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MONETARY POLICY SHOCKS AND THE ROLE OF HOUSE PRICES ACROSS EUROPEAN COUNTRIES

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Abstract

This paper provides a discussion of the 'housing market' channels of the monetary transmission mechanism (MTM) and offers some evidence on institutional differences in the European housing and mortgage markets. Using a number of VAR models, estimated individually for nine European countries over the pre-EMU period, we find that house prices are significantly affected by monetary policy shocks. The relative role of these policy-induced fluctuations in house prices for private consumption is then investigated. We show that house prices may enhance the effects of monetary shocks on consumer spending in those economies where housing and mortgage markets are relatively more developed and competitive.

Keywords: Monetary transmission, house prices, impulse responses.

JEL Codes: C32, E21, E52, R21.

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1. Introduction

The main task of the European Central Bank (ECB) is to conduct monetary policy for the euro area, with the primary objective of ensuring price stability and, although not directly specified as a final goal, non-inflationary economic growth. To achieve these objectives, however, the monetary authorities need to have a clear understanding of the effects of their policy upon the economy and the monetary transmission mechanism (MTM) across the Economic and Monetary Union (EMU) member countries. Many argue that the monetary regime switch created by the institution of the ECB renders any attempt to study the real effects of national central bank's actions with pre-1999 data less relevant. However, it is doubtful that this institutional change brought about behavioural changes in a sharp and discontinuous fashion. In this regard, evidence on agents' reaction to previous regimes can provide some useful insights on how they are currently behaving, and attempts to throw some light on the MTM based on the past experience might still have informative policy implications.

Over the last few years, many researchers have been trying to compare and analyse the effects of a monetary policy shock across countries (see for instance Barran *et al*, 1998; Peersman and Smets, 2001; Clements, *et al.*, 2001 and Sala, 2003). However, few of them attempt to identify the relative importance of individual channels of the MTM. Even fewer have tried to assess the specific role of asset prices. This is surprising, because the last decades have witnessed large asset price fluctuations, which have been shown to have affected the real activity in many industrialised countries (Girouard and Blöndal, 2001; Ludwig and Sloek, 2002 and Case *et al.,* 2002). In this regard, a particular emphasis has to be given to housing assets. This is justified by a number of factors. Firstly, housing represents more than half of the net wealth of the private sector in most European economies. Secondly, and differently from financial assets mainly owned by the better-off part of the population, home ownership is distributed more equally across households. Thirdly, and perhaps more significantly, housing has a crucial collateral role in the lending sector, which makes it a potential amplifying channel in the real effects of monetary disturbances. Finally, European countries present quite divergent and segmented housing and mortgage markets, which reflect differences in the intensity of competition of the banking sector, legal procedures, regulations in the rented sector, fiscal treatment of interest rates, housing transaction costs, *etc*.

Whereas some authors have pointed out the special transmission mechanism channels, through which house prices might play a significant role (Maclennan *et al*, 1998; Mishkin, 2001), relatively little work has been done to investigate the quantitative importance of such mechanisms. This paper aims at filling this gap, by providing some empirical evidence on the link between monetary shocks and residential prices, and between house prices and the largest component of aggregate demand (that is, consumption) for a number of European countries over the pre-EMU period.[1] This might provide not only useful indications in the U.K. and the Scandinavian countries (where, due to the financial liberalisation process of the 1980s, the housing and mortgage markets are relatively more competitive and efficient), but also policy implications for those economies in which this process is expected to show its effects in the future.

The remainder of the paper is organised as follows. Section 2 offers a brief descriptive discussion of the MTM channels, with a particular emphasis on those related to the housing-system. Section 3 presents a concise attempt to identify the main characteristics of the housing and mortgage systems across the EU countries, highlighting the potential implications for house price sensitivity to interest rate changes, and the role of residential asset price changes in the transmission mechanism. Section 4 contains the empirical results. The first subsection studies the role of interest rate shocks to house price fluctuations by making use of impulse response and variance decomposition analysis from alternative VAR models. The second subsection explores the role of these (monetary-policy induced) residential price changes on private consumption through the implementation of counterfactual exercises. Section 5 concludes.

2. The Monetary Transmission Mechanism and the Housing System

Economists point out a number of different channels through which a monetary policy change can influence consumption and investment choices. In particular, they distinguish between two main and not mutually exclusive views: the 'money view' and the 'credit view.' The conventional 'money view' refers to the traditional understanding of the monetary transmission based on the standard IS-LM-FE model, in which money supply and interest rate movements directly affect the real activity through the cost-of-capital, the

[1] Due to data availability on high frequency (quarterly) aggregate house price indices, the countries under study are Belgium, Finland, France, Ireland, Italy, the Netherlands, Spain, Sweden and the United Kingdom.

substitution and the income effects, and indirectly through asset price channels (that is, the exchange rate channel, the Tobin's *q* and the wealth effect).

More recently, additional mechanisms based on the 'credit view' have been explored. Bernanke and Blinder (1988) indicate two main effects through which credit enters the MTM: the bank lending channel and the balance sheet channel. The bank lending channel emphasises the special role that banks play in alleviating the problems of asymmetric or incomplete information in the credit market and in providing finance sources to certain borrowers (typically households and small firms) which depend heavily on bank loans. The balance sheet channel focuses on the effects of monetary policy on borrowers' financial position or net worth linked to their income accounts and balance sheets, and the resulting consequences on the overall terms and availability of credit.

Although the money and credit views provide different explanations of the functioning of the MTM, they share a common understanding of the importance of asset prices and, in particular, house prices. This is justified by a number of factors, such as the quantitative importance of housing wealth in most of the industrial economies, as well as the special characteristics of the housing system in the lending sector. Residential assets, however, are very different from other tangible and financial goods, in the sense that they have the dual nature of commodities yielding utility and investment assets. It is probably the presence of such factors, which makes it difficult to compare housing systems across countries and, more importantly, provide a clear-cut classification of the channels through which these markets enter the MTM. The next section provides a simple attempt in this direction.

2.1 The Housing Market MTM Channels

Maclennan (1994) argues that a fall in the cost of borrowing following a policy-controlled interest rate decrease has three main direct effects on the housing sector (Figure A.1 in Appendix A). Firstly, there will be an increase in construction of new dwellings and renovation of existing dwellings, through the traditional cost-of-capital channel. The second mechanism is linked to the interest-rate-income effects, according to which the existing borrowers with variable mortgage interest rates will take advantage of the lower cost of borrowing (and higher disposable income) by increasing their consumption and investments. Finally, first-time buyers and likely-moving owners may be encouraged to

purchase.[2] Given the rigidity of real estate supply in the short run (due to restricted land zoning and planning policies), they will also impact on house prices.

Obviously, the operativeness of the above channels depends upon the pass-through from official to bank mortgage interest rates and on the provision of housing lending. To this regard, different institutional characteristics of the banking system might play a significant role. In particular, as far as the pass-through to lending rates is concerned, for countries with a high diffusion of long-term fixed rates, monetary policy shocks will be propagated much more slowly, and therefore housing demand will react with some delay.[3] Other factors, which also affect the availability or supply of housing lending, depend upon the health of the banking system, its degree of competition and the legal aspects (e.g. repossession procedures).

The increase in house prices deriving from the higher demand is thought to affect the economic activity through a number of channels. First, on the basis of the so-called Tobin's *q* theory, residential investment could be further stimulated. In particular, when the ratio between house prices and construction costs is above unity, it is profitable for agents (i.e. individuals and construction company developers) to build new dwellings. The responsiveness of supply of new housing to house price movements (as well as interest rates and other demand shocks), depends upon the degree of competition in the construction industry, building regulations, land planning, availability of specialised labour and fiscal treatment of new housing.[4]

Second, residential price movements might lead to important income effects working through the market rented sector. With deregulated renting systems, higher house prices can be expected to cause higher rents for tenants. Higher revenues for landlords or institutional investors owning rental housing can partially offset the negative income effects faced by tenants. Under the assumption of a higher marginal propensity to spend out of income for the latter agents, however, it is reasonable to expect an overall negative income effect. The strength of this channel depends upon the housing tenure structure, the

[2] Similar to other asset prices (e.g. bonds and equities), house price increases reflect the rise in the present value of future streams of housing services. Other effects may come from increased income expectations, expectations of future house price rises as well as speculative behaviour (ECB, 2003).

[3] The reaction of long-term rates to policy-controlled interest rates is affected by inflation expectations and future short-term rates. While the mix between fixed and variable rates reflect differences in tastes and traditions, it is also true that individual inflation histories have played a crucial role.

[4] The ECB (2003) and Ball (2002) review some of the main cross-country studies, from which it emerges that a relatively low price elasticity of supply exists in Europe by comparison to the U.S., above all in the short run.

functioning of the rental market and the different reactions of agents (tenants, landlords and institutional investors). A rise in house prices is also likely to have positive saving effects for households planning to purchase a house, above all in those countries with high down-payment requirements or with a poorly developed (and rationed) housing finance system, which implies a higher use of internal funds (Kennedy and Andersen, 1994 and Muellbauer and Lattimore, 1995). The strength of this effect depends upon the required deposit/value ratios, which can be quite low in deregulated financial systems and highly competitive lending markets. Positive saving (or substitution) effects are also operative through changes in imputed rents of home-owners, although the perception of higher housing costs by the latter agents may be relatively low.

The third mechanism through which house price changes can affect the real activity is related to the balance-sheet channel, according to which home-owners are able to borrow against the (rising) collateral values. Miles (1994) and Muellbauer and Murphy (1997) have emphasised the role of mortgage equity withdrawal (MEW) (that is, the excess of net - of repayment - new lending for house purchase over all forms of investment in residential property), which provided households with liquidity to use in non-housing consumption in the U.K.. The ability of house-owners to extract equity embodied in housing wealth depends upon the competitive conditions in the mortgage markets, which affect the average loan-to-value (LTV) ratios, ease in re-mortgaging, possibility of second mortgages, and, in general, a greater availability of mortgage products.

The fourth channel is the housing wealth effect. Miles (1994) argues that it is unclear why changes in house prices should be expected to affect private spending through this channel. The fact that demand increases must be matched by the supply from the selling agents (trading-down or last-time sellers) implies that, at the aggregate level, gainers and losers might tend to balance out their wealth or capital changes. Therefore, there is no *a priori* reason why an increase in real house prices should be treated as a boost in real wealth, unless houses are traded internationally.[5] There are, however, some conditions under which the positive wealth effects for owner-occupiers could dominate the negative income effect on consumption for prospective new buyers. They are related to different marginal propensities to consume out of housing wealth between the two groups of agents. Additionally, it might be argued that, if owner-occupiers and landlords are not credit

[5] If a house in a country is bought by a foreigner, capital gains are enjoyed by the residents at the expense of capital loses of the buyers. This is what is happening in Spain and other Mediterranean countries where many British and North European citizens are buying second houses for retirement or holidays.

constrained and believe (possibly mistakenly) that the rise in real house prices is long-lasting or permanent, the increase in their housing wealth could lead to higher consumption levels of these agents.[6] In this regard, the 'liquidity' and 'perceived spendability' of housing assets play a central role.

Finally, the effects of house price changes on the real activity and, in particular, on the non-housing consumption expenditure could be further amplified or reinforced through expectations and 'confidence' effects. More specifically, a booming housing market could be the result of optimism over future income. Since current consumption is largely dependent upon the consumer sentiment, consumers could be stimulated to increase their spending even further (Arnold, van Els and de Haan, 2002).

3. Housing and Mortgage Systems across EU Countries

The previous section has shown the channels through which house prices could enter the transmission of a monetary shock into households' spending and investment decisions. The operativeness of these mechanisms, however, largely depends upon a number of factors related to the housing and mortgage systems. For instance, Maclennan *et al.* (1998) argue that: *"...countries with high (housing) transaction costs, low loan-to-value ratios, a small owner-occupied sector, a large tenure proportion in the private rented sector, and a large proportion of fixed interest mortgage loans, should experience relatively low real house price volatility, small house price effects on consumption and a small role for housing in interest rate transmission mechanism."*

This section provides some evidence on the major housing institutional differences between the EU countries and tries to assess whether the housing sector (and in particular house prices) could play an important role in the MTM across European countries.[7] Namely, we concentrate our attention on a number of factors which seem particularly relevant: the housing tenure structure, the transaction costs, and the main characteristics of the mortgage markets. Although the comparability and availability of data is not very satisfactory, the picture that emerges is clear enough to demonstrate a very high degree of heterogeneity in housing and mortgage systems across European countries.

[6] Ludwig and Sloek (2002) distinguish between 'realised' and 'unrealised' housing wealth effects. The latter refer to a higher discounted value of wealth which affect today's private consumption of non-credit constrained households.

[7] The structure and the content of this section draws on the paper by Maclennan *et al.* (1998), which has become the main reference for cross-country studies of housing and mortgage systems. Recently, the ECB published a report in which additional and more recent information has been collected (ECB, 2003).

