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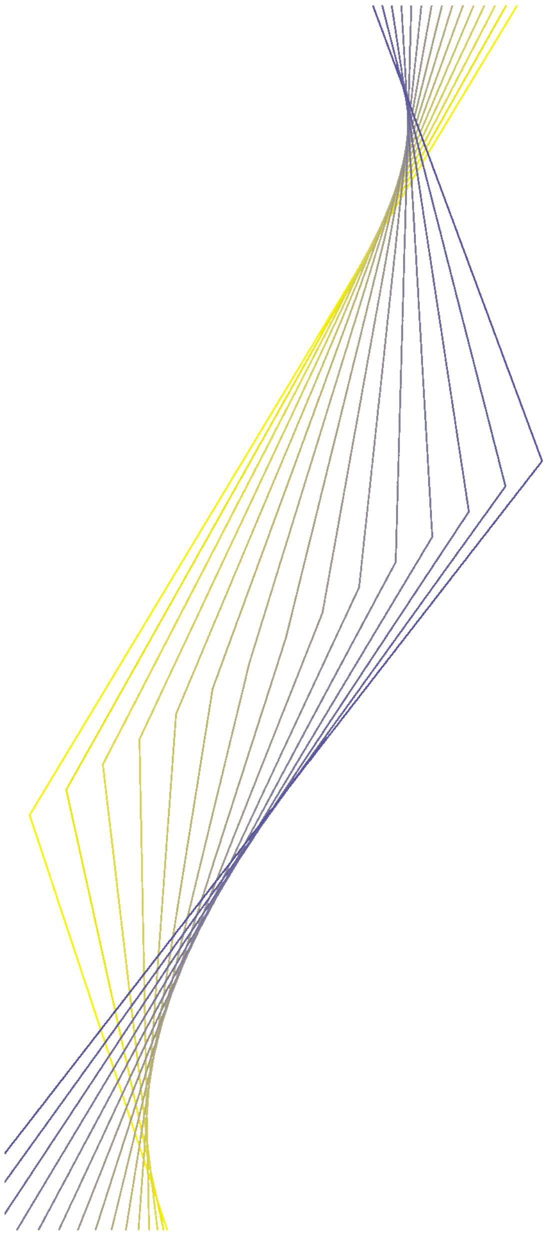

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Abstract

This paper uses a structural vector autoregressive (SVAR) approach to identify the main macroeconomic factors behind fluctuations in house prices in six European countries (France, Germany, Italy, Spain, Sweden and UK) over the last twenty-five years. Quarterly time series for GDP, house prices, money, inflation and interest rates are characterised by a multivariate process driven by supply, nominal, monetary, inflation and demand shocks. The results show that: (i) adverse monetary shocks have generally a significant negative impact on real house prices, and the timing of the response in house prices matches that of output; (ii) the magnitude of the response in house prices to a monetary shock can be partly justified by looking at the different housing and financial market institutions in the countries; (iii) monetary and demand shocks play an important role in driving house price fluctuations over the short run. The paper also interprets the major house price cycles and their link with the economic activity in light of the estimated shocks. Overall, the approach suggests that house prices can be embedded in a relatively simple macroeconometric model in a useful way, and that understanding their dynamics can shed some light over several macroeconomic episodes of the last quarter of century in Europe.

Non executive summary

In the last three decades or so, big changes in asset prices have occurred in many industrialised economies. While it is felt that macroeconomic factors in general and monetary policy conditions in particular were an important factor behind asset price inflation and deflation, there appears to be a lot of uncertainty upon the impact of these factors on long-term asset prices, such as those of equity, land and real estate. It is agreed that central bankers should respond to asset price volatility in the context of an overall strategy for monetary policy, and the profession seems to converge on the effects of an exogenous monetary shock on output and consumer prices. However, less is known on how to respond to asset price volatility, as well on the impact of macroeconomic disturbances on asset prices.

To address the second of these two issues, the paper uses a structural vector autoregressive (SVAR) approach to identify the main macroeconomic factors behind fluctuations in house prices in six European countries (France, Germany, Italy, Spain, Sweden and UK) over the last twenty-five years. It uses quarterly time series for GDP, house prices, money, inflation and interest rates to understand how these variables react to supply, nominal, monetary, inflation and demand shocks.

The results show that:

1) adverse monetary shocks have generally a significant negative impact on real house prices, and the timing of the response in house prices matches that of aggregate GDP;
2) the magnitude of the response in house prices to a monetary shock can be partly justified by looking at the different housing and financial market institutions in the countries;
3) Monetary and demand shocks play an important role in driving house price fluctuations over the short run.

The paper also interprets the major house price cycles and their link with the economic activity in light of the estimated shocks. It appears that the major boom-busts in house prices occurred in the countries under exam over the last decades have been driven by a combination of factors all pushing in the same direction.

The overall contribution of the paper is three-fold: first, the approach suggests that house prices can be embedded in an effective way in a relatively simple macroeconometric model that can provide some quantitative estimates of the sensitivity of asset prices to macroeconomic conditions. Secondly, it provides evidence that house prices, as expected, are much more sensitive than consumer prices to the stance of monetary policy and to other macroeconomic disturbances. Thirdly, it shows that understanding house price dynamics can shed some light over several macroeconomic episodes of the last quarter of century in Europe.

1 Introduction

In the last three decades or so big changes in asset prices have occurred in many industrialised economies. While it is felt that macroeconomic factors in general and monetary policy conditions in particular were an important factor behind asset price inflation and deflation[1], there appears to be a lot of uncertainty upon the effects of these factors on long-term asset prices, such as those of equity, land and real estate. It is agreed that central bankers ought to respond to asset price volatility in the context of an overall strategy for monetary policy, and the profession seems to converge on the effects of an exogenous monetary policy shock on output and consumer prices[2]. However, less is known on how to respond to asset price volatility, as well on the impact of macroeconomic disturbances on asset prices[3]. Both these concerns were on the agenda in the 1999 Kansas Fed Symposium "New Challenges for Monetary Policy": symposium participants noted that the interpretation of asset price changes was complicated because of problems in distinguishing movements driven by economic fundamentals from asset price bubbles. They also agreed that research was needed to identify the channels by which asset price changes are transmitted into the real economy and to determine the quantitative importance of these effects (Sellon and Buskas, 1999).

This paper takes a preliminary step towards the second point, analysing in a structural vector autoregression (VAR) context how house prices respond to the main shocks that are thought to drive economic fluctuations, using data on six major European economies. Putting house prices in an otherwise standard VAR may appear puzzling at first sight. Yet a large fraction of personal sector's net worth in the developed economies is in the form of housing equity[4], and the total value of the housing stock exceeds GDP, often substantially; changes in its value can have effects on aggregate consumption, or on the ability of households to borrow for consumption or production, thus transmitting their effects to the real economy.

Using a VAR to explain house prices can also help disentangling how much of the variability in house prices is attributable to monetary and other factors, such as demand and supply disturbances. Although it does not allow to analyse directly the link between financial liberalisation and house prices that has received a lot of attention in recent literature[5], it has the virtue to give some qualitative and quantitative evidence on the interrelationships between the housing

[1] See, among the others, Shigemi (1995), Ito and Iwaisako (1995), Hutchison (1994), Bernanke and Gertler (1999).

[2] On the nature of this agreement, see Christiano et al.(1999) and Sims (1998).

[3] Some exceptions are Lastrapes (1998) on the effect of monetary shocks on stock prices in the G7 countries and Hutchison (1994) on monetary shocks and land prices in Japan. On how to respond to asset price volatility, see Bernanke and Gertler (1999).

[4] This fraction is between 50 and 70 percent, according to Poterba (1991).

[5] See for instance the papers by Miles (1992) and Ortalo-Magne' and Rady (1999).

market and the wider economy. Looking at more than one country, in addition, can provide a robustness check for the results, as well as giving indications upon the differences in the transmission mechanism. This is particularly important in the light of the fact that housing markets differ significantly between European countries, and these differences might play a part in the transmission mechanism of the shocks.

The results of the paper can be summarised as follows: vector autoregressions using data on house prices and other macroeconomic variables in six major European economies (France, Germany, Italy, Spain, Sweden and UK) reveal that: (i) adverse monetary shocks have generally a significant negative impact on real house prices, with a timing in the response of house prices that matches that of output; (ii) the magnitude of the response of house prices to a monetary disturbance can be partly justified by looking at the different housing and financial market institutions in the countries; (iii) monetary and demand shocks play an important role in driving house price fluctuations over the short run. In addition, the approach yields plausible results for the responses of the other variables in the model, thus suggesting that house prices can be embedded in a relatively simple macroeconometric model in an effective way.

The remainder of paper is organised as follows: the next Section surveys theory and evidence on house price fluctuations and the macroeconomy. Section 3 explains how a VAR framework can be usefully adopted to describe the main macroeconomic forces driving house prices and lays out the econometric methodology, that relies on the common trends approach developed by King, Plosser, Stock and Watson (KPSW, henceforth) (1991). Section 4 describes the data and their time-series properties. Section 5 presents the main results, i.e. impulse responses and variance decompositions. Section 6 uses the estimated structural shocks to interpret the major macroeconomic episodes that have accompanied asset price movements in the countries under exam over the last 20 years or so. Finally, Section 7 concludes.

2 Theories and evidence on house price fluctuations

Since the theoretical and empirical literature on house (and, in general, asset) price dynamics and their link with the macroeconomy is enormous, it would be unwise to attempt to fully review it here. I have picked out for discussion a number of papers that are more closely related to the approach of this work. I have separated studies that are more specific to the house price dynamics in particular from those that try to build a bridge between house prices and the macroeconomy.

2.1 Housing market characteristics and the "microeconomics" of house prices

There are many reasons why the housing market is unlike the markets for many other goods and services (see Kenny, 1998). Housing goods have a dual nature of commodities and of investment asset, normally accounting for a much greater fraction of household net worth than corporate equity (Poterba, 1991). There are also many other special features of the housing market (Quigley, 1992, and Miles, 1995): (i) its relatively high cost of supply, (ii) its durability, (iii) its heterogeneity, (iv) its locational fixity, (v) the possibility to raise loans against housing collateral; (vi) the existence of a well-developed secondary market. These features imply that the housing market is really a collection of loosely connected but segmented markets. As a result, talking of house prices in general is a bit hazardous, although it turns out to be a necessary abstraction for the purposes of the paper.

In the simplest theoretical framework, due to Poterba (1984), the housing market is described as consisting of two separate markets, one for the stock of existing homes, which determines their price, and the other for the new construction flow, which determines the level of new investment. Equilibrium requires that homeowners-investors earn the same return on housing investment as on other assets, where housing return is the sum of the value of rental services and capital gains. The value of rental services is assumed to be determined in a perfect market for housing services, equating demand and (predetermined) supply. The dynamics of supply come from a Tobin's q-type investment function. Given current house prices, this determines future supply and hence tomorrow's rent, and hence, via arbitrage, the rate of capital gains. According to this model, a sudden demand shock (e.g., an increase following a favourable tax reform) causes rents to increase in order to maintain equilibrium. This will lead investments to increase, which will induce expectations of future rent decreases from the new higher level as the stock adjusts upwards. This implies that an unexpected positive shock to the housing market will have an immediate positive impact on house prices, which will be followed by an adjustment towards the long-run equilibrium in which there will be continuous price decreases. Therefore, prices will have a mean-reverting tendency. More importantly, observed price movements will reflect a combination of shocks and adjustment mechanisms, the latter implying positive autocorrelations in the house prices.

This standard model implies that, following a shock, house prices will smoothly adjust towards equilibrium. Of course, it is not the only possibility: mechanisms that would give rise to cyclical adjustment involve, for instance, borrowing constraints, like in Stein (1995). Stein's starting point is that the purchase of a house requires a substantial down payment. At any level of house prices, families-buyers (who already own a house but have reasons to move) can be sorted into three groups: 1) "unconstrained movers"; 2) "constrained movers"; 3) "constrained non-movers". Families in the first group are sufficiently wealthy that financial constraints do not affect their behaviour. For them, demand for houses is a decreasing function of the price. Families in the second group have not enough wealth, and face binding financial constraints: their net demand for housing is an increasing function of the price, since with a higher price they can afford a higher downpayment for a new house. Families in the third group are so wealth constrained that they are better off sitting tight, neither buying nor selling. One key implication of this model is that, subject to certain conditions, the impact of fundamental disturbances on house prices can be greatly magnified relative to the benchmark case of no financial constraints.

Miles (1992, 1995) develops a number of theoretical models in which the key element is the derivation of an expression for the user cost of housing. In particular, he explicitly models the impact of the restrictions on the availability of funds to the households, in the form of a lower bound on the amount of housing equity that individuals must own. His main result is that the effect of allowing equity withdrawal from the housing market upon saving, consumption and house prices can be both substantial and prolonged: in particular, he shows that the easing of credit conditions will lead to increase in house prices and in the stock of outstanding mortgages in the economy.

Early empirical studies of the housing market have focused on some particular features of the house prices, looking in particular at the US market[6]: Case and Shiller (1989, 1990) study their autocorrelation properties; Poterba (1991) focuses on changes in the construction costs, in the real after-tax cost of homeownership, and on demographic factors as possible determinants of shifts of demand and supply in the housing market: by using median house prices on 39 cities from 1980 to 1990, he shows that shifts in income and in construction costs have important effects on real house price changes but finds little support for the importance of demographic factors. Besides looking at microeconomic determinants of house prices, another debated issue has been whether house prices have only been driven only by fundamental demand and supply factors or if it is possible to find evidence of bubbles in the housing market. A good survey of these issues is Cho (1996).

2.2 Housing markets, monetary policy and the macroeconomy

The idea that asset prices might play a role in the transmission mechanism and in the macroeconomy in general is not new in economics, and dates back at least to Veblen (1904) and Fisher (1933). In recent years, the idea seems to have become increasingly popular. Many of the survey

[6] Many house price equations, mostly seen as inverted demand curves for housing, have been estimated in the past for the United Kingdom too. See Muellbauer and Murphy (1997) and references therein.

papers published in the Winter 1995 Journal of Economic Perspectives symposium on the Monetary Transmission Mechanism analyse, directly or indirectly, the role of the housing market in the transmission mechanism[7].

The so-called "monetarist" view (Meltzer, 1995) commonly emphasises two views: these involve Tobin's q theory of investment and wealth effects on consumption. The latter has its roots in Modigliani's life-cycle model, in which consumption is determined by the lifetime resources of consumers, which are made up of human capital, real assets and financial wealth. When asset prices fall, so do lifetime resources, and consumption falls.

The Tobin's q view starts by recognising that the transmission process begins and operates in the asset market, where costs of information and transaction are lower than the costs of changing production or adjusting consumption or investment in durables. If there is uncertainty about the monetary policy initial impulse, asset prices respond more quickly. Changes in relative prices on the asset markets spill over to the output markets; in the case of an expansionary monetary policy, the price of the asset can be above its replacement cost, and production increases.

The "credit channel" view (Bernanke and Gertler, 1995), on the other hand, assumes that credit markets are not frictionless, because of problem of information, enforcement and incentives. Because of this, credit can be more easily given to agents with sound financial positions, or who can offer collateral as a guarantee. An implication of this is that the value of the collateral (for instance, home equity value) determines agent's ability to borrow and lend, and its fluctuations affect the agent's leverage and her ability to consume and produce. In turn, this implies that procyclical movements in the financial conditions of borrowers have first order effects on aggregate output and wealth, and can magnify investment and output fluctuations relative to a frictionless economy (as in Kiyotaki and Moore, 1997, and Bernanke, Gertler and Gilchrist, 1999).

There is a lot of empirical evidence on housing market fluctuations and the macro-economy: much of it is mainly descriptive in nature. Englund and Ioannides (1997) take an international empirical perspective on housing prices in a panel of 15 OECD countries: their work, while documenting the positive impact of GDP growth and the negative impact of increase in interest rates on house prices, does not provide evidence on the dynamics that house prices might have following a shock.

Other evidence comes from two BIS studies: in their cross-country study on the link between real house prices and household saving, Kennedy and Anderson (1994) point out the difficulty in identifying the factors governing house price fluctuations. While they cannot rule out the possi-

[7] Examples are Bernanke and Gertler (1995) and Meltzer (1995); Taylor (1995, pag.17) discusses how mortgage rates can be affected by changes in the short term interest rates.

bility of speculation in the housing markets across countries, they suggest that monetary policy stance, fiscal treatment of housing and financial liberalisation might play a role in driving price swings. Borio, Kennedy and Prowse's (1994) univariate regressions of a real asset price index on credit and other variables suggest that the credit plays and important role in driving asset prices, and suggest for the 1980s a transmission mechanism going from financial liberalisation to increase in credit to increase in asset prices in Sweden, Finland and Norway.

Meltzer (1995) compares rates of price change for new one-family houses and the U.S. GDP deflator, and shows that peaks in the rate of change of housing prices precede each peak in the deflator by about two years. He also documents similar patterns for UK and Sweden. Bomhoff (1994) explains quarterly fluctuations in GDP growth in U.S., Japan and Germany from 1972 to 1991. He shows that growth depends positively on lagged real house prices, a finding that can be consistent with a monetarist view of the transmission mechanism. Higgins and Osler (1997) use cross-country data for OECD countries from 1984 to 1993: they argue that housing and equity prices were inflated by speculative price bubbles in many countries, and that asset price declines of the early 1990s represented a 'hangover' from earlier bubbles. They base this conclusion on the observation that countries whose asset prices rose furthest in the late 1980s found their asset prices falling the furthest later on, a result that holds even accounting for the influence of economic fundamentals.

3 Econometric methodology: Vector Autoregressions and Common Trends

3.1 Why VARs?

A surprising fact of almost all the empirical studies on house price fluctuations and the macroeconomy is that, while they recognise the importance of house prices in the transmission mechanism, they do not make use of one of the most convenient and used tools to summarise the dynamic relationships between the variables. Instead, following standard practice since Sims' (1980) seminal contribution, this paper uses vector autoregressions to describe macroeconomic dynamics involving consumer and house prices, output, money and interest rates.

Of course, applying this methodology to house price dynamics is not without its skeptics[8]. In a recent paper on the Housing Market and the EMU, Maclennan, Muellbauer and Stephens (1998) (MMS, henceforth) argue that the institutional differences existing in Europe, in particular in housing and credit conditions, "necessarily imply large differences in the monetary transmission mechanism across European countries". They also state that VAR studies of the transmission mechanism are subject to a number of serious criticisms, the first being of mis-

[8] Perhaps this is the reason why nobody has run VARs with house prices after all.

specification because of the omission of important variables, such as asset prices. Furthermore, they argue that a VAR could only be a poor approximation to the dynamic responses of asset prices to structural shocks. It seems that the applied econometrician is left with no hope: either include house prices, and being unable to fully capture their dynamics, or to exclude them, underspecifying the model. By including house prices in an otherwise relatively standard specification, this paper hopes to be immune at least in part to the second criticism.

In applying the VAR methodology to house prices, some warnings are therefore in order.

1) As Cochrane (1994) points out, any VAR mechanically accounts for 100% of the variance of the variables by unforecastable movements in the endogenous variables. Searching for exogenous disturbances is a way to look for policy, or technology, or beliefs-induced changes in that variable. It does not say a lot about perfectly anticipated shocks or systematic policies. Nor can it easily distinguish between fundamental versus non-fundamental determinants of house prices, such as speculative bubbles. After all, and despite the commonly held view that in the late 1980s asset markets in many industrialised countries were held aloft by bubbles[9], one of the lessons to come from research is that one can never prove whether a given boom-bust cycle in house prices was truly a bubble (Hamilton and Whiteman, 1985). To the extent that even the most extreme price rise might have been driven by some unobserved fundamental factor, the VAR approach of this paper will try to analyse which factors could be the source of house price fluctuations.

2) Linearity is also a crucial issue. House prices and other variables can react differently to shocks equal in magnitude but of opposite sign. MMS (1998), for instance, argue that in speculative markets, such as the housing market, the dynamics or the response of house prices to interest rates are non-linear and non-constant over time.

3) The issue of the propagation mechanism is crucial too. The same impulse generates different responses because of an underlying different propagation mechanism. From the magnitude and the shape of the responses, or controlling for other variables that might play a role in the transmission of a shock, it is possible to infer something on what happens following a shock, and why. However, in many cases more than one transmission channel is consistent with the same response.

3.2 The empirical methodology

This section describes how the long-run propositions of economic theory can be used to identify the main sources of economic fluctuations. In that the approach of Blanchard and Quah (1989), KPSW (1991), and Warne (1993) is followed. A more detailed description of the methodology

[9] See the discussion in Higgins and Osler (1997, page 115) and references therein.

is in the Appendix A.

As it is well known, when a group of variables is found to be non-stationary but cointegrated, a useful specification for their dynamic interaction is a vector-error-correction (VECM) model. A VECM model, in particular, places non-linear reduced-rank restrictions on the matrix of long-run impacts from a VAR. KPSW (1991), in particular, propose a distinction between structural shocks with permanent effects on the level of the variables (say, a positive supply shock, raising output in the long-run) from those with only temporary effects (say, a demand shock that can be thought to have zero long-run effect on output and other real variables). The permanent shocks are the sources of the so-called common stochastic trends across the series, and the number of these shocks is equal to the number of variables in the system less the number of cointegrating relationships between them. The (remaining) transitory innovations equal the number of cointegrating relationships (intuitively, a cointegrating vector identifies a linear combination of the variables that is stationary thus eliminating the trend, so that shocks to it do not eliminate the steady state in such a system).

I specify a five dimensional VAR with $X_t = \begin{bmatrix} y & mp & hp & i & \pi \end{bmatrix}'$, where X_t is a vector comprising real income (y_t), a measure of real money balances (mp_t), a real house price index - i.e., a nominal house price index deflated by the consumer price level - (hp_t), a short-term nominal interest rate (i_t), and annualised quarterly (consumer price) inflation (π_t). Real variables are specified in natural logarithms, interest rate and consumer price inflation in percentage terms. Several empirical questions can be answered from this representation. Is there evidence of a long-run money demand schedule? Is the real interest rate stationary? How do real house prices behave in the long-run and what is their relationship with real output? How do real and nominal variables interact following a disturbance? How can we disentangle innovations with permanent effects on the variables from those with only transitory effects? What accounts for most of the observed volatility in real house prices that has characterised many advanced economies over the last decades?

3.3 Hypotheses about cointegration

With 5 variables in the dataset, how many common stochastic trends can we expect to find?

