House Prices and Business Cycles in Europe: a VAR Analysis

Matteo Iacoviello
Boston College

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E-mail: iacoviel@bc.edu
Address: BC, Department of Economics, Chestnut Hill, MA 02467 USA
Phone: +1-617.552.3689
Fax: +1-617.552.2308

Abstract

A structural vector autoregressive approach identifies the main macroeconomic factors behind fluctuations in house prices in France, Germany, Italy, Spain, Sweden and the UK. Quarterly GDP, house prices, money, inflation and interest rates are characterised by a multivariate process driven by supply, nominal, monetary, inflationary and demand shocks. Tight money leads to a fall in real house prices; house price responses are hump-shaped; the responses of house prices and, to a lesser extent, GDP to a monetary shock can be partly justified by the different housing and financial market institutions across countries; transitory shocks drive a significant part of short-run house price fluctuations.

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1. Introduction

The last decades have witnessed big swings in asset prices in many advanced economies. While it is felt that macroeconomic conditions and the stance of monetary policy were a key factor behind asset price movements (Shigemi, 1995, Hutchison, 1994 and Bernanke and Gertler, 1999), there appears to be uncertainty upon the overall contribution and the relative importance of these factors. Furthermore, while it is agreed that central bankers ought to look at asset prices in the context of an overall strategy for monetary policy, less is known on how to respond to asset prices movements and on the impact of macroeconomic shocks on asset prices themselves.[1]

This paper analyses in a VAR context how house prices interact with the shocks that drive economic fluctuations, using data on six major European economies. Including house prices in a VAR may appear surprising. Yet a large fraction of personal sector's net worth in the developed economies is in the form of housing equity.[2] The total value of the housing wealth exceeds GDP. Changes in asset prices can have effects on aggregate consumption, or on the ability of agents to borrow for consumption or production.[3] An empirical model of the transmission mechanism must describe, and control for, these effects: for instance, if one believes that credit and net worth effects play a role in the propagation of macroeconomic shocks, then a specification that incorporates housing prices into a traditional VAR can provide a better picture of the dynamic response of the economy to various disturbances. Moreover, adopting a cross-country perspective can provide a robustness check for the results and give indications upon differences in the transmission mechanism. This is particularly important in light of the differences across housing and financial markets in Europe, which in turn might play a part in the transmission mechanism of the shocks.

The main results can be summarized as follows. Adverse monetary shocks have a sizeable negative impact on real house prices. The timing of the response in house prices matches that of output. Across

[1] Some exceptions include 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.

[2] This fraction varies between 50 and 70 percent, according to Poterba (1991). Over the 1990s, this fraction is likely to have gone down a little reflecting the relatively slow growth of housing prices relative to stocks.

[3] See for instance Kiyotaki and Moore (1997).

countries, the different responses of house prices to a monetary disturbance find an explanation in the different housing and financial market institutions across countries. Variance decompositions show that monetary and demand shocks play an important role in driving house price fluctuations over the short run. Altogether, the approach suggests that house prices can be embedded in a simple macro-econometric model in an effective and constructive way.

The paper proceeds as follows. Section 2 lays out the econometric methodology, which relies on the common trends approach. Section 3 describes the data and their time-series properties. Section 4 presents the main results. In light of these results, section 5 explores the link between monetary policy, housing market institutions, and house prices. Section 6 uses the estimated structural shocks to interpret the major macroeconomic episodes that have accompanied asset price movements in the period under exam. Section 7 concludes.

2. Methodology: VARs and Common Trends

Over the past decades, industrial economies have witnessed an upward trend in housing prices. Alongside this trend, housing prices have fluctuated around typical business cycle frequencies. A specification offering an empirically valid description of the interrelations in actual data while being consistent with standard economic theory must take these effects into account. In particular, one needs to separate permanent innovations, which are the source of the upward trend in real variables, from the transitory ones, that need to satisfy a neutrality criterion. To this end, the common trends methodology turns out to be useful.

2.1. Model specification

This section describes how the short and long run propositions of economic theory can be used to identify the main sources of economic fluctuations. I follow the common trends approach of King *et al.* (1991) and Warne (1993). A detailed description of the methodology is in Warne (1993).

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

I specify a five dimensional VAR with real GDP (y_t), a measure of real money (mp_t), a real house price index - i.e., a nominal house price index deflated by the consumer price level - (q_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? What accounts for most of the observed volatility in real house prices that has characterised many advanced economies over the last decades?

2.2. Hypotheses about cointegration

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

Money, Output and Interest Rates. The secular rise in the price level in most countries suggests the possibility of a stochastic trend associated with the design of monetary policy: as suggested by Gali (1992), the central bank's desire to avoid output fluctuations may result in nominal instability, leading to a common trend between nominal rates, money balances and output. Alternatively, the relation between these variables can be seen, as in Coenen and Vega (1999), as a 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 a number of reasons (see Ericsson, 1998). In fact, there could be many cointegration vectors in a similar system: money demand (between mp, y and i) is one, but aggregate demand as well, for instance (between y and i); a measure of short-term interest rates can well represent own rather than outside rate on money; any measure of money is an aggregate over components with different characteristics; the frequency of observation may affect both exogeneity and cointegration.

Interest Rates and Inflation. There are theoretical reasons to believe that real interest rates are stationary. In other words, there is a link between interest rates and inflation that corresponds to a *modified* Fisher equation, i.e. $i_t = \mu + \pi_t + \varepsilon_t$.[4]

Output and 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, if any factor determining real estate supply, such as land, lumber or construction workers, is available in fixed supply, one can expect that the production possibility frontier between houses and other goods is not flat. That implies an upward trend in real house prices over time.[5] On the other hand, one can expect real house prices to be cointegrated with GDP, since the latter gives a measure of how the production possibilities frontier is shifting out over time.

[4] The word *modified* is used because the Fisher relationship links nominal interest rates and *expected* inflation. 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.

[5] 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 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).

This candidate cointegration 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 structures does not shift over time.

I look therefore for the following representations:

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

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 GDP, i.e. $q_t = \tau y_t$, and the last one implying a stationary real interest rate. Altogether, after the normalisation on mp, q and π, this specification imposes $r\,(r-1) = 3 \times 2 = 6$ non-testable zero restrictions (r being the number of cointegration vectors). 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.[6]

2.3. Identifying structural shocks

The cointegration vectors can be used to restrict the long-run multipliers of the permanent shocks. In fact, information about the cointegration space allows formulating 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 $E\varepsilon\varepsilon' = \Sigma$

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

its VECM representation is (denoting with Δ the first difference operator):

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

[6] 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.

and the moving average representation can be cast as:

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

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. The columns of $C(1)$ - the matrix of the long-run multipliers in the restricted VAR - are orthogonal to the cointegration vectors: $\beta' C(1) = 0$. One can partition $C(1) = [\Psi \mid 0]$, so that Ψ 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. Ψ must be specified so that its columns are orthogonal to the matrix of cointegration relations.

With the variables ordered as $\begin{pmatrix} y & mp & q & i & \pi \end{pmatrix}'$, I restrict the $(1,2)$ element of Ψ to be zero, so that one of the two permanent shock can be precluded from having a long-run effect on y.[7] That is:

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

The shock in the first column affects GDP, real balances (via the money demand equation) and real house prices (via the housing supply curve) in the long run, with weights dictated by the estimated cointegration vectors. So long as θ (to be estimated) is not diagonal, this shock can change permanently inflation and nominal rates (by the same amount). I call this shock *supply shock*.

For any value of θ (to be estimated), the shock in the second column leaves output and relative prices unchanged, yielding a lower (higher) level of real balances and higher (lower) inflation and interest rates in

[7] This procedure might seem 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 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).

the long run.[8] 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 can capture a commitment to a different inflation target. I call this innovation *nominal shock*.

Transitory Shocks. Transitory shocks, which are assumed orthogonal to the permanent shocks and to each other, will have no long-run effect on the variables. Following Mellander *et al.* (1992), they can be identified following the recursiveness approach: the *monetary policy shock* has no immediate effect on output and CPI inflation, but can contemporaneously affect real balances (by affecting liquidity supply), interest rates and real house prices.

The *demand shock* has zero impact effect on CPI inflation, but potentially affects contemporaneous GDP, by affecting its spending components, as well as house prices, real money balances, and interest rates. This disturbance could also capture episodes originating in the housing market, such as temporary tax advantages to housing investment or a sudden increase in demand fuelled by expectations of appreciation in house prices.

The third and last shock can contemporaneously affect all variables. I call it *transitory inflation shock.*, i.e. a temporary upward shift in the aggregate supply schedule of a basic AD/AS model. This shock might for instance proxy for an oil price or an exchange rate shock, that temporarily raise the prices of imported goods (the impulse responses are, in most of the countries, consistent with this hypothesis).

3. Properties of the data

3.1. 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.

French data for house prices are from the residential house price index calculated by the Banque de France.[9] German data are from the Aufina Residential Price Index: the original series was annual, and

[8] 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 i.

[9] This index is described in Grunspan (1998, *Asset Prices Over Twenty Years,* unpublished manuscript). Since 1978, an

a quarterly one was obtained via interpolation assuming an ARIMA(1,2,0) in the log of original series.[10] Data for Italy are from the residential property price index calculated by "Il Consulente Immobilare" (with elaboration by the Banca d'Italia); the original semi-annual frequency was converted into quarterly via ARIMA(1,2,0) interpolation. Spanish data come from the "Residential Property Price Index per Square Meter" calculated by the Ministerio de Economia y Hacienda. For Sweden, the data were provided by the Central Statistical Office House Price Index.[11] The UK data are from the Nationwide house price index for all properties.

All the time series are available approximately from the mid '70s, with the exception of Spain (where the house prices series starts in 1987) and the UK (1963). In order to analyze similar periods, the estimation period for the UK begins in 1973. The resulting samples are as follows: for France, 1978Q1-1997Q4; for Germany, 1973Q1-1998Q3; for Italy, 1973Q1-1998Q2; for Spain, 1987Q4-1998Q4; for Sweden, 1977Q4-1998Q4; for the UK, 1973Q1-1998Q3. House price and consumer price indices are shown in Figure 1. The Figure provides evidence of the large swings in house prices that have occurred in the last decades, with prolonged cycles of increasingly rising prices followed by slumps; oscillations in real house prices have been particularly strong in Sweden and the UK; periods of falling nominal house prices have been common.