Table A.1 in Appendix A shows the overall tenure structure of the EU countries, distinguishing between home-ownership, social housing and privately owned renting. This classification is particularly interesting, because a rise in real house prices can be thought of as having positive wealth effects for owner-occupiers and negative income and substitution effects for tenants in the market rented sector. Therefore, the higher the percentage of owner-occupiers and the lower the proportion of households renting a house, the larger the house price effect will be on consumption decisions. Moreover, the collateral effects of house price movements on private spending will be stronger, the higher the proportion of owner-occupied dwellings. The table displays pronounced cross-country differences, which could be explained by factors related to the heterogeneous fiscal treatment of home-ownership versus rental market, and to historical and cultural reasons. As far as the importance of owner-occupied dwellings is concerned, Ireland, Spain, Italy, Greece and Luxembourg range between 72% and 80%, while Belgium, Finland, Portugal, Sweden and the U.K. are in the range of 61% to 67%. All the remaining countries (namely, Austria, Germany, France, the Netherlands and Denmark) are particularly notable for owner-occupation rates which are well below the European average (63%).

Although the share of rented dwelling stock has decreased since the 1980s in most European countries,[8] the proportion of the private rented sector is still very high in Portugal, Austria and Germany (respectively, 30%, 35% and 40%). Belgium, Italy and Greece range between 22% and 27% and all the remaining EU members have low private rental sectors (in particular Ireland and the U.K.). As emphasised by Maclennan *et al.* (1998), however, the role of the private rented sector (and the corresponding income effects linked to house prices movements) has to be moderated by the presence of rent controls, which limit the sensitivity of the rental market to house price dynamics and the overall efficiency of the housing system. The latter controls are even more dominant in social rental accommodation, which represents more than half of the total rental sector in Finland, France, Ireland, the Netherlands, Denmark, Sweden and the United Kingdom.

The figures on the housing tenure can be better evaluated in relation to other important factors, which directly affect the sensitivity of housing demand and the perceived 'spendability' or 'liquidity' of housing assets: the presence of low transaction costs, easy

[8] The main reasons being the strict rent controls and the increased demand for home ownership related to easier access to mortgage credit, and favourable tax and subsidy policies. See Oxley and Smith (1996) and, more recently, the ECB (2003) for a more detailed discussion.

credit availability, instruments permitting MEW, high LTV ratios and a large diffusion of floating interest rate mortgages.

As far as transaction costs are concerned, the available data are not strictly comparable across EU countries. Nevertheless, Table A.2 show that Belgium, Spain, Portugal and Greece present the highest proportion of total transaction costs (e.g. solicitor's fees or notary's fees, property registration and taxes), which on average is higher than 10% of the house value. While the U.K., Sweden and Finland present the lowest percentage in Europe (between 3% and 4%), Austria, Denmark, Germany, France, Ireland, Italy, and the Netherlands are somewhere in the middle (around 7-8%). An important element of the total transaction costs, whose quantitative relevance is relatively easier to collect, are stamp duties. Data are not fully comparable in this case either and different sources provide different figures. However, recent figures reported by the ECB (2003) indicate that Denmark, Germany, Finland, France, the U.K., Sweden and Portugal present the lowest rates (between 1% and 4%). On the other side of the spectrum are Belgium and Greece (10%-13%), and Italy, the Netherlands, Austria and Ireland (6%-9%).

An influential factor affecting the sensitivity (and spendability) of house prices is given by non-monetary costs. For instance, EMF (2000) shows that the typical length of time necessary to conclude a housing transaction (including the mortgage credit procedure) might take more than four months in Italy, around two in France and the Netherlands, and not more than a month in Denmark and Sweden. These figures are consistent with the number of housing transactions, which provides a measure of liquidity of the housing market. From EMF data, it emerges that over the period 1987-98, the (yearly) number of transactions per 1,000 residents was as follows: Greece, 6.5; Germany, 7.2; Italy, 8.7; Belgium, 10.3; France, 12.1: Ireland, 13.5; Finland, 14.8; Denmark, 15.1; the Netherlands, 15.2; Portugal, 15.3; Sweden, 17.8 and the United Kingdom, 20.6.

Mortgage markets also differ widely from country to country in their size (which gives a measure of ease in accessing the housing loans for owner-occupation) and the variety of instruments available. Despite the deregulation and liberalisation process of the 1980s and 1990s, which affected the housing lending sector in most European countries, from Table A.2 it is possible to see how, in 1998, there were still quite pronounced differences in the household mortgage debt to GDP ratio. In particular, the latter ranges from 6-7% in Italy and Greece to 65% in Denmark. Sweden, the U.K. and Germany also present high ratios (between 50% and 57%). Data on the number of new residential mortgage loans provides another indicator of credit ease. Over the period 1987-98 the number of new mortgages

per 1,000 residents in Belgium, Ireland and Spain was respectively 13, 12.9 and 10.1. On the other side of the spectrum for the Netherlands, the U.K and Denmark, the respective figures were 26.2, 27.7 and 44.4. Finally, the ECB (2003) shows that some countries (Denmark, Germany, Ireland, the Netherlands, Finland, Sweden and the United Kingdom) offer instruments that permit households to tap on their housing wealth directly, providing some evidence in favour of a heterogeneous spendability of residential assets in Europe.

Data on the typical LTV ratios available to borrowers are shown in column five of Table A.2. With the only exception of Italy, which presents an extremely low 50% ratio, the remaining EU countries show ratios of around 70-80%, which are still well below the 90-95% ratio offered by the British banks. Although these figures refer to a specific year (namely 1998) and are affected by the position in the country-specific housing cycle, they are particularly informative, because they provide an approximate measure of the down-payment requirements, and represent an indicator of the collateral role of housing.[9] It is worth pointing out, however, that over the recent years the typical LTV ratios have shown a growing trend, although most EU countries have in place some mechanism rendering it costly to borrowers and lenders to agree on ratios above 75-80% (ECB, 2003).

Columns three and four of Table A.2 provide some information on the contractual features of the existing mortgage stock, that is, the typical term maturity and the interest adjustments of mortgage debt. Although the financial deregulation process has increased the product availability making, it very hard to define a typical contract in each country, Denmark is again an extreme case with a wide diffusion of mortgages with an interest rate fixed for the entire 25-year term. High levels of fixed interest rates can also be observed in France, Italy and Belgium. At the other end of the spectrum are Portugal, Finland and Spain (with, respectively, 100, 90 and 80% of variable interest rates), and the UK with almost all the mortgages categorised as renewable or re-viewable. All the remaining countries are characterised by the presence of a mixture of fixed, variable, reviewable and renegotiable interest rates.

It is clear, however, that even under the presence of a similar mix of variable versus fixed interest rates, the size and the timing of the pass-through of policy rates to mortgage

[9] Chiuri and Jappelli (2003) report the down-payment ratios for a number of European countries. Consistently with the figures on LTV ratios displayed in Table A.2, they show that the average down-payment ratio extended to home-buyers during the 1980s and 1990s was around 20% in Belgium, Finland, France, the Netherlands and Spain. Much lower figures characterise the U.K. and Sweden (on average around 10-15%), whereas Italy and Germany show the highest values (around 40%). Besides country-specific regulations, these differences can be explained by the judicial efficiency for the performance of credit markets, which affect the enforcement costs in mortgage markets.

rates play a crucial role in the sensitivity of the demand for housing to monetary shocks and, under short-run rigid supply, of residential prices. In this regard, some authors (BIS, 1994; Borio and Flitz, 1995; Cottarelli and Kourelis, 1995; Mojon, 2000 and Toolsema, Sturm and de Haan, 2002) have examined the short-term and long-term pass-through of money market rates to various bank retail rates across a number of countries. Although results are not clear-cut and must be considered with caution due to the specific rates used, different empirical approaches and sample periods, they show that there is a significant heterogeneity, which can be partly explained by country-specific legal aspects of the banking sector, the degree of competition and the integration of financial markets (Cecchetti, 2001). Looking at the effects of changes in money market rates on lending rates and mortgage rates, the above studies show that the United Kingdom and the Netherlands have the fastest response, whereas Italy, Germany, Spain, France and Finland present a much lower degree of pass-through.

From the above analysis, it is difficult to draw a clear-cut identification of the countries where house prices could play an important propagating role in the MTM. Nevertheless, it might be useful to attempt a rough classification on the basis of the institutional features outlined so far. Table A.3 provides the results of an 'experiment,' in which a number ranging between 1, 2 and 3 (indicating a relatively low, medium and high value) is assigned to the following five factors of the housing and mortgage markets:

- ratio between the size of the rented market and ownership tenure;
- number (and length) of housing transactions and transaction costs;
- mortgage lending availability and permissibility of products for MEW;
- typical LTV ratios and down-payments;
- mix between variable/fixed interest rate and 'pass-through.'

Although it is difficult to assess the relative importance of each factor, a visual inspection of the table suggests a low potential role of house prices in the MTM in Belgium, France, Italy and Spain, while a relatively more significant amplifying role could be played in Sweden, Finland and the United Kingdom. The following section aims at investigating whether these stylised facts are reflected in the estimation results.

4. The Empirical Methodology and Results

The empirical method adopted in this paper follows the vast majority of existing empirical literature. In particular, in order to identify discretionary monetary shocks and study their

impact on the variables of interest, we estimate a number of vector autoregressive (VAR) models. Letting $\mathbf{x}_t$ denote the *(nx1)* vector of endogenous variables and $\boldsymbol{\varepsilon}_t$ the *(nx1)* vector of structural shocks, it is assumed that the economy is represented by a linear, stochastic dynamic system of the following structural form:

$$\mathbf{B}_0\mathbf{x}_t = \mathbf{B}_1\mathbf{x}_{t-1} + ... + \mathbf{B}_p\mathbf{x}_{t-p} + \boldsymbol{\varepsilon}_t \quad (1)$$

where $\mathbf{B}_i$, $i = 0,...n$, are *(nxn)* matrix of coefficients and where the structural disturbances $\boldsymbol{\varepsilon}_t$ are assumed to be mutually orthogonal and have unit variance, implying that $E(\boldsymbol{\varepsilon}_t\boldsymbol{\varepsilon}_t') = \mathbf{I}$. Eq. (1) can be rewritten in the following reduced form:

$$\mathbf{x}_t = \mathbf{A}_1\mathbf{x}_{t-1} + ... + \mathbf{A}_p\mathbf{x}_{t-p} + \mathbf{u}_t \quad (2)$$

where the innovations $\mathbf{u}_t$ are assumed to have variance-covariance matrix $E(\mathbf{u}_t\mathbf{u}_t') = \boldsymbol{\Sigma}$. Noting that $\mathbf{A}_i = \mathbf{B}_0^{-1}\mathbf{B}_i$, for $i = 1,...n$, and the relationship between the innovations $\mathbf{u}_t$ and the structural shocks $\boldsymbol{\varepsilon}_t$ is given by :

$$\boldsymbol{\varepsilon}_t = \mathbf{B}_0\mathbf{u}_t \quad (3)$$

While OLS can be used to obtain consistent estimates of the parameters in (2) and an estimate of the symmetric variance-covariance matrix $\boldsymbol{\Sigma}$, to identify the structural shocks $\boldsymbol{\varepsilon}_t$ and the impulse response functions (IRF) coefficients it is necessary to determine the n^2 elements of $\mathbf{B}_0$. As is well known in the literature, system (3) provides n^2 equations in only *n(n+1)/2* restrictions defined by $\boldsymbol{\Sigma}$. Just-identification of such a model and, therefore, estimation of the matrix $\mathbf{B}_0$ and the structural innovations $\boldsymbol{\varepsilon}_t$ require *n(n-1)/2* additional restrictions. The most common strategies used by the VAR literature imply the imposition of restrictions (i) on the contemporaneous effects of reduced-form shocks or on the contemporaneous effects of the endogenous variables $\mathbf{B}_0$ (Sims, 1980; Bernanke, 1986 and Sims, 1986); and (ii) long-run *a priori* theoretical restrictions (Blanchard and Quah, 1989); and some combination of (i) and (ii) (Christiano *et al.*, 1999 and Galí, 1992). Given the lack of reliable or uncontroversial neutrality long-run restrictions, in this paper we adopt the first identification strategy. In particular, in order to add the required additional restrictions, we use a Choleski decomposition of the variance-covariance matrix $\boldsymbol{\Sigma}$ and, therefore, assume that $\mathbf{B}_0$ is lower triangular. The subsequent contemporaneous restrictions are discussed more thoroughly in the following sections.

4.1 The Role of Monetary Shocks for House Price Fluctuations

For a house price channel to exist, two inter-related channels should be operating, the first from monetary policy to house prices, and the second from the latter to the domestic economy. This subsection focuses upon the first link by using alternative VAR models estimated separately for each of the nine countries under investigation (namely, Belgium, Finland, France, Ireland, Italy, the Netherlands, Spain, Sweden and the U.K.). Similarly to a number of previous studies aiming at studying the MTM of European countries within a single monetary regime, the estimation sample is the pre-EMU period 1979:3-1998:4.

