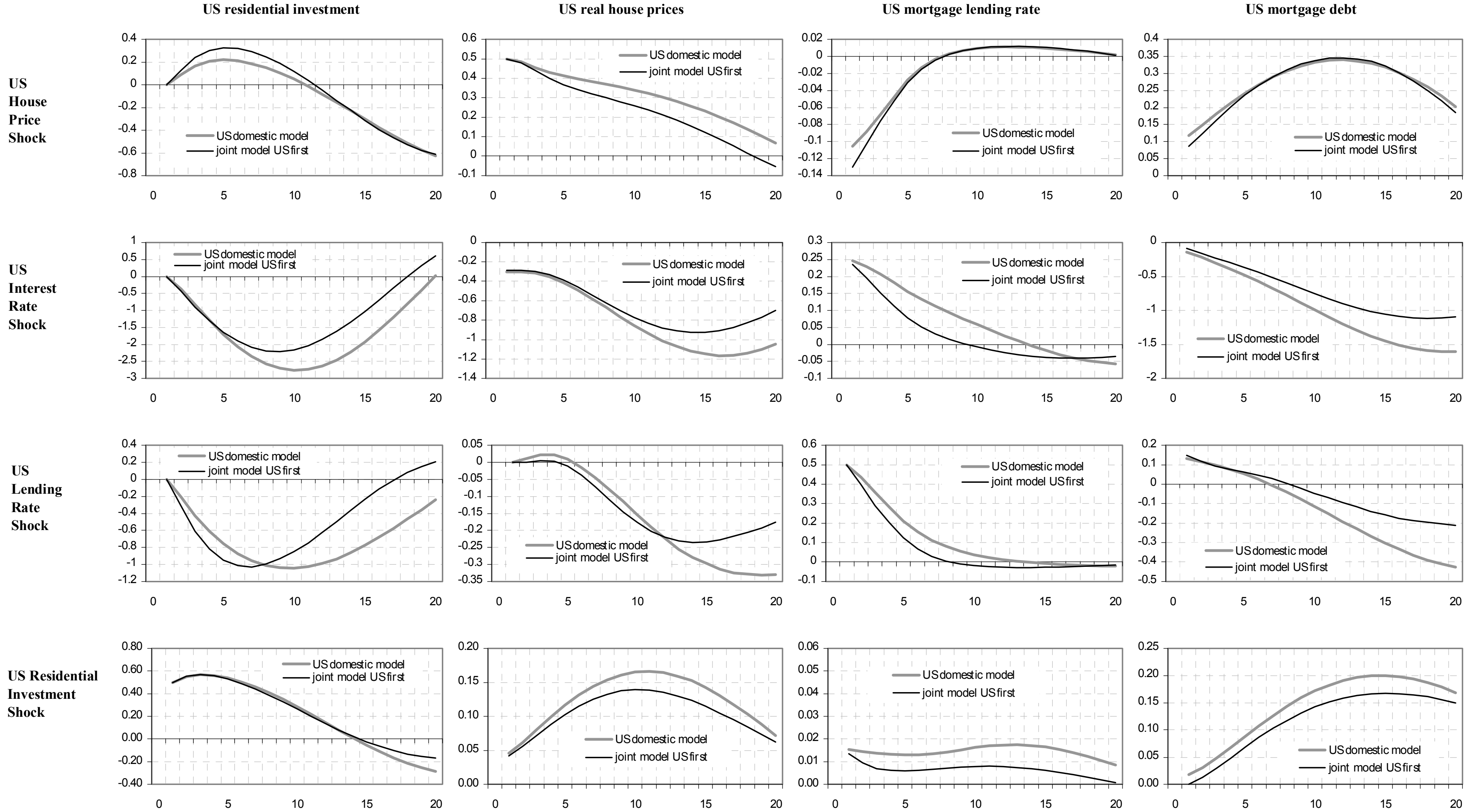






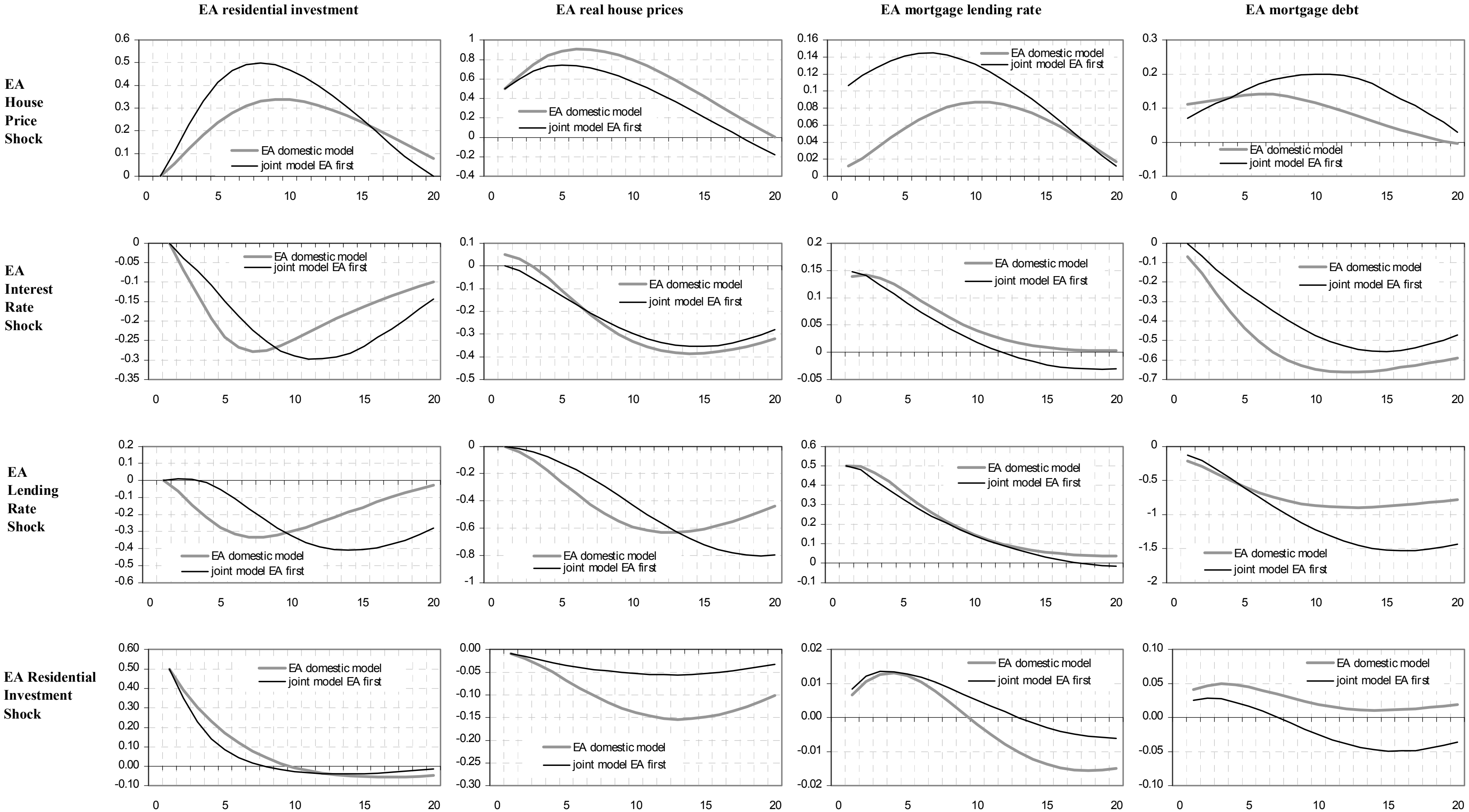
Note: Impulse responses to euro area shocks based on the joint VAR model (see text for further explanations), estimated on the sample period 1986:1 to 2009:2. Confidence bands are based on the 68% significance level.

Figure 12a. Comparison of impulse responses of US housing market variables to US shocks across two models



Note: Impulse responses to U.S. shocks based on the baseline (domestic) VAR model for the U.S. and on the joint U.S.-euro area model (see text for further explanations), estimated on the sample period 1986:1 to 2009:2. Confidence bands are based on the 68% significance level.

Figure 12b. Comparison of impulse responses of euro area housing market variables to euro area shocks across two models



Note: Impulse responses to euro area shocks based on the baseline (domestic) VAR model for the euro area and on the joint U.S.-euro area model (see text for further explanations), estimated on the sample period 1986:1 to 2009:2. Confidence bands are based on the 68% significance level.

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