The other series were obtained from International Financial Statistics: y is the (log of) GDP at constant prices, seasonally adjusted; i is a short-term interest rate, expressed in percentages, namely money market rate for Italy, call money rate for France and Germany, 3 months T-Bills rate for Spain, Sweden and the UK; real money mp is the log of M2 for France, Spain and Sweden; M1 for Germany, Italy and the UK, all deflated by the consumer price index. In the last three countries, M1 produced more plausible estimates of

annual index of residential property prices has been estimated based on the portfolio of the FNAIM national federation of real estate agents, which comprises 220,000 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.

[10] 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 is similar to that constructed by Holmans (1994) using city-level data provided by the estate agency Ring Deutscher Makler.

[11] The Swedish house price series is constructed as weighted mean of primary and leisure homes.

the cointegration vectors and of the responses to shocks. Inflation π is measured by the annualised quarterly change of the logged CPI.

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 dummies were used to correct for German reunification (1990Q3 and 1991Q1). An impulse dummy variable for UK for 1987Q1 was introduced to capture a coverage break in the money+quasi-money series.

3.2. 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 - degree of integration and the presence of cointegration relationships - must be characterised.

Unit root tests. Two univariate unit-root tests were conducted, the augmented Dickey-Fuller test and the Phillips-Perron (1988) test. Tables 1 and 2 report the results from the tests. The evidence from the tests suggests that the variables are $I(1)$, although, according to the Phillips-Perron test, in some cases the null hypothesis of a unit root in the inflation rate is rejected in favour of stationarity.

Cointegration tests. The cointegration vectors were estimated with the multivariate cointegration techniques developed by Johansen and Juselius (1990). According to the λ-max statistic, 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 cointegration vectors were suggested in France, Germany and Sweden, whereas two appear more likely in Germany and Italy, and four in Spain. On plausibility grounds, and in order to have more easily comparable results across countries, a common rank of 3 was chosen.

3.3. Cointegration relations

Table 3 reports the estimated (restricted) cointegration vectors for each country, together with p-values for the over-identifying restrictions. The restrictions were rejected at the 95% confidence level in Sweden and

Spain.[12] Since it has been shown (Jacobson *et al.*, 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 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. I find that:

- The income elasticity of money demand b_y is greater than one whenever it is not restricted to unity. This could be the consequence of omitting wealth variables in the money demand, such as housing wealth, which is positively correlated with income.

- The semi-elasticity of money demand with respect to the short-term interest rate, b_i, is negatively signed in two cases out of six. For France and Sweden, the implied elasticity of real $M2$ is positive: yet a positive elasticity is plausible on theoretical grounds, as a negative coefficient should be expected a priori only on a narrow money measure.

- The cointegration vector between real house prices and GDP favours an interpretation of the long-run upward trend in house prices that, despite the short length of the series, is consistent across countries.[13] The point estimates of the coefficient τ range from a lower limit of .063 for Germany to 1.69 for Spain. Although fully consistent with economic theory, these estimates should be treated with care, as they are 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.

[12] 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.

[13] This is broadly in line with the cross-country evidence in the paper by Kennedy and Anderson (1994).In 13 out of 15 nations real house prices were higher in 1993 than in 1970. Cutler (1995) shows similar evidence for the G7 economies from 1970 to 1992.

4. Empirical evidence

4.1. Impulse Responses

Supply shock. The first row in Figures 2 to 7 shows the estimated responses to a favourable supply shock (one standard deviation is size), along with one-standard error asymptotic confidence bands.[14]

The initial effect on GDP is positive in all countries: in the impact period, the point estimate ranges from 0.02% in Italy to 0.6% in the UK. After about three years, output stabilises at its higher steady state level having increased by, on average, 1%. In all countries but Spain, consumer prices are below the baseline after one year. 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 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.[15]

In all countries, house prices go down for some quarters before increasing to their new, higher steady state 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 explanation for the result is the following: by raising the return to capital, the permanent supply shock increases real interest rates; this temporary effect reduces housing demand; only when real rates are back to the baseline, the *income* effect dominates the *substitution* (user cost) effect, and real house prices go up.

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 structural emphasis on this shock, especially because there is not a homogeneous, discernible pattern across economies in the response of the variables. One possibility is that of a permanent change to the expected rate of inflation: in this case, 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

[14] Warne (1993) discusses how to compute confidence intervals for the common trends model.

[15] Spain is the only exception.

increase in expected inflation elicits an upward response of nominal interest rates, which is suggestive of an anti-inflationary monetary policy from the monetary authority.

Monetary shock. The third row of Figures 2 to 7 shows that the monetary shock elicits upward pressure in interest rate, a contraction in the monetary aggregate,[16] and a temporary decline in output, which bottoms out approximately between 4 and 9 quarters after the impulse. These are general indications of a contractionary monetary policy stance.

Consumer prices remain above the baseline for one year in the UK, Germany and Sweden. In the UK and Sweden this pattern is plausible, as variable rate mortgage costs have a large weight in household budgets, as well as on measured inflation; in Germany, the initial CPI rise might occur if the monetary shock captures some systematic response to unaccounted disturbances generating inflationary pressures. Unlike consumer prices, house prices respond more strongly, and, with some differences across countries, they significantly decrease. I defer a more detailed discussion of these issues to the next section.

Demand shock. The demand shock results in short-term output effects with consumer prices fixed in the impact period. Following Gerlach and Smets (1995), it is possible to label this disturbance "demand shock" since it elicits positive output and price responses and due to its transitory imprint on the real variables in the system. The responses (row 4 of Figures 2 to 7) show an increase in real house prices that peaks after about 2 years and dies out only after 5/6 years. This is consistent with the idea that the shock might be a combination of various factors, such as: temporary tax incentives that give an advantage to invest in housing; increase in housing demand stemming from optimistic expectations; an increase in aggregate demand deriving from other sources (e.g. devaluation of national currency under fixed exchange rates) that feeds back into house price inflation with some lag.

In all countries, nominal and real interest rates go up. Output rises protractedly. Inflation goes up as well, except in Germany. Real house price increases are particularly strong in the UK and Sweden. The increase, whose timing closely matches that of output, lasts several years.

[16] Although real balances temporarily rise in France and the UK, the effect on nominal balances is unambiguously negative.

Inflation shock. In many countries, the tax system implicitly allows homeowners' to benefit from high inflation, 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 row 5 of Figures 2 to 7, inflation increases drive downward movements in output and interest rates that counterbalance this effect. For instance, in all countries but France output temporarily falls.

4.2. Variance decompositions

In which proportion do the different innovations contribute to the volatility of house prices and other macroeconomic variables?

Figure 8 plots the fraction of the k-step ahead forecast error variance for real house prices explained by the different shocks.[17] While the results confirm that not much of variance of output (around 15% or less) is attributable to monetary innovations, they 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% (Germany) to 40% (France) of the volatility of real house prices comes from the policy shock measure.

Demand shocks play a major role over the short run too, especially in France, Sweden and the UK. The UK result is particularly striking, with 60% of volatility in house prices coming from the demand shock, even at a 10 years horizon: this is perhaps evidence that in such a liquid market[18] transitory factors play an important role in determining house price fluctuations. At the other side of the spectrum is Germany, where most of the unforecast variability comes from supply factors.

The variability of interest rates and money balances is in large part due to monetary factors. Moreover, the assumptions made in the identification scheme imply that the two permanent shocks dominate as the forecast horizon grows larger.

[17] For reasons of space, I do not report variance decompositions for the other variables. The results are available from the author upon request.

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

5. House prices response to monetary policy and housing market institutions

Can the different responses of output and house prices to a monetary contraction be justified by looking at the different housing markets institutions? How might these differences play a role in the transmission mechanism? This subsection tries to give an answer. 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. Here, I present two sets of comparative responses: in the first one (Figure 9) the contraction is one standard error in size; in the second (Figure 10), I rescale the initial impact on the interest rate to be 50 basis points for all countries.[19] Here, I also show the implied responses of consumer (P), nominal house prices (H), and ex post real interest rates ($i - DP$).

Once the interest rate rise is rescaled (Figure 10), Italy and the UK experience the largest short-run sensitivity of house prices to interest rates; France and Germany are at the other end of the spectrum (in Germany, real house prices initially rise); Spain and Sweden somewhere in between. The effect is quantitatively sizeable. Six quarters after the monetary tightening nominal house prices are respectively 1.3% and 1.5% below the baseline in Italy and the UK, whereas they are 0.6% and 0.1% below in France and Germany. In real terms, house prices fall slightly less, given the decrease in consumer prices. It is difficult to say with precision whether these responses are significantly different across nations. However, after six quarters, the lower confidence band (one s.e.) for the fall in Germany is above the higher one for the UK, thus suggesting that there are some differences between the extreme cases.

The different responses can be justified as follows: countries with low transaction costs, high LTV ratios, a large owner-occupied sector and a large proportion of variable-interest mortgages should experience relatively high house price volatility and a great role for housing in the transmission mechanism (see Maclennan *et al.*, 1998). The results seem to confirm this conjecture: the UK is one of the countries with lowest transaction

[19] Normalising for the initial impact on the interest rate is 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, both the initial impact and the time path of the policy variables matter for the response of the real variables (see Cochrane, 1998).

costs as a percentage of price (2%), with mortgage rates in most of the cases reviewable or renegotiable, high LTV ratios, and a high owner occupied tenure rate. Interestingly, it is the country more affected by a contraction if one looks at its combined impact on output and real house prices as a metric for its effects.

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 *et al.* (1996) report that 75% of mortgage credit is at rates that are indexed on the short term rate. However, despite the large 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 significant role in the transmission mechanism. An additional factor that reinforces this conjecture is the observation that property and government securities are often seen as alternative forms of investment by Italian households. The fall in house prices might simply reflect portfolio reallocation decisions, with no sizeable effects on consumption and investment decisions.

Germany and France (and, to some extent, Spain) tend to be at the opposite side of the spectrum. In Germany tenure rates are relatively low and transaction costs are relatively high.[20] In addition, the initial contraction might signal a credible disinflation policy by the central bank in the future, thus lowering expected inflation and future rates. The response of output is very strong, although it is a consequence of the imposed normalisation: an increase of the interest rate of 50 basis points is a "large" disturbance for a country with relatively low and stable inflation and interest rates.