As in the vast majority of the monetary literature based on VARs (Christiano, *et al.*, 1999), although standard unit root tests indicate that some variables used in the models might be integrated of order one, we estimate the systems in levels, without explicitly modelling cointegrating relationships.[10] The models are estimated with different lag lengths according to the selection made by the Akaike Information Criterion (AIC) and the Schwartz Bayesian Criterion (SC). Longer lag lengths do not change the main qualitative results, although the rapid loss of degrees of freedom affects the statistical significance and the precision of the resulting impulse response functions (IRFs). In order to increase the efficiency of the estimated parameters, some dummies have been included for Ireland, Italy, and Sweden to take outliers into account, which were mainly observed in the reduced-form interest rate equations during the exchange rate crisis of 1992-93.[11]

4.1.1 Estimation of the Baseline Model

The first specification (Model 1) is characterised by the minimum number of endogenous variables necessary to model a monetary rule, in which authorities are concerned about output and price dynamics. In particular, this baseline model includes the (natural) log of the consumer price index (*CPI*), the log of the real gross domestic product (*GDP*), the log of the real house prices (*RHP*) and the money market interest rate (*MMR*) (see Appendix B

[10] Preliminary estimates show the presence of cointegrating vectors amongst the variables used in the models below. The correspondent long-run relationships, however, are difficult to interpret and to identify. Sims, Stock and Watson (1990) show that if cointegration among the variables exists, the system's dynamics can be consistently estimated in a VAR in levels. An alternative approach is to estimate VARs in first differences. This solution, however, implies discarding the information contained in the levels, and could lead to misspecification and over-differentiation.

[11] A time trend, a constant and a set of seasonal dummies are also included. With the only exception of Belgium (for which a constant only is used), the results with and without a time trend are very similar. In previous studies on house price equations it has been shown that a time trend could be a good approximation for housing stock dynamics. As a result, we prefer to include a linear trend to capture these effects.

for definitions).[12] The monetary policy shocks are identified through a Choleski decomposition consistent with the above ordering. Namely, it is assumed that interest rates react contemporaneously to changes in all the variables of the system, whereas prices, output and house prices are sluggish and react to interest rate innovation only after a quarter. Assuming alternative orderings does not change the main qualitative results.

Figure C.1 in Appendix C shows the IRFs of the baseline model. The restrictive monetary policy generates a significant and temporary decline in output in all the countries.[13] The only exception is Spain, where the real output fall is relatively small and not statistically significant. The timing of the real activity response differs from country to country. The maximum effect is reached after only 3-4 quarters in Italy and Sweden, whereas in all the other countries it takes between 5 and 8. In most cases, the increase in the short-term interest rate results in a temporary (but generally not significant) increase of the consumer price index, which tend to permanently decrease after around two years.[14]

In all countries but Ireland, real house prices follow a statistically significant U-shape pattern. Although a rigorous comparison of the point estimates is not warranted by the presence of heterogeneous definitions and construction (see Appendix B for a discussion), by normalizing the exogenous increase of the money market rate to 100-points, the maximum response varies between less than 1% in Spain, Sweden and Belgium, and more than 2% in France, Finland and the U.K.. Ireland, Italy and the Netherlands, with a response between 1.5% and 1.8%, are somewhere in the middle. These findings are roughly consistent with the analysis of the housing and mortgage systems across Europe, which suggest a heterogeneous sensitivity of residential prices to interest rate changes.

Figure C.1.1 shows the share of the total variation of the real house price attributable to each specific shock. The figures indicate that in all countries, residential price volatility is mainly driven by innovations to the real house price equation. Besides shocks to the

[12] In this paper as many previous studies, innovations in short-term interest rates are used as a measure of shocks to monetary policy. Although central banks have a wider set of policy instruments at their disposal, the assumption that during the sample period 1979-98, the individual European CBs have used short-term interest rates as their main tool does seem more than reasonable (Borio, 1997).

[13] Confidence bands are the 5th and the 95th percentiles computed by Monte Carlo simulations based on 1,000 replications. See Sims and Zha (1999).

[14] The previous empirical literature on the MTM in small open economies generally finds statistically significant increases of the price level following a monetary contraction (that is a 'price puzzle'). This result is generally associated with the low number of endogenous variables included in the models, and the subsequent omission of leading indicators for inflation, to which central banks react (Sims, 1992). The main successful solution proposed by the empirical U.S. literature relies on adding current and lagged values of commodity or oil prices. This strategy, however, does not seem to be very successful in European countries (results not shown). Our estimated IRFs show that in most countries, the price puzzle is not a serious problem, providing some evidence in favour of the relevance of house prices to study price dynamics.

output equation, innovations to the *MMR* equation play a significant role (between 7-8% in Finland, and around 25% in Italy, France, and the U.K) in driving house price fluctuations. This provides additional evidence on the role of interest rates changes in explaining house price dynamics.

4.1.2 Augmenting the Model with the Exchange Rate and the German Interest Rate

The above specification describes a closed economy model. This might not be an ideal choice if the aim is to identify unexpected monetary shocks for relative small and open economies. Moreover, the estimation period has been characterised by exchange rate targeting and management of the currency parities, and by a leading role of German monetary authorities. As a result, in order to account for the anchoring role of the Bundesbank monetary policy during the ERM, the robustness of Model 1 is tested by augmenting the previous specification with the log of the nominal exchange rate versus the DM (*NER*), and including the contemporaneous German money market rate as exogenous variable (Model 2).

Figure C.2 shows the IRFs of the system in which the exchange rate is positioned last.[15] Results are very similar to the ones estimated from Model 1. Due to the loss of degrees of freedom, however, the uncertainty around the points estimates is higher. In most of the countries, it is found that a rise in the money market rates is associated with a domestic appreciation, which is not always statistically significant. In Spain and Italy a puzzling exchange rate depreciation (the so-called 'exchange rate puzzle') is visible. To test the robustness of these findings, following Sims (1986) and Bernanke (1986), for each country we have estimated a semi-recursive VAR allowing for contemporaneous feedback effects between the money market rate and the exchange rate. This identification strategy seems to solve the exchange rate puzzle in Italy and Spain, but the impulse responses of all the other variables in the system are qualitatively very similar to the results obtained in the recursive Model 2.[16]

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[15] Under the Choleski decomposition, however, it is hard to find an ordering which is unquestionable. Ordering the exchange rate before the interest rate would imply the assumption that the latter does not contemporaneously affect the former. The reverse would impose no current feedback reaction of the monetary authorities to exchange rate fluctuations over the same quarter. Bearing this in mind, both orderings have been imposed with no evidence of significant differences in the estimated impulse response functions.

[16] A detailed description of the structure of the contemporaneous identifying restrictions and the resulting results are documented in Chapter 2 of Giuliodori (2003) and are available from the author upon request.

Hence, in what follows, we continue to present and discuss the results obtained with the Choleski decomposition. Moreover, although the nominal exchange rate and the German money market rates can improve the identification of the monetary shocks in the countries under investigation, the above findings indicate that their contribution in explaining the effects of discretionary interest rate shocks on the variables under investigation is marginal. As a result, in order to save degrees of freedom, we proceed with the baseline model as our benchmark specification.

4.1.3 Augmenting the Model with Mortgage Market Variables

In this section we further generalise Model 1 by augmenting it with two important variables entering the MTM to house price, that is, the mortgage interest rate and the housing mortgage stock. The inclusion of the former variable allows us to model house price dynamics including a more direct cost of housing lending. The second aims at controlling for the effects of the financial liberalisation process which, started in the early 1980s, lead to a dramatic rise in housing lending availability with subsequent sharp booms of the housing market in many countries. The resulting vector of endogenous variables forming this system (Model 3) is $\mathbf{x}_t = (CPI_t, GDP_t, RHP_t, MMR_t, MST_t, MR_t)$, where *MST* is the (natural) log of the real housing lending stock and *MR* is the level of the representative mortgage interest rate (see Appendix B for definitions).[17]

Figure C.3 displays the estimated impulse responses. As expected, in most of the countries a temporary increase in the money market rate generates a contemporaneous increase in all the mortgage rates. The only exception is France, where the mortgage rate is hardly affected. Although a comparison of the responses across countries is not warranted because of heterogeneous definitions of the mortgage rates used in the estimation, it is worth point out that the maximum effect is reached only after four quarters in Belgium and two quarters in the Netherlands, France and Ireland. As for the real mortgage stock dynamics, in all countries but Ireland monetary shocks are followed by a reduction of the overall housing lending, which closely matches the response of house prices to the monetary contraction.[18] Finally, the IRFs of the other variables are qualitatively very

[17] For Italy the mortgage stock and the mortgage interest rate were only available from 1989 and 1987, respectively. Due to degrees of freedom problems, Italy is not included in the sample. We have, however, tested the robustness of the results including the long-term interest rate, finding no significant changes.

[18] Substituting the housing lending stock with the money aggregates (M2 or M3) produces very similar responses. The latter variable is generally included to improve the identification of money demand from money supply shocks.

similar to the results of Models 1 and 2. Overall, the identified monetary shocks seem to play an influential role in the housing market. However, it is not clear to what extent these policy-induced response of residential prices enter the MTM to the real activity. The next section makes a step forward in this direction.

4.2 The Role of House Prices in the MTM to Consumption

So far, attention has been focused on how discretionary money market rate shocks affect real house prices. The purpose of this sub-section is to investigate the quantitative significance or amplifying role of these effects in the transmission of monetary shocks to non-housing expenditure. In order to achieve this, two approaches are implemented. The first is based on a counterfactual simulation exercise in which the effect of house price on private consumption is shut off, the second on the estimation and comparison of models in which house prices enter the systems endogenously and exogenously, respectively.

4.2.1 A Counterfactual Simulation Exercise

Following Bernanke, Gertler and Watson (1997), Sims (1998), and more recently, Lettau, *et al.* (2002), we implement a two-stage approach. In the first stage, to directly identify the effects of monetary shocks on private spending, Model 1 is augmented with the (natural) log of the real private consumption (*CON*). The resulting baseline model (Model 4) is then given by the following endogenous variables $\mathbf{x}_t = (CPI_t, GDP_t, CON_t, RHP_t, MMR_t)$.[19] In imposing a Choleski decomposition, similarly to the systems estimated in the previous sections, real variables are assumed to react sluggishly to interest rate changes, whereas monetary authorities can account for prices and real variables dynamics in setting their interest rates. Additionally, the above ordering imposes the hypothesis that consumption is not contemporaneously affected by house price fluctuations. The latter assumption is suggested by the fact that the actual house price data might not be readily available within the same quarter and, as a result, consumer spending is not affected by contemporaneous changes in real asset values. Alternatively, this restriction can be thought of as a sluggish response by consumers to house price changes.[20] The above system, in which the

[19] In a previous version of this paper (Giuliodori, 2003), a similar counterfactual simulation exercise was conducted. Differently from above, however, the baseline specification contained the same variables of Model 2, and the monetary shocks were identified, allowing for feedback effects between money market rates and exchange rates. Results are very similar to the estimates provided below.

[20] The reverse ordering, according to which consumers' behaviour is affected by real house prices within the same quarter, was tested with no significant changes of the main results.

endogenous response of house prices and their influence on consumption are incorporated, is used to trace out the impulse response function of private spending to the interest rate shock in the conventional way.[21]

In the second stage, the effects of such a shock are simulated under a counterfactual regime, in which the effects of house price fluctuations to private consumption are 'shut off.' This is done by setting to zero the estimated coefficients of the matrixes $\mathbf{B}_1,...,\mathbf{B}_p$ in eq. (1) corresponding to the lagged effect of real house prices on the consumption equation, but, at the same time, keeping all the remaining structural parameters fixed to their baseline value. The 'counterfactual' impulse response function of the private spending to the same money market rate innovation is then re-computed and compared with the one estimated in the first stage. The difference between the two responses can be interpreted as a measure of the propagating contribution of the house price in the effects of a monetary shock to household consumption.[22]

Figure C.4 shows the responses to a monetary contraction in Model 4, our first-stage specification. As for the variables common to the previous models, the quantitative and qualitative responses are basically unchanged and support the main findings on the sensitivity of the house prises to the identified monetary policy shock. Additionally, a statistically significant U-shaped response of private consumption is found.

Figure C.5 displays the point estimates of the response of private consumption to the monetary contraction under the counterfactual and the baseline scenarios. From a visual inspection, it is interesting to see that the propagating role of house price on consumption seems particularly strong in the U.K., and, by concentrating on the peak response of private spending to monetary shocks, in Sweden, the Netherlands and Spain. In countries like Finland, Italy and France, the estimated responses under the two scenarios are very similar, giving some support of a weak role of house price in the MTM to consumption. In Belgium (and also Spain after 10 quarters), the simulated response of consumption to the monetary shocks is larger than in the baseline model. This is consistent with the

[21] We have also estimated the above system substituting the total output with the "rest of GDP", that is, the difference between GDP and private consumption. Results obtained with this change are almost identical to the ones shown in this section. Given that the GDP could proxy the dynamics of disposable income (a key variable in any consumption equation), in order to avoid misspecification problems, we have opted for the above specification.

[22] In doing so, we are subject to the Lucas Critique. Differently from Sims (1998) and other authors, however, we do not entirely replace the estimated equations of the baseline model with alternative ones estimated from a different sample period, but simply try to assess the quantitative role of a variable in the MTM within the same model. Given the nature of the counterfactual employed in this paper, the risks associate with the Lucas Critique seem less severe.

dominance of the saving effect over the balance-sheet and wealth channel emphasised in Section 2.