Money, Output and Interest Rates: The rise in price levels in most countries during the last decades suggests the possibility of a stochastic trend associated with the design of the monetary policy: in other words, as suggested by Gali (1992), the central bank's desire to avoid output fluctuations may result in nominal instability, in the sense of leading to a common trend leading nominal rates, money balances and output. Alternatively, the relation between these variables can be interpreted, as done for instance in Coenen and Vega (1999) and Crowder, Hoffman and Rasche (1999), as a traditional money demand function linking real balances to a scale variable and a measure of the opportunity cost of maintaining liquidity. That this link is a money demand function must be interpreted with caution though, for at least 5 reasons[10]: 1) there could be many cointegrating vectors at issue in a similar system: money demand (between mp, y and i) is one, but aggregate demand as well, for instance (between y and i); 2) a measure of short-term interest rates can well represent own rather than outside rate on money; 3) any measure of money is an aggregate over components with different characteristics; 4) definitional and structural breaks cannot be ignored; 5) the frequency of observation may affect both exogeneity and cointegration, as discussed by Hendry (1995).

Interest Rates and Inflation: There are theoretical reasons to believe that real interest rates are stationary. In other words, there is a link between the two nominal variables that corresponds to a modified Fisher equation, i.e. $i_t = \mu + \pi_t + \varepsilon_t$[11].

Output and Real House Prices: Is there a long run relationship between house prices and consumer prices? Should we expect real house prices to be constant over time or not? A possible answer, which is suggested by Poterba (1984), goes as follows: if the long-run housing supply curve and the supply curve for all the other goods were perfectly elastic, the steady state price of structures would depend entirely on construction costs, which are probably independent of the level of construction. However, provided that any factor determining real estate supply, such as land, lumber or construction workers, is available in fixed supply - thus acting as a limiting factor -, one can expect that the production possibility frontier between houses and other goods[12] is not flat. That implies a possible upward trend in real house prices over the long-run[13]. Yet one can reasonably expect real house prices to be cointegrated with GDP, since the GDP can give a measure of how much the production possibilities frontier is shifting out over time[14]. In a sense, this candidate cointegrating vector, measuring elasticity of real house prices to output, can be thought of a long-run supply curve for the housing stock, provided that new investment in stock is a constant fraction of GDP and that the supply curve for housing

[10] See Ericsson (1998) for a thorough discussion of these points.

[11] The word *modified* is used because the Fischer relationship should be more properly modelled as a long run relationship between nominal interest rates and *expected* inflation, as done in Crowder et al. (1999). Using inflation in period $t+1$ as a proxy for inflation expectations and modelling the system with π_{t+1} instead of π_t yielded almost unchanged results.

[12] A representative sample of "other goods" enters the consumer price index, of course.

[13] For the United Kingdom, Miles (1995, page 40) documents an upward trend in real house prices over the last century. Although it is conceivable that at least part of the apparent rise in the real price of houses is due to home improvements, a quality adjusted index of real house prices would probably still be growing over time. For cross-country evidence over the last decades only, see Cutler (1995).

[14] Note that I am not investigating a related but different issue, such as the possibility that housing wealth is a constant fraction of income over time. This information defines a cointegrating vector, but cannot be included in our analysis since our z does not include any measure of the housing stock.

structures does not shift over time[15].

I look therefore for the following representations:

$$\begin{array}{rcl} & & \quad y \quad mp \quad hp \quad i \quad \pi \\ \beta_1 & = & \begin{bmatrix} -b_y & 1 & 0 & b_i & 0 \end{bmatrix}' \\ \beta_2 & = & \begin{bmatrix} -\tau & 0 & 1 & 0 & 0 \end{bmatrix}' \\ \beta_3 & = & \begin{bmatrix} 0 & 0 & 0 & -1 & 1 \end{bmatrix}' \end{array}$$

the first identifying a long-run money demand schedule, say, $mp_t = b_y y_t - b_i i_t$, the second linking real house prices and output, i.e. $hp_t = \tau y_t$, and the last one implying stationary (ex ante) real interest rate. Altogether, after the normalisation on mp, hp and π, this specification imposes $r\,(r-1) = 6$ non-testable zero restrictions. The three remaining restrictions (two being zero restrictions and one imposing a -1 coefficient on the interest rate in β_3), given the others, are instead testable[16].

3.4 Identifying structural shocks

The parameters of the cointegrating vectors can be used to restrict the long-run multipliers of the permanent shocks (for details, see Appendix A).

This derives from the fact that information about the cointegrating space allows to formulate a VAR in the form of an error correction model. Starting from the reduced form of a VAR in levels, where X is the column vector of endogenous variables, Z is a vector of deterministic components, k is the lag order and $E\varepsilon\varepsilon' = \Sigma$

$$X_t = A_1 X_{t-1} + ... + A_k X_{t-k} + \mu Z_t + \varepsilon_t$$

the VECM representation of the VAR, where, with usual notation, Δ represents the first difference operator, is:

$$\Delta X_t = \Pi X_{t-1} - (A_2 + ... + A_k)\,\Delta X_{t-1} - ... - A_k \Delta X_{t-k+1} + \mu Z_t + \varepsilon_t$$

and the moving average representation can be cast as:

$$\Delta X_t = C(L)\varepsilon_t$$

[15] Needless to say, any estimated relationship will have to be interpreted with caution, as there are not long time series on house prices for many of the countries that this study analyses.

[16] Johansen (1991) shows that the asymptotic distribution of the maximum likelihood estimates for β is a mixed Gaussian distribution. That implies that the likelihood ratio test for given hypothesis about restrictions on β is, for given rank, asymptotically distributed as a χ^2.

PERMANENT SHOCKS: Identification of the permanent shocks can then be achieved by imposing just enough restrictions so that the shocks and their long-run effects may be given an economic interpretation. Engle and Granger (1987) have shown that the columns of $C(1)$ in the restricted VAR above are orthogonal to the cointegrating vectors, i.e. $\beta' C(1) = 0$. In this vein, the identification strategy imposes the following constraints on the 5×5 matrix of the long-run multipliers $C(1)$. This matrix is partitioned in: $C(1) = [P \; 0]$ so that the matrix P is a 5×2 matrix whose columns represent the long-run responses of the variables to permanent shocks, whereas the long-run responses to the temporary shocks are assumed to be zero. The 5×2 matrix P giving the long-run multipliers of the permanent shocks must be specified in a way such that its columns are orthogonal to the matrix of cointegrating relations.

With the variables ordered as $\begin{bmatrix} y & mp & hp & i & \pi \end{bmatrix}'$, I restrict the $(1,2)$ element of the long-run impact matrix P to be zero, so that one of the two permanent shocks can be precluded from having a long-run effect on the level of output y[17]. Accordingly, I allow the other shock to affect y in the long run: this shock is therefore the only source of unit root behaviour in the GDP, and can be thought of as a supply shock.

In detail, the P matrix of common trends will be:

$$P = \widetilde{P}\Theta = \begin{bmatrix} 1 & 0 \\ b_y & -b_i \\ \tau & 0 \\ 0 & 1 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ \theta & 1 \end{bmatrix} \leftarrow \begin{bmatrix} \text{long run effect of shock on } y \\ \text{long run effect of shock on } mp \\ \text{long run effect of shock on } hp \\ \text{long run effect of shock on } i \\ \text{long run effect of shock on } \pi \end{bmatrix}$$

For any value of the parameter θ (to be estimated), the *nominal* shock (second column) leaves output and relative prices unchanged, yielding a lower (higher) level of real balances and higher (lower) inflation and interest rates in the long run[18]. One possible interpretation of this shock, following Coenen and Vega (1999), can be that of a change in the monetary policy objective of the monetary authority: in the European experience, it could capture a possibly preannounced commitment to a different inflation target, but also, more in general, it might stand for a permanent nominal shock.

The *supply* shock (first column) increases output, real balances and real house prices in the long-run, with weights dictated by the estimated cointegrating vectors. So long as the estimate

[17] This procedure might appear a bit *ad hoc*, but choosing P "in a way that associates each shock with a familiar economic mechanism" is not a bad idea, especially when, as with this procedure, strong beliefs about the effects of all shocks on each variables exceed the minimum requirements for identification. See, for a discussion, Fischer et al. (1995).

[18] Opposite signs on real balances and on nominal rates only obtain if the estimated cointegrating vector between money, output and interest rates yields coefficients of the same sign on mp and r.

of Θ is not diagonal, this shock can also change inflation and nominal rates (by the same amount) in the long run.

TRANSITORY SHOCKS: Transitory shocks, which are assumed to be orthogonal to the permanent shocks and to each other, will have no long-run effect on any of the variables. Following Mellander, Vredin and Warne (1992), they can be given an economic interpretation along the lines of the traditional VAR methodology that identifies shocks in a recursive fashion. I identify three separate, traditional sources of short-run fluctuations: a *monetary policy shock* has no immediate effect on output and CPI inflation, but can contemporaneously affect real balances (by driving down nominal money supply), interest rates and real house prices (for instance because house prices, as asset prices, react on the news[19]).

Unlike the monetary one, a *demand shock* has zero impact effect on CPI inflation, but potentially affects contemporaneous GDP, by affecting its spending components (see Gali, 1992, for a related point), as well as house prices, real money balances, and interest rates. This disturbance could represent a shock that has its roots in episodes concerning the housing market, such as temporary tax advantages to housing investment or a sudden increase in demand fuelled by self-fulfilling expectations of appreciation in house prices.

The third and last shock transitory shock (that can contemporaneously affect all the variables) might be, as in Crowder, Hoffman and Rasche (1999), a *transitory inflation shock*, i.e. a temporary upward shift in the aggregate supply schedule of a basic AD/AS model: indeed, as we will see, the impulse responses are in most of the countries consistent with the responses from an aggregate supply/aggregate demand curve model, with no shift in the aggregate demand curve, no change in inflation expectations, and no shift in the long-run aggregate supply curve[20].

4 Properties of the data

4.1 Sources of data

The data consist of quarterly observations on output, a monetary aggregate, consumer prices, house prices and a nominal short-term interest rate in six European economies (France, Germany, Italy, Spain, Sweden and United Kingdom). With the exception of Spain, where a quarterly house price was available only starting from 1987, the data cover a period which spans approximately over the last 25 years.

[19] An example - yet not of a monetary shock - showing that house prices are not as sticky as consumer prices and that imposing zero impact restrictions on them might be inappropriate (even in times low-inflation periods) is provided by Poterba (1991): house prices are reported to have risen 5 percent within a week of the selection of Berlin as the new capital of Germany.

[20] An alternative interpretation is that this shock might be an exchange rate shock, that raises the prices of imported goods thus temporarily depressing output. I thank Gunther Coenen for this suggestion.

The quality of data for house prices, which were collected from different sources, differs from country to country: however, since the purpose of this paper is more to provide evidence on dynamics of house prices rather than comparing their levels across countries, measurement problems should not be overstated. It is possible, in principle, that the time series do not reflect adjustments for the quality of housing stock. Nevertheless, this should only affect the estimate of the cointegrating vector between real house prices and output, without any other major side-effects on other, short-run, dynamics.

French data for house prices come from the Banque of France (1999), which has recently started to calculate a residential house price index[21]. German data are from the Aufina Residential Price Index: the original series was annual, and a quarterly one was interpolated via interpolation assuming an ARIMA(0,2,0) in the original series[22]. Data for Italy are from the residential property price index calculated by the magazine "Il Consulente Immobilare" (with elaboration by the Bank of Italy); the original semi-annual frequency was converted into quarterly via interpolation. Data for Spain come from the Residential Property Price Index per Square Meter, provided by the Ministerio de Economia y Hacienda. For Sweden, the data were provided by the Central Statistical Office House Price Index[23]. Finally, UK data came from the Nationwide Anglia quarterly house price index for all properties. All the time series are available approximately from the mid '70s, with the exception of Spain (where the series begins in 1987) and UK (1963). To make results more comparable across countries, the estimation period for UK starts in 1973.

The resulting samples turned out to be as follows: for France, 1978:1 - 1997:4 (80 observations); for Germany, 1973:1 - 1998:3 (103 observations); for Italy, 1973:1 - 1998:2 (102 observations); for Spain, 1987:4 - 1998:4 (45 observations); for Sweden, 1977:4 - 1998:4 (85 observations); for United Kingdom, 1973:1-1998:3 (103 observations). The resulting house price indices, together (for comparison purposes) with the consumer price indices, are shown in Figure 1. The Figure provides evidence of the large swings in house prices that have occurred in all the countries in the last decades, with prolonged cycles of increasingly rising prices followed by slumps; oscillations in real house prices seem to have been particularly strong in Sweden and

[21] Since 1978, an annual index of residential property prices has been estimated in France on the basis of the portfolio of the FNAIM national federation of real estate agents, which comprises 220000 properties. The Banque de France has then transformed this index into a quarterly one by profiling using the index of the Chambre Syndicale des notaires for old unoccupied apartments sold in Paris.

[22] The AUFINA/ERA index shows the average price for a cubic metre enclosed area for a 3 year old house with an average index. It is constructed through surveys conducted by AUFINA/ERA across real estate agents in the country.

In the words of Holmans (1994), "German house price history is far from firm". However, the series provided by Aufina, which is used in this paper, is similar to that constructed by Holmans (1994) using city-level data provided by the estate agency Ring Deutscher Makler.

[23] The Swedish house price series is constructed as weighted mean of primary and leisure homes (I thank Bharat Barot for kindly providing me with the series).

UK; periods of falling nominal house prices have been common in all the countries.

The other series were all obtained from International Financial Statistics of the IMF: y is measured by (log of) GDP at constant prices, seasonally adjusted; i is a measure of a short-term interest rate, expressed in percentages, namely money market rate for Italy, call money rate for France and Germany, 3 months T-Bill rate for Spain, Sweden and United Kingdom; real money mp is the (deflated by the consumer price index) log of M2 for France, Spain and Sweden; M1 for Germany, Italy and UK. The results did not vary much using M2 instead of M1 for the last three countries, but M1 produced more plausible estimates of the cointegrating vectors and of the responses to shocks. Inflation, π, is measured by the annualised quarterly change of the (log of) consumer price index.

For each country, the estimated VAR contained a lag length of 3 (France, Spain, Sweden) or 4 (Germany, Italy, UK), depending on which was sufficient to obtain noiselike residuals. Two impulse dummies were used to correct for German reunification (1990:3 and 1991:1). An impulse dummy variable for UK for 1987:1 was introduced to capture a coverage break in the money+quasi-money IFS series.

4.2 Unit root and Cointegration Tests

As a preliminary step, and in order to specify the model correctly, the long-run properties of the time-series involved, i.e. their degree of integration and the eventual presence of cointegrating relationships, must be characterised.

4.2.1 Unit root tests

Two univariate unit-root tests were conducted, the augmented Dickey-Fuller test and the Phillips-Perron (1988) test. Tables 4.1 and 4.2 report the results from the tests. Overall, the picture that emerges from the tests hints that the variables are integrated of order one, although, using the Phillips-Perron test, in many countries the null hypothesis of a unit root in the inflation rate is rejected in favour of stationarity.

4.2.2 Cointegration tests

This sub-section describes the estimation of the cointegration vectors for each country with the multivariate cointegration techniques described by Johansen and Juselius (1990). The three cointegrating vectors can be interpreted as a money demand schedule, a long run housing supply curve and a Fisher equation. However, the vectors should be interpreted with care, at least for three reasons: 1) the specification of the money demand schedule is probably underparametrised,

Table 4.1: Augmented Dickey-Fuller unit root tests

	FRANCE	GERMANY	ITALY	SPAIN	SWEDEN	U.K.
y	-0.10	0.14	-2.23	-0.99	-0.62	-0.09
mp	-1.27	1.10	-0.88	-0.21	-2.07	-0.14
hp	-2.61	-2.36	-2.31	-2.64	-2.39	-1.40
i	-0.97	-2.62	-1.59	-0.21	-1.67	-2.31
π	-0.65	-2.20	-1.61	-0.68	-1.77	-2.76

Augmented Dickey-Fuller unit root tests statistics for the series, with a lag length of 3 for France, Spain and Sweden, 4 for Germany, Italy and UK; * indicates rejection of the null hypothesis of unit root at the 95% confidence level, ** at the 99% level - depending on the sample size, the 95% MacKinnon (1991) critical value ranges from -2.89 to -2.92 -.

Table 4.2: Phillips-Perron Unit root tests

	FRANCE	GERMANY	ITALY	SPAIN	SWEDEN	U.K.
y	-0.45	-0.43	-2.05	-1.77	-0.62	-0.09
mp	-0.58	0.98	-1.11	-0.82	-1.95	1.19
hp	-2.44	-3.27*	-1.94	-4.08**	-1.71	-0.39
i	-1.13	-2.48	-1.90	-0.59	-1.73	-2.38
π	-1.53	-4.98**	-2.97*	-3.06*	-4.91**	-4.48**

Phillips-Perron unit root tests statistics for the series, with a lag length of 3 for France, Spain and Sweden, 4 for Germany, Italy and UK; * indicates rejection of the null hypothesis of unit root at the 95% confidence level, ** at the 99% level - depending on sample size, the 95% critical value ranges from -2.89 to -2.92 - .

as long-term interest rates, financial wealth and inflation are excluded from the specification; 2) financial innovation is likely to affect the stability of money demand over the sample; 3) cointegrating relationship are identified only up to a linear combination, hence no single vector can be easily interpreted as describing a meaningful economic relationship[24].

Cointegration tests were run for the six countries. According to the lambda-max statistic (see Johansen and Juselius, 1990, for a description), the null hypothesis of no-cointegration versus one cointegration vector, of one cointegration vector versus two was rejected at the 90% confidence level in all countries. Three cointegrating vectors were suggested in France, Germany and Sweden, whereas two appear more likely in Germany and Italy, and four in Spain. However, theoretical reasons to believe that a cointegrating rank of three leads to a plausible economic interpretation of the shocks have led me to base the rest of the analysis on a rank of $r = 3$.

[24] The literature on this issue is of course enormous. To name a few studies, see Fase and Winder (1998), Hendry (1995), Ericsson (1998).

Table 4.3: Parameter estimates of the cointegration vectors

Country	Period	CV1	CV2	CV3	P-value	#cv 90% (λ-max)
France	78:4 - 97:4	$mp2 = y + \underset{(1.074)}{5.044}\ r$	$hp = \underset{(.05)}{.373}\ y$	$i_t = \pi_t$	.11	3
Germany	73:1 - 98:3	$mp1 = \underset{(.029)}{2.075}\ y + \underset{(.272)}{.35}\ r$	$hp = \underset{(.102)}{.063}\ y$	$i_t = \pi_t$	.10	2
Italy	73:1 - 98:2	$mp1 = 1.495y + \underset{(.409)}{3.01}\ r$	$hp = \underset{(.187)}{1.24}\ y$	$i_t = \pi_t$	.53	2
Spain	87:4 - 98:4	$mp2 = \underset{(.18)}{1.65}\ y - \underset{(.12)}{3.67}\ r$	$hp = \underset{(.21)}{1.69}\ y$	$i_t = \pi_t$	.01	3
Sweden	77:4 - 98:4	$mp2 = y + \underset{(.834)}{5.37}\ r$	$hp = \underset{(.159)}{.864}\ y$	$i_t = \pi_t$	.04	3
UK	73:1 - 98:3	$mp1 = \underset{(.12)}{1.926}\ y - \underset{(.515)}{7.02}\ r$	$hp = \underset{(.11)}{.63}\ y$	$i_t = \pi_t$	.82	4

Parameter estimates of the three cointegration vectors (standard errors in brackets). The next to last column refers to the p-value of the likelihood ratio test statistic for overidentifying restrictions on the cointegrating vectors, whereas the last column refers to the number of cointegrating vectors suggested by the lambda-max statistic at the 90% confidence level.

4.3 Cointegration relations

Table 4.3 reports the estimated three cointegrating vectors for each country given one over-identifying restriction on the cointegrating space, together with p-values for the over-identifying restriction imposed upon the cointegrating vectors. The restrictions were rejected at the 95% confidence level only in Sweden and Spain[25]. Since it has been shown (Jacobson, Vredin and Warne, 1998). that the likelihood ratio test for hypothesis about the cointegration vectors for a given rank tends to be oversized, I prefer to present for reasons of space only the restricted cointegrating vectors, with standard errors in parentheses: the loss of information should not be great, as unrestricted and restricted vectors (upon a convenient rotation of the latter) should be similar.

A few comments are in order given the evidence on these cointegrating vectors.

1) The estimated income elasticity of money demand b_y is always greater than one in the cases in which is not restricted to unity. This might be the consequence of omitting wealth variables in the money demand, such as housing wealth, which is positively correlated with income.

2) The estimated semi-elasticity of money demand with respect to the short-term interest rate, b_i, is negatively signed only in two cases out of six. For France and Sweden, the implied elasticity of real $M2$ is significantly positive: yet a positive elasticity is plausible on theoretical grounds, as a negative coefficient should be expected a priori only on (some measure of) narrow money, as discussed for instance by Fase and Winder (1998) and Ericsson (1998). This specification is that it implies the somehow counterfactual result that the *nominal shock* yields higher

[25] In France and Sweden, I imposed unit elasticity of money with respect to income, as the unrestricted income elasticity was measured with great imprecision and led to implausible estimates for the money demand elasticities.

nominal rates and higher inflation in the long-run, but also lower real money balances. This result does not affect the interpretation of the transitory shocks, and could be more grounded on economic theory if we labelled the disturbance as, say, a "velocity" shock rather than a credibility shock.

3) The estimated cointegration vector between real house prices and GDP favours an interpretation of the long-run upward trend in house prices that, despite the short datasets, seems to be consistent across countries[26]. The point estimates of the coefficient τ range from a lower limit of .063 for Germany to 1.69 for Spain. These estimates should in any case be treated with great care, as they are very sensitive to the period they cover: cointegration between real house prices and output can be a statistical property of the data, but putting structural emphasis on cross-country differences would be probably too ambitious, not least because the house price indices are not homogenous across countries.

5 Empirical evidence

5.1 Impulse responses

This section looks at the econometric results of the specification. The purpose of this section is threefold:

1) To check whether the identification scheme leads to plausible estimates of the shocks; as Christiano, Eichembaum and Evans (1999) make clear, there is no convergence in the literature on a particular set of assumptions for identifying the effects of an exogenous shock to monetary policy. The same remark applies to other shocks that drive economic fluctuations (Cochrane, 1994). Yet the inference upon the effects of many of these shocks is robust across a large subset of identification schemes that have been tried in the literature: after a contractionary monetary shock, interest rates go up, price level responds slowly, output and monetary aggregates fall. After a positive demand shock, output, interest rates and prices increase, as in Gali (1992) and Gerlach and Smets (1995).