In France nominal house prices jump immediately to (and even overshoot) their new long-run equilibrium level, and the implied real house prices dynamics follow 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. The result is consistent with evidence presented in Barran *et al.* (1996), who report that in France almost 95% of mortgage credit is on completely fixed rates. Therefore, one would expect the impact of the contraction to affect only potential homebuyers, rather than already indebted homeowners, with small wealth effects for this group.

One caveat. It is hard to compare different monetary innovations across countries. Here I have shown the

[20] Of course, a distinction has to be drawn between eastern and western Germany. See Kemp, 1996.

responses with and without normalisation of the initial impact on the nominal rate. The normalization has the virtue of providing a useful benchmark now that four of these countries are under a common monetary policy; the second procedure compares in all the countries a “typical” benchmark shock over the period in question. Despite these difficulties, the overall evidence suggests a link between housing market institutions on the one hand and sensitivity of house prices to a monetary disturbance on the other. Although it deserves future research, comparing output responses is perhaps harder, especially because it is problematic to control for other factors that influence the transmission mechanism.

6. An informal interpretation of house price movements

Figures 11 to 16 plot for each country real house prices, inflation, interest rates and GDP in the first row, and estimates of the five structural shocks in the second.[21] For ease of interpretation, I construct nine quarter, centered moving averages for each of the otherwise uncorrelated disturbances. I focus only on some specific, relevant periods of significant house prices changes 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.

FRANCE. France had a boom during the year 1980, with house prices peaking at the beginning of the 1981 and falling by 15% in real terms in the following two years; a similar 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 seems the effect of demand shocks: monetary policy appears to have been tight over that period, and might have contributed to the fall in house prices that

[21] The historical decomposition of the time series yield similar results. They are available from the author upon request.

started at the beginning of 1991. Between 1997 and 1998, house prices showed a slow recovery. Various fiscal incentives and new contracts offered to potential house buyers (such as the introduction of the "propriétée allégée") managed to stimulate the demand again.

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, but much larger increases in the big cities - seems due to a positive demand shock. The "demand" shock has its roots not just in the booming economy of the late '80s, but also in specific housing market episodes: in 1987 capital gains tax exemptions were introduced; from 1991, it was possible to deduct interest payments up to DM 12,000 per annum for the first three years from the purchase of a newly built house. In addition, the big cities saw an influx of migrants from the east of Germany as well as from elsewhere which placed pressure on the west German housing market and helped to create a new housing shortage there.[22]

ITALY. The main increases in house prices 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 rise, prices fell 15% in real terms between 1993 and 1996. Figure 13 highlights that nominal factors and demand shocks played a distinctive role in driving house prices down from 1993 onwards. Among the negative demand shocks, a role could have been played by policies that revised upward the fiscal value ("valore catastale") of the residential property. This made investment in housing unattractive 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). The inversion in the falling trend at the end of the sample reflects the effect of falling real interest rates. In the Italian case, this episode probably implies not only cheaper mortgages but also reduction in yields from government securities, which have always represented a traditional alternative investment to property.

[22] See Kemp, 1996, Housing Policy in the EU Member States, unpublished manuscript.

SPAIN. Positive demand and supply shocks seem to have driven the late '80s boom. Only a small fraction of the fluctuations in house prices seems attributable to the monetary policy stance, which was 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 tighter monetary policy and negative demand shocks. The increase in the late '90s is the result of the prolonged decrease in real interest rates as well as the economic expansion, alongside the increased demand for second homes from people in need to get rid of black money in the run-up to the single currency.

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, deregulation 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. Demand shocks were consistently positive in all years until 1990, when a quickly deepening recession set in. An international recession, a reformed tax system that abolished investment allowances and falling asset prices contributed to the severity of the downturn (see Berg and Gröttheim, 1997).

UK. Between 1974 and 1998, the UK has experienced two main house price boom-busts cycles, the first from 1978 to 1982, the second from 1983 to 1992. 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.

The house price boom of the late '80s could have been driven by a combination of three factors: positive supply and demand shocks and expansionary monetary policy. Among the factors that contributed:

1) demand side factors: the announcement in 1988 that mortgage tax relief would be restricted to £30,000 per residence regardless of the number of borrowers boosted housing demand. Financial liberalization permitted higher gearing, as borrowers were able to obtain higher LTV ratios. In addition, optimistic expectations about rising incomes played a role: the experience of housing appreciation reinforced expectations of further

appreciation to come.

2) monetary policy: a loose monetary policy followed the appreciation of the pound from 1987.

3) supply side factors: the (permanent) income rise led to a rise in housing demand, but supply grew more slowly, with construction of social housing falling to a small fraction of its level in the 1970s.[23]

The early 1990s bust derived from the reversal of most of these factors. Interest rates rose. Income growth expectations weakened. The introduction of a new tax on houses (the Council Tax) depressed property values further. Mortgage lenders tightened their lending criteria, in a reversal of the financial liberalization of the late '80s. The increase of the late '90s (from 1996) seems to reflect more demand and supply shocks than loose monetary policy conditions. Besides the traditional factors outlined above, a "demand shock" has been represented, particularly in the London area, by the 'buy-to-let' boom, supported by a change in the attitude of mortgage lenders towards landlords.

7. Conclusions

This paper has shown that the dynamics of house prices can be dealt with using a tractable VAR framework in a straightforward way. I have developed and estimated a simple macroeconometric model driven by five exogenous disturbances, all of which can have effects on house price inflation. In particular, I have shown that monetary policy shocks can have serious effects on house prices. What supports these findings is that a set of reasonable identifying assumptions yields plausible results for the responses of money, consumer prices and output to shocks. To this, I add a relatively new piece of evidence, showing that, unlike consumer prices, house price inflation is highly 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

[23] It is often argued that financial liberalisation could have contributed to the housing boom in the '80s: restrictions on bank lending were abolished in 1980, enabling banks to compete with building societies; average LTV ratios for first time buyers rose from .74 in 1980 to .86 in the mid 80s. Yet the boom came several years after the deregulation, suggesting that financial liberalisation itself cannot be the sole cause. Demographic factors are mentioned too (population in the 20-29 age range rose by 1.3 million over the 80s, compared to .1 million over the previous decade) but they can be hardly considered shocks: such a phenomenon was predictable and one would expect the main impact of demographics to be on quantities rather than prices.

in expectations more quickly than consumer prices -, it is encouraging that it has been obtained with a highly stylised macroeconomic model, which in other respects closely matches the predictions of a standard IS-LM-Phillips curve paradigm.

The results hint that different housing and credit market institutions play a role in this transmission mechanism: however, as institutions change, this relationship might change too. Fiscal, regulatory and legal structure and the new monetary policy regime are likely to affect this relationship.[24]

The debate on asset prices and the business cycle has a long tradition in macroeconomics, at least since Irving Fisher (1911) argued that policymakers should aim to stabilise a broad price index including, besides goods and services, shares, bonds and property. There are widespread concerns on whether expansionary monetary policies are at the origin of dramatic asset price changes. With respect to the housing market, the evidence presented here suggests that the unsystematic component of monetary policy (and other macro factors) can play an important role in driving asset price fluctuations.

[24] A maintained assumption here is that the link between house prices and the macroeconomy has remained relatively stable over time. Of course, the period analysed has witnessed several changes in the housing market and in the financial system. Iacoviello and Minetti (forthcoming) explore the issue analysing the impact of financial liberalisation on the link between monetary policy and house prices. They use vector autoregressions to study the role of monetary policy shocks in house price fluctuations in Finland, Sweden and the UK, characterised by financial liberalisation episodes over the last twenty years. They find that the response of house prices to interest rate surprises is bigger and more persistent in periods characterised by more liberalised financial markets.

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Tables

Table 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
q	-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

ADF unit root tests statistics for the series, with a lag length of 3 for France, Spain and Sweden, 4 for Germany, Italy and the 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 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
q	-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 the 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.

Table 3: Parameter estimates of the cointegration vectors

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

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

Figures for "House Prices and Business Cycles in Europe: A VAR Analysis"