4.2.2 Endogenous versus Exogenous House Price Models

To test for the sensitivity and robustness of the counterfactual simulations, an alternative approach aiming to disentangle and quantify the strength of the house price channel is now implemented. In particular, following Morsink and Bayoumi (1999) and Clements *et al.* (2001), as in the previous section we first estimate the baseline model (Model 4), in which the real house price is included as an endogenous variable. This model is then re-estimated, eliminating the house price equation, while maintaining the lagged values of the real house price in each equation of the system. In doing so, the latter model (in which residential prices are treated as exogenous) blocks off any effect within the VAR that pass-through the endogenous house price response to the interest rate shock.[23]

Similar to the counterfactual experiment shown above, comparing the responses of the two models to monetary policy shocks could provide a measure of the role of the house price channel in the MTM. Figure C.6 shows the results, from which it is possible to roughly confirm the conclusions of the previous simulation. The only difference is given by Finland, where the peak response of consumption in the exogenous-house-price model is much smaller than in the baseline scenario.[24] In Spain the reaction of private spending to the monetary contraction under the 'exogenous' scenario is now much smaller over most of the horizon period.

Overall, the results shown in Figures C.5 and C.6 are consistent with the existence of an amplifying role of house prices in the MTM to consumption in those countries where housing and mortgage markets are relatively more competitive. These conclusions seem to be in line with the estimated responses of private spending to an exogenous house price shock estimated from Model 4 (Figure C.7). In Finland, Spain, the Netherlands, Ireland, Sweden and the U.K., a positive innovation to the house price equation generates a statistically significant positive response of private consumption. In France and Italy the response is not statistically different from zero, whereas in Belgium is negative.

[23] We have also performed a 'block exogeneity' or 'block exclusion' test to determine whether lags of the real house price index enter the other equations. In most cases, except Italy and Ireland, the likelihood tests indicate that RHP is not block exogenous at the 5% level of significance.

[24] France also presents some differences, but in the medium-long run where the response of consumption to monetary shocks are not statistically significant.

5. Conclusions

Over the last few years many researchers have been trying to compare and analyse the effects of monetary policy shocks across European countries. Few of them, however, focus on single channels of the MTM. Even fewer have attempted to assess the role of house prices. This is rather surprising, because housing represents more than half of the net wealth of the private sector, and plays a crucial role as collateral for households' borrowing. In this respect, while many economists argue that residential prices fluctuations have effects on the real activity, little work has been done in investigating the role of such assets in the MTM.

This paper provides some qualitative and quantitative evidence of the link between monetary shocks and residential prices, and between house prices and economic activity over the ERM period for nine European countries, by using alternative VAR models. From the estimated impulse response functions and variance decomposition analyses, house prices are found to be significantly affected by monetary shocks in most of the countries under investigation. In particular, the results show that temporary restrictive unexpected monetary policies have short-run negative effects on real house prices and that the size of the response is partly consistent with differences in the housing and credit systems.

The role of these house price changes in the MTM to private non-housing consumption is then assessed through the implementation of two alternative exercises in which the amplifying role of these assets is directly quantified. Results show that in those countries where the financial liberalisation process strongly affected the housing lending system (Sweden, the U.K. and Finland), house prices appear to play an important role in the transmission of a monetary shock to household consumer spending. Results in this direction are also found in Spain and the Netherlands.

The above findings suggest that in European countries where the financial deregulation process was less intense, house prices might become a significant amplifying variable in the MTM and that their role should not be ignored in a proper assessment of the effects of interest rate changes on real activity. The recent upward competitive pressures witnessed in the mortgage markets in many continental countries and the subsequent increase in the housing lending to the household sector and mortgage products over the last few years are evident signs in this direction.

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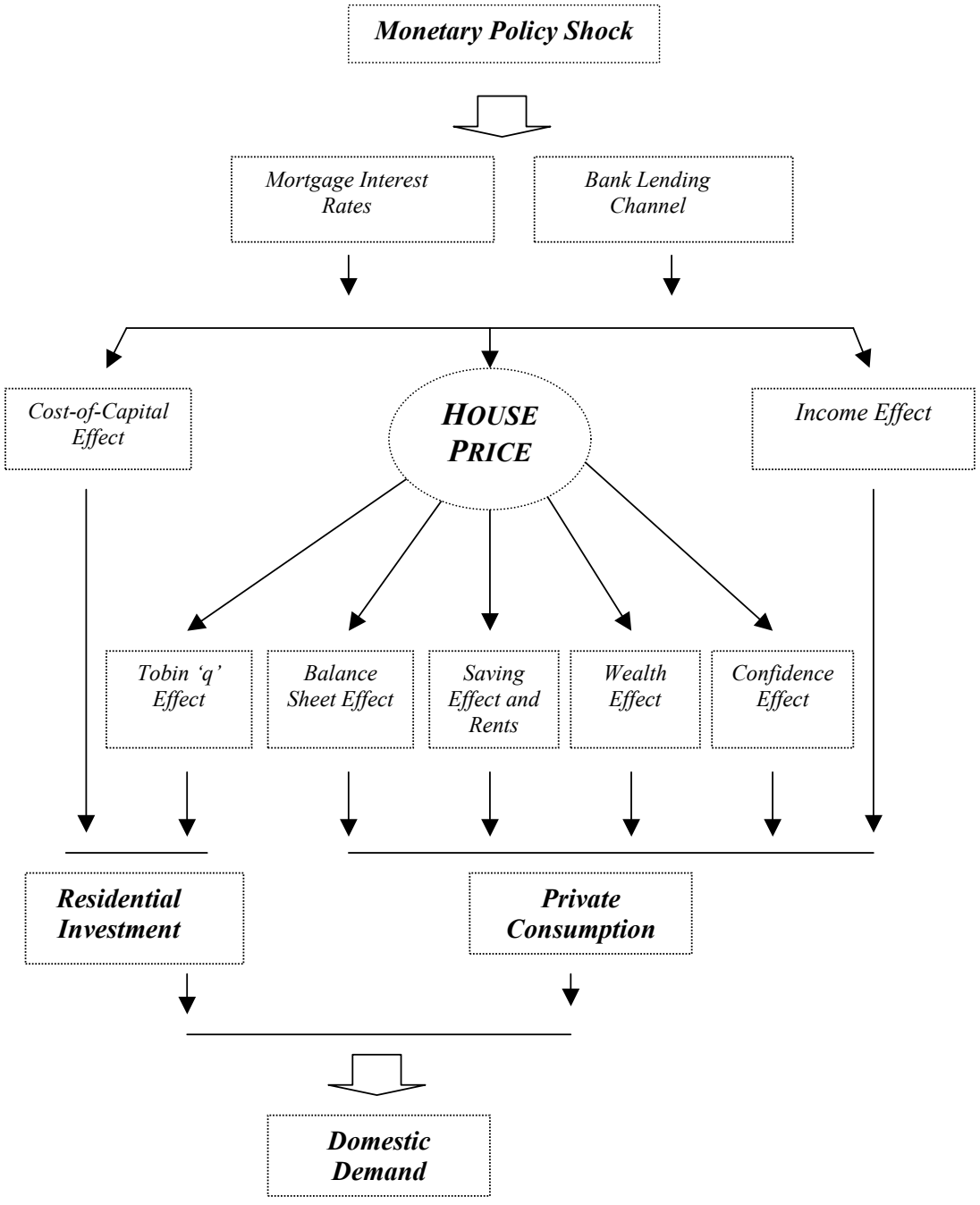
APPENDIX A

FIGURE A.1 The 'Housing-Market-Related' Monetary Channels



Notes: For simplicity, the diagram does not display all interactions between variables. See the main text for a discussion.

TABLE A.1 Housing Tenure Structure in Europe

	Owner Occupation Rate	*Social Rental Occupation Rate*	*Private Rental Occupation Rate*	*Other*
Austria	50	15	35	0
Belgium	65	8	27	0
Finland	62	16	14	8
France	54	21	17	8
Germany	40	20	40	0
Greece	75	0	24	0
Ireland	80	10	10	0
Italy	75	3	22	0
Luxembourg	72	23	2	3
Netherlands	50	36	14	0
Portugal	66	4	30	0
Spain	78	0	18	4
Denmark	53	21	18	8
Sweden	61	22	17	0
United Kingdom	67	23	10	0
Euro Area	*64*	*13*	*21*	*2*
EU	*63*	*15*	*20*	*2*

Sources:EMF (1998), Oxley and Smith (1996) and Maclennan *et al.* (1998).
Notes: Tenure expressed as % housing stock and refer to the mid-1990s. Data are not fully comparable for the presence of different definitions. See the above references for details.

TABLE A.2 Mortgage Systems in EU Countries

	Residential Mortgage Loans Stock as % GDP	*Interest Adjustment*	*Typical Term (years)*	*Typical LTV Ratio*	*Total Transaction Costs*
Austria	33	Some F Mostly N R	20-30	80%	7-8%
Belgium	22	N (40%) F (60%)	20	80%	Over 10-12.5%
Finland	30	V (90%)	10-15	70-80%	Over 4%
France	21	F (80%) V (20%)	15-20	70-80%	13.8% (1994) 7-8%
Germany	51	F (20%) N (40%) R (40%)	25-30	60-80%	7.1%
Greece	7	F (12%) R (72%) N (16%)	15	50-75%	Up to 20%
Ireland	27	F (64%) R (31%)	20	80%	7-8%
Italy	7	V (40%) F (60%)	10	50%	7.4%
Netherlands	60	V (10%) N (65%) F (25%)	30	75%	7-8%
Portugal	26	V (100%)	15	80%	> 10% in 1994
Spain	22	V (80%) F (20%)	15-20	70-80%	10.4%
Denmark	65	V (10%) F (90%)	25	80%	7.2% (2001)
Sweden	51	Mainly R and Short Term N	20-30	70-75%	Less than 3%
United Kingdom	57	R (70%) N (30%)	25	90-95%	Less than 3%
Euro Area	*27.8*		*19*	*73%*	
EU	*34.2*		*20*	*75%*	

Sources: EMF (1998), Lea *et al.* (1997), Maclennan, *et al.* (1998), Henley and Morley (2001), ECB (2003).
Notes: EMF data are mortgage loans for owner-occupation and rental purposes (not fully comparable). Fixed (F): rate fixed until final maturity; Renegotiable (N): rate not fixed over entire term, but more than one year; Variable (V) rate adjustable according to index; Re-viewable (R): rate adjustable at discretion of lender.

TABLE A.3 The Role of House Prices in the MTM

	Housing Tenure (Rented vs Ownership)	*Number (Length) of Transactions and Transaction Costs*	*Mortgage Availability and Equity Withdrawal (MEW)*	*Typical Loan-to-Value (LTV)*	*Fixed vs Variable Interest Rates and Pass-through*
Belgium	1	1	1	2	1
Finland	2	3	2	2	3
France	2	1	1	2	1
Ireland	3	2	2	2	1
Italy	2	2	1	1	1
Netherlands	2	2	3	2	2
Spain	2	1	1	2	2
Sweden	2	3	3	2	3
United Kingdom	3	3	3	3	3

Notes: In all columns 1 indicates relatively low, 2 a medium and 3 a relatively high potential propagating role of the house prise in the monetary transmission mechanism. The first column classifies the countries according to the housing tenure. The average ratio between the size of the rented market and ownership tenure is 0.32. The only country above this number is Belgium (0.41). The U.K. and Ireland present a ratio equal to 0.15 and 0.12, respectively. The other countries range between 0.23 and 0.31. The second column summarises the information on number, length and cost of transactions. Belgium and Spain have the lower number and/or the highest cost of housing transactions. On the other side of the spectrum, Finland, Sweden and the U.K. have relatively higher number of transactions (over 15 transactions per 1,000 people each year), lower costs (between 1-4%) and (if available) shorter transaction length (around one month). The third column summarises the information of the availability of housing lending and the permissibility of products for MEW. As for the former criterion, France (21%), Belgium (22%), Italy (7%) and Spain (22%) are well below the average (34%). Although the ratio in Finland (30%) and Ireland (27%) are still relatively low, their markets have instruments facilitating MEW (as a result they have been classified with 2). The remaining countries (the U.K., Sweden and the Netherlands) have ratios greater then 51%. Column four contains the information on loan-to-value ratios. The average typical LTV ratio is 70-80%. Italy is the only one below this value (50%), whereas the U.K. the only one above (90-95%). Finally, the last column provides a classification based on the diffusion of variable mortgage interest rates. Finland, Sweden and the U.K. have mainly variable interest rates (over 90%), whereas Belgium, France, Ireland and Italy shares of fixed rates above 60%.

APPENDIX B Data Description and Sources

Data are obtained from the International Financial Statistics (IFS) of the International Monetary Fund and the Business Sector Data Base (BSDB) of the OECD. The variables used in this paper are the following:

GROSS DOMESTIC PRODUCT at constant prices. The quarterly real GDP series are taken from BSDB (series GDPV) and are seasonally adjusted.

CONSUMER PRICE INDEX. The series on the non-harmonised consumer price index (CPI) are obtained from IFS (series 64…ZF… for each national series) and the original base year is 1995=100.

PRIVATE FINAL CONSUMPTION at constant prices. The quarterly private consumption series are taken from BSDB (series CPV) and are seasonally adjusted. It includes goods and services, as well as durable products (such as cars, washing machines, and home computers), purchased by households. It excludes purchases of dwellings, but includes imputed rent for owner-occupied dwellings.

OUTSTANDING STOCK OF HOUSING LENDING. The series on the nominal value of the stock of housing lending to households are provided by the NCBs. Definitions and construction methods are not homogeneous across countries, but they are within the same national housing mortgage markets. Data are available starting from 1980. The real housing lending stock used in the estimations are deflated with the GDP deflator.