2) To compare the response of economies following a shock. We would expect that the same identification scheme yields consistent estimates across economies. It would be hard to label a transitory disturbance "monetary shock" if it implies a set of impulse responses that is inconsistent with every element in the set of macroeconomic models that we wish to discriminate between.

[26] This is broadly in line with the evidence that the Kennedy and Anderson (1994) study on 15 countries over the last 25 years provides: a look at the graphs from page 32 to 35 of their paper shows that in 13 out of 15 nations real house prices were higher in 1993 than in 1970. Same evidence is found in Cutler (1995) for the G7 economies from 1970 to 1992.

Table 5.1: Long run impact of the permanent shocks

	FRANCE		GERMANY		ITALY		SPAIN		SWEDEN		UK	
	sup.	nom.	sup.	nom.	sup.	nom.	sup.	nom.	sup.	nom.	sup.	nom.
y	1.21	0.00	0.97	0.00	0.88	0.00	1.01	0.00	1.22	0.00	0.83	0.00
π	-0.02	0.47	-0.21	0.53	0.01	0.42	0.05	0.33	-0.20	0.30	0.10	0.46
mp	1.09	2.36	1.94	0.19	1.44	1.46	1.50	-1.21	0.18	1.62	0.77	-3.31
hp	0.52	0.00	0.06	0.00	0.95	0.00	1.71	0.00	1.06	0.00	0.48	0.00
r	-0.02	0.47	-0.21	0.53	0.01	0.42	0.05	0.33	-0.20	0.30	0.10	0.46

Long run impact of the two permanent (supply and nominal) shocks, one standard error in size (percentage changes).

3) To assess how house prices respond to shocks, whether the responses are consistent across economies, what might be the reasons for these responses, and whether it is possible to infer any particular transmission mechanism with which the impulse responses for house prices might be consistent. Needless to say, this is a very difficult task, because of the uncertainty surrounding the impulse responses and because the empirical procedure only identifies "equilibrium" responses to monetary shocks.

5.1.1 Permanent shocks

Table 5.1 presents the estimates of the long-run impacts of supply and demand shocks (corresponding to the P matrix discussed above) for the 6 countries analysed. This table shows, for instance, that the long-run effect of a one-standard deviation supply shock raises output in France by 1.21 percentage points (the figure in the top left panel), real balances (via increased money demand) by 1.09 percent, real house prices by 0.52 percent, and has a negligible effect (-0.02 percent) on inflation and interest rates.

Supply shocks The first row of Figures 2 to 7 provide the estimated response of the economy to a favourable, one-standard deviation shock to the aggregate supply disturbance, along with one-standard error asymptotic confidence bands[27]. Based on the specification of the cointegration vectors and on the matrix of common trends, this shock has been identified under the assumption that it leads to an increase of output in the long-run, as well as to an increase in real house prices, with proportions dictated by the coefficient τ measuring the long-run elasticity of real house prices to GDP. A cross country comparison of the impulse responses can be seen in Figure 8, where I also plot the implied responses of consumer (P), nominal house prices (H), and ex post real interest rates ($R - DP$). I will repeat a similar exercise for the other shocks as

[27] For a discussion on how to compute confidence intervals for the common trends model, see Warne (1993) and Vlaar (1998).

well.

The initial effect on output is positive for all the countries: in the impact period, the point estimate ranges from 0.02 percent in Italy to 0.6 percent in United Kingdom. After about three years, output stabilises at its higher steady state level having increased by, on average, 1 percentage point. In all the countries but Spain consumer prices are below the baseline after one year, as predicted by a simple aggregate demand - aggregate supply model. The nominal interest rate hardly moves, as the increase in money demand is satisfied by a temporary decrease in the price level and by increased money supply. In all the countries, the long-run effect of a supply shock on inflation and nominal rates is negligible, although there is a negative long run effect on the *level* of consumer prices[28].

In all countries, house prices go down for some quarters before increasing to their new steady state, higher level. In a perfect capital market, one would expect overshooting of house prices followed then by a gradual adjustment towards the long-run, higher equilibrium level. One possible justification for the result is the following: by raising the return to capital, the supply shock generally increases real interest rates; this temporary effect reduces the demand for houses; only when real rates are back to the baseline, the *income* effect becomes greater than the *substitution* (user cost) effect, and real house prices go up. Visual inspection of Figure 8 suggests a negative correlation between behaviour of real rates and behaviour of real house prices.

Nominal shock The permanent nominal innovation (second row of Figures 2 to 7) raises inflation and nominal rates by the same amount in the long run. It is inadvisable to put too much structural emphasis on this shock, especially because, as shown in Figure 9, there is not a homogeneous, discernible pattern across economies in the response of the variables. One interpretation is that of a permanent innovation to the expected rate of inflation; therefore the associated responses in house prices can test whether houses are viewed as a hedge against inflation. In Sweden, Italy and Germany real house prices go up, although the error bands are somewhat large. This increase in expected inflation also elicits an upward response of nominal interest rates, which is suggestive of an anti-inflationary monetary policy from the monetary authority: yet this monetary policy reaction does not bring about any significant effect in the housing market.

[28] Spain is the only exception.

5.1.2 Temporary shocks

Monetary shock I separate the three temporary shocks imposing restrictions on their contemporaneous effects in a recursive fashion. Following widespread tradition in the VAR literature, the monetary disturbance is identified under the assumption that it does not affect contemporaneously output and inflation. The identification scheme seems successful, as evidence in Figure 10 (and third row of Figures 2 to 7) shows that this shock elicits upward pressure in interest rate, a contraction in the monetary aggregate[29], and a temporary decline in output, that bottoms out approximately between 4 and 9 quarters after the impulse in all the countries. These are general indications of a contractionary monetary policy stance.

How do prices respond? Both consumer prices and house prices go down, with some exception. For instance, consumer prices are above the baseline for one year in United Kingdom, Germany and Sweden. In U.K. and Sweden this pattern is plausible, as variable rate mortgage costs have a large weight in household budgets, as well as on measured inflation; for Germany the initial increase might be due to the fact that part of the innovation in the interest rate captures some residual systematic response to unaccounted disturbances generating inflationary pressures[30].

Yet the short run response in house prices is much more pronounced, and real house prices significantly decrease in virtually all the countries. A corollary of this is that house price inflation is more sensitive than consumer price inflation to a monetary innovation. There are many general reasons that might justify this result, of course, and I defer a discussion of this to the next subsection. In what follows, I try to see whether the different responses of house prices can be justified by looking at the different housing markets in the countries analysed and whether and how these differences might play a role in the transmission mechanism.

To be clear, a direct comparison of the stance of monetary policy is made hard by the fact that a typical shock varies in size, shape and duration across countries, as well as by the different sample sizes[31]. Here I present two sets of comparative responses: in the first one (Figure 10) the contraction is one standard error in size; in the second (Figure 11), I rescale the initial impact on the interest rate to be the same (50 basis points) for all the countries.

[29] Although real balances temporarily increase in France and United Kingdom, the implied effect on nominal balances is unambiguously negative.

[30] This is a common explanation in the literature to justify the well known *price puzzle*, i.e. the fact that after a contractionary monetary policy shock consumer price initially increase rather than decrease (e.g., Sims, 1992).

[31] When it comes to comparative VAR studies, the evidence is not very conclusive as far as the impact of monetary and other shocks is concerned. Tables B.1 and B.2 in the Appendix B provide a flavour of the uncertainty involved in estimating (and comparing) the responses of some European economies to an identified monetary policy shock. Although the estimates refer to different time spans and to shocks of different magnitude, a quick glance at these Tables shows that it seems at least hazardous to rank the economies according to the size of their reaction to a monetary expansion (whether it is an increase in some monetary aggregate or a decrease in the short-term interest rate).

Once the interest rate increase is rescaled (Figure 11), it seems that Italy and United Kingdom experience biggest house price fluctuations whereas France and Germany are probably at the other extreme (in Germany, real house prices initially increase after the contraction), with Spain and Sweden somewhere in between. To give some quantitative flavour, six quarters after the monetary tightening nominal house prices are respectively 1.3 and 1.5 per cent below the baseline in Italy and UK, whereas they are 0.6 and 0.1 per cent below in France and Germany. Real house prices, of course, fall a bit less, given the moderate decrease in consumer prices. It is difficult to say whether these responses are significantly different across countries. However, after six quarters the lower confidence band (one s.e.) for the fall in Germany is above the higher one for United Kingdom, thus suggesting that there are some significant differences between the most extreme cases.

The different responses can be justified as follows: countries with low transaction costs, high loan-to-value ratios, a large owner-occupied sector and a large proportion of variable-interest mortgage loans should experience relatively high real house price volatility and a great role for housing in the interest rate transmission mechanism (see MMS, 1998). The evidence here seems to confirm this conjecture: the UK is one of the EU countries with lowest transaction costs as a percentage of price (2%), with mortgage rates in most of the cases reviewable or renegotiable, very high loan-to-value ratios, and a high owner occupied tenure rate as a percentage of the housing stock. In Italy, although most of the funding for house purchase comes from own funds, the impact of a monetary contraction is likely to affect households who are still repaying their mortgage: Barran, Coudert and Mojon (1996) report that 75 per cent of mortgage credit is at rates that are directly indexed on the short term rate. However, despite the big reaction in terms of house price volatility, the response in output is not very strong: overall, that suggests that in Italy house prices, although very volatile, do not play a big role in the transmission mechanism.

The United Kingdom is the country that is affected most if we use as a metric for the impact of the shock the combined effect on output and real house prices. To this aim, Figure 12 shows a plot of the response of GDP and real house prices to a 50 basis point unexpected increase in the short term rate.

Germany and France (and, to some extent, Spain, although the sample covers only a small period starting in 1987) tend to be at the opposite side of the spectrum. As argued by MMS (1998), in Germany tenure rates are relatively low and transaction costs as a fraction of the price are relatively high. Also, the initial contraction might signal a credible disinflation policy by the central bank in the future, thus lowering expected inflation and future rates. Surprisingly, though, the response of output is very strong, although it might be a consequence of the imposed normalisation. For a country such as Germany with a long history of low and stable inflation and interest rates an increase of the interest rate of 50 basis points is a "bigger" disturbance in relative terms, as Figure 10, showing one-standard deviation innovations, shows.

Interestingly, in France nominal house prices seem to jump immediately to - and even to overshoot - their new long-run equilibrium level, and the implied dynamics in real house prices seem all to stem from the slow adjustment of consumer prices. Overall, the impact on house prices of the contraction in France is not very strong, and after about 6 quarters real house prices are back to the baseline after the initial fall. The result is consistent with evidence presented in Barran, Coudert and Mojon (1996), who report that in France almost 95 per cent of mortgage credit is on completely fixed rates. Therefore, one would expect the impact of the contraction to affect only those who are going to buy a house, rather than already indebted households, with small wealth effects for this group.

The responses for Spain and Sweden again provide general evidence of a monetary contraction.

Two remarks are in order. The first is related to the difficulty of comparing different monetary innovations across countries, especially given that the shocks take different shapes and sizes in the observed pattern of the interest rate and nominal money, the typical short term intermediate targets the monetary policy authority. Here I have shown the responses having and not having normalised for the initial impact on the nominal interest rate[32]. The first procedure (normalising) has the virtue of providing a useful benchmark if we think that four of these countries are now under a common monetary policy; the second (not normalizing) compares in all the countries a "typical" benchmark shock over the period in question.

The second relates to the observed dynamics in the house prices following a shock. A standard-monetarist model of the housing market (as described in Poterba, 1984 or Meltzer, 1995) would predict that there should be a jump followed by a smooth adjustment of the asset price towards the equilibrium. The evidence here shows that the timing of the response in real house prices matches that of output, with a peak in real house prices occurring either contemporaneously or a few quarters before that of output; and the adjustment of house prices to the new steady state takes several years, with house prices falling in real terms for about one or two years before reverting to the baseline. One way to interpret this evidence is that some broad "credit channel" might be in action too: with depressed asset prices, consumption

[32] Normalising for the initial impact on the interest rate is more pacific if only unanticipated monetary policy matters (the standard VAR interpretation). In this case what happens to the path of interest rate and money after a shock is irrelevant for the response of the real variables. If anticipated policy matters too, not only the initial impact but also the time path of the policy variables are important in determining the response of the real variables (this important distinction is due to Cochrane, 1998; see also Leichter and Walsh, 1999, for a discussion on the European case).

and investment could suffer too, and the effects might reinforce each other, as in the standard Kiyotaki-Moore (1997) model.

Overall, the responses cannot clearly help in distinguishing between different views of the monetary transmission mechanism: but in the context of the present model, the estimated dynamics of house prices seem to hint some role for housing and credit institutions in the different response of the house prices, and for house prices in turn in the propagation mechanism. This is consistent both a "broad credit channel" view of the transmission mechanism and with a "monetarist view", as described in Meltzer (1995).

Why should house prices respond more than consumer prices to a monetary contraction? When policy is tightened through a decrease in reserve provision, interest rates rise. As Morris and Sellon (1995) explain, a rise in interest rates leads to a reduction in spending in particular in interest-sensitive sectors of the economy, such as purchases of durable goods and housing. This result could appear at first sight surprising, as there should be some a priori reasons to believe that the decision to buy a house depends more on a long-term interest rate. In principle, if central bank future actions after the initial shock are perfectly anticipated, the long-term rate should raise by less than the short rate (it could even fall, if the monetary tightening is viewed as credible and effective). Despite that, to the extent that mortgage rates (at least on new housing loans) or other terms of the mortgage contract (for instance, the amount of downpayment required) depend at least in part on the current stance of the monetary policy, one can expect a *user cost effect* to operate and reduce relative demand for housing[33].

Ad additional channel through which monetary policy could influence house prices is the one that sees it working through credit (let us call it *credit supply effect*). If monetary policy works by directly constraining the ability of banks to make new loans, making credit less available to borrowers who are dependent on bank financing, this additional effect might reinforce and amplify the initial one that operates through the traditional user cost - demand side channel (for instance, see Kashyap, Stein and Wilcox, 1993).

Furthermore, the bigger response in house prices is also consistent with the fact that the housing supply curve (call it *inelastic housing supply effect*) is steeper than the supply curve for all other goods in the short run[34].

[33] Bernanke and Gertler (1995) show that residential investment is much more sensible to monetary tightening than other components of spending.
[34] There is also another reason why price volatility could arise in the housing market: when house prices are rising, demand appears to rise, and when prices are falling the converse appears to be the case. In other words, not only might the supply curve be inelastic, but also the demand curve might be upward sloping.

Demand shock The second transitory shock results in short-term output effects with consumer prices fixed in the impact period. Following Crowder, Hoffman and Rasche (1999) and Gerlach and Smets (1995), it is possible to label this disturbance "transitory demand shock" since it elicits positive output and price responses and due to its transitory imprint on the real variables in the system. Yet this does not identify any particular source of aggregate demand innovation. The fact that the responses (shown in row 4 of Figures 2 to 7 and, on a comparative basis, in Figure 13) display an increase in real house prices that peaks after about 2 years and dies out only after 5/6 years is consistent with the idea that the shock might be the outcome of:

a) temporary tax incentives that give an advantage to buy houses;

b) increase in housing demand stemming from optimistic consumer or investor expectations, that also translates onto the wider economy;

c) an increase in aggregate demand deriving from other sources (say, devaluation of national currency under a fixed exchange rate regime) that translates into house price inflation with some lag.

The results in Figure 13 are consistent with a upward shift in the IS curve of the economy. Nominal and real interest rates go up. Output rises protractedly. Inflation goes up too, except in Germany. Real house price increases are particularly strong in UK and Sweden. The increase, whose timing closely matches that of output, is protracted for several years, again lending support to some "broad" credit channel theory.

Inflation shock In many countries, the tax system is such that higher inflation rates reduce homeowners' user cost because while nominal mortgage interest payments are tax deductible, the capital gains from house appreciation are essentially untaxed. A transitory inflation shock should therefore increase demand for houses, thus raising their price. On the other hand, as shown in Figure 14 (and row 5 of Figures 2 to 7), inflation increases also drive endogenous movements in output and interest rate that might counterbalance the effect. For instance, in all countries but France output goes temporarily down.

The picture is made complicated by the fact that this disturbance might in reality mean at least three things: 1) increase in world commodity prices; 2) imported inflation following devaluation of the domestic currency; 3) temporary negative supply shock. The second interpretation is consistent with an increase in output, as the impulse responses for France show.

It is also interesting to note the link between real rates and house prices: where the shock leads to higher volatility in the real interest rate, as in UK for instance, we also observe a decrease in real house prices.

As for the permanent nominal disturbance, it is inadvisable too put to much structural emphasis on this shock, that might indeed be a miscellaneous of disturbances coming from many different sources.

5.2 Variance decompositions

Up to now the paper has focused on answering the question: what are the dynamic effects of supply, demand, nominal, inflation and in particular monetary shocks on house prices? A related but different question is: in which proportion do the different innovations contribute to the volatility of house prices and other macroeconomic variables? Answering this question is important, because it can give a flavour of what are the main factors driving house price fluctuations at different horizons.

Figure 15 plots the fraction of the k-step ahead forecast error variance for real house prices explained by the different shocks. For reasons of space, I do not report variance decompositions for the other variables[35].

While the results highlight that not much of variance of output (around 15% or less) is attributable to monetary innovations, they seem to hint some role for monetary factors in explaining house prices variability, at least over the short run. After, say, 6 quarters, a fraction that goes from 5% to 40% of the volatility of real house prices comes from the policy shock measure: this fraction is smallest in Germany.

Demand shocks play a major role over the short run too: whether they represent simply aggregate demand - say, shifts in the IS curve - or housing markets specific disturbances (even bubbles fuelled by self-fulfilling expectations) is in any case a question that it is difficult to answer in this framework. France, Sweden and UK are, in this respect, the countries where demand innovations play a major role in the short run.

The UK result is particularly striking - 60% of volatility in house prices comes from the demand shock, even at a 10 years horizon! -. This is probably indirect confirmation of the fact that in a (allegedly) speculative market, such as the UK one[36], transitory factors play an important role in determining house price fluctuations. At the other side of the spectrum is Germany. Most of the unforecast variability in house prices for Germany comes from supply factors.

Not surprisingly, in addition, the variability of nominal interest rates and money balances is in large part due to monetary factors. Of course, the assumptions made in the identification scheme imply by construction that the two permanent shocks will dominate the transitory ones

[35] Results are available from the author upon request.

[36] Levin and Wright (1997) present some evidence of the process of speculation as a possible determinant of house prices in UK-wide housing market.

as the forecast horizon grows larger.

6 An informal interpretation of house price movements

Figures 16 to 21 provide for each country the plots of log of real house prices[37], inflation, interest rates and log of output in the first row, and estimates of the five structural shocks in the second. To make the graphs easier to interpret, I construct 2 year moving averages for each of the otherwise uncorrelated disturbances, so that it is easier to identify periods in which some of them were playing a prominent role[38]. I also focus only on some specific, relevant periods of significant house prices movements for each country. The overall picture that emerges is that no boom can be easily associated with a single source of macroeconomic fluctuations. Each major variation in house prices appears to have been driven by a combination of factors pushing in the same direction[39].

FRANCE France (Figure 16) had a significant boom during the year 1980, with prices peaking at the beginning of the 1981 and falling by 15% in real terms in the following two years; a similar process of boom-bust occurred from 1985 to 1989 (prices peaked at the end of 1987). After a peak at the beginning of 1991, prices had fallen in real terms by about 25% at the beginning of year 1997. Demand shocks seem to have played an important role in driving house price fluctuations, together with other transitory factors. The 1985 - 1987 boom followed a period of positive supply shocks and expansionary monetary policy. Money and credit growth were rising (thanks to abolition of credit control measures known as "encadrement du credit": see Hickok and Osler, 1994). Instead, the growth of prices from 1989 to 1991 seem more due to demand shocks: monetary policy appears to have been tight over that period, and might have contributed to the fall in house prices occurred at the beginning of 1991 once demand started to slow and the economy entered into recession.

GERMANY The German house price boom of the late '80s - with the real house price index up 15% in the 4 years from 1986 to 1990 (as shown in Figure 17), but much bigger price increases in the big cities - seems due in particular to increases in aggregate demand. Some of these "demand" shocks seem to have their roots not only in the booming economy of the late

[37] Distances on the vertical axis can accordingly be interpreted as percentage changes.

[38] As visual inspection of the graphs shows, periods of higher than average interest rates are normally associated with contractionary monetary policy. Although this point is interesting per se, it should not be overstated, for at least two reasons: 1) I identify monetary policy by using short and long run restrictions, so there is not a 1 to 1 mapping between high nominal interest rates (or low money supply) and negative monetary shocks; 2) monetary (and other) shocks only refer to unexpected movements in the variables: therefore systematic monetary policy that raises interest rates does not constitute a monetary shock.

[39] Expansionary monetary policies correspond to the monetary shock variable taking negative values.

'80s, but also in specific housing market episodes that might have increased demand around that period. In particular, in 1987 capital gains tax exemptions were introduced - provided the property was not sold within 2 years of purchase - and from 1991 it was possible to deduct interest payments up to DM 12000 per annum for the first three years from the purchase of a newly-built house (Smith, 1994). In addition, the big cities saw, at the beginning of the decade, an influx of workers from Eastern Germany that boosted demand: Frankfurt is reported to have seen a 44% price rise in 1990-91 (The Economist, 1992).

ITALY Italy has experienced great volatility in house prices. The main booms appear to have occurred between 1979 and 1981 and in the late '80s. A sharp drop between 1982 and 1985, with prices falling by one-third in real terms, followed the first boom. After the late '80s increase, prices fell by almost 15% in real terms between 1993 and 1996. A look at the structural shocks in Figure 18 highlights that nominal factors and demand shocks might have played a distinctive role in driving house prices down from 1993 onwards. In particular, among the negative demand shocks, a role could have been played by policies in the last decade that have revised upward the fiscal value ("valore catastale") of the residential property, thus making unattractive the investment in housing in a period of economic recession, low household expectations about future incomes, and near saturation of the market, with tenure rates as high as 78%, one of the highest levels in Europe (Censis, 1996).

SPAIN Positive demand and supply shocks seem to have driven the late '80s boom (see Figure 19). Only a small fraction of the fluctuations in house prices seems attributable to the monetary policy stance, which was fairly neutral during that period. The decline in real house prices for most of the '90s started with the recession in 1992 and 1993 and was driven by both tighter monetary policy and negative demand shocks.