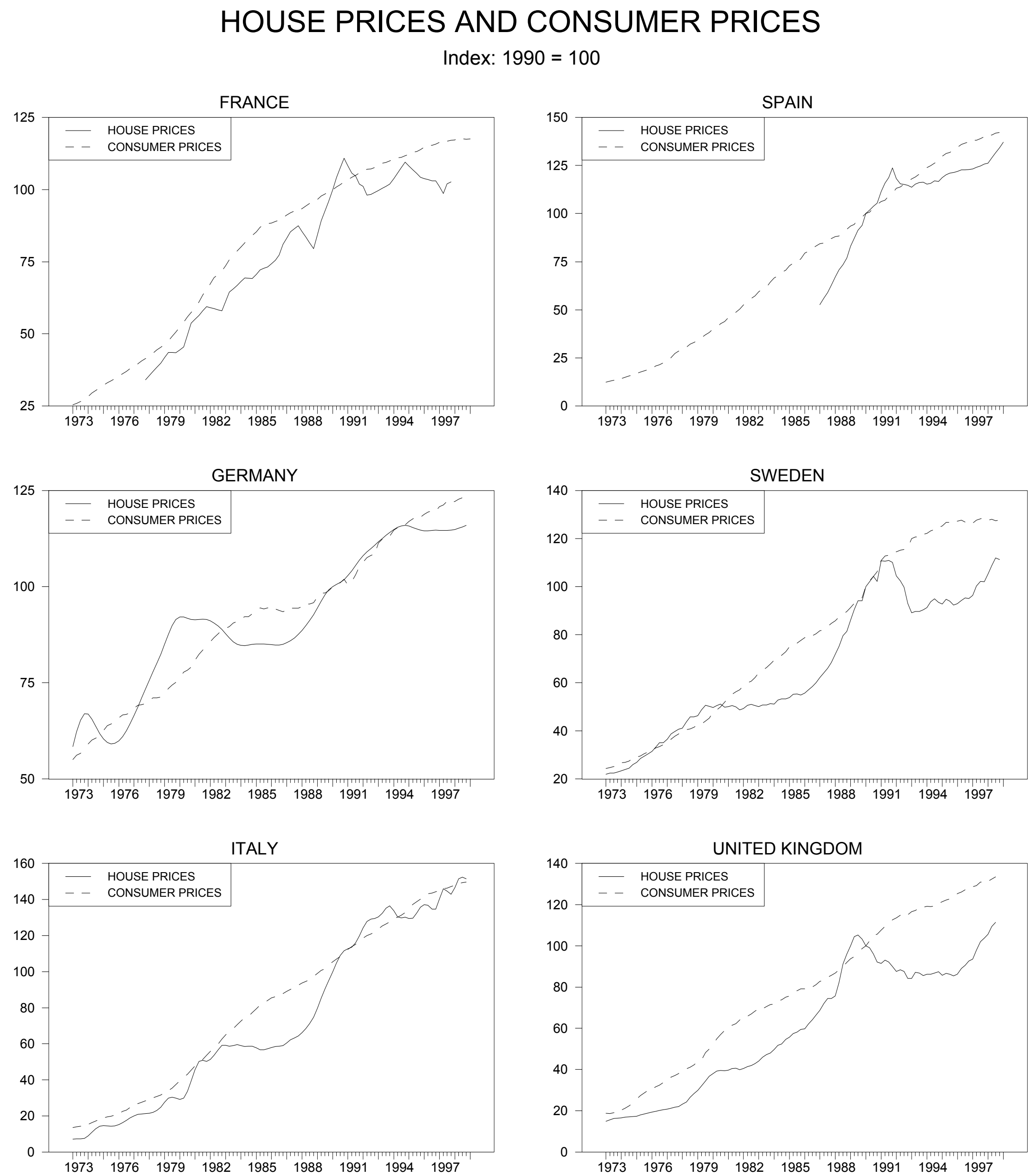
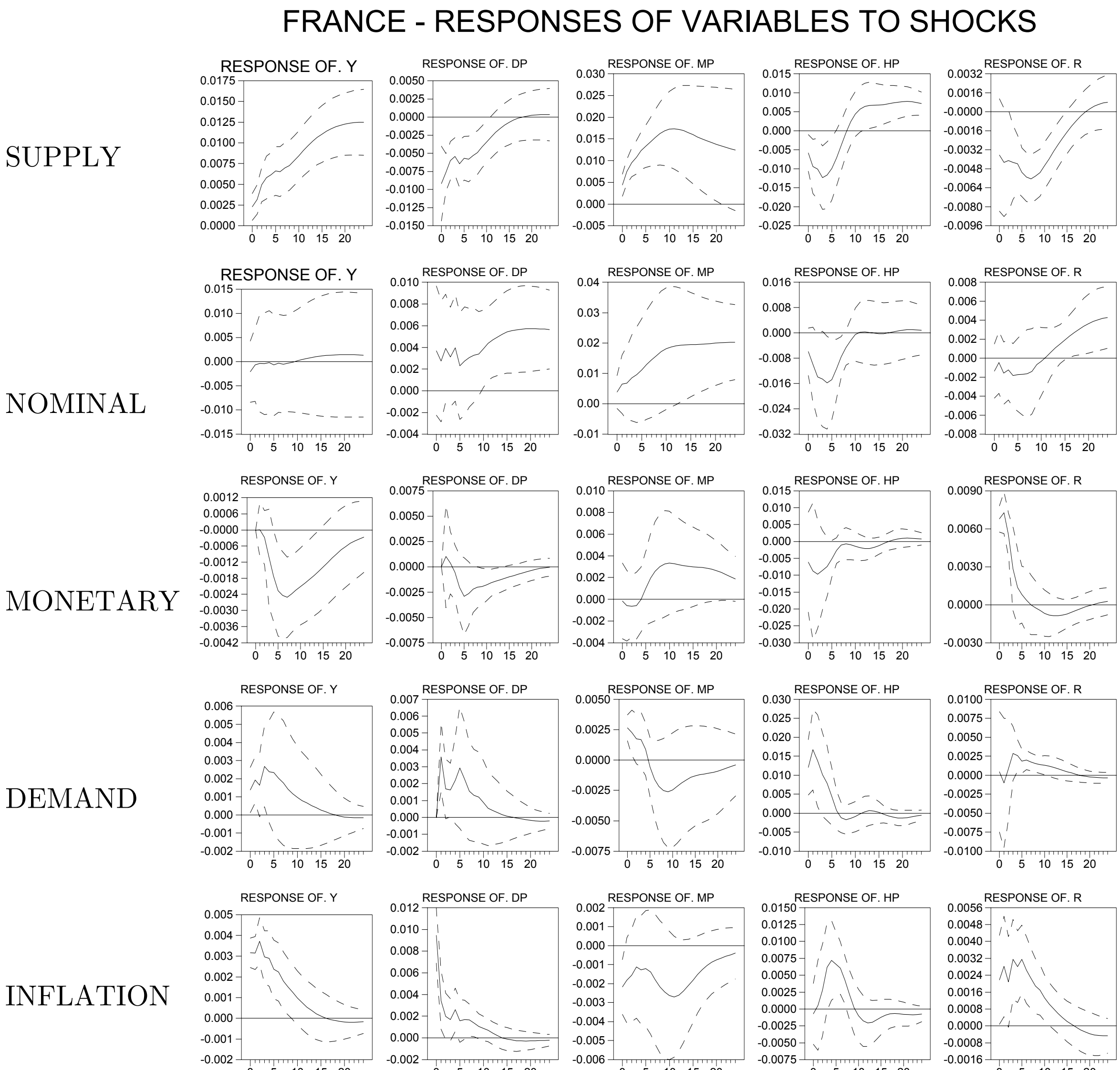


Figure 1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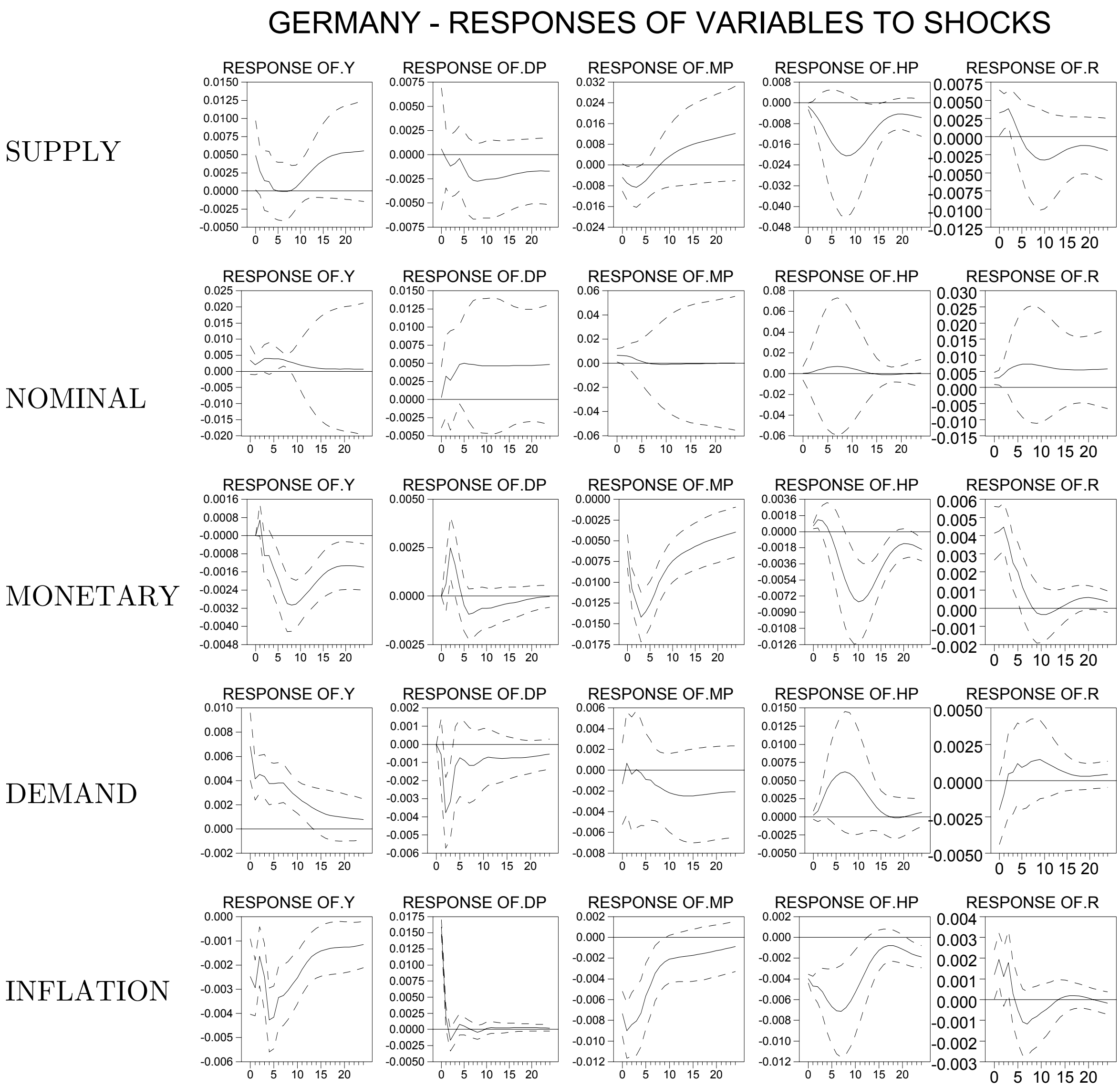
SUPPLY
NOMINAL
MONETARY
DEMAND
INFLATION
RESPONSE OF. Y
RESPONSE OF. DP
RESPONSE OF. MP
RESPONSE OF. HP
RESPONSE OF. R