OIL PRICE INDEX. This is the US$ price per oil barrel taken from IFS (series 000176AAZZF…).

NOMINAL EXCHANGE RATE. The nominal exchange rate refers to calculated units of domestic currency per D-Mark and are calculated by using the IFS data (series …RH..ZF). For Ireland we use the Irish Punt/Sterling exchange rate.

SHORT-TERM INTEREST RATES. The nominal interest rate is the money market rate (IRS) and comes from IFS (series 60bZF…).

MORTGAGE INTEREST RATES. These have been collected from two main sources: NCBs and the ECB web page. Although an effort has been made to obtain a representative mortgage interest rate weighted according to the typical mortgage instruments offered in each country, in some cases, due to availability, they refer to a specific contract. As a result, it is not advisable to make cross-country comparisons concerning the level of these interest rates. In some cases, in order to extend the time availability, annual data are

interpolated using the growth rate of long-term interest rates. Table A.1. shows the sources and, when available, the definitions. Italy is not available.

TABLE B.1 Mortgage Interest Rates in the EU

	Definition and Source
Belgium	Mortgage Loans with Amortisation. Refers to lowest rate offered to clients, secured with a full mortgage. Fixed rate, 5-year revision. ECB
Finland	Average of mortgage interest rates to the households referred to new loans and the stock. Floating rate. ECB.
France	Weighted average of fixed (80%) and variable (20%) interest rates on mortgages. ECB.
Ireland	Variable mortgage lending to households. Rates are the average variable rates offered by building societies to households. Floating rate. ECB.
Netherlands	Nominal 5-years rate on mortgages for residential real estate and shop-property. Mortgage loans from credit institutions. Fixed for 5 year rate. ECB.
Spain	Average interest rate on new mortgage loans to households for house purchase (in domestic currency) offered by commercial and saving banks. NCB.
United Kingdom	Average effective mortgage rate. NCB.
Sweden	Average of the daily Sweden 5-year (Spintab) mortgage lending rate and the 'Stadshypotekets lån till villor löptid 5 år' (mortgages to villas, 5 year). NCB.

HOUSE PRICE INDEX. Table B.2 shows the sources of house price statistics together with their time span availability and description. The data refer to transaction prices recorded by private real estate associations and, in many cases, collected and published by central banks and central statistical offices in different countries. House price developments are at the national level and refer to sales prices of existing dwellings or, when not available, those of new dwellings. The indices do not directly take into account regional house price dynamics, which, as shown by several studies (see Meen and Andrew, 1998 for a review) can differ quite significantly. However, broad measures are used in order to represent the trends in average house prices in each country. Differences in the construction of these indices, in the characteristics of dwellings (i.e. mix of properties traded over time, quality changes, etc), in the composition of the dwelling stock within and across countries make quantitative attempts to draw strong international comparisons not very robust.

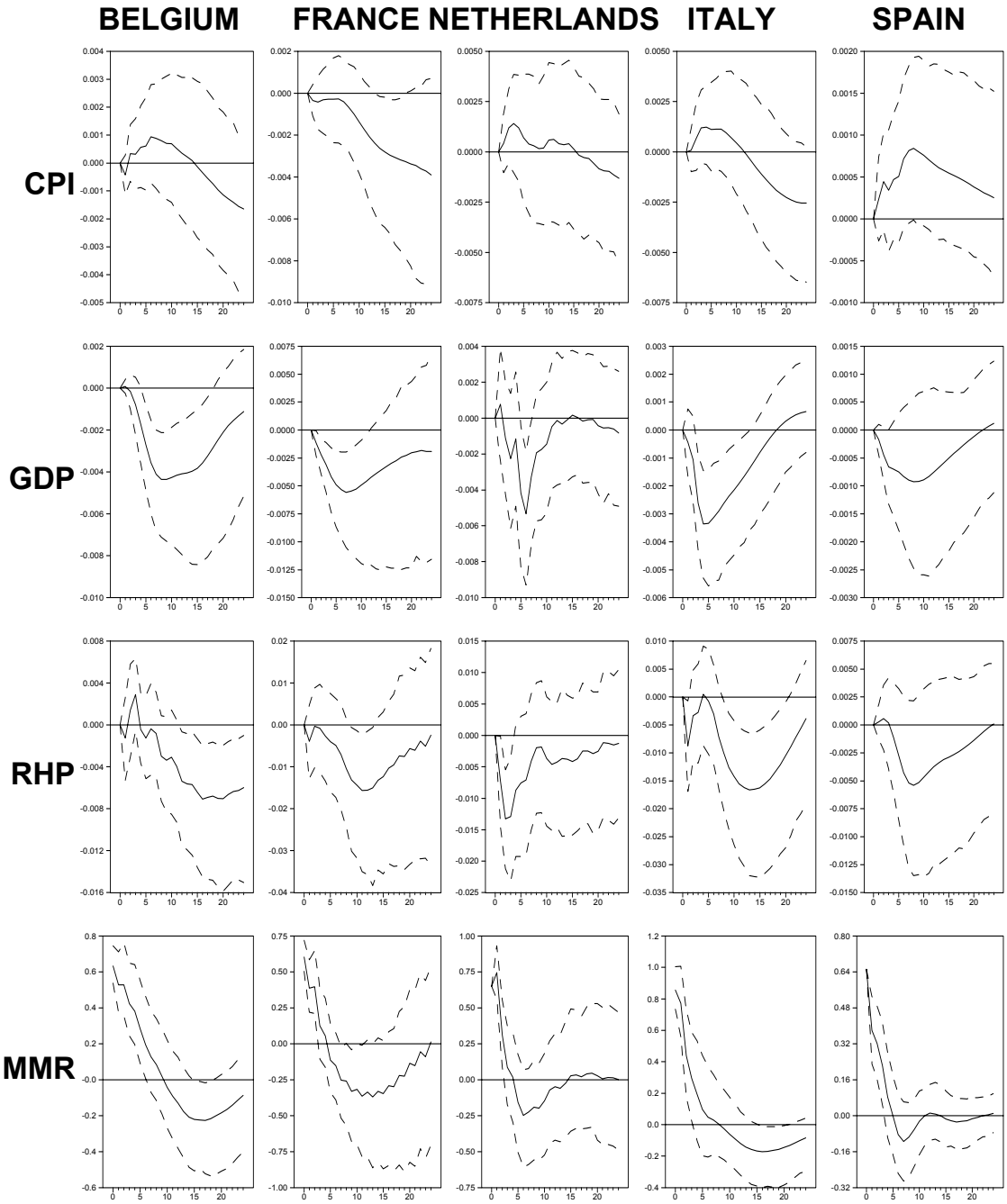
TABLE B.2 House Price Definitions and Sources

	Period	*Source*	*Definition/Notes*
Belgium	81Q1-99Q4	AN-Hyp Bruxelles, (Antwerpse Hypotheek Bank) Antwerpen	Price index for small and middle houses
Finland	70Q1-00Q2	Bank of Finland Huoneistokeskus	Average price for existing flats per square meter
France	72Q1-98Q4	Banque de France – Chambre Syndacale de Notaries - INSEE	Prices of Apartment in Paris per square meter in FF
Ireland	78Q1-00Q3	Department of the Environment and Local Government	Average gross prices of new (and second-hand) houses for which loans were approved by "All Agencies"
Italy	72Q1-99Q4	Il Consulente Immobiliare with elaboration from Bank of Italy	Residential property index – Interpolated from semi-annual data assuming a ARIMA(1,1,0)
Netherlands	77Q1-99Q4	NVM (50-60% of total transactions)	Average Selling Price of existing single and multy-family houses
Spain	75Q1-00Q1	INE – Ministerio de Economia y Hacienda	Residential Property Price Index per Square Meter – Before 1987 linked to interpolated annual data from former housing studies
Sweden	72Q1-99Q1	Central Statistical Office (CSO)	House Price Index as weighted mean of primary and leisure homes
United Kingdom	74Q2-00Q1	Department of the Environment, Transport and the Regions (DETR)	UK mix-adjusted house price index, all dwellings; based on survey of all lenders

The semi-annual original series for Italy was interpolated into quarterly by using the RATS interpolation procedure INTERPOL.SRC, which allows for the estimation of different ARIMA models. A number of alternative models have been estimated which all show that different interpolation approaches were not affecting the main results of the VAR analysis. The results shown in the main text are based on an ARIMA (1,1,0). All series have been deflated using the CPI index.