SWEDEN Demand and monetary policy shocks drove the housing boom of the late '80s: house prices went up 35% in real terms between 1986 and 1989, and fell by almost the same amount in the years from 1991 to 1993. Loose fiscal policy, de-regulation of the financial markets (ceilings on bank lending rates and quantitative controls on bank loans were abolished in 1985) and a tax system that encouraged debt-financed consumption spurred aggregate demand and increased asset prices. Looking at Figure 20, demand shocks were consistently positive in all years until 1990, when a quickly deepening recession set in. As argued by Berg and Gröttheim (1997), the combination of an international recession, a reformed tax system which abolished investment allowances and falling asset prices contributed to the severity of the downturn.

UK Over the period going from 1974 to 1998, the United Kingdom has experienced two main house price boom-busts cycles, the first from the 1978 to 1982, the second from 1983 to 1992. Both cycles are widely documented and discussed in the literature (see for instance Cutler, 1995, Holmans, 1994, and Curwen, 1997). During the first (smaller) cycle, house prices rose in real terms by 20%, hit a peak at the end of 1979, and then fell by 15%. In the second (bigger) cycle, real house prices rose about 60%, peaked in 1989, and then fell by 47%, bottoming at the end of 1995. Looking at Figure 21, the house price boom of in the second half of the '80s seems to have been driven by a combination of three factors: positive supply and demand shocks and expansionary monetary policy. This is consistent with the view that rising household expectations about their future incomes, policies to promote housing purchases (such as the announcement in March 1988 that from August of that year mortgage tax relief would be restricted to £30,000 per residence regardless of the number of borrowers) and a loose monetary policy that followed the appreciation of the pound from around 1987 all played a role in the housing boom[40].

7 Conclusions

This paper has shown that the dynamics of house prices can be dealt with using a tractable VAR framework in a relatively straightforward way. I have developed and estimated a simple macroeconometric model driven by five exogenous disturbances, all of which can potentially have effects on house price inflation. In particular, I have shown that monetary policy shocks - identified under the assumption that they do not affect output (and consumer price inflation) in the period of the shock and in the long run - can have serious effects on house prices, which might in turn play a role in the propagation mechanism of the shocks. What seems supportive of these findings is that a set of common and sensible identification assumptions yields plausible results as far as the interrelationships between money, consumer prices and output are concerned; moreover, it adds a relatively new piece of evidence, showing that, unlike consumer prices, house price inflation might be very sensitive to the forces driving economic fluctuations. Although this result is not surprising in *itself* - after all, house prices, as asset prices, can be expected to reflect shifts in expectations more quickly than consumer prices -, it is encouraging that it has been obtained with a highly stylised macroeconomic model, that in other respects closely matches the

[40] Financial liberalisation episodes are often reported in the literature to have contributed to the housing boom in the 1980s: restrictions on bank lending were abolished in 1980, enabling banks to compete with building societies; average loan-to-value ratios for first time buyers rose from .74 in 1980 to .86 in the mid 1980's. However, the fact that the boom came several years after the deregulation suggests that financial liberalisation itself cannot explain the boom. Demographic factors are also mentioned too - the population in the 20-29 age range rose by 1.3 million over the 1980s, compared to .1 million over the previous decade -, but they can be hardly labelled as shocks - after all, this phenomenon was largely predictable and, under efficient markets, one would expect the main impact of demographic factors to be on quantities rather than prices.

predictions of a standard IS-LM-Phillips curve paradigm, thus providing an important robustness check.

Of course, understanding which are the channels underlying the observed patterns for the different responses in house prices remains a key issue in the research agenda. Although the demand shocks identified in the paper might capture some credit liberalisation episodes, the roles of financial liberalisation and of credit in driving asset price fluctuations have not been directly addressed by this paper. In other words, while I have tried to make the black box of the channels of transmission larger, I have not tried to open it.

The results also hint that different housing and credit market institutions play a role in this transmission mechanism: so long as they do so, of course, they also suggest that this relationship is unlikely to remain invariant over time. Changes in fiscal, regulatory and legal structure, as well as the change in the monetary policy regime with the advent of the monetary union, are likely to affect this relationship. This would be also particularly likely if the ECB decided to target house prices as part of its monetary policy strategy[41].

The debate on money, macroeconomy and asset prices goes back to at least 1911, when Irving Fisher argued that policymakers should aim to stabilise a broad price index that included shares, bonds and property as well as good and services. And there are growing concerns on whether expansionary monetary policies can fuel asset price bubbles. Yet the link between monetary policy and asset prices is far from being clear. The evidence presented in this paper overall suggests that the unsystematic component of monetary policy (and other macro factors) can play an important role in driving asset price fluctuations.

[41] This follows directly from Goodhart's Law and the Lucas critique.

A The Common Trends Methodology

This appendix describes the common trends methodology for the econometric model used in the paper. The exposition follows Warne (1993) and Fischer, Fackler and Orden (1995).

A.1 Common trends and cointegration

The specific model can be represented by a $n \times 1$ vector of endogenous variables X_t, which has the following form:

$$FX_t = F_1 X_{t-1} + .. + F_k X_{t-k} + F\mu Z_t + u_t \qquad (1)$$

where X_t and u_t are of dimension $(n \times 1)$, u_t is a vector of white noise and mutually orthogonal structural shocks, k is the lag length, Z_t is a vector of deterministic variables such as constants and seasonal dummies, and F's and μ are unknown coefficients. The reduced form of the model is:

$$X_t = A_1 X_{t-1} + ... + A_k X_{t-k} + \mu Z_t + \varepsilon_t \qquad (2)$$

where $\varepsilon_t = F^{-1} u_t$, $A_i = F^{-1} F_i$, $E\varepsilon\varepsilon' = F^{-1} F^{-1\prime} = \Sigma$. This model can be reparametrised (in first differences and with an error correction term) as follows:

$$\begin{aligned} \Delta X_t &= \Pi X_{t-1} - (A_2 + ... + A_k)\,\Delta X_{t-1} - ... - A_k \Delta X_{t-k+1} + \mu Z_t + \varepsilon_t & (3) \\ A(L)\,\Delta X_t &= \Pi X_{t-1} + \mu Z_t + \varepsilon_t & (4) \end{aligned}$$

where $\Pi = A_1 + ... + A_k - I$.

If the series are non-stationary and cointegrated, then the following holds: $0 < r = \operatorname{rank} \Pi < n$ and the equation (4) above is the VECM form of the model.

As shown in Johansen (1991) and Warne (1993), from the stochastic part of the reduced form of restricted VAR (equation 4 above) it is possible to get the following moving average representation:

$$\Delta X_t = C(L)\varepsilon_t \qquad (5)$$

This is obtained as follows. Define the transformation matrix

$$M \equiv \begin{bmatrix} P' \\ \beta \end{bmatrix}, \ \beta' P = 0$$

and the matrices

$$D(L) \equiv \begin{bmatrix} I_{n-r} & 0 \\ 0 & (1-L)\,I_r \end{bmatrix}, \quad D_\perp(L) \equiv \begin{bmatrix} (1-L)\,I_{n-r} & 0 \\ 0 & I_r \end{bmatrix} \Rightarrow D(L)\,D_\perp(L) = (1-L)\,I_n$$

Also, let α^* be an $n \times n$ matrix such that:

$$\alpha^* \equiv \begin{bmatrix} 0_{n\times(n-r)} & \alpha_{n\times r} \end{bmatrix}$$

It can be verified that:

$$\alpha\,(\beta' X_t) = \alpha^*\,(D_\perp(L)\,MX_t)$$

Premultiply both sides of the VECM in (4) by M:

$$MA(L)\,\Delta X_t = M\alpha\,(\beta' X_{t-1}) + M\mu Z_t + M\varepsilon_t = M\alpha^*\,(D_\perp(L)\,MX_{t-1}) + M\mu Z_t + M\varepsilon_t \qquad (6)$$

This can be rewritten as:

$$\begin{aligned} MA(L)\,M^{-1}D(L)\,D_\perp(L)\,MX_t - M\alpha^* L\,(D_\perp(L)\,MX_t) &= M\mu Z_t + M\varepsilon_t & (7) \\ M\left(A(L)\,M^{-1}D(L) - \alpha^* L\right)X_t^* &= R(L)\,X_t^* = M\mu Z_t + M\varepsilon_t & (8) \end{aligned}$$

The VAR has now been transformed in a VAR with a new n dimensional variable, X_t^*[42], where:

$$X_t^* \equiv D_\perp (L) M X_t$$

Inverting (8) yields:

$$X_t^* = R(L)^{-1} M \mu Z_t + R(L)^{-1} M \varepsilon_t \tag{9}$$

Noting that $\Delta X_t = M^{-1} D(L) X_t^*$, we have, abstracting for a moment from deterministic components:

$$\Delta X_t = M^{-1} D(L) R(L)^{-1} M \varepsilon_t \tag{10}$$

Therefore:

$$C(L) = M^{-1} D(L) R(L)^{-1} M \tag{11}$$

A.2 Identification of permanent and transitory shocks

Subject to identification, an observationally equivalent representation for ΔX_t is:

$$\Delta X_t = \Gamma(L) u_t \tag{12}$$

We know that $\Gamma(1)$ measures the long-run effect of the structural shocks. Engle and Granger (1987) have shown that the columns of $C(1)$ are orthogonal to the cointegrating vectors β, so $\beta' C(1) = 0$. Thus, any basis for n-dimensional vectors ($n = 5$ is number of variables in the model) can be divided into a space spanned by the $r = 3$ cointegrating vectors and an orthogonal space spanned by the $n - r = 2$ linearly independent columns of $C(1)$. Since $\beta' C(1) = 0$, for any β there are $(n-r)r = 6$ independent reduced-form coefficients of $C(1)$. The F matrix contains n^2 parameters; for given β, there are $(n-r)n$ independent RF coefficients in $C(1)$, as many as in $\Gamma(1)$; Σ contains information $n(n+1)/2$ parameters Hence we need $n^2 - (n+1)n/2 = n(n-1)/2$ parameters to identify the model.

Structural and reduced form are linked at $L = 1$ by:

$$C(1) = \Gamma(1) F$$
$$\varepsilon = F^{-1} u$$

The methodology suggested by KPSW goes through the following steps:

1) Partition $\Gamma(1)$ so that $\Gamma(1) = [P \mid 0]$, where P is a $n \times (n-r)$ matrix whose columns represent the long-run responses of the variables to permanent shocks, whereas the long-run responses to the temporary shocks are assumed to be zero. These are the sources of the common stochastic trends among the variables. For the remaining r shocks, permanent effects are assumed to be zero, so these shocks have only temporary effects. This imposes $(n-r)r$ identifying restrictions.

2) Partition the shocks according to:

$$u = \begin{bmatrix} u_{n-r} \\ u_r \end{bmatrix}$$

where u_{n-r} denotes shocks whose permanent effects are nonzero, while u_r denotes shocks whose permanent effects are zero (transitory shocks).

3) Partition F conformably to $\Gamma(1)$ with its first $n-r$ and last r rows as F_{n-r} and F_r respectively. We have that $C(1) = \Gamma(1) F = P F_{n-r}$ as well as:

$$C(1) \Sigma C(1)' = PP'$$

[42] In our case, for instance, given $X_t = [y \quad mp \quad hp \quad r \quad \pi]'$, we have:

$$X_t^* = \begin{bmatrix} \Delta y + b_y \Delta mp + \tau \Delta hp \\ -b_i \Delta mp + \Delta i + \Delta \pi \\ -b_y y + mp + b_i i \\ -\tau y + hp \\ i - \pi \end{bmatrix}$$

There are $(n-r)(n-r+1)/2$ independent equations on the LHS and $(n-r)^2$ free parameters in P. Hence we need $(n-r)(n-r-1)/2$ additional restrictions on P, which can be dealt with assuming that this matrix is lower triangular.

4) $C(1)$ has rank $n-r$, hence, in order to decompose it, we cannot use standard Choleski decomposition procedure for $C(1)\Sigma C(1)'$. To deal with this it is possible for instance define P by $P = \widetilde{P}\Theta$, where $\widetilde{P}$'s columns are known coefficients specified a priori and $\Theta_{(n-r)(n-r)}$ is a lower triangular matrix of coefficients to be estimated.

5) Conformably with $\widetilde{P}\Theta$, let D be an $(n-r) \times n$ matrix solving $C(1) = \widetilde{P}D$, such as $D = (\widetilde{P}'\widetilde{P})^{-1}\widetilde{P}'C(1)$. Get Θ with a lower triangular Choleski decomposition of $D\Sigma D'$, then use Θ to calculate P.

6) Given that $C(1) = PF_{n-r} = \widetilde{P}\Theta F_{n-r} = \widetilde{P}D$, we have $F_{n-r} = \Theta^{-1}D$, hence we can obtain the structural shocks u with permanent effects by premultiplying the reduced form residuals ε by F_{n-r}.

7) Hence:

$$F_{n-r}\Delta X_t = F_{n-r}\Pi X_{t-1} - ... - F_{n-r}F_k\Delta X_{t-k+1} + F_{n-r}\mu\ Z_t + u_{n-r,t}$$

Once F_{n-r} is estimated, the dynamic effects on X_t of the shocks with permanent effects are obtained using:

$$\Gamma(L)_{n-r} = C(L)\left[F^{-1}\right]_{n-r} = C(L)\,\Sigma F'_{n-r}$$

where $\left[F^{-1}\right]_{n-r}$ denotes the first $n-r$ columns of F^{-1}.

8) Identification of the structural parameters associated with the shocks with only transitory effects can proceed from: $[0 \quad I_r]_{r\times n} = [F_r\Sigma F_{n-r} \quad F_r\Sigma F_r']$. One possibility to identify F_r is specify a triangular structure in it, as is done in this paper.

Table B.1: Output response to an expansionary monetary shock

AUTHOR(S)	GERMANY	FRANCE	U.K.
Fung Kasumovich (1998)	-.8 / .8 (6q)	.15 / .2 (1q)	.1 / .15 (7q)
Barran et al. (1996)	0 / .5 (7q)	0 / .45 (6q)	0 / .5 (8q)
Gerlach Smets (1995)	0 / .25 (6q)	0 / .8 (6q)	0 / .65 (7q)
Ramaswamy Slok (1998)	0 / .7 (13q)	0 / .5 (8q)	0 / .7 (14q)
Lastrapes (1998)	.2 / .4 (5q)	1 / 1 (1q)	.4 / .5 (3q)
Sims (1992)	0 / .7 (7q)	-.1 / 1.2 (6q)	0 / .5 (7q)
Kim (1999)	0 / .3 (5q)	0 / .3 (5q)	0 / .3 (4q)
Grilli Roubini (1996)	0 / .3 (3q)	0 / .18 (4q)	0 / .25 (4q)
AVERAGE	*.49*	*.58*	*.44*

Estimated output response in percentage to an expansionary monetary policy shock - one standard deviation in size - in the works of the authors in the first column: the first figure in each cell refers to the percentage impact response of output in the period of the shock, the second to its maximum deviation from the baseline (the quarter in which the maximum is reached is in brackets). The figure in the last row is the average across peak responses

Table B.2: CPI response to an expansionary monetary shock

AUTHOR(S)	GERMANY	FRANCE	U.K.
Fung Kasumovich (1998)	0.6	0.4	0.7
Barran et al. (1996)	***	***	***
Gerlach Smets (1995)	0.25	0.2	0
Ramaswamy Slok (1998)	***	***	***
Lastrapes (1998)	0.3	0.7	1
Sims (1992)	0.05	-0.2	0
Kim (1999)	0.1	0.4	0.8
Grilli Roubini (1996)	0.2	0.4	0.4
AVERAGE	*.58*	*.58*	*.44*

Estimated CPI response to an expansionary monetary shock (1 s.e.) in the works of the authors in the first column: the figure in each cell refers to deviation of the CPI from the baseline after 8 quarters; the figure in the last row is the average across the responses after 8 quarters; *** indicates that the results for the CPI response are not shown in the paper.

B Comparing monetary shocks in Europe

Comparing across countries the effects of a monetary shock is not a simple exercise, as evidence is rather mixed across studies and identification schemes (see Guiso et al., 1999, and Ehrmann, 2000). Tables B.1 and B.2, that refer to the response of output and consumer prices to an expansionary monetary shock in France, Germany and United Kingdom, should convince the reader why comparing the effect of a monetary shock across counties is an hazardous task. Overall, one would be tempted to conclude that the differences in the transmission mechanism across Europe are not large.

References

[1] Banque de France (1999), "Asset Prices over Twenty Years", May, mimeo.

[2] Barran, F., V.Coudert and B.Mojon (1996), "The Transmission of the Monetary Policy in the European Countries", London School of Economics, Financial Markets Group, Special Paper, No.86.

[3] Berg, C., and R.Gröttheim (1997), "Monetary Policy in Sweden since 1992", BIS Public Policy paper no.2.

[4] Bernanke, B., and M.Gertler (1995), "Inside the Black Box: The Credit Channel of Monetary Policy Transmission", *Journal of Economic Perspectives*, 9, 4, 27-48.

[5] Bernanke, B., and M.Gertler (1999), "Monetary Policy and Asset Price Volatility", *Federal Reserve Bank of Kansas City Economic Review*, 4, 5-12.

[6] Bernanke, B., M.Gertler and S.Gilchrist (1999) "The Financial Accelerator in a Quantitative Business Cycle Framework", in J.Taylor and M.Woodford (eds.), *Handbook of Macroeconomics.*

[7] Blanchard, O. and D.Quah (1989), "The Dynamic Effects of Aggregate Demand and Supply Disturbances", *American Economic Review*, 79, 4, 655-673.

[8] Bomhoff, E.J. (1994), *Financial Forecasting for Business and Economics*, London, Academic Press.

[9] Borio, V., N. Kennedy and S. D. Prowse (1994), "Exploring Aggregate Asset Price Fluctuations Across Countries: Measurement, Determinants and Monetary Policy Implications", BIS Economic Papers, No. 40.

[10] Case, K., and R.Shiller (1989), "The Efficiency of the Market for Single-Family Homes", *American Economic Review*, 79, 1, 125-137.

[11] Case, K., and R.Shiller (1990), "Forecasting Prices and Excess Returns in the Housing Market", *AREUEA Journal*, 18, 253-273.

[12] Censis (1996), *Trentesimo Rapporto sulla Situazione Sociale del Paese*, FrancoAngeli, Milano.

[13] Cho, M. (1996), "House Price Dynamics: A Survey of Theoretical and Empirical Issues", *Journal of Housing Research*, 7, 2, 145-171.

[14] Christiano, L., M.Eichembaum and C.Evans (1999), "Monetary Policy Shocks: what have we Learned and to what End?", in J.Taylor and M.Woodford (eds.), *Handbook of Macroeconomics.*

[15] Cochrane, J. (1994), "Shocks", *Carnegie Rochester Conferences Series on Public Policy*, 41, 295-364.

[16] Cochrane, J. (1998), "What do the VARs Mean? Measuring the Output Effects of Monetary Policy", *Journal of Monetary Economics,* 41, 2, 277-300.

[17] Coenen, G., and J-L.Vega (1999), "The Demand for M3 in the Euro Area", ECB Working Paper No. 6.

[18] Crowder, W.J., D.Hoffman, and R.Rasche (1999), "Identification, Long-Run Relations, and Fundamental Innovations in a Simple Cointegrated System", *Review of Economics and Statistics*, 81, 1, 109-121.

[19] Curwen, P. (1997), *Understanding the UK Economy*, Macmillan, Houndmills, Basingstoke.

[20] Cutler, J. (1995), "The Housing Market and the Economy", *Bank of England Quarterly Bulletin*, 35, 3, 260-269.

[21] Ehrmann, M. (2000), "Comparing Monetary Policy", forthcoming, *Review of World Economics*.

[22] Engle, R.F. and C.W.J. Granger, (1987), "Co-integration and Error Correction: Representation, Estimation and Testing", *Econometrica*, 55, 1-87.

[23] Englund, P., and Y.M.Ioannides (1997), "House Price Dynamics: an International Empirical Perspective", *Journal of Housing Economics*, 6, 119-136.

[24] Ericsson, R. (1998), "Empirical Modelling of Money Demand", *Empirical Economics*, 23, 3, 295-315.

[25] Fase, M., and C.Winder (1998), "Wealth and the Demand for Money in the European Union", *Empirical Economics*, 23, 3, 507-524.

[26] Fisher, I. (1911), *The Purchasing Power of Money*, The MacMillan Press.

[27] Fisher, I. (1933), "The Debt Deflation Theory of Great Depressions", *Econometrica*, 1, 337-357.

[28] Fischer, L., P.Fackler and D.Orden (1995), "Long-Run Identifying Restrictions for an Error-correction Model of New Zeland Money, Prices and Output", *Journal of International Money and Finance*, 14, 127-147.

[29] Fung, B., and M.Kasumovich (1998), "Monetary Shocks in the G6 Countries: is there a Puzzle?", *Journal of Monetary Economics*, 42, 575-592.

[30] Gali, J. (1992), "How Well Does the IS-LM Model Fit Postwar U.S. Data?", *Quarterly Journal of Economics*, 107, 2, 709-738.

[31] Gerlach, F., and F.Smets (1995), "The Monetary Transmission Mechanism: Evidence from the G7 Countries", CEPR Discussion Paper No. 1219.

[32] Grilli, V., and N.Roubini (1996), "Liquidity Models in Open Economies: Theory and Empirical Evidence", *European Economic Review*, 40, pp.847-859, 1996.

[33] Guiso, L., A.Kashyap, F.Panetta and D.Terlizzese (1999), "Will a Common European Monetary Policy Have Asymmetric Effects?", *Federal Reserve Bank of Chicago Economic Perspectives*, 1, 56-75.

[34] Hamilton, J., and C.H.Whiteman (1985), "The Observable Implications of Self-Fulfilling Expectations", *Journal of Monetary Economics*, 16, 353-74.

[35] Hendry, D., (1995), *Dynamic Econometrics*, Oxford University Press, Oxford.

[36] Hickok, S., and C.Osler (1994), The Credit Slowdown Abroad, in "*Studies on Causes and Consequences of the 1989-92 Credit Slowdown*", Federal Reserve Bank of New York.

[37] Higgins, M., and C.Osler (1997), "Asset Market Hangovers and Economic Growth: The OECD During 1984-93", *Oxford Review of Economic Policy*, 13, 3, 110-34.

[38] Holmans, A.E., (1994), "House Prices, Land Prices, the Housing Market and House Purchase Debt in the UK and Other Countries", *Economic Modelling*, 11, 2, 157-200.