Figure 2


GERMANY - RESPONSES OF VARIABLES TO SHOCKS
RESPONSE OF.Y
RESPONSE OF.DP
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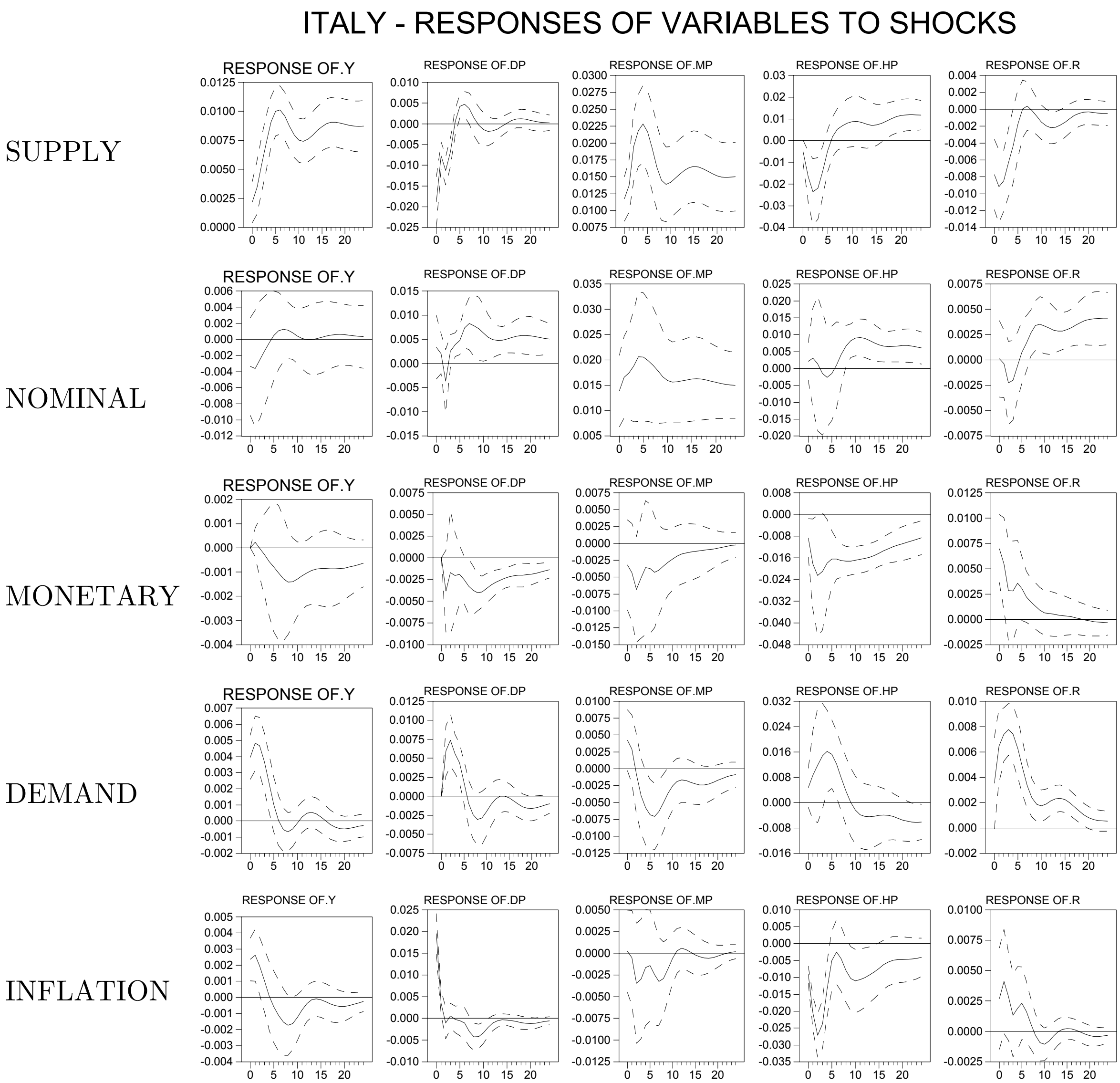
DEMAND
INFLATION

Figure 3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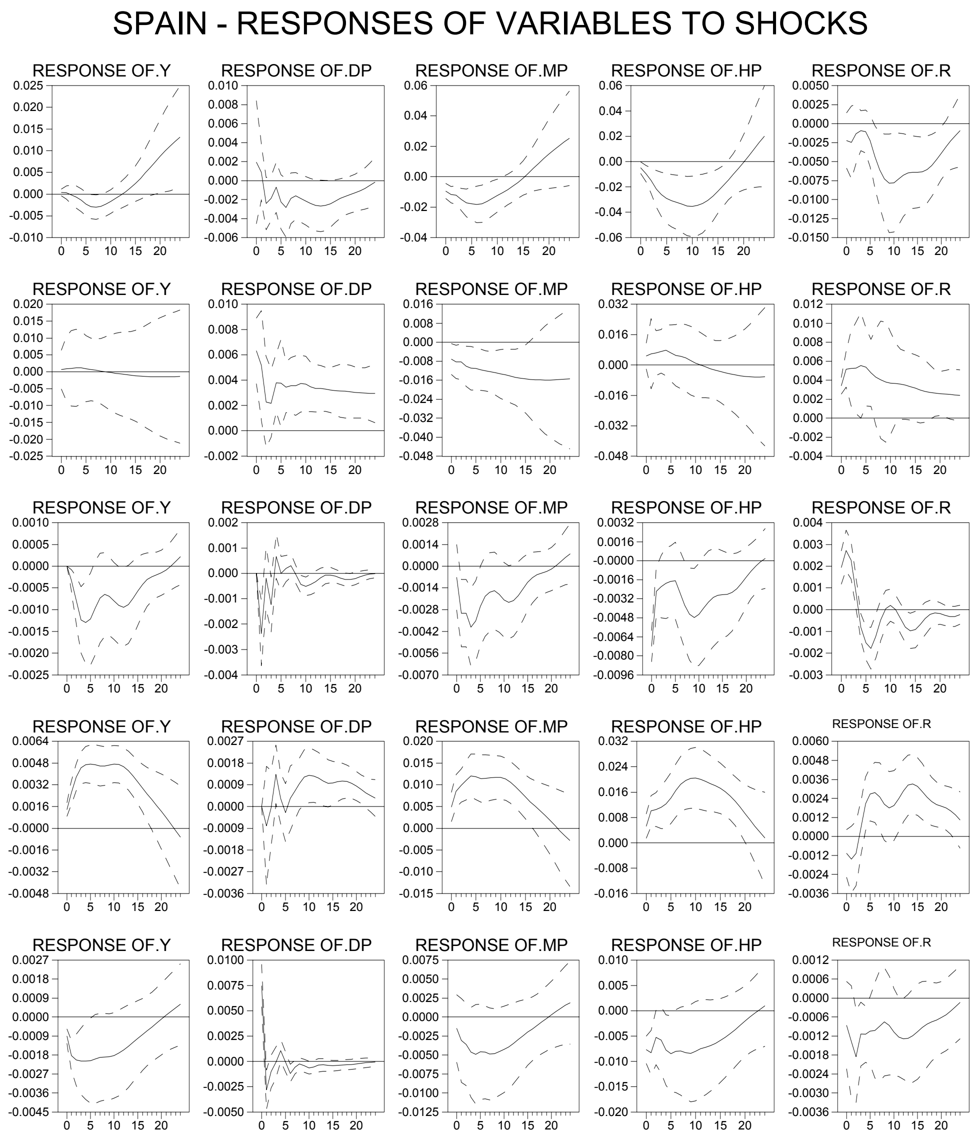
RESPONSE OF.Y
RESPONSE OF.DP
RESPONSE OF.MP
RESPONSE OF.HP
RESPONSE OF.R
SUPPLY
NOMINAL
MONETARY
DEMAND
INFLATION