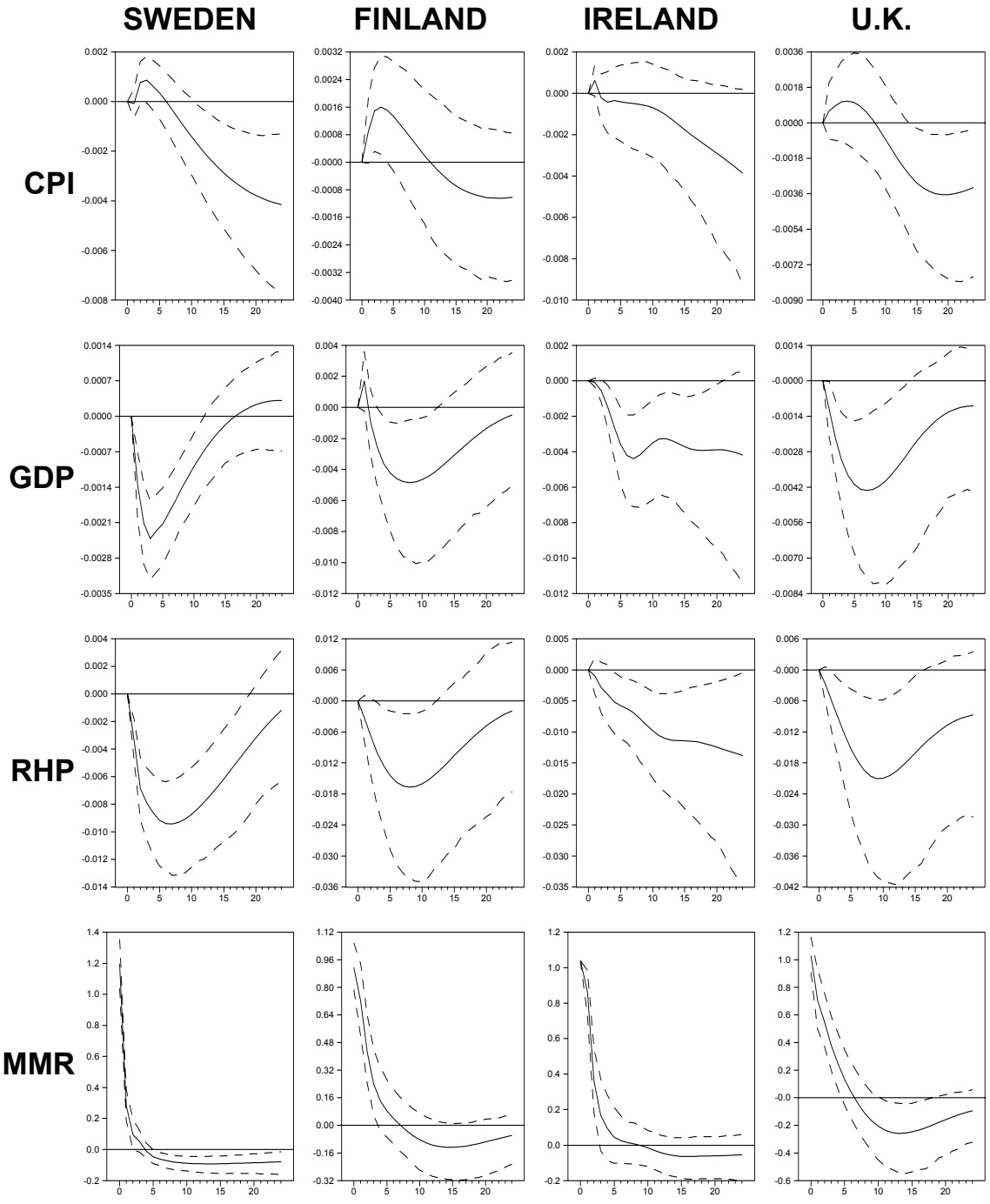
APPENDIX C *Estimation Results*

FIGURE C.1 **Impulse Responses to Monetary Contraction - MODEL 1**



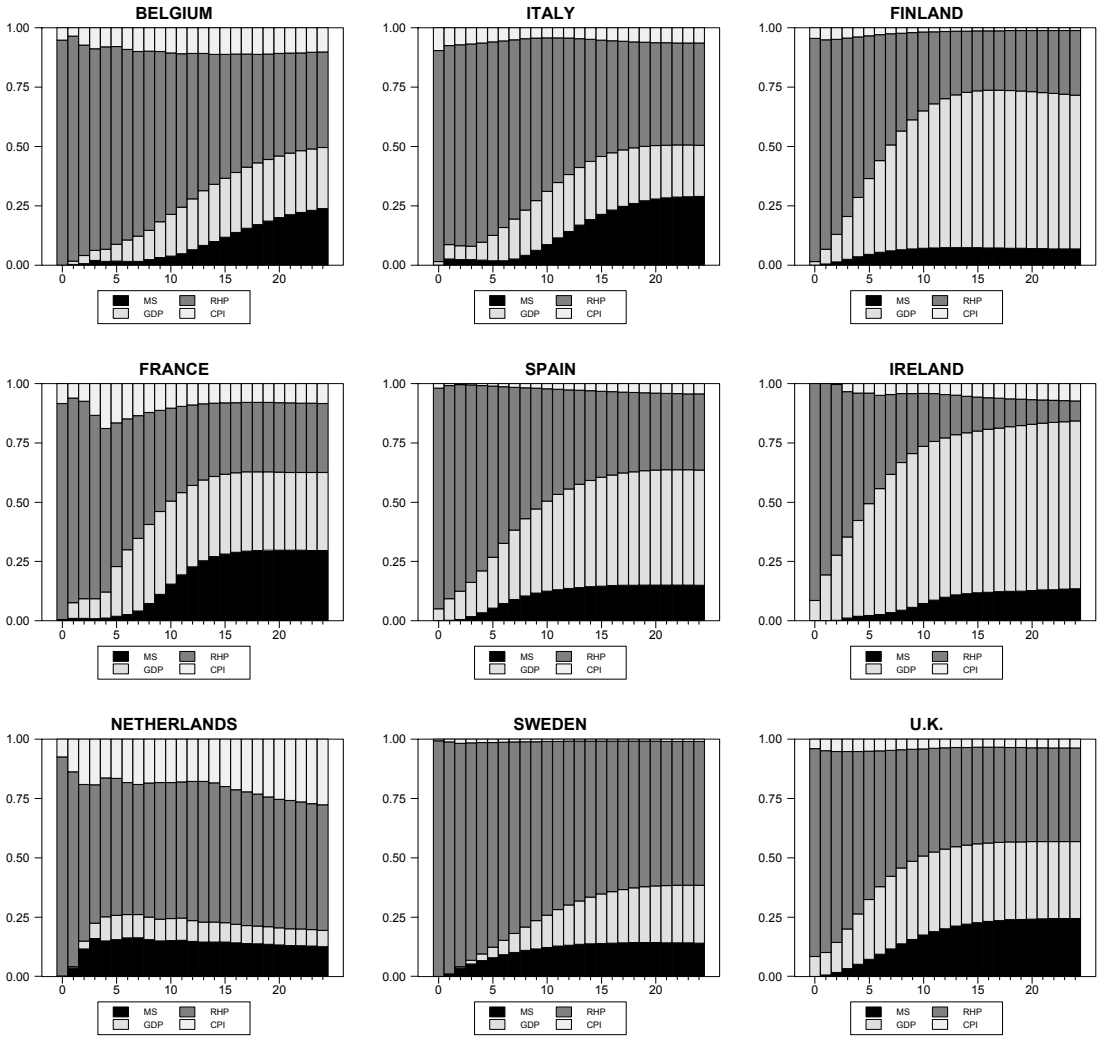
Notes: MODEL 1 contains in the following order: the consumer price index (CPI), the real gross domestic product (GDP), the real house price (RHP) and the money market rate (MMR). Confidence bands are the 5th and the 95th percentiles computed by Monte Carlo simulations based on 1,000 replications.

FIGURE C.1 Impulse Responses to Monetary Contraction - MODEL 1 (*cont.*)



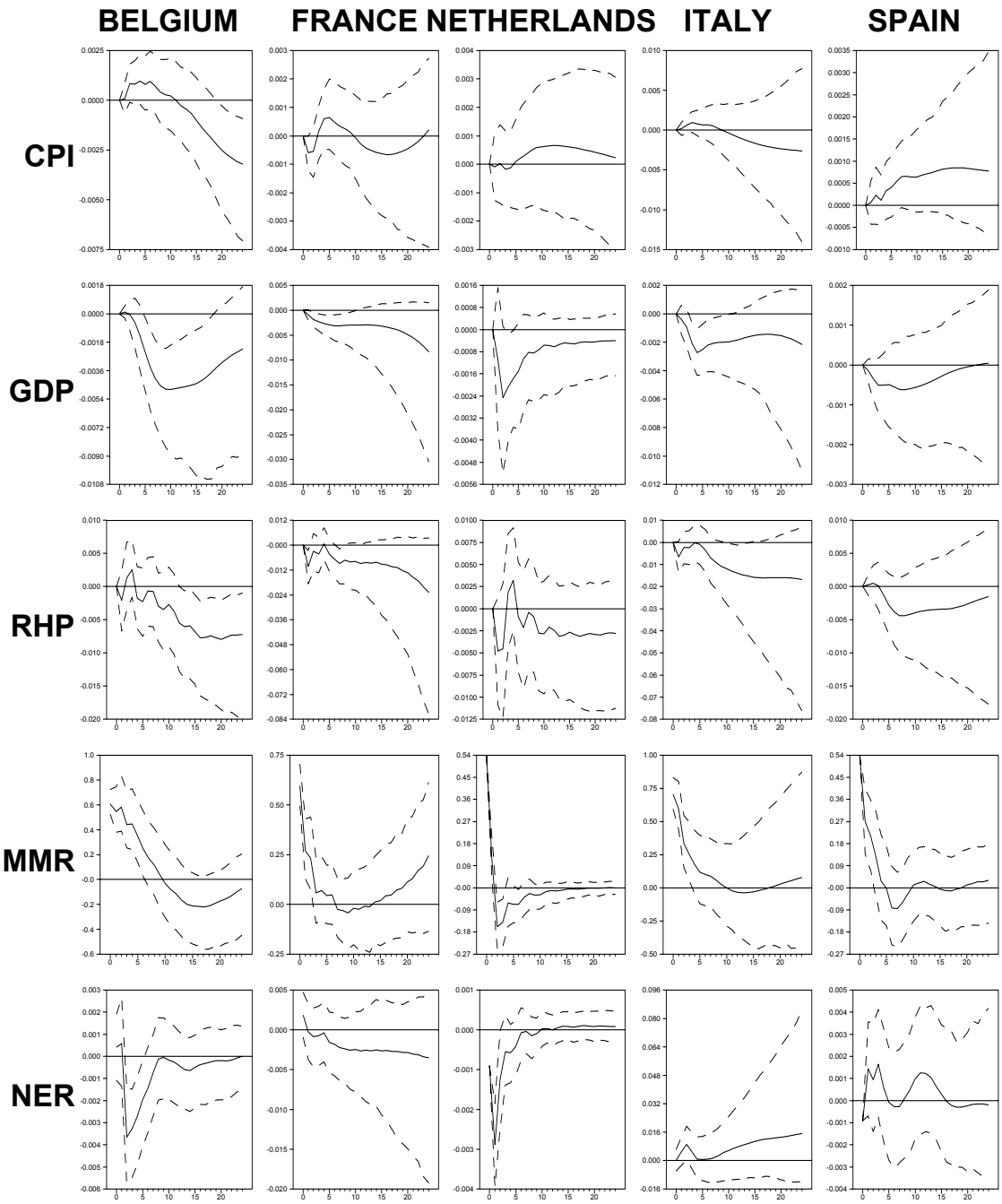
Notes: MODEL 1 contains in the following order: the consumer price index (CPI), the real gross domestic product (GDP), the real house price (RHP) and the money market rate (MMR). Confidence bands are the 5th and the 95th percentiles computed by Monte Carlo simulations based on 1,000 replications.

FIGURE C.1.1 Forecast Error Variance Decomposition of RHP in MODEL 1



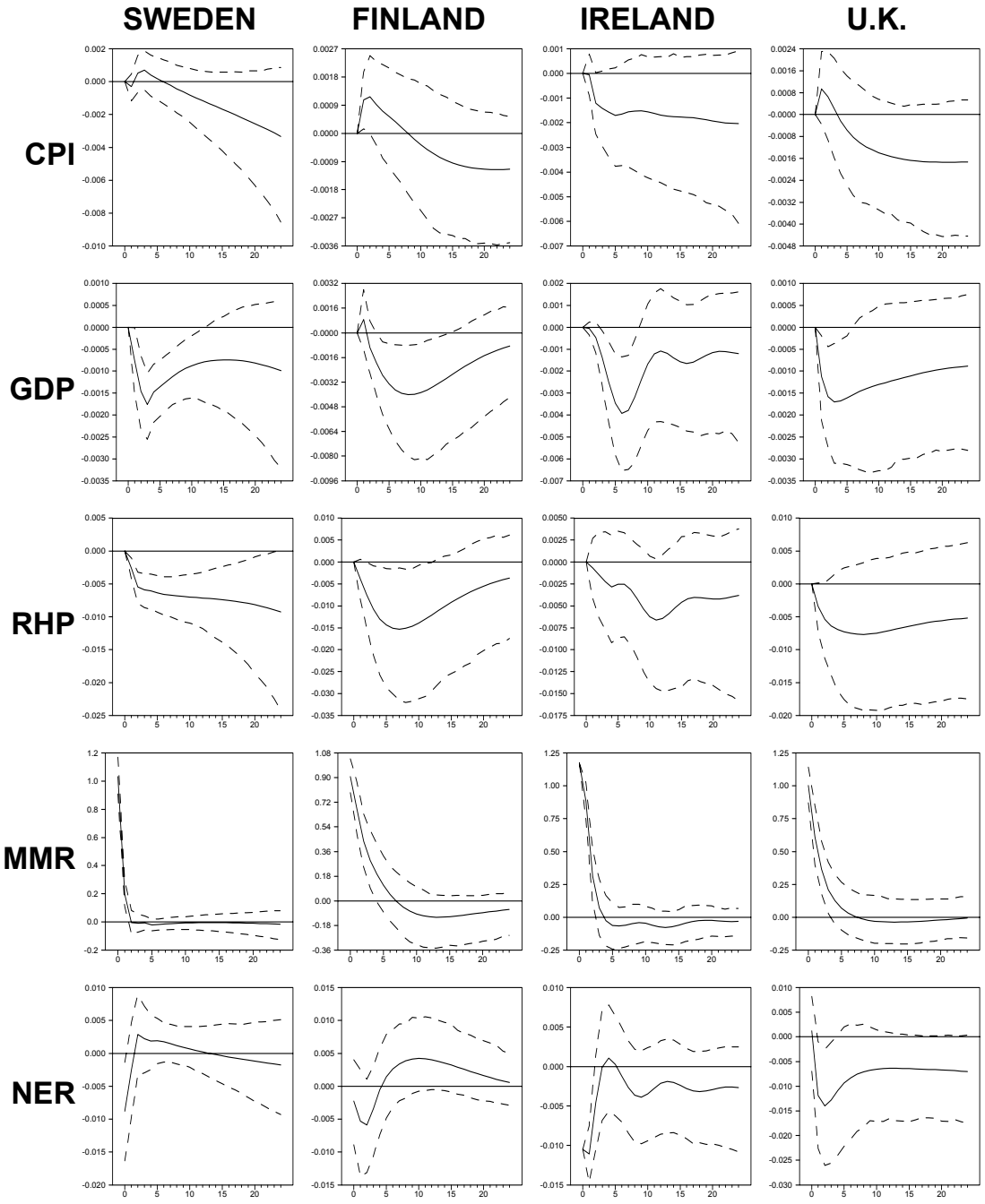
Notes: MODEL 1 contains in the following order: the consumer price index (CPI), the real gross domestic product (GDP), the real house price (RHP) and the money market rate (MMR). The top white area represents the contribution of CPI shock, the dark grey area of the RHP shock, the light grey area of the GDP shock and the bottom black area of the monetary shock (MS).