[39] Hutchison, M.M. (1994), "Asset Prices Fluctuations in Japan: What Role for Monetary Policy?", *BOJ Monetary and Banking Studies*, 12, 2, 61-83.

[40] Ito, T., and T.Iwaisako (1995), "Explaning Asset Bubbles in Japan", NBER Working Paper No. 5538.

[41] Jacobson, T., A.Vredin, A.Warne (1998), “Are Real Wages and Unemployment Related”, *Economica*, 65, 69-96.

[42] Johansen, S., (1991), “Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models”, *Econometrica*, 59, 1551-1580.

[43] Johansen, S., and K.Juselius (1990), “Maximum Likelihood Estimation and Inference on Cointegration - with Applications to Demand for Money”, *Oxford Bulletin of Economics and Statistics*, 52, 169-210.

[44] Kashyap, A., J.Stein and D.Wilcox (1993), ”Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance”, *American Economic Review*, 83, 78-98.

[45] Kennedy, N., and P.Anderson (1994), “Household Saving and Real House Prices: An International Perspective”, BIS Working Paper No. 20.

[46] Kenny, G. (1998), “The Housing Market and the Macroeconomy: Evidence from Ireland”, Bank of Ireland Working Paper.

[47] Kim, S., (1999), “Do Monetary Shocks Matter in the G-7 Countries? Using Common Identifying Restrictions about Monetary Policy across Countries”, *Journal of International Economics*, 48, 387-412.

[48] King, R., C.Plosser, J.Stock and M.Watson (1991), “Stochastic Trends and Economic Fluctuations”, *American Economic Review*, 81, 4, 819-840.

[49] Kiyotaki, N. and J.Moore (1997), “Credit Cycles”, *Journal of Political Economy*, 105, 211-248.

[50] Lastrapes, W.D., (1998), “International Evidence on Equity Prices, Interest Rates, and Money”, *Journal of International Money and Finance*, 17, 377-406.

[51] Leichter, J., and C.Walsh (1999), “Different Economies, Common Policy: Policy Trade-offs under the ECB”, mimeo, University of California Santa Cruz.

[52] Levin, E.J., and R.E.Wright (1997), “The Impact of Speculation on House Prices in the United Kingdom”, *Economic Modelling*, 14, 567-589.

[53] MacKinnon, J.G. (1991), “Critical Values for Cointegration Tests”, in R.Engle and C.Granger eds., *Long-Run Economic Relationships*, Oxford University Press, Oxford.

[54] Maclennan, D., J.Muellbauer, and M.Stephens (1998), “Asymmetries in Housing and Financial Market Institutions and EMU”, *Oxford Review of Economic Policy*, 14, 3, 54-80.

[55] Mellander, E., A.Vredin and A.Warne (1992), “Stochastic Trends and Economic Fluctuations in a Small Open Economy”, *Journal of Applied Econometrics*, 7, 369-394.

[56] Meltzer, A.H. (1995), “Monetary, Credit and (Other) Transmission Processes: A Monetarist Perspective”, *Journal of Economic Perspectives*, 9, 4, 49-72.

[57] Miles, D. (1992), “Housing Markets, Consumption and Financial Liberalisation in the Major Economies”, *European Economic Review*, 36, 5, 1093- 1127.

[58] Miles, D. (1995), *Housing, financial markets and the wider economy*, John Wiley and Sons, New York.

[59] Morris, C., and G.Sellon (1995), “Bank Lending and Monetary Policy: Evidence on a Credit Channel”, *Federal Reserve of Kansas City Economic Review*, 2, 59-75.

[60] Muellbauer, J., and A.Murphy (1997), “Booms and Busts in the UK Housing Market”, *Economic Journal*, 107. 1701-27.

[61] Ortalo-Magnè, F., and S.Rady (1999), "Boom in, Bust out: Young Households and the Housing Price Cycle", *European Economic Review*, 43, 755-66.

[62] Phillips, P.C.B., and P. Perron (1988), "Testing for a Unit Root in Time Series Regression", *Biometrika*, 75, 335-346.

[63] Poterba, J. (1984), "Tax Subsidies to Owner-Occupied Housing: An Asset Market Approach", *Quarterly Journal of Economics*, 99, 729-752.

[64] Poterba, J. (1991), "House Price Dynamics: The Role of Tax Policy and Demography", *Brookings Papers on Economic Activity*, 2, 143-203.

[65] Quigley, J. M (1992), "Housing Markets" in J. Eatwell, M. Milgate and P. Newman (eds.), *The New Palgrave: A Dictionary of Economics*, 3-20, London, Macmillan Press.

[66] Ramaswamy, R., and T.Slok (1998), "The Real Effects of Monetary Policy in the European Union: What Are the Differences?", *IMF Staff Papers*, 45, 2, 374-396.

[67] Sellon, G., and C.R.Buskas (1999), "New Challenges for Monetary Policy: A Summary of the Bank's 1999 Symposium", *Federal Reserve Bank of Kansas City Economic Review*, 4, 5-12.

[68] Shigemi, Y., (1995), "Asset Inflation in Selected Countries", *BOJ Monetary and Banking Studies*, 13, 2, 1995.

[69] Sims, C., (1980), "Macroeconomics and Reality", *Econometrica*, 48, 1-48.

[70] Sims, C., (1992), "Interpreting the Macroeconomic Time-series facts: the Effects of Monetary Policy", *European Economic Review*, 36, 975-1011.

[71] Sims, C., (1998), "Comment on Glenn Rudebusch's 'Do Measures of Monetary Policy in a VAR Make Sense?"', *International Economic Review*, 39, 4, 933-941.

[72] Smith, E.O. (1994), *The German Economy*, Routledge, London and New York.

[73] Stein, J. (1995), "Prices and Trading Volumes in the Housing Market: A model with Downpayment Constraints", *Quarterly Journal of Economics*, 110, 379-406.

[74] Taylor, M. (1995), "The Monetary Transmission Mechanism: An Empirical Framework", *Journal of Economic Perspectives*, 9, 4, 11-26.

[75] The Economist, A few Home Truths, 20th June 1992.

[76] Veblen, T. (1904), *The Theory of Business Enterprise*, Scribner, New York.

[77] Vlaar, P.J.G. (1998), On the Asymptotic Distribution of Impulse Response Functions with Long-run Restrictions, De Nederlandsche Bank, Research Memorandum WO&E nr 539/9809, Amsterdam.

[78] Warne, A. (1993), "A Common Trends Model: Identification, Estimation and Inference", seminar paper No.555, IIES, Stockholm.