Figure 4



SUPPLY

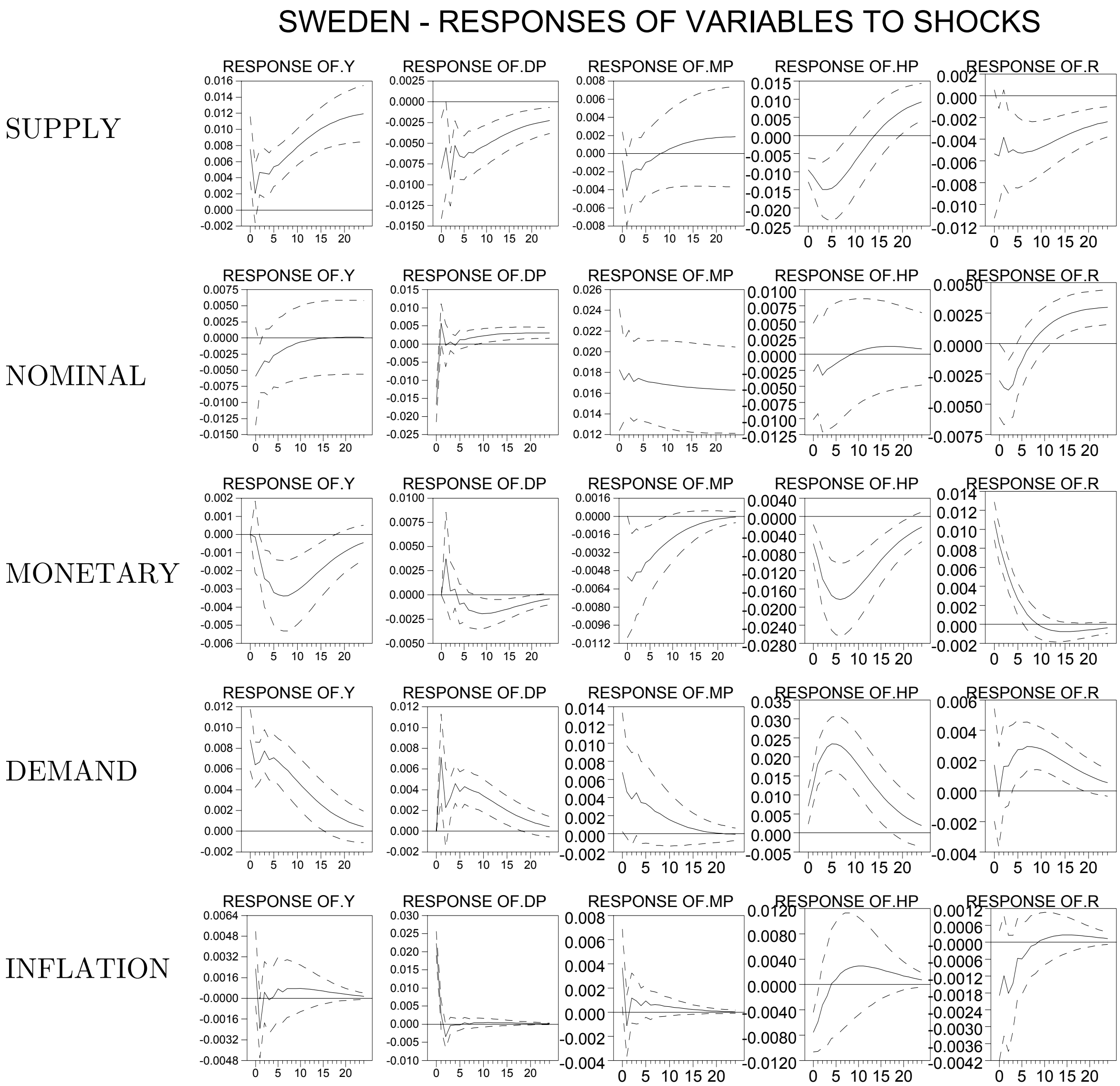
NOMINAL

MONETARY

DEMAND

INFLATION

Figure 5


SWEDEN - RESPONSES OF VARIABLES TO SHOCKS
RESPONSE OF.Y
RESPONSE OF.DP
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RESPONSE OF.HP
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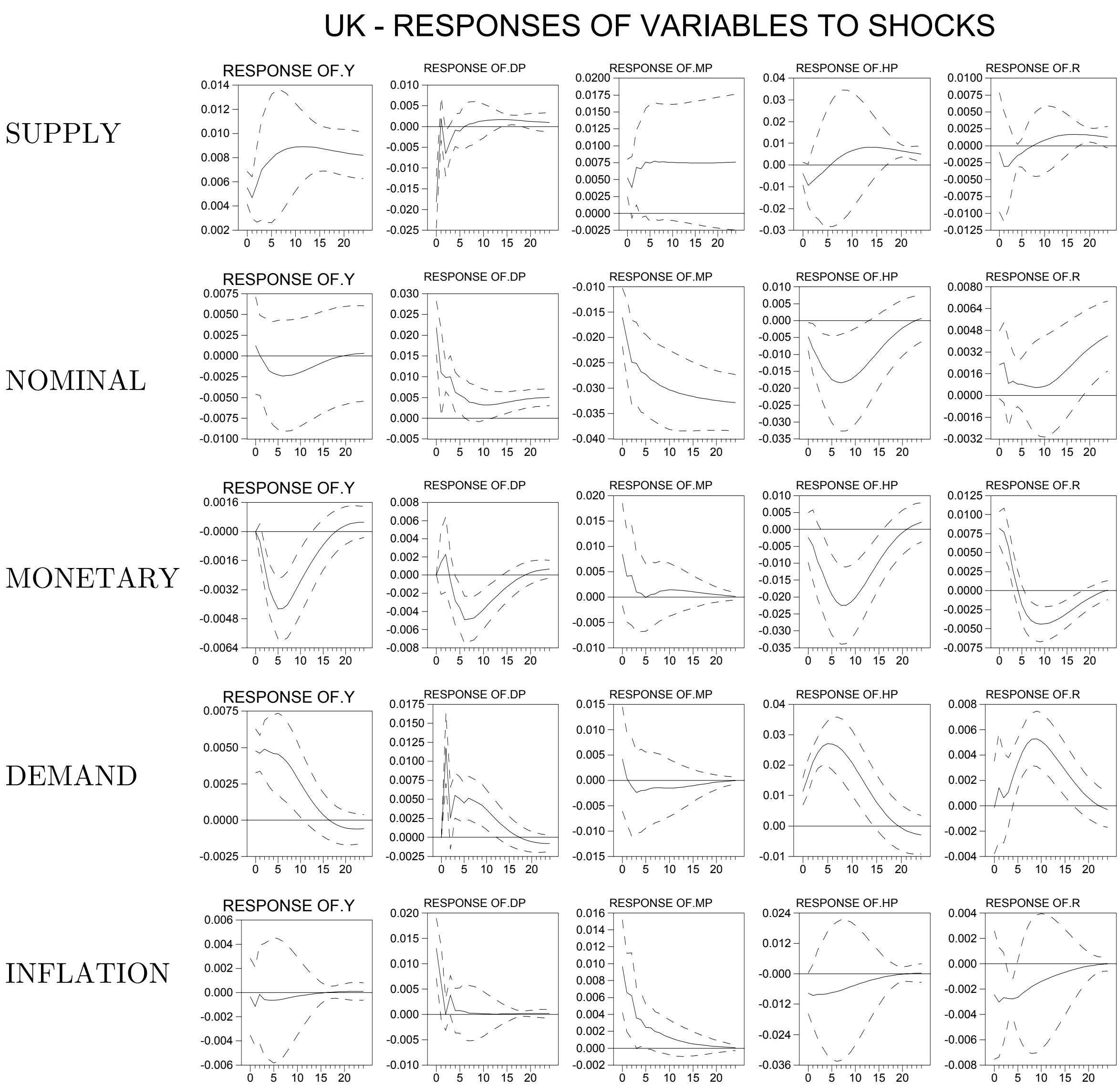
SUPPLY
NOMINAL
MONETARY
DEMAND
INFLATION

Figure 6


UK - RESPONSES OF VARIABLES TO SHOCKS
SUPPLY
NOMINAL
MONETARY
DEMAND
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RESPONSE OF.Y
RESPONSE OF.DP
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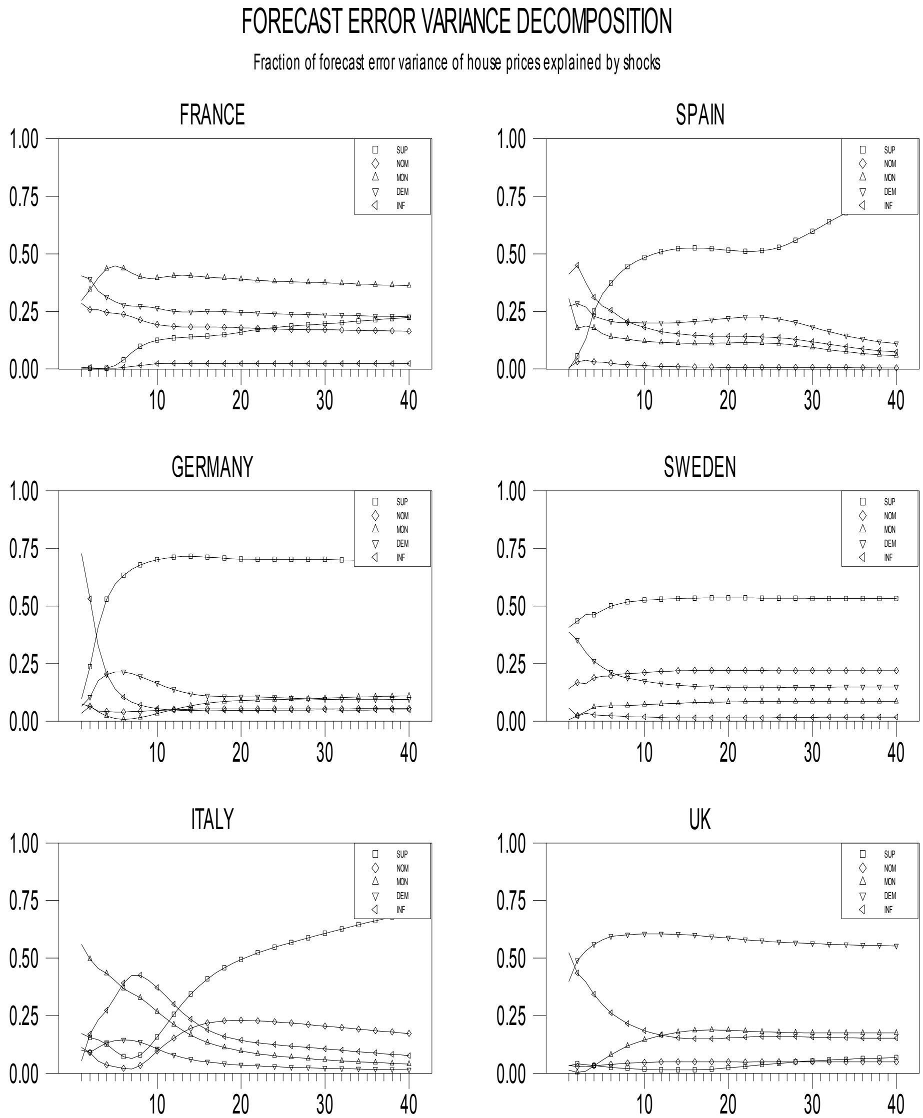
RESPONSE OF.R