FIGURE C.2 Impulse Responses to Monetary Contraction - MODEL 2



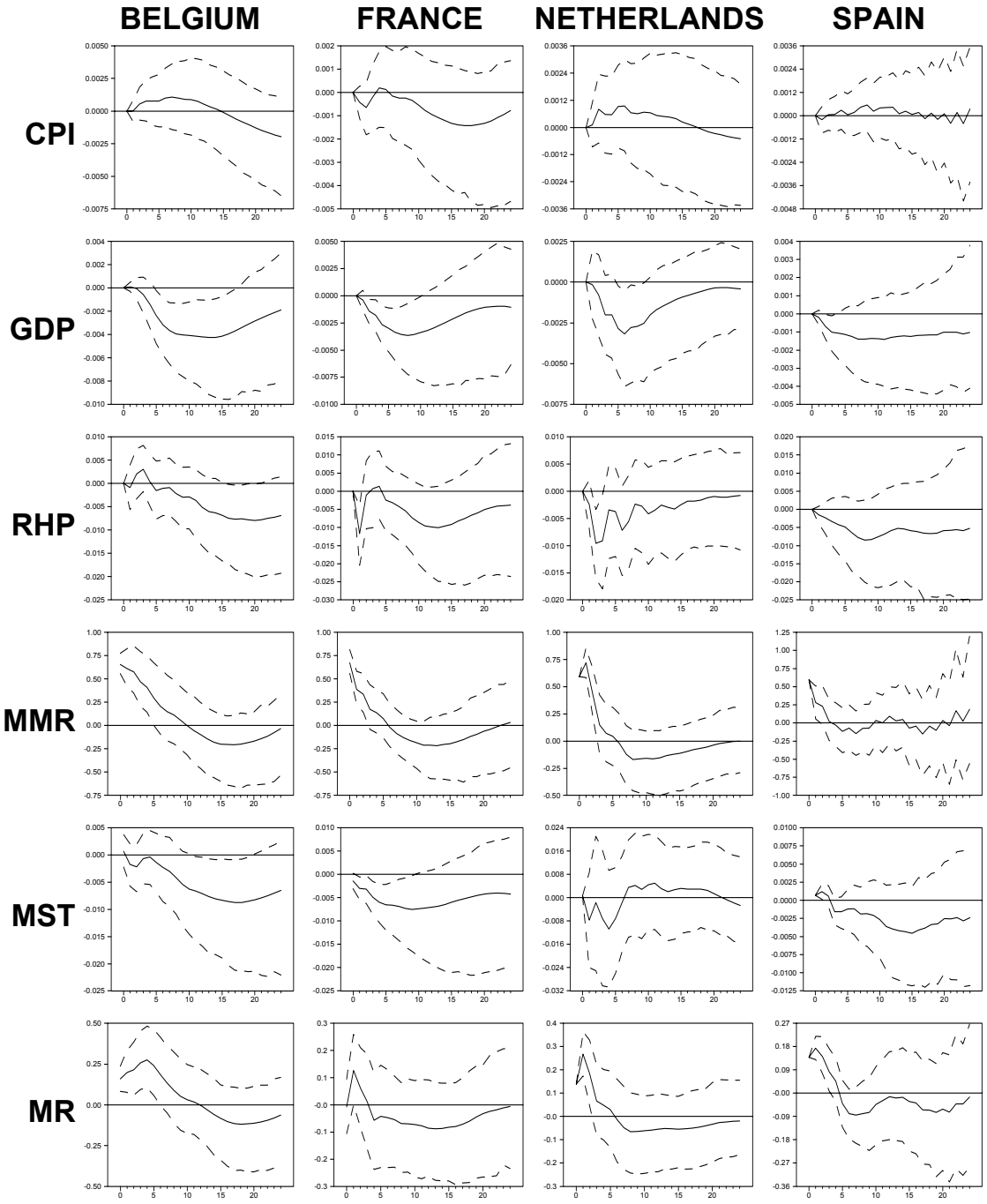
Notes: MODEL 2 contains in the following order: the consumer price index (CPI), the real gross domestic product (GDP), the real house price (RHP), the money market rate (MMR) and the nominal exchange rate versus the DM (NER). Confidence bands are the 5th and the 95th percentiles computed by Monte Carlo simulations based on 1,000 replications.

FIGURE C.2 Impulse Responses to Monetary Contraction - MODEL 2 *(cont.)*



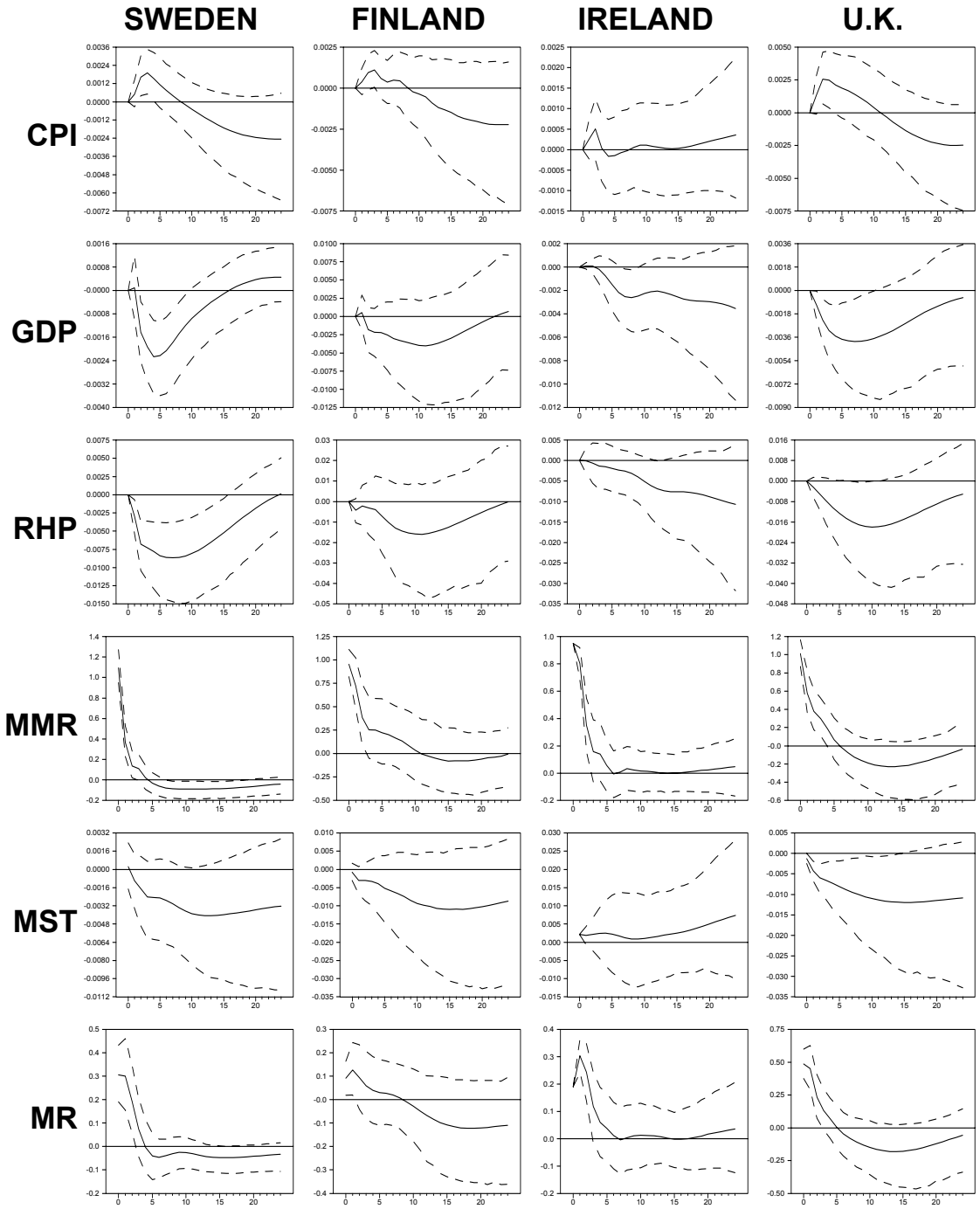
Notes: MODEL 2 contains in the following order: the consumer price index (CPI), the real gross domestic product (GDP), the real house price (RHP), the money market rate (MMR) and the nominal exchange rate versus the DM (NER). Confidence bands are the 5th and the 95th percentiles computed by Monte Carlo simulations based on 1,000 replications.

FIGURE C.3 Impulse Responses to Monetary Contraction - MODEL 3



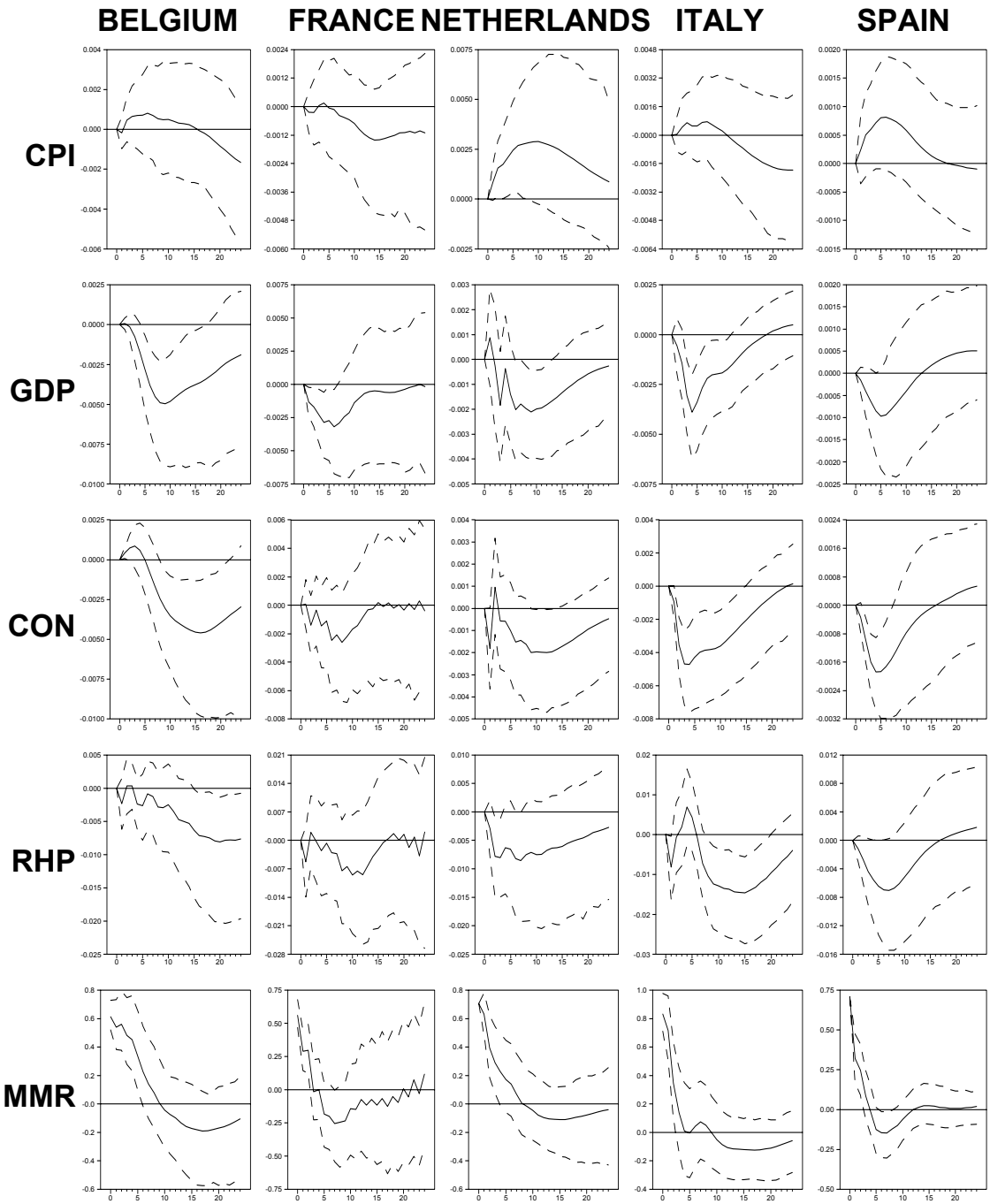
Notes: MODEL 3 contains in the following order: the consumer price index (CPI), the real gross domestic product (GDP), the real house price (RHP), the money market rate (MMR), the real mortgage stock (MST) and the mortgage interest rate (MR). Confidence bands are the 5th and the 95th percentiles computed by Monte Carlo simulations based on 1,000 replications.

FIGURE C.3 Impulse Responses to Monetary Contraction - MODEL 3 *(cont.)*



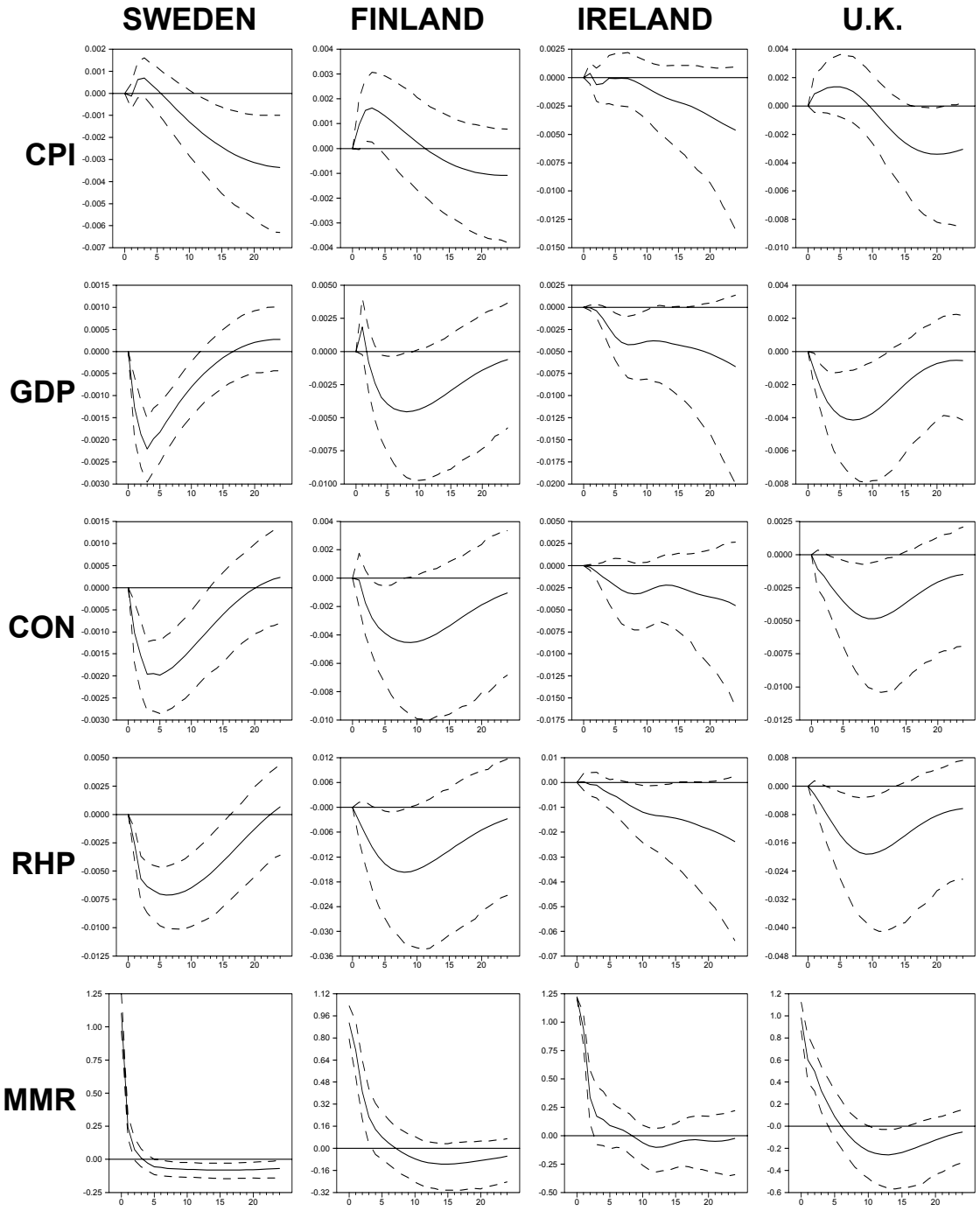
Notes: MODEL 3 contains in the following order: the consumer price index (CPI), the real gross domestic product (GDP), the real house price (RHP), the money market rate (MMR), the real mortgage stock (MST) and the mortgage interest rate (MR). Confidence bands are the 5th and the 95th percentiles computed by Monte Carlo simulations based on 1,000 replications.