HOUSE PRICES AND CONSUMER PRICES

Index: 1990 = 100

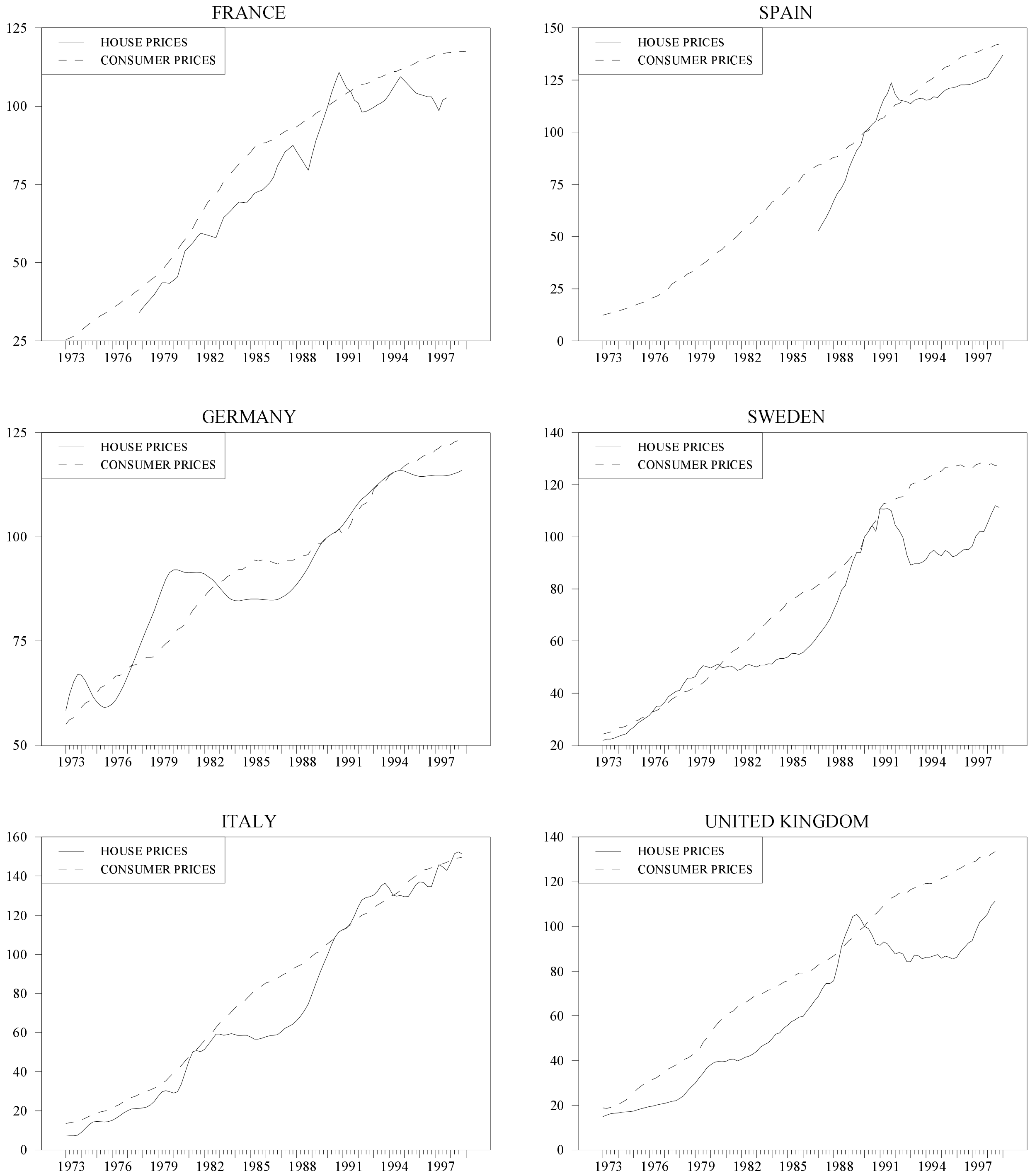


Figure 1

FRANCE - RESPONSES OF VARIABLES TO SHOCKS

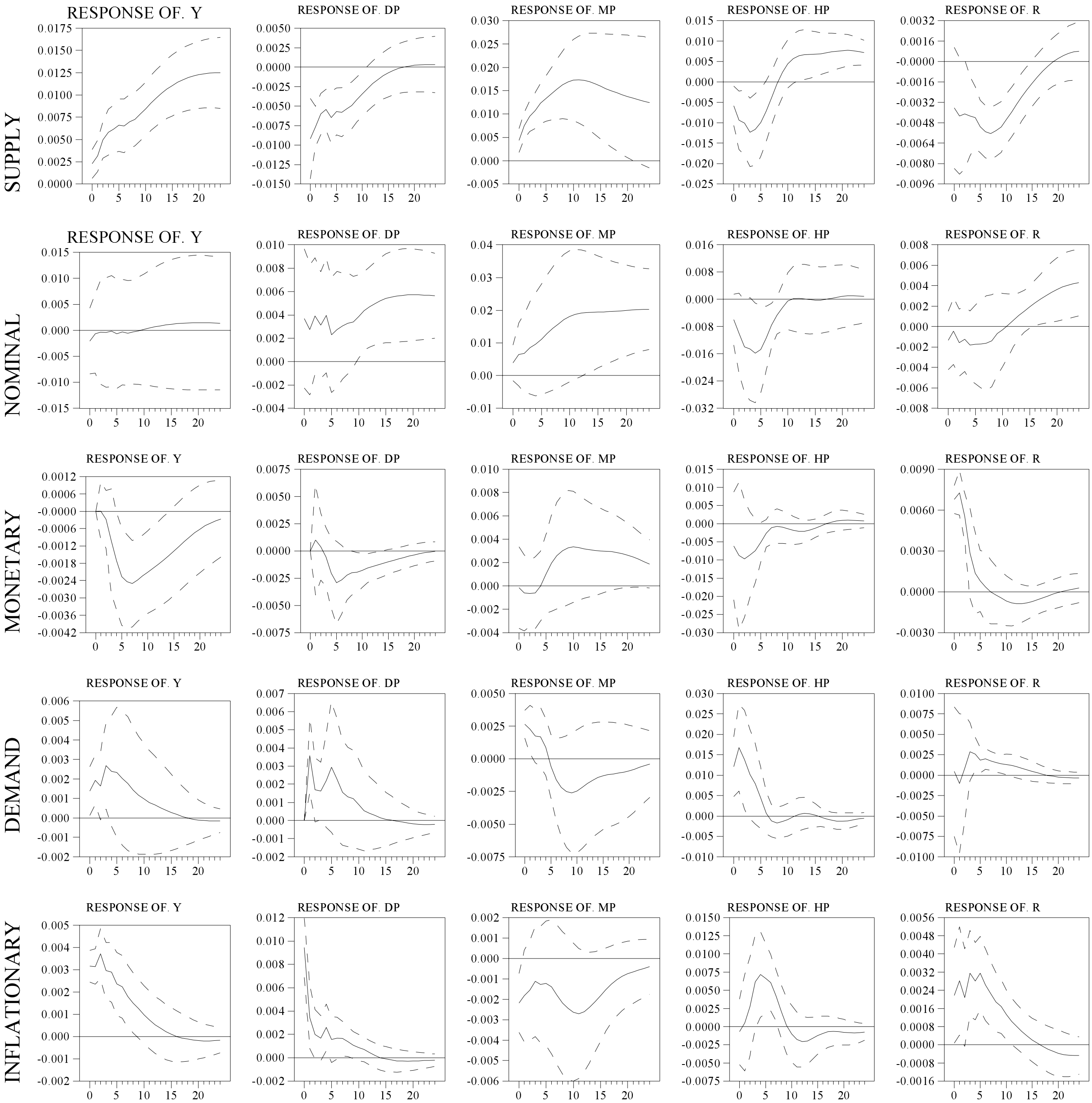


Figure 2

GERMANY - RESPONSES OF VARIABLES TO SHOCKS

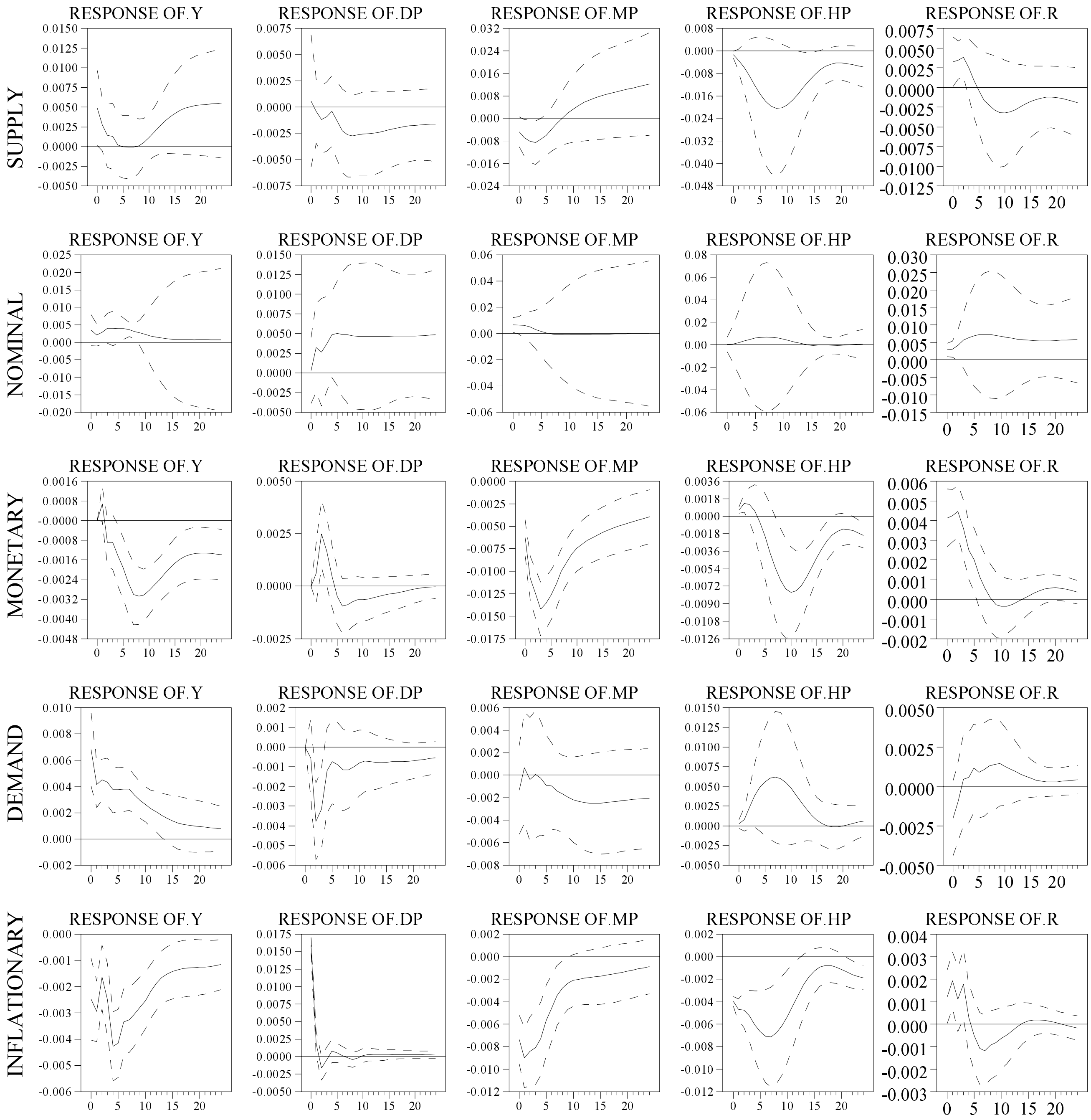


Figure 3

ITALY - RESPONSES OF VARIABLES TO SHOCKS

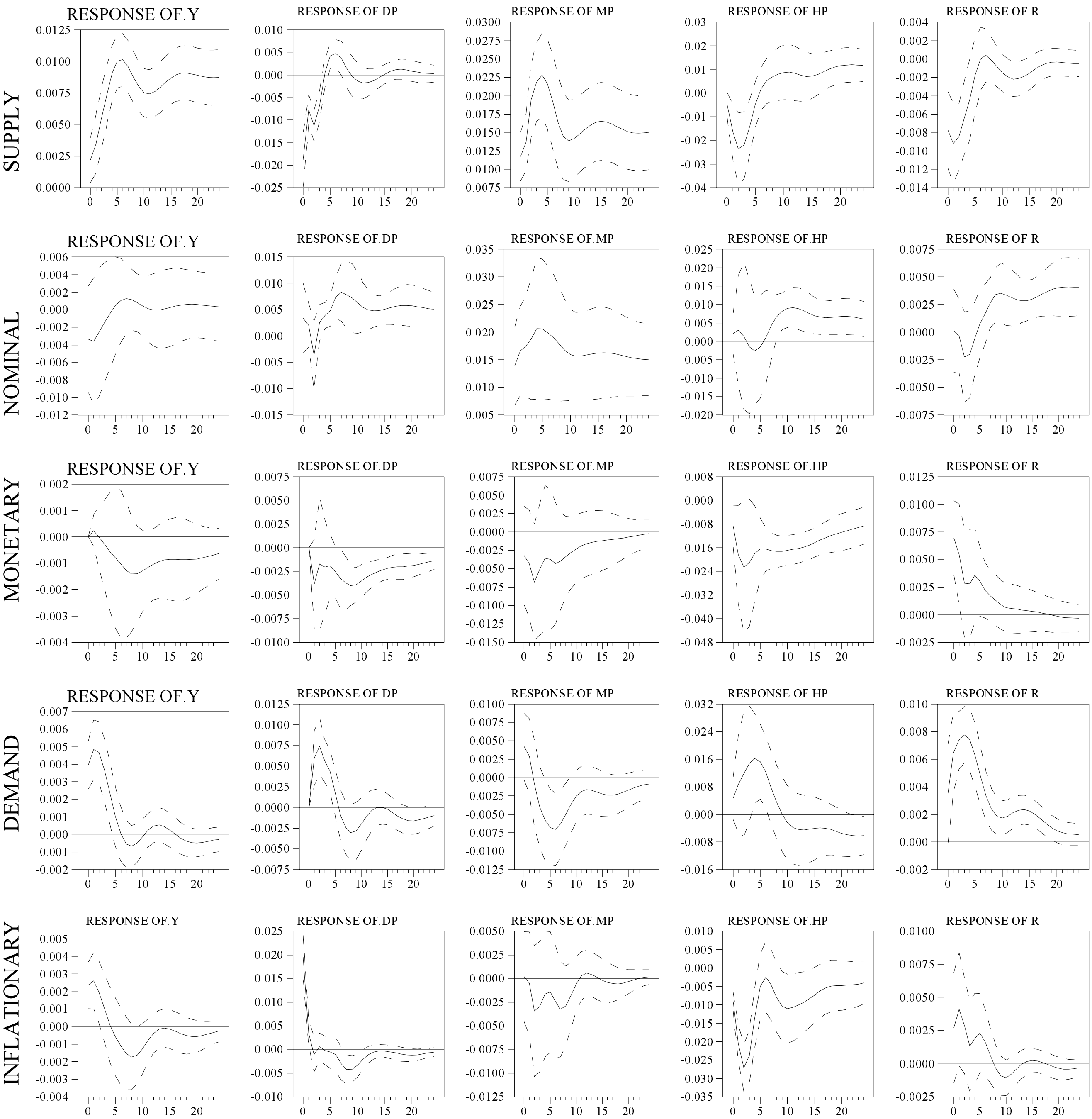


Figure 4

SPAIN - RESPONSES OF VARIABLES TO SHOCKS

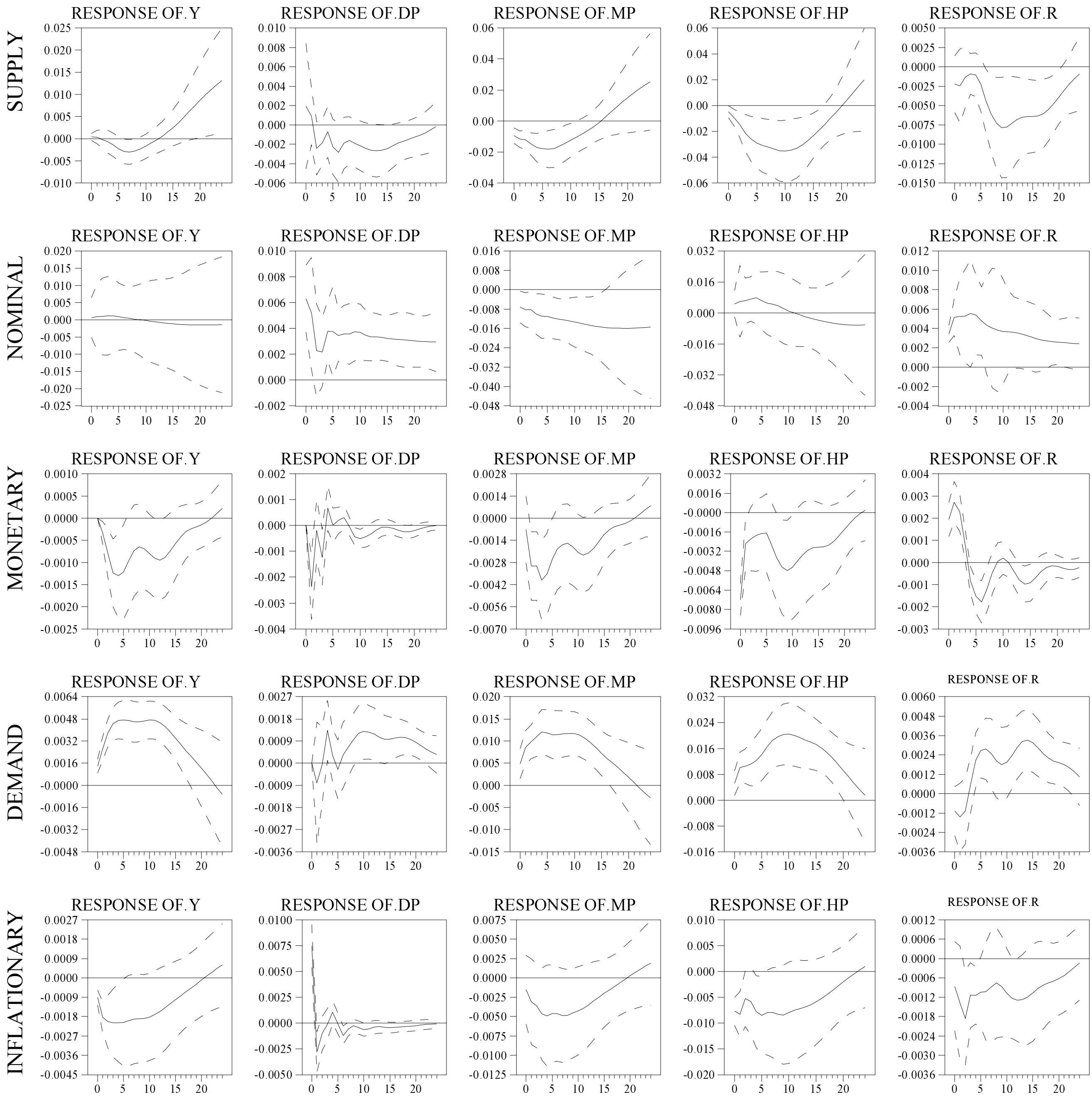


Figure 5

SWEDEN - RESPONSES OF VARIABLES TO SHOCKS

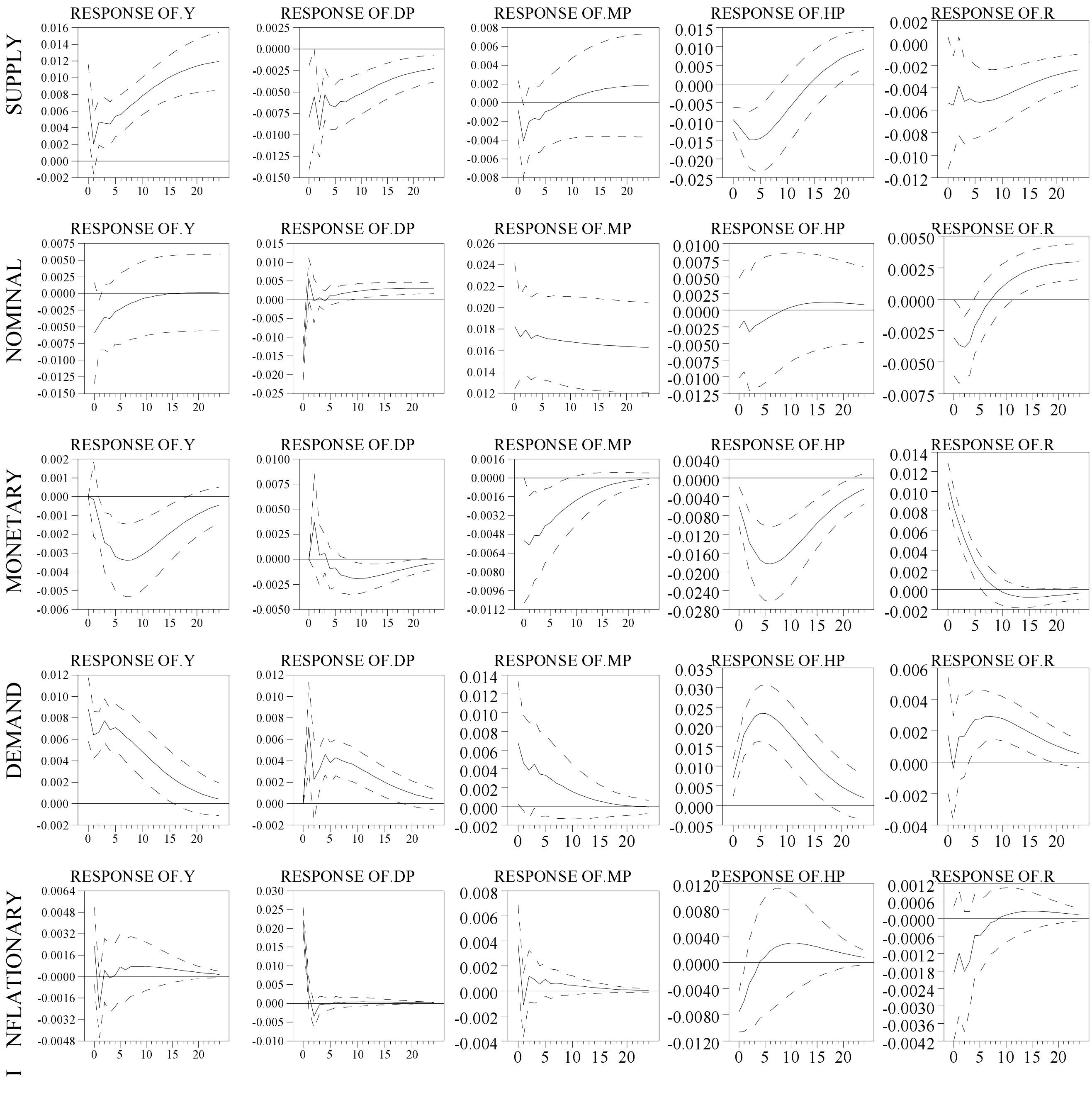


Figure 6

UK - RESPONSES OF VARIABLES TO SHOCKS

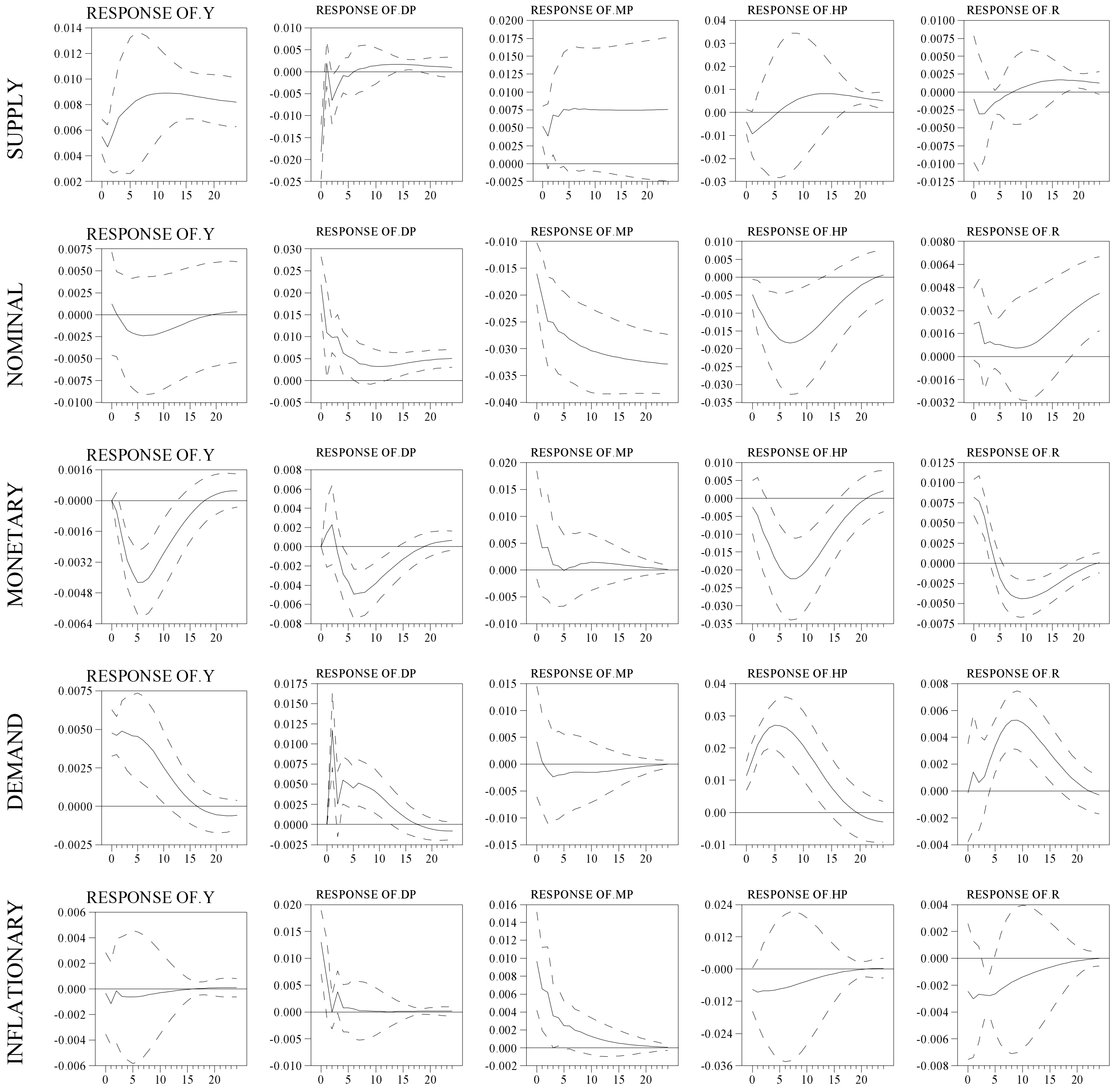


Figure 7

SUPPLY SHOCK: CROSS-COUNTRY COMPARISON

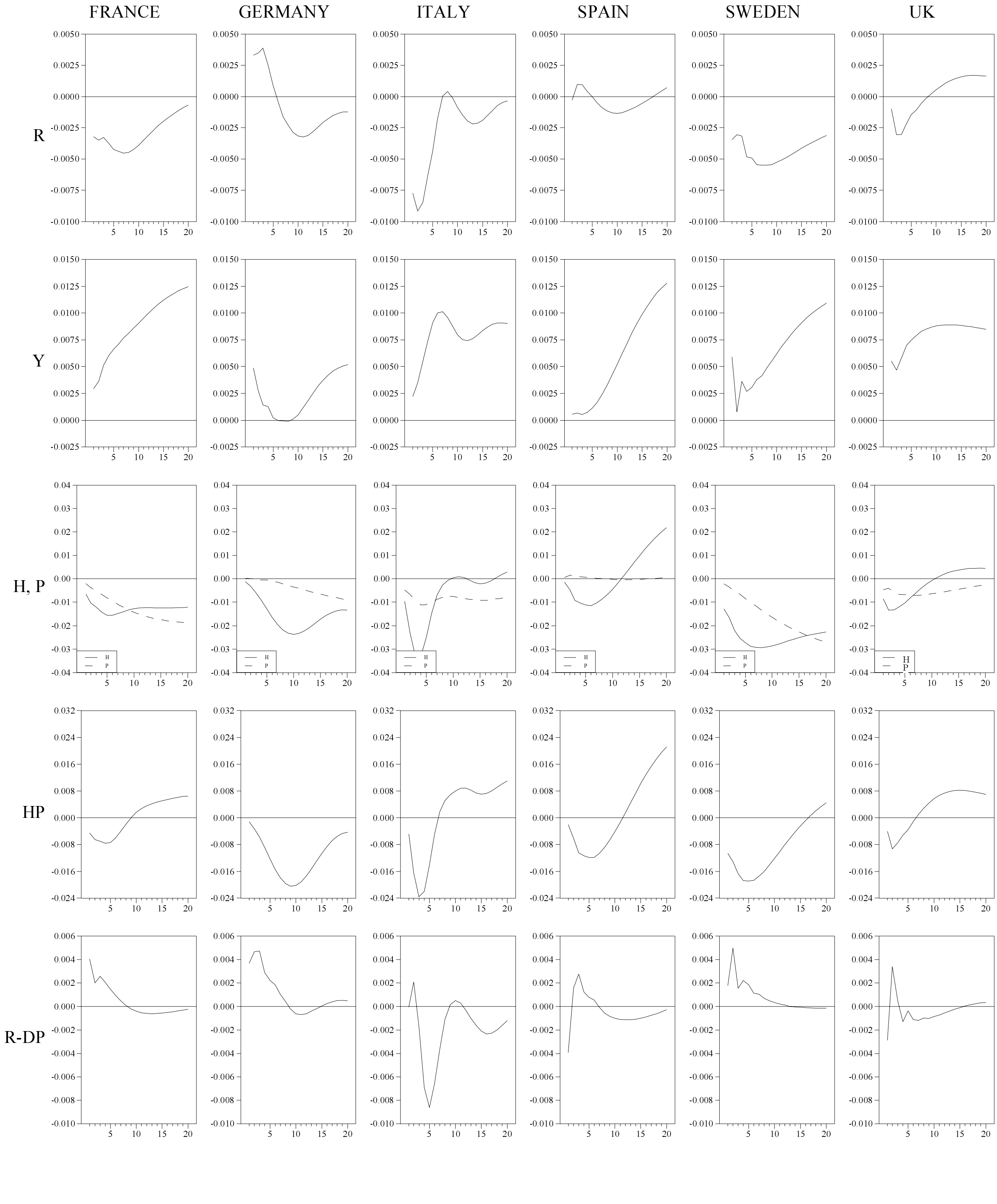


Figure 8

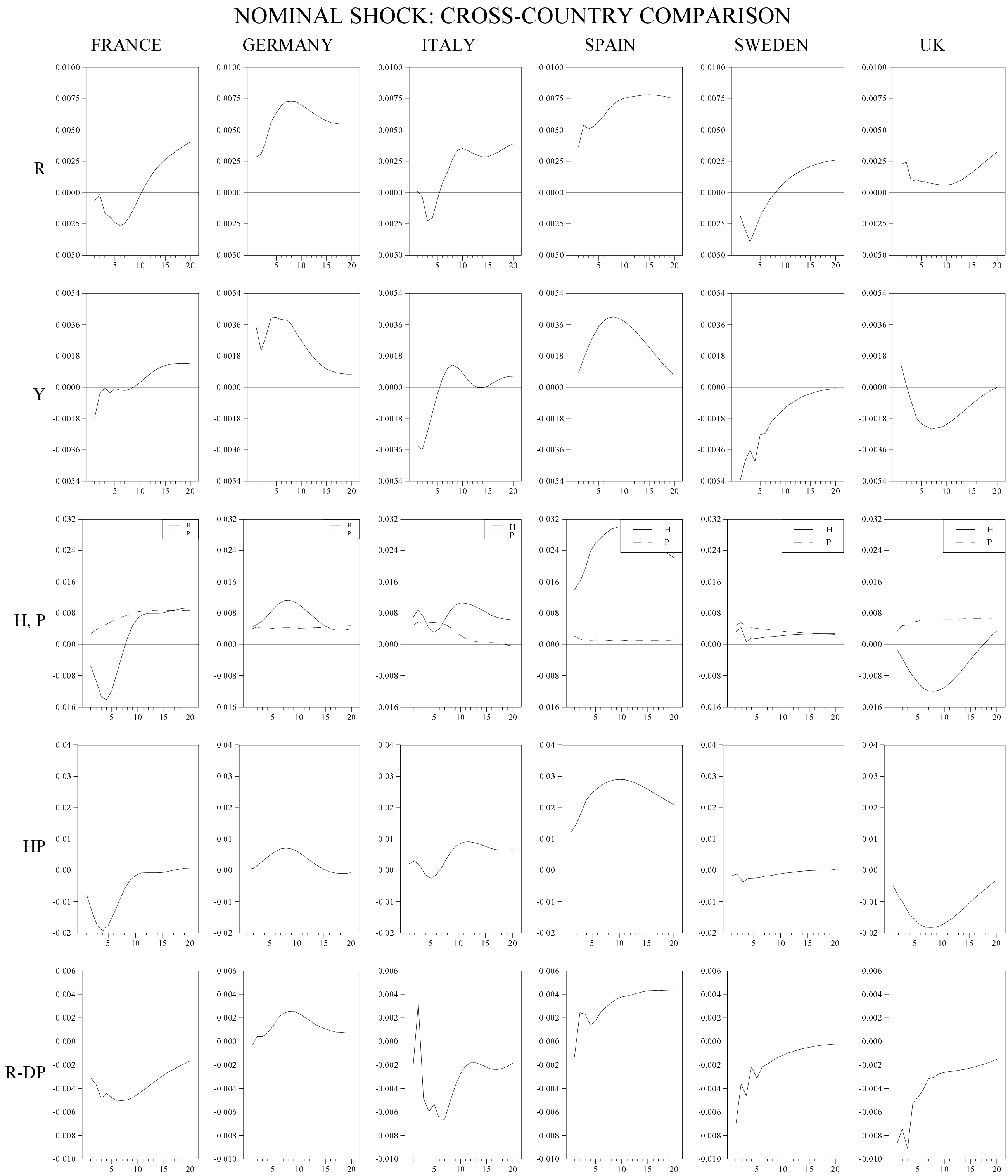
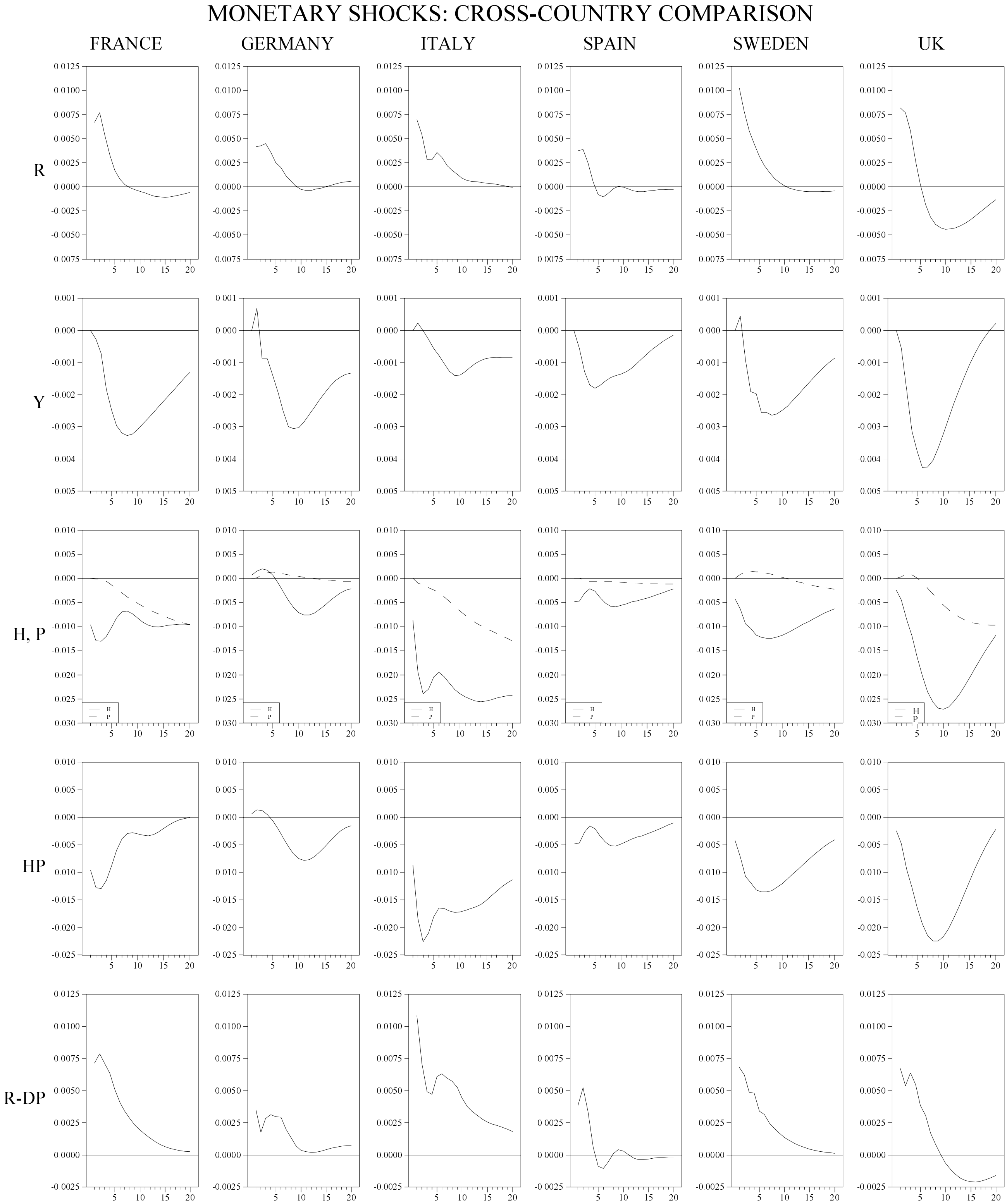