Figure 7


FORECAST ERROR VARIANCE DECOMPOSITION
Fraction of forecast error variance of house prices explained by shocks
FRANCE
SPAIN
GERMANY
SWEDEN
ITALY
UK
SUP
NOM
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DEM
INF
1.00
0.75
0.50
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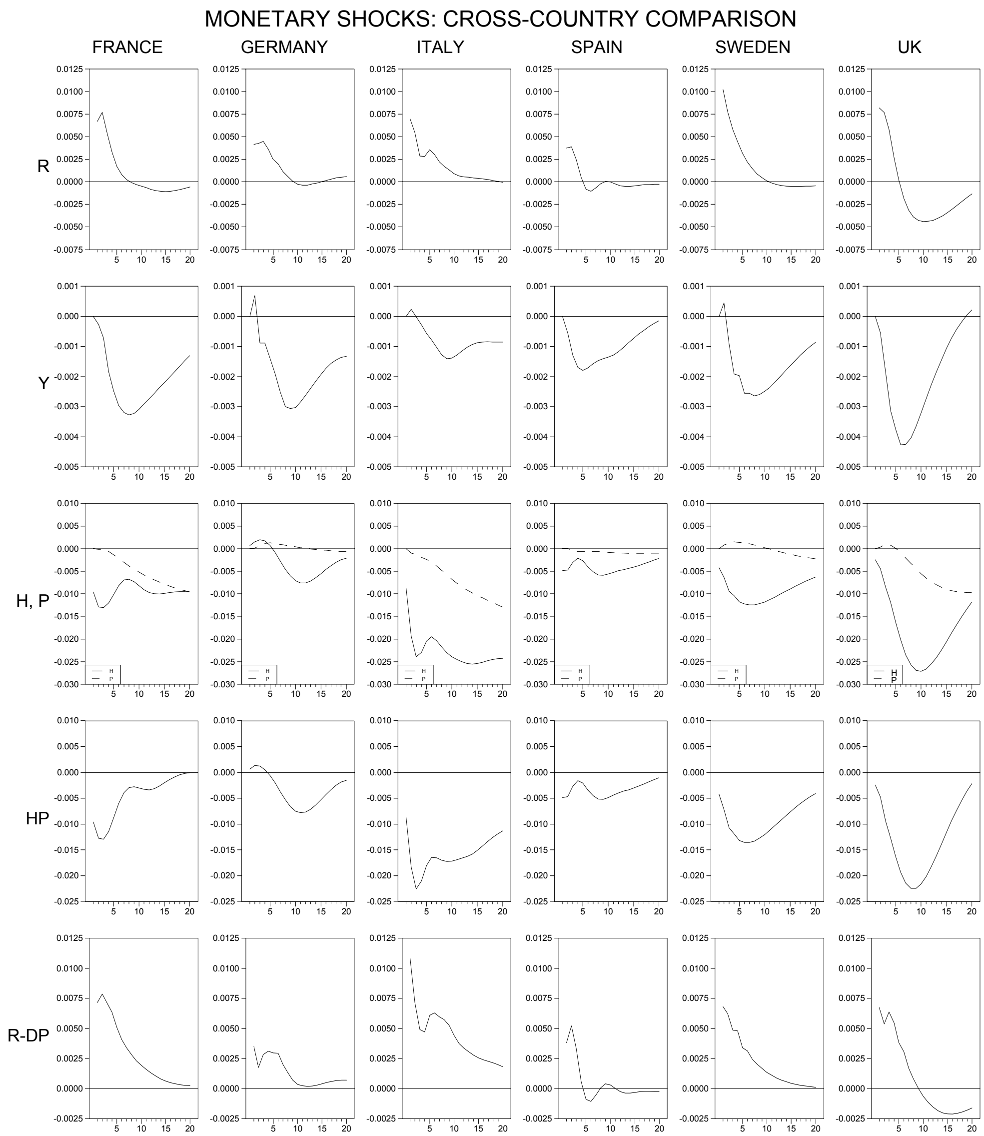
0.00
10
20
30
40

Figure 8


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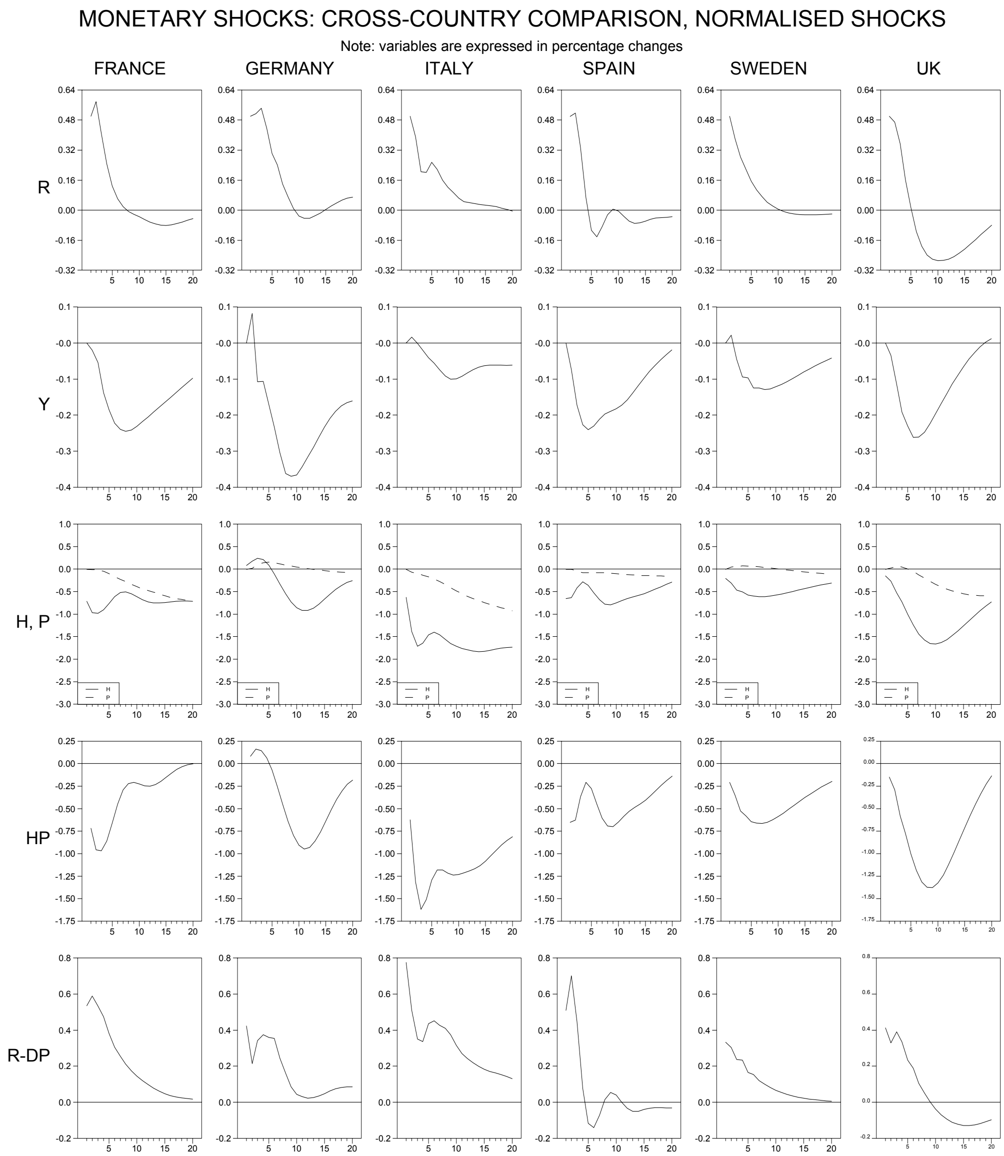
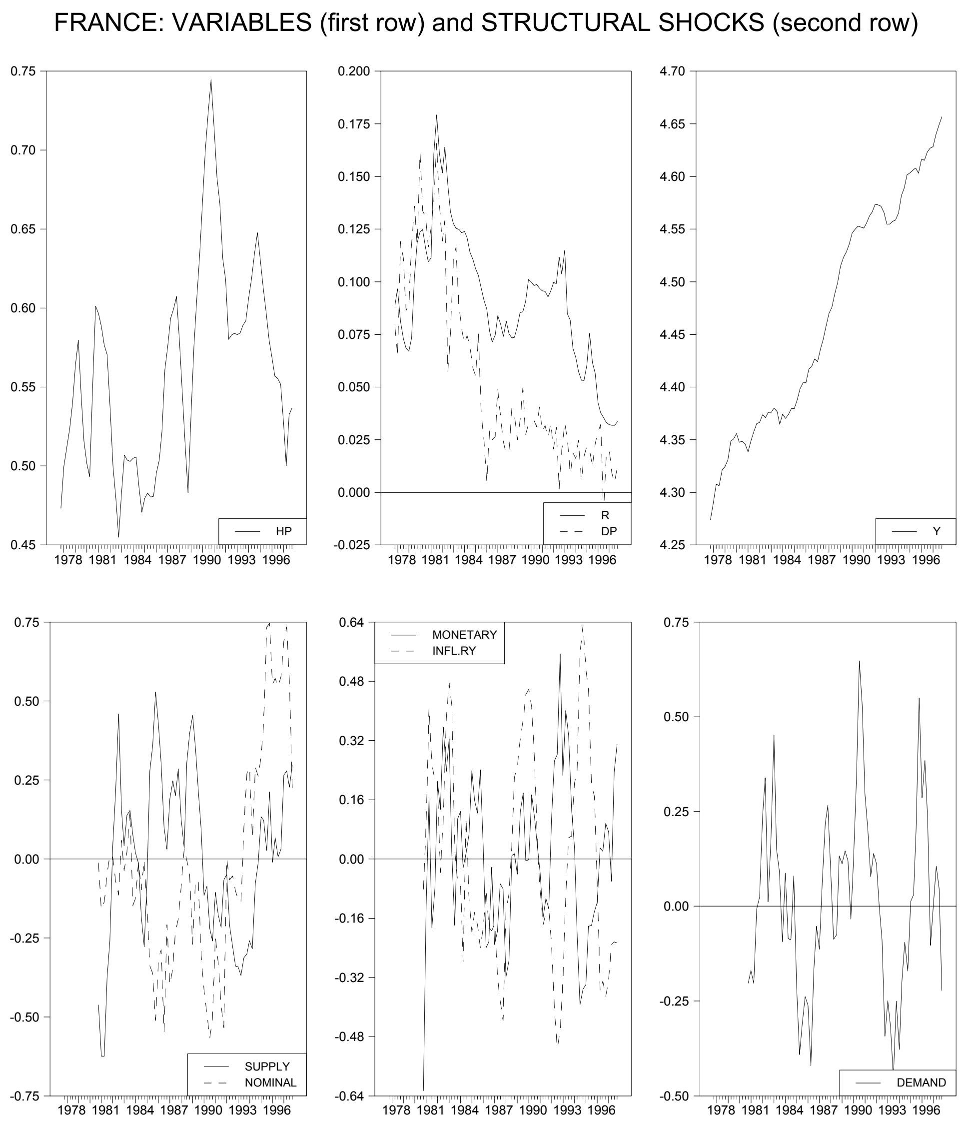
H, P
HP
R-DP

Figure 9



MONETARY SHOCKS: CROSS-COUNTRY COMPARISON, NORMALISED SHOCKS
Note: variables are expressed in percentage changes
FRANCE
GERMANY
ITALY
SPAIN
SWEDEN
UK
R
Y
H, P
HP
R-DP