FIGURE C.4 Impulse Responses to Monetary Contraction - MODEL 4



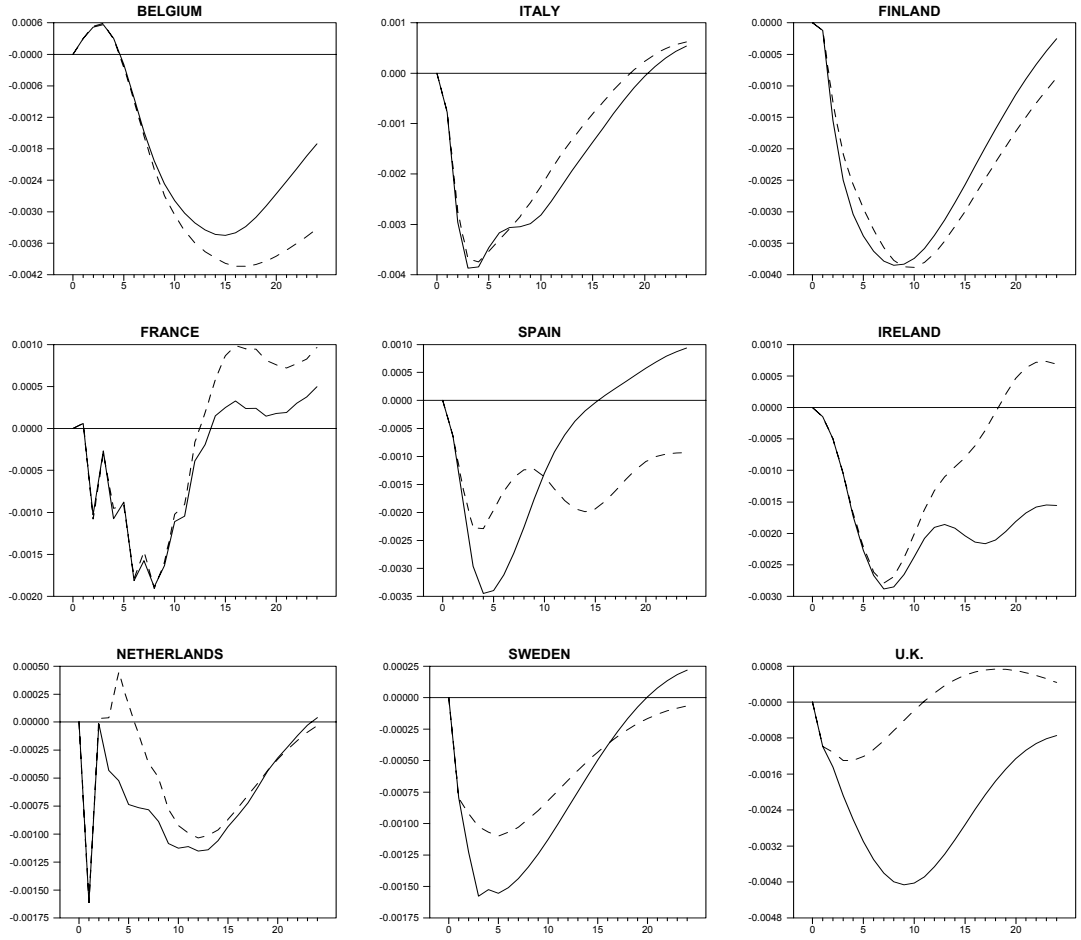
Notes: MODEL 4 contains in the following order: the consumer price index (CPI), the real gross domestic product (GDP), the real private consumption (CON), the real house price (RHP) and the money market rate (MMR). Confidence bands are the 5th and the 95th percentiles computed by Monte Carlo simulations based on 1,000 replications.

FIGURE C.4 Impulse Responses to Monetary Contraction - MODEL 4 *(cont.)*



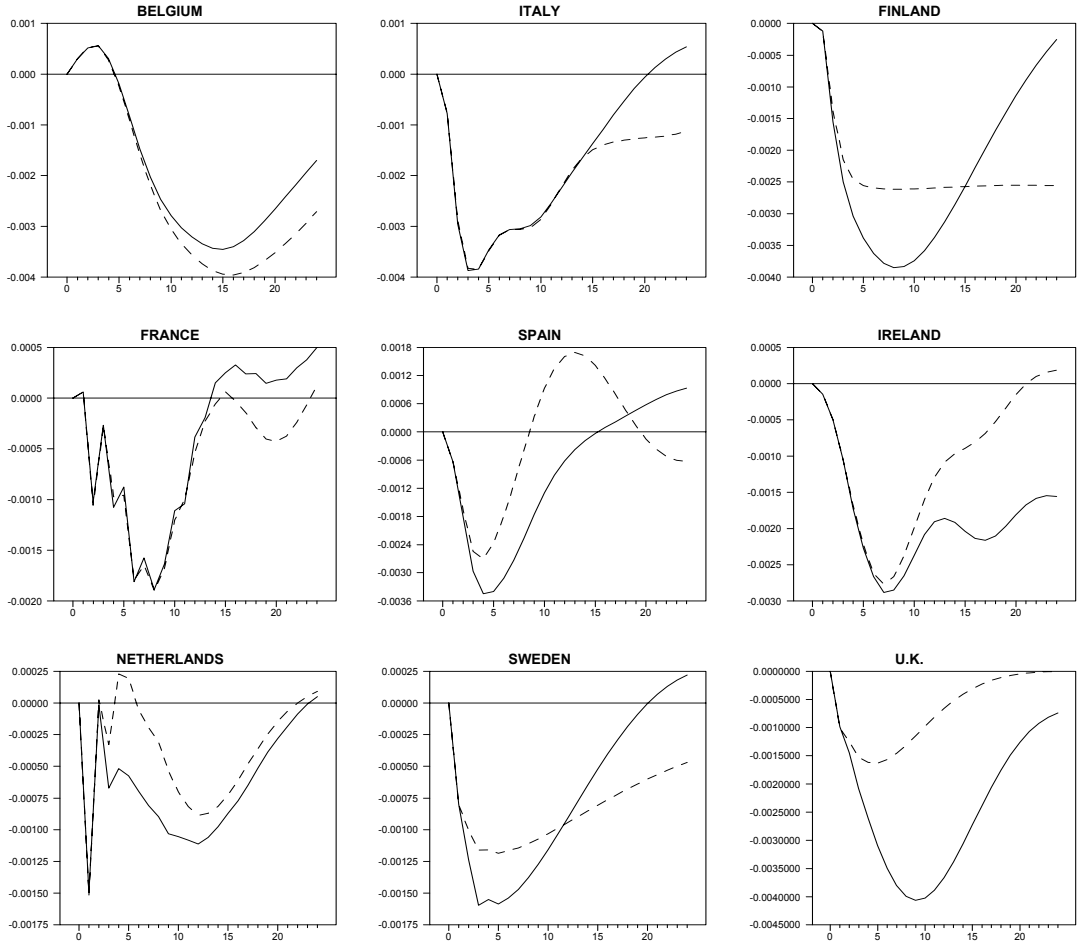
Notes: MODEL 4 contains in the following order: the consumer price index (CPI), the real gross domestic product (GDP), the real private consumption (CON), the real house price (RHP) and the money market rate (MMR). Confidence bands are the 5th and the 95th percentiles computed by Monte Carlo simulations based on 1,000 replications.

FIGURE C.5 Counterfactual Simulation in MODEL 4



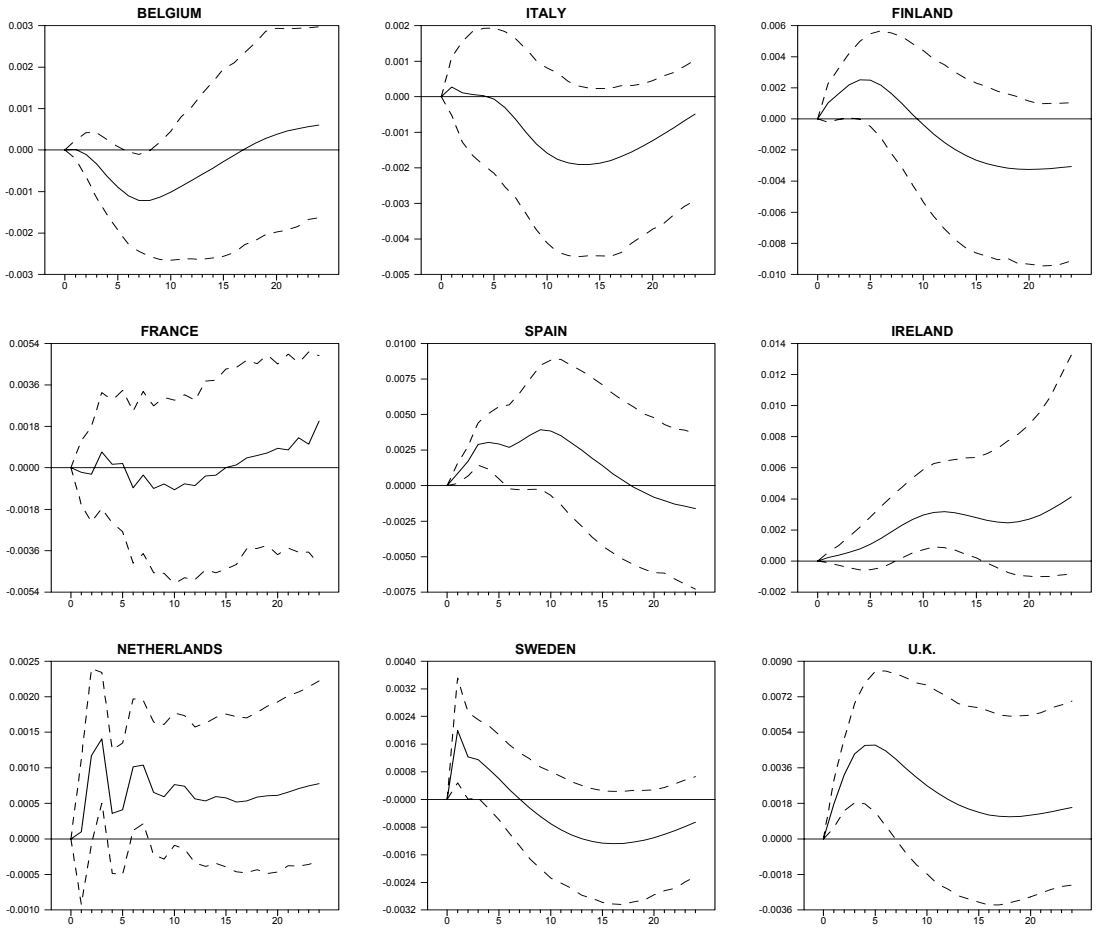
Notes: MODEL 4 contains in the following order: the consumer price index (CPI), the real gross domestic product (GDP), the real private consumption (CON), the real house price (RHP) and the money market rate (MMR). The full lines are the responses of CON to a monetary contraction in the unrestricted MODEL 4. The dotted lines are the responses of CON to a monetary shocks under the counterfactual simulation.

FIGURE C.6 Endogenous versus Exogenous RHP in MODEL 4



Notes: MODEL 4 contains in the following order: the consumer price index (CPI), the real gross domestic product (GDP), the real private consumption (CON), the real house price (RHP) and the money market rate (MMR). The full lines are the responses of CON to a monetary contraction in the unrestricted MODEL 4. The dotted lines are the responses of CON to a monetary shocks under with RHP included as exogenous variable.

FIGURE C.7 Impulse Responses of CON to a RHP Shock in MODEL 4



Notes: MODEL 4 contains in the following order: the consumer price index (CPI), the real gross domestic product (GDP), the real private consumption (CON), the real house price (RHP) and the money market rate (MMR). The two dotted lines on each side of the mean impulse response give the 90% confidence bands computed by Monte Carlo simulations based on 1,000 replications.