NOMINAL SHOCK: CROSS-COUNTRY COMPARISON
FRANCE
GERMANY
ITALY
SPAIN
SWEDEN
UK
R
Y
H, P
HP
R-DP
H
P

Figure 9



MONETARY SHOCKS: CROSS-COUNTRY COMPARISON
FRANCE
GERMANY
ITALY
SPAIN
SWEDEN
UK
R
Y
H, P
HP
R-DP

Figure 10

MONETARY SHOCKS: CROSS-COUNTRY COMPARISON, NORMALISED SHOCKS

Note: variables are expressed in percentage changes

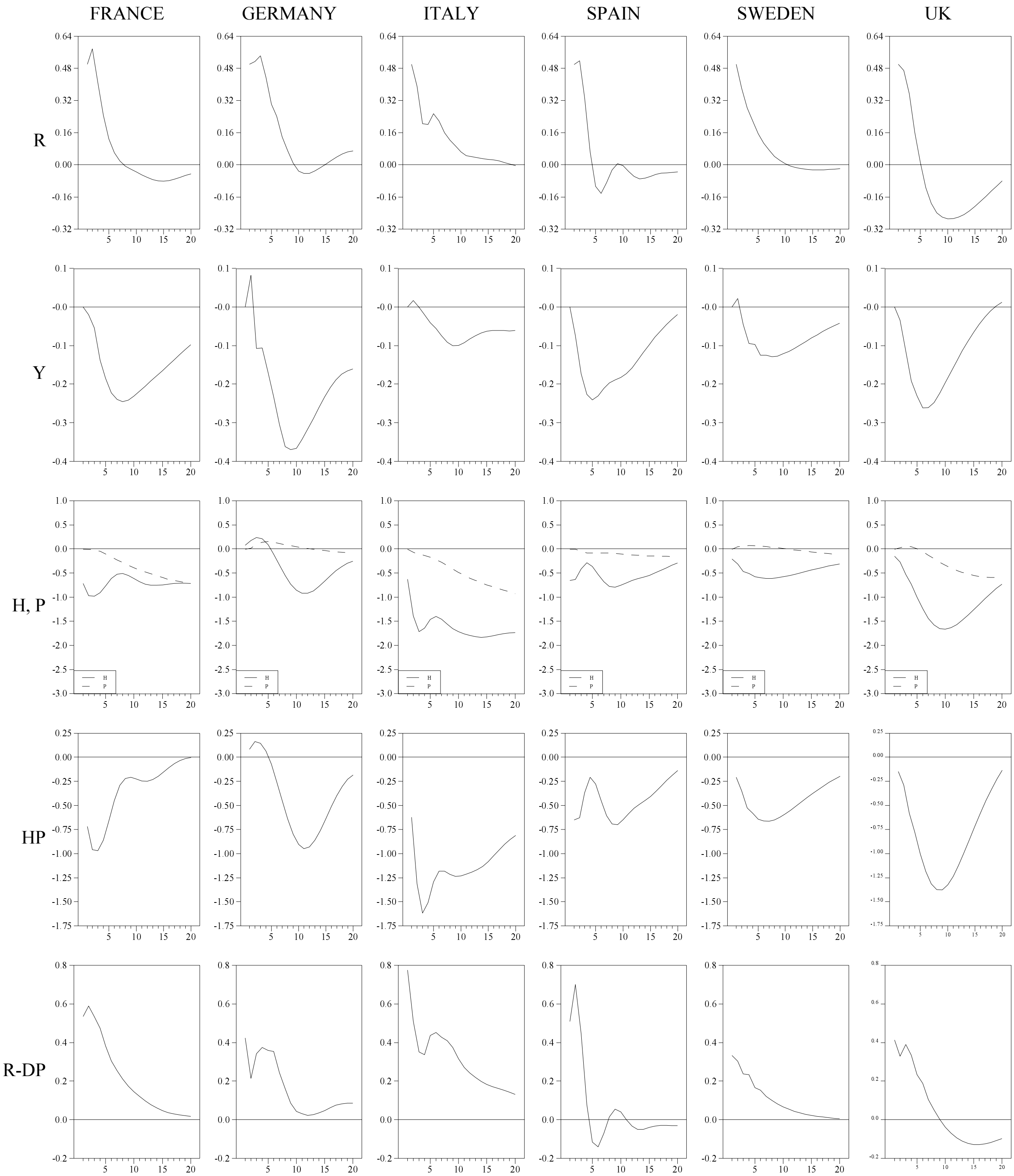


Figure 11

REAL HOUSE PRICES & OUTPUT

Effects of a Increase in the nominal rate of 50 basis points

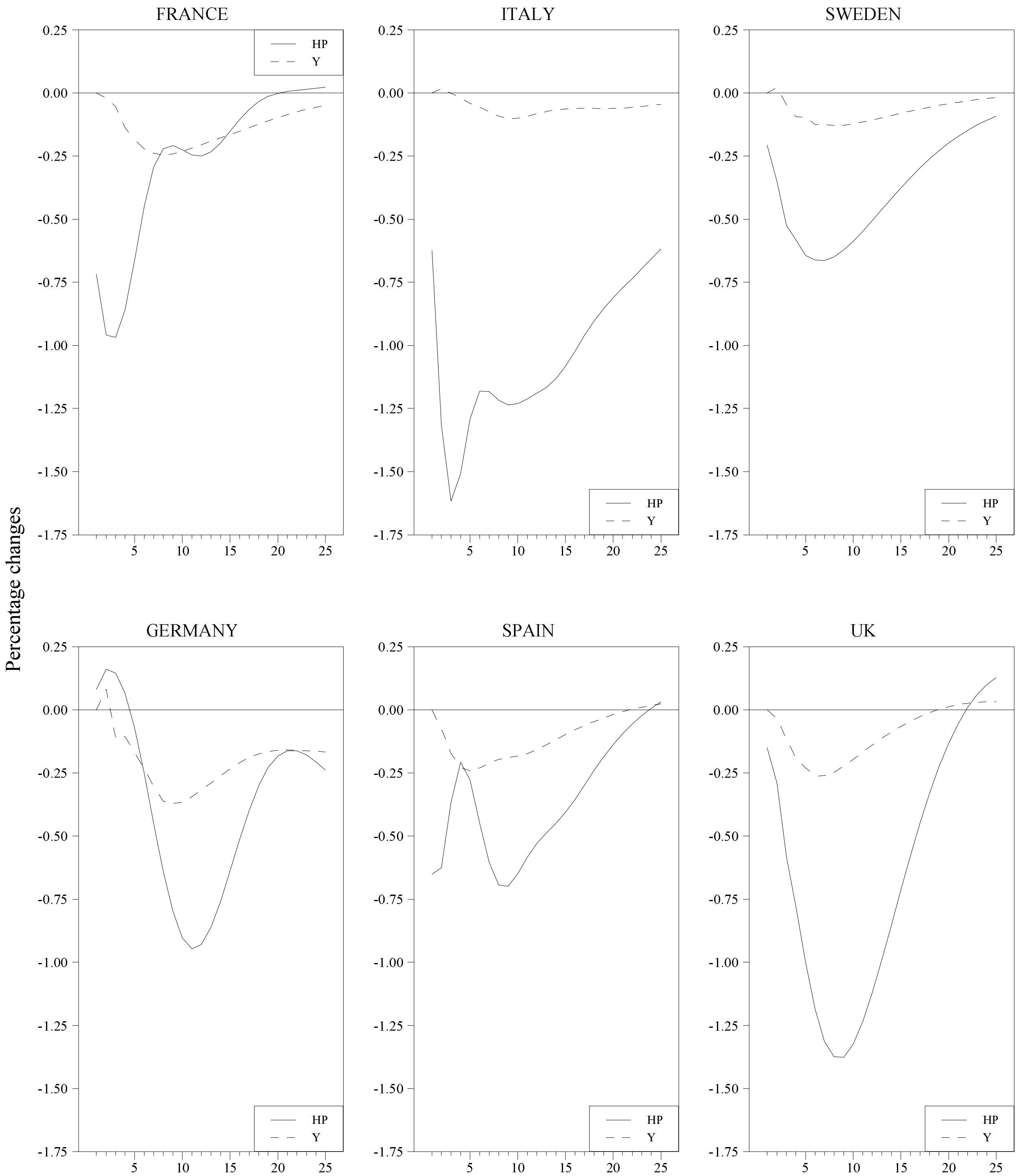
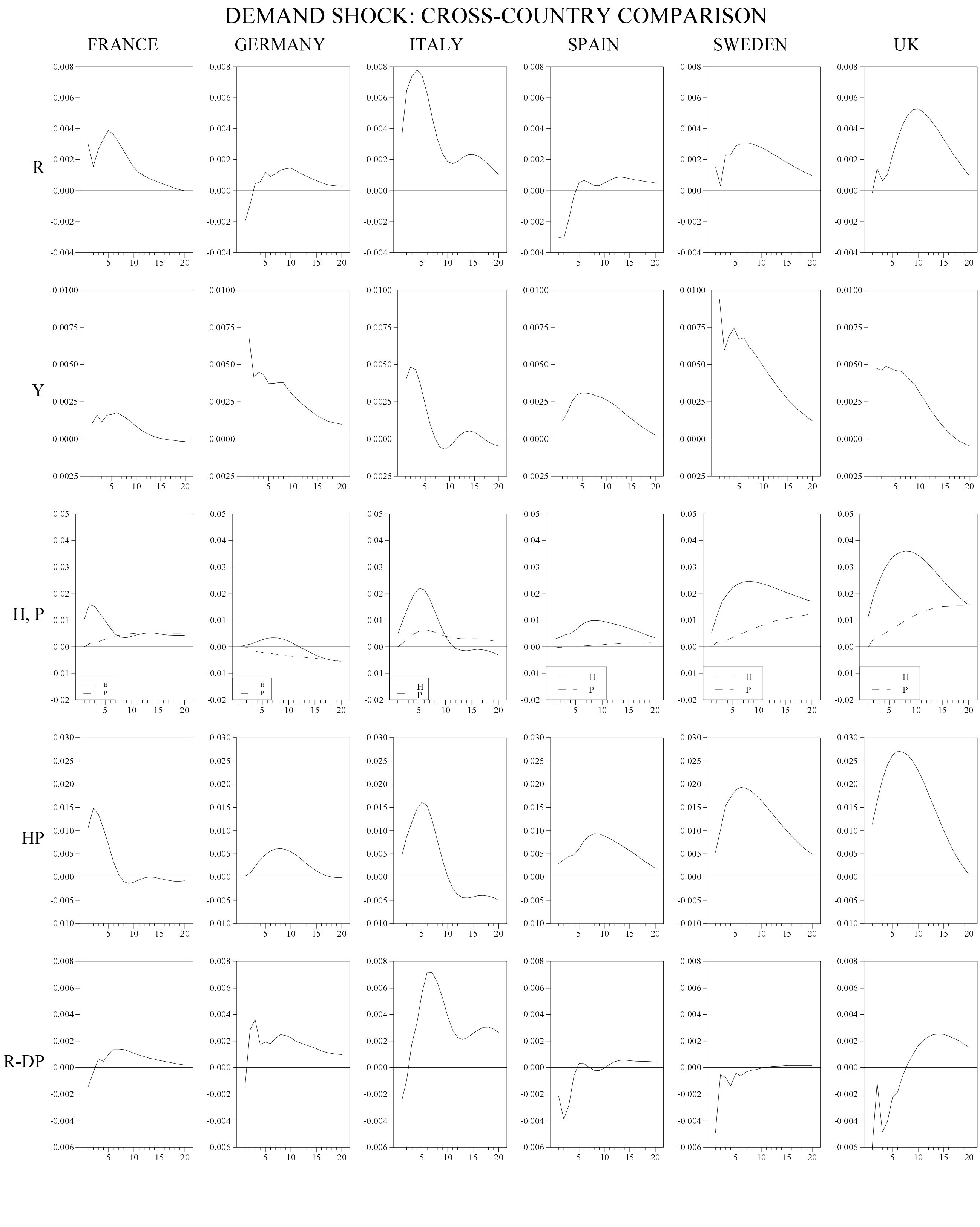


Figure 12


DEMAND SHOCK: CROSS-COUNTRY COMPARISON
FRANCE
GERMANY
ITALY
SPAIN
SWEDEN
UK
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Y
H, P
HP
R-DP
H
P

Figure 13

INFLATION SHOCK: CROSS-COUNTRY COMPARISON

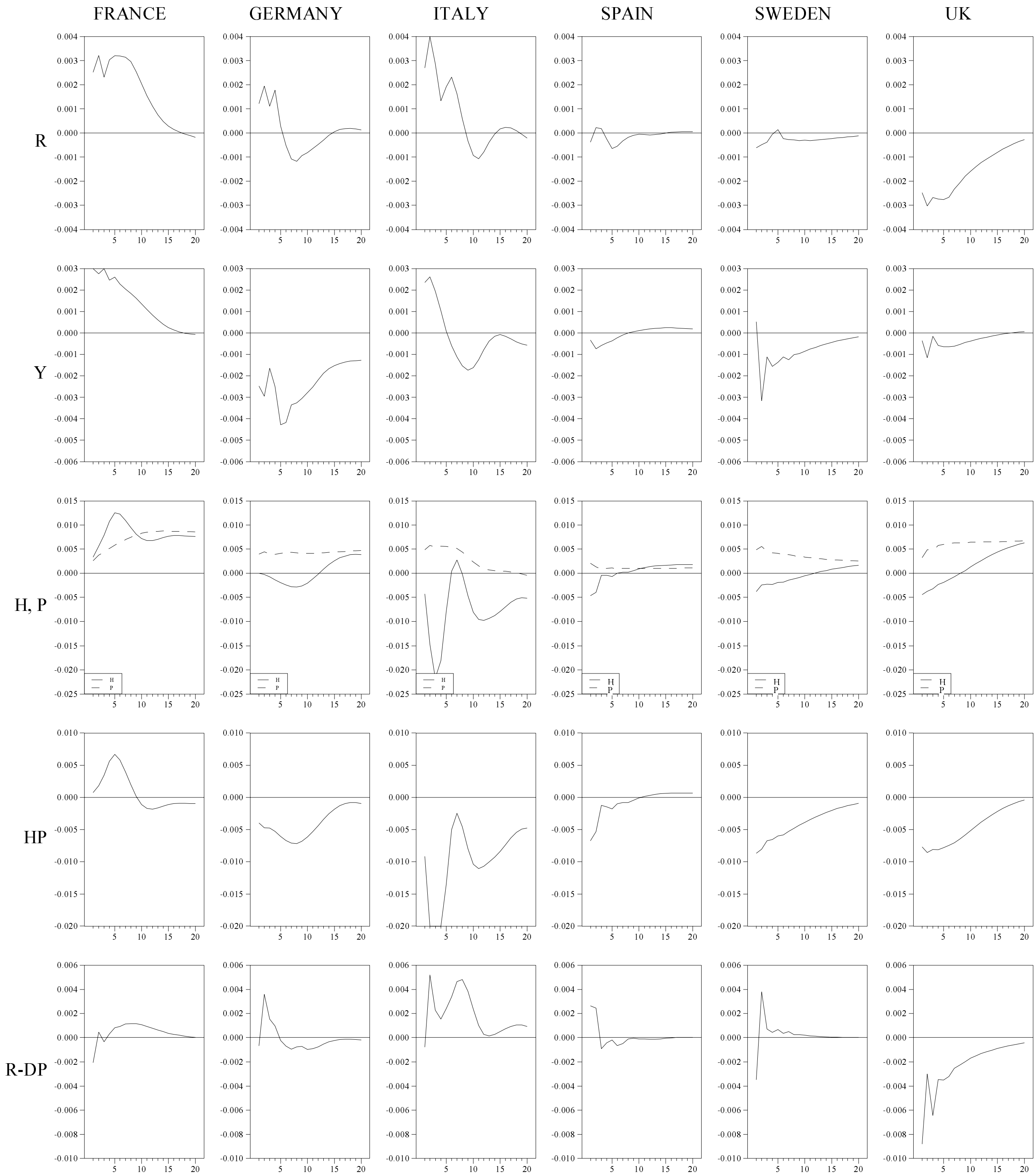
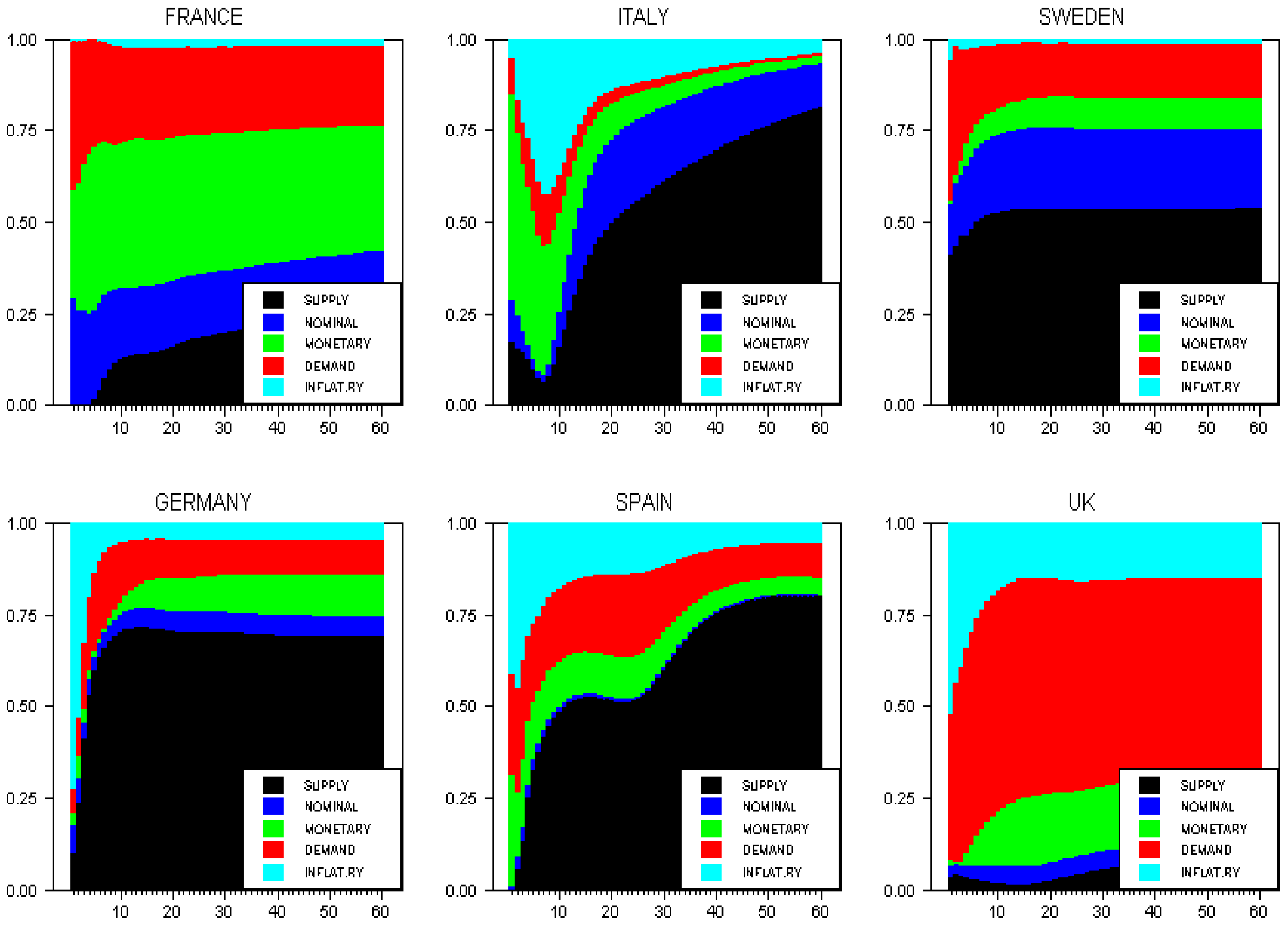


Figure 14

FORECAST ERROR VARIANCE DECOMPOSITION

Fraction of forecast error variance of house prices explained by shocks



FRANCE: VARIABLES (first row) and STRUCTURAL SHOCKS (second row)

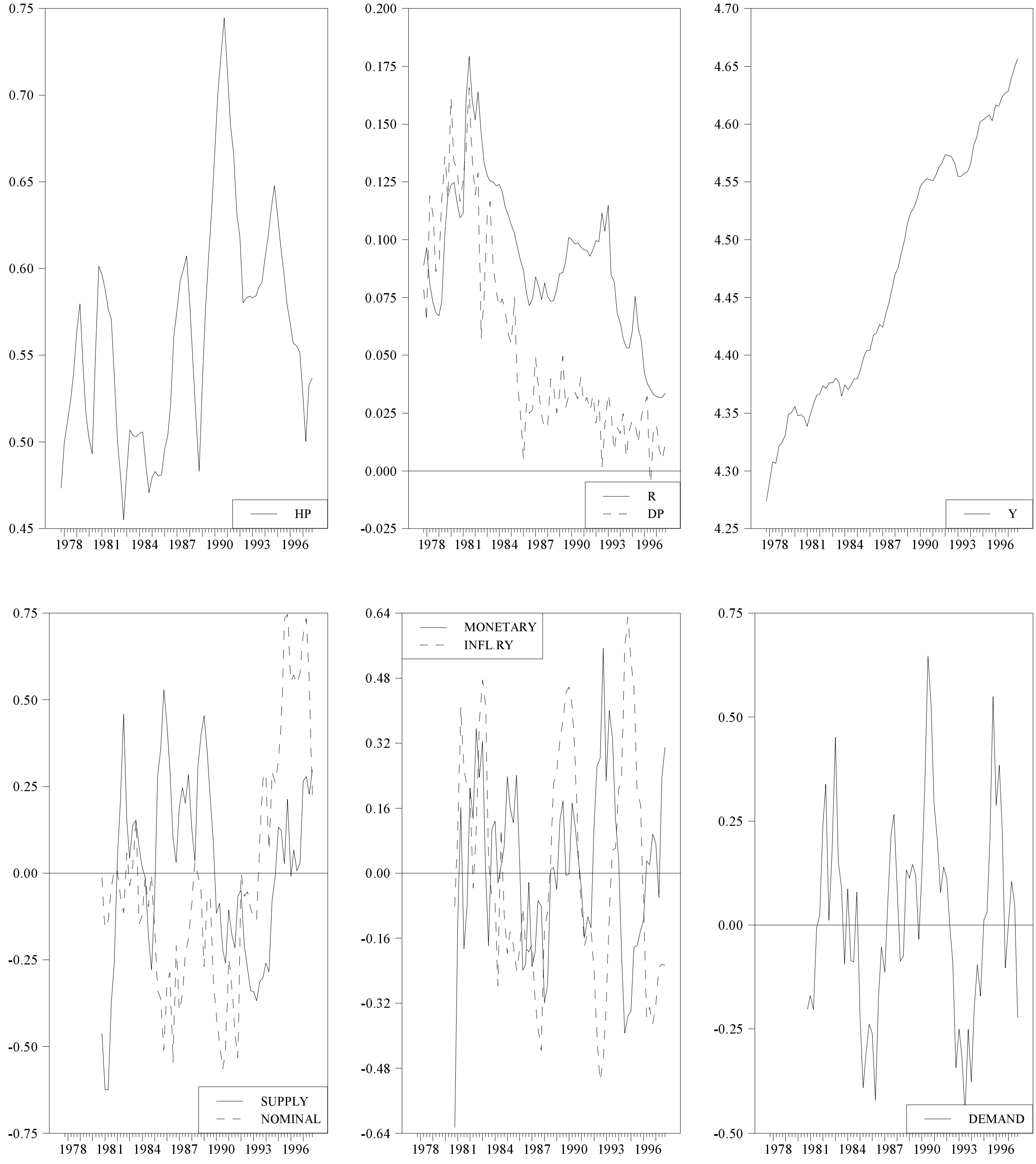


Figure 16

GERMANY: VARIABLES (first row) and STRUCTURAL SHOCKS (second row)

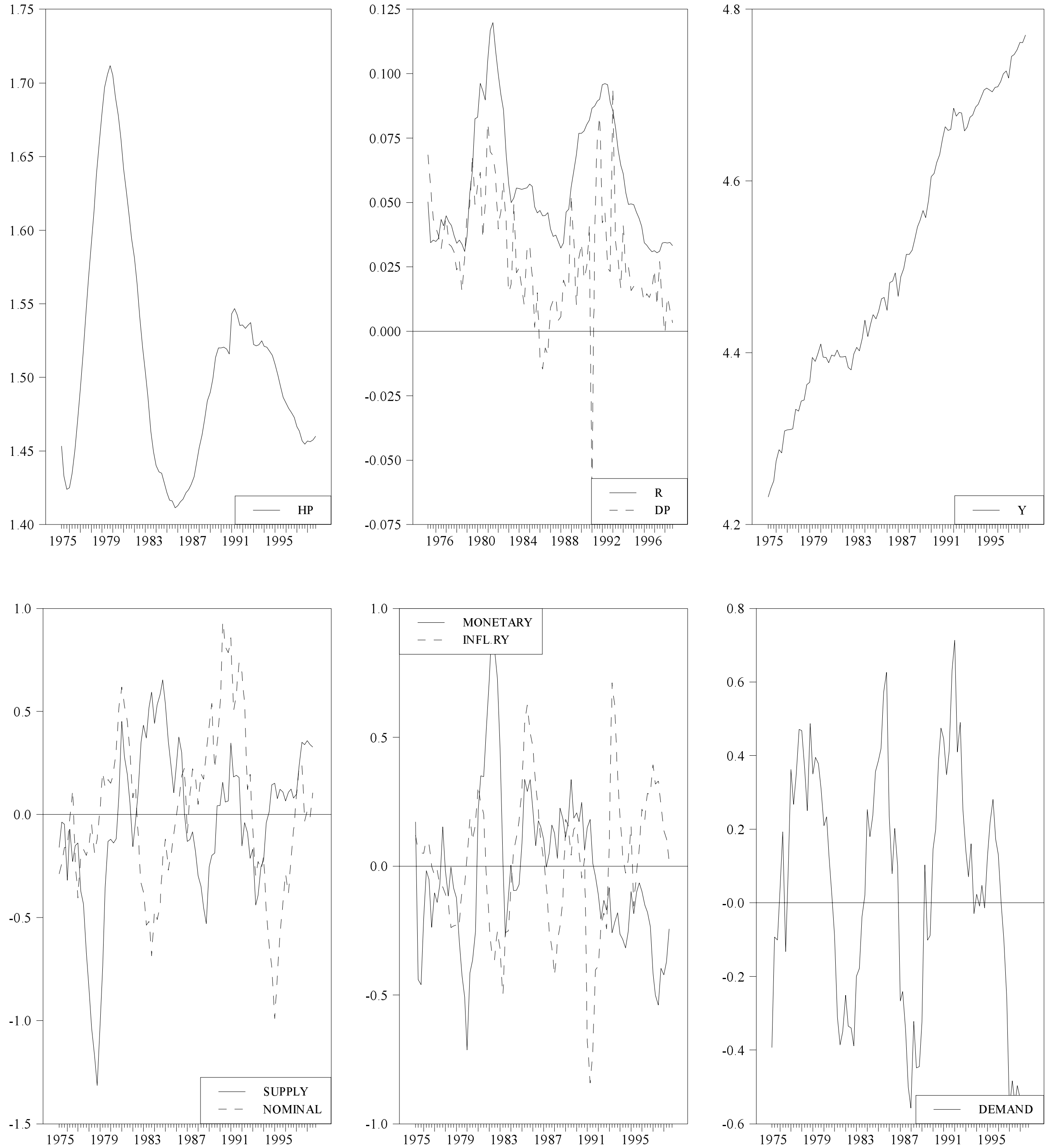


Figure 17

ITALY: VARIABLES (first row) and STRUCTURAL SHOCKS (second row)

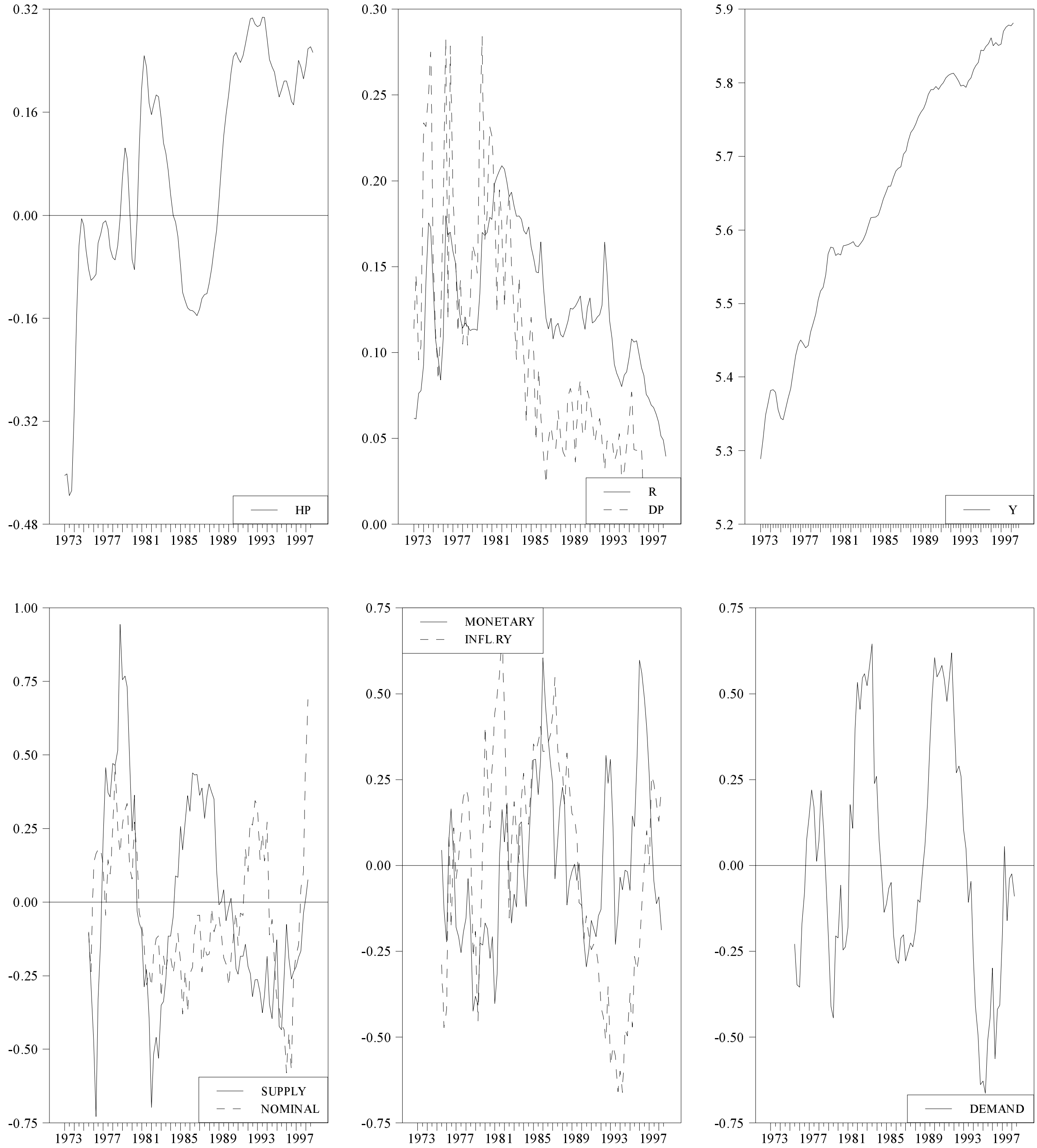


Figure 18

SPAIN: VARIABLES (first row) and STRUCTURAL SHOCKS (second row)

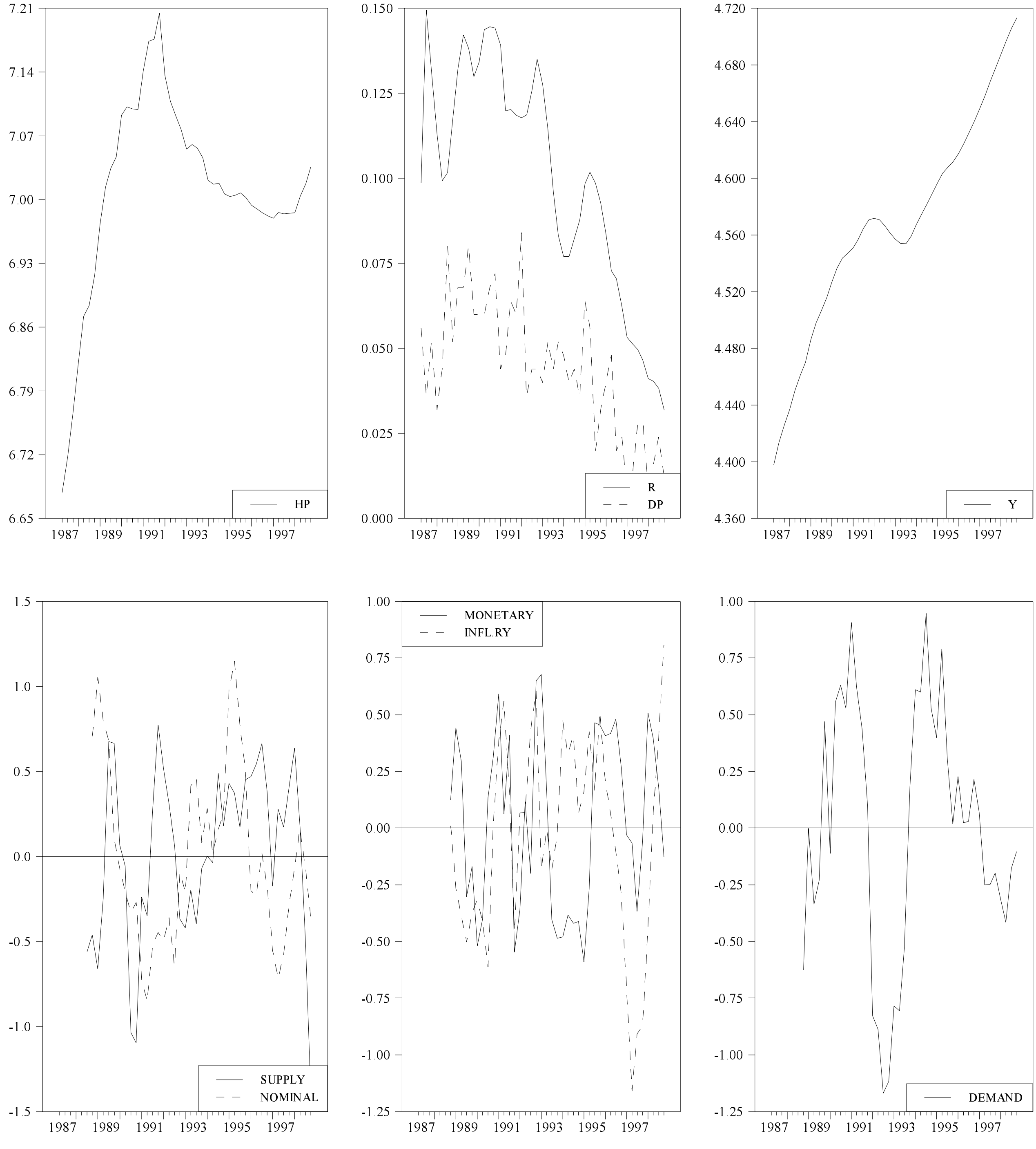


Figure 19

SWEDEN: VARIABLES (first row) and STRUCTURAL SHOCKS (second row)

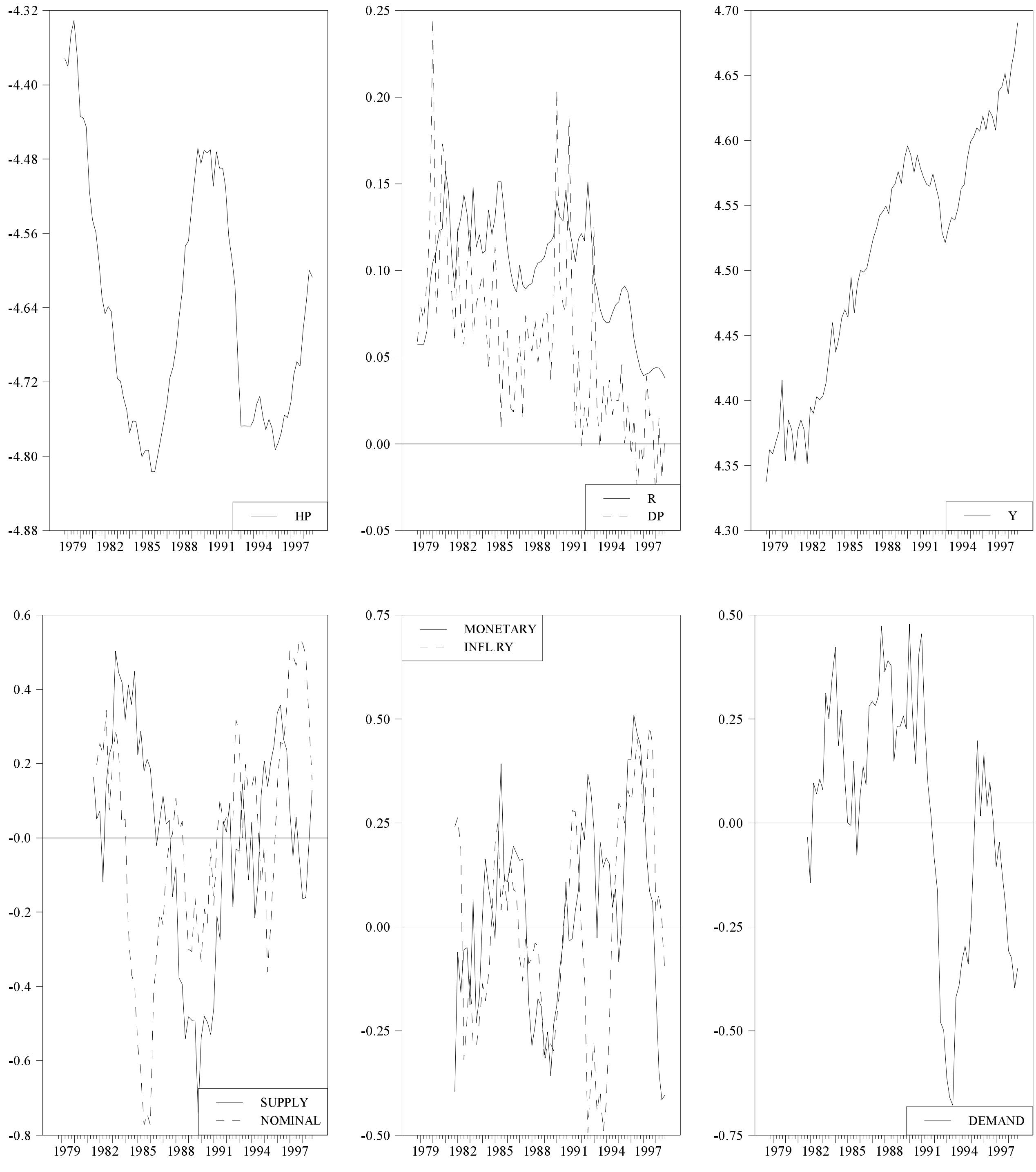


Figure 20

UK: VARIABLES (first row) and STRUCTURAL SHOCKS (second row)

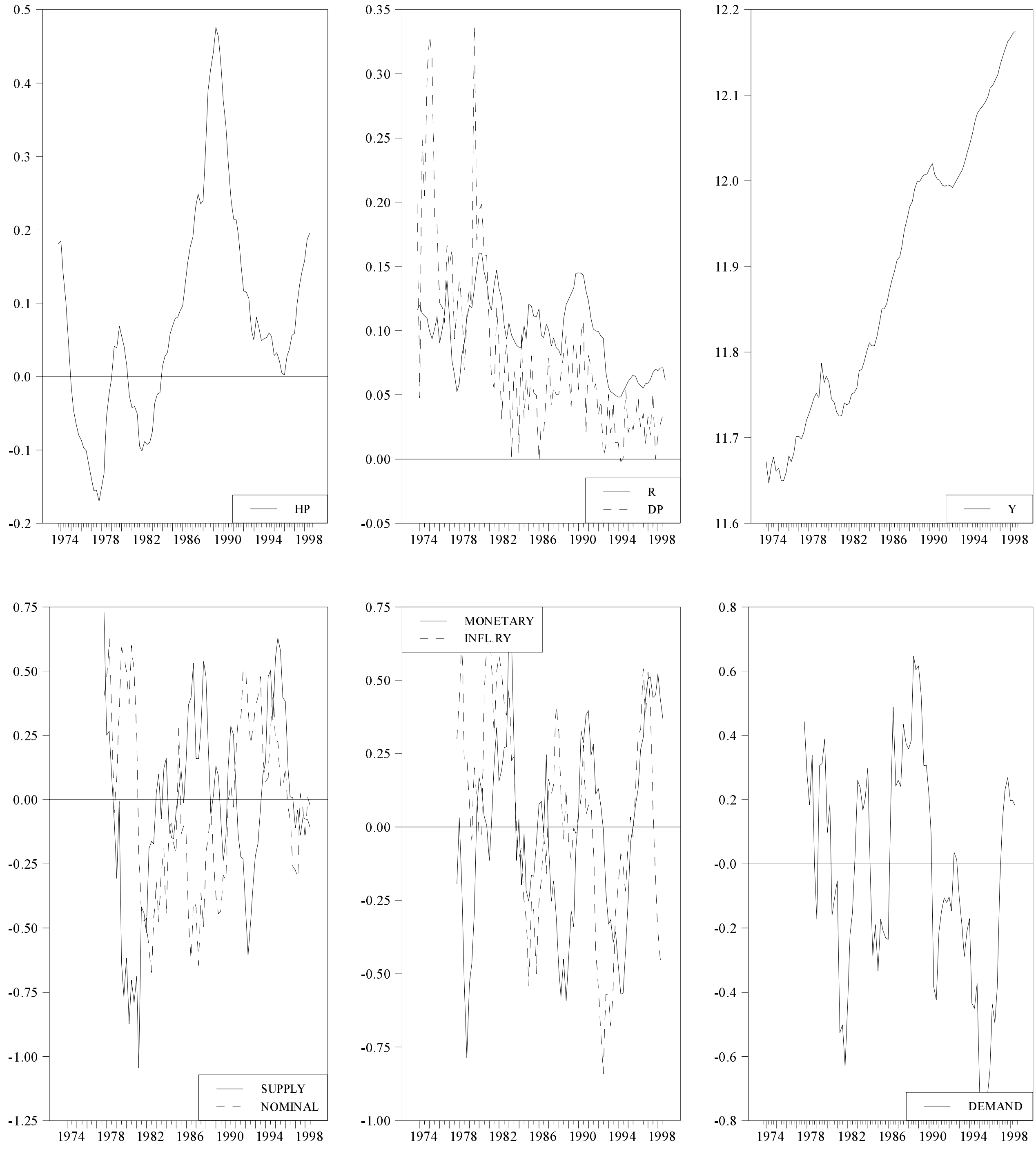


Figure 21

European Central Bank Working Paper Series

1 “A global hazard index for the world foreign exchange markets” by V. Brousseau and F. Scacciavillani, May 1999.

2 “What does the single monetary policy do? A SVAR benchmark for the European Central Bank” by C. Monticelli and O. Tristani, May 1999.

3 “Fiscal policy effectiveness and neutrality results in a non-Ricardian world” by C. Detken, May 1999.

4 “From the ERM to the euro: new evidence on economic and policy convergence among EU countries” by I. Angeloni and L. Dedola, May 1999.

5 “Core inflation: a review of some conceptual issues” by M. Wynne, May 1999.

6 “The demand for M3 in the euro area” by G. Coenen and J.-L. Vega, September 1999.

7 “A cross-country comparison of market structures in European banking” by O. de Bandt and E. P. Davis, September 1999.

8 “Inflation zone targeting” by A. Orphanides and V. Wieland, October 1999.

9 “Asymptotic confidence bands for the estimated autocovariance and autocorrelation functions of vector autoregressive models” by G. Coenen, January 2000.

10 “On the effectiveness of sterilized foreign exchange intervention” by R. Fatum, February 2000.

11 “Is the yield curve a useful information variable for the Eurosystem?” by J. M. Berk and P. van Bergeijk, February 2000.

12 “Indicator variables for optimal policy” by L. E. O. Svensson and M. Woodford, February 2000.

13 “Monetary policy with uncertain parameters” by U. Söderström, February 2000.

14 “Assessing nominal income rules for monetary policy with model and data uncertainty” by G. D. Rudebusch, February 2000.

15 “The quest for prosperity without inflation” by Athanasios Orphanides, March 2000

16 “Estimating the implied distribution of the future short term interest rate using the Longstaff-Schwartz model” by Peter Hördahl, March 2000

17 “Alternative measures of the NAIRU in the euro area: estimates and assessment” by Silvia Fabiani and Ricardo Mestre, March 2000

18 “House prices and the macroeconomy in Europe: Results from a structural VAR analysis” by Matteo Iacoviello, April 2000