Figure 10


FRANCE: VARIABLES (first row) and STRUCTURAL SHOCKS (second row)
HP
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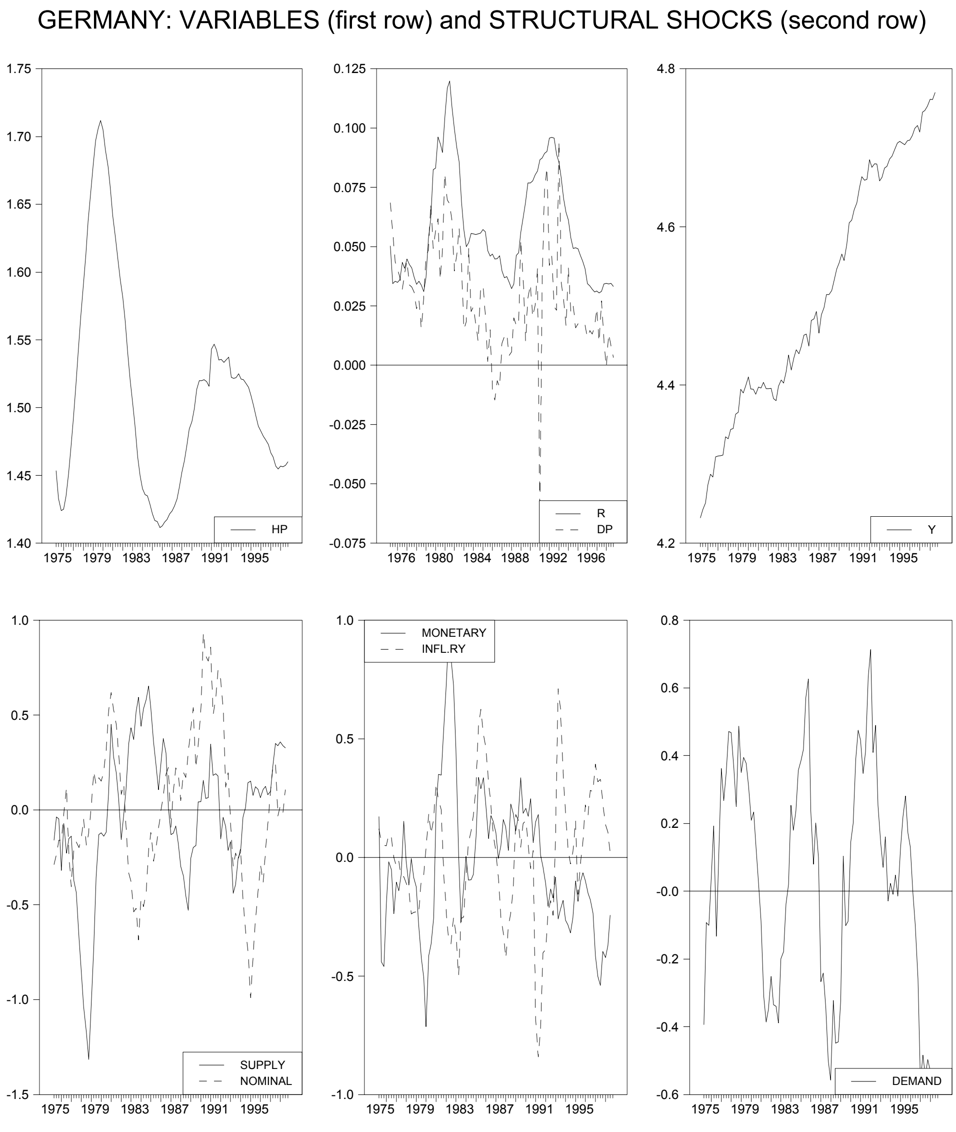
DP
Y
SUPPLY
NOMINAL
MONETARY
INFL.RY
DEMAND
1978 1981 1984 1987 1990 1993 1996

Figure 11


GERMANY: VARIABLES (first row) and STRUCTURAL SHOCKS (second row)
HP
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1975
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Figure 12

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

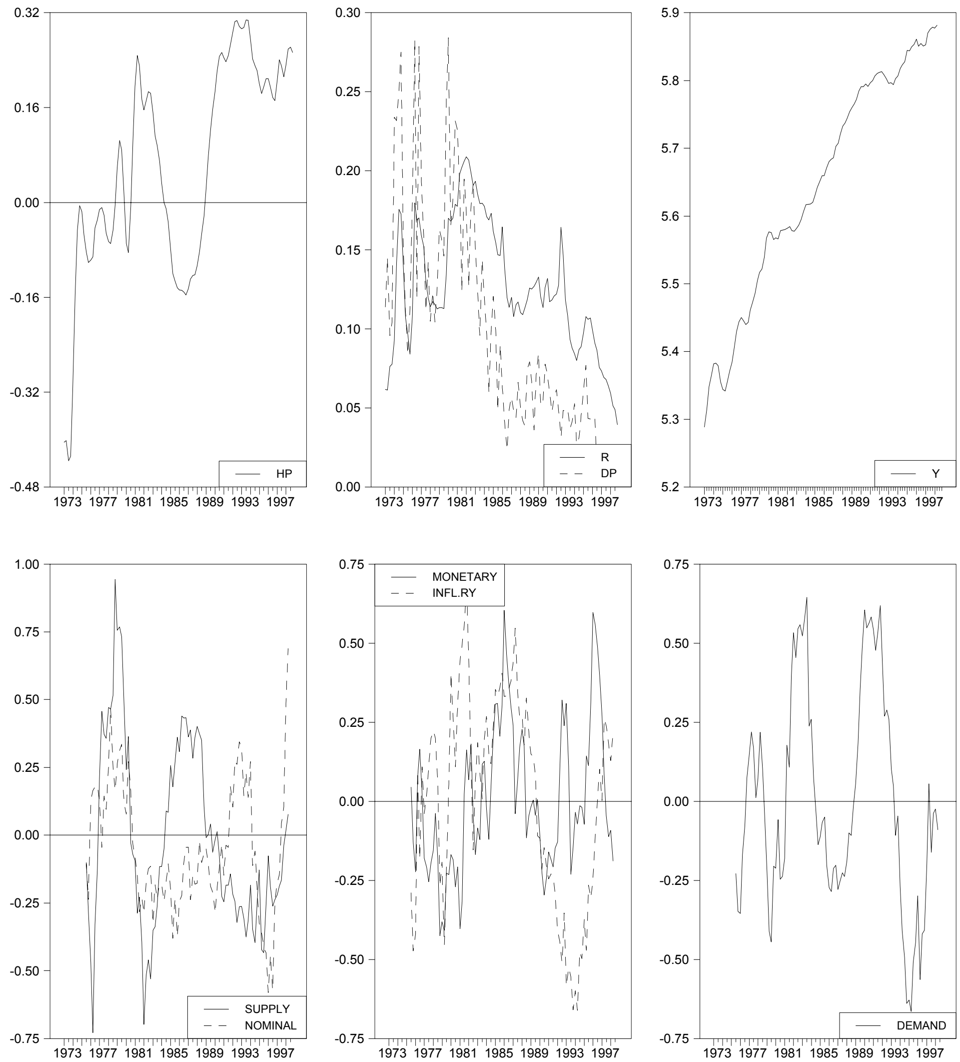

Figure 13

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

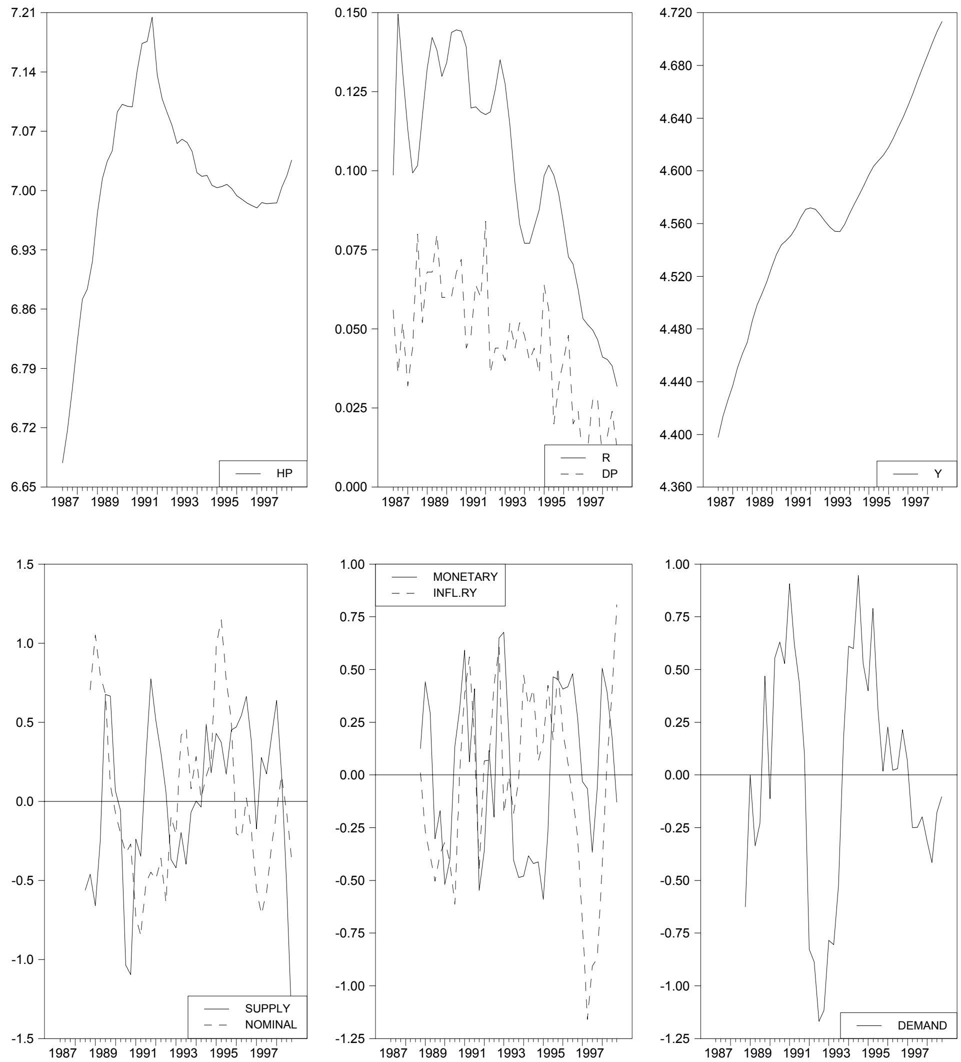

Figure 14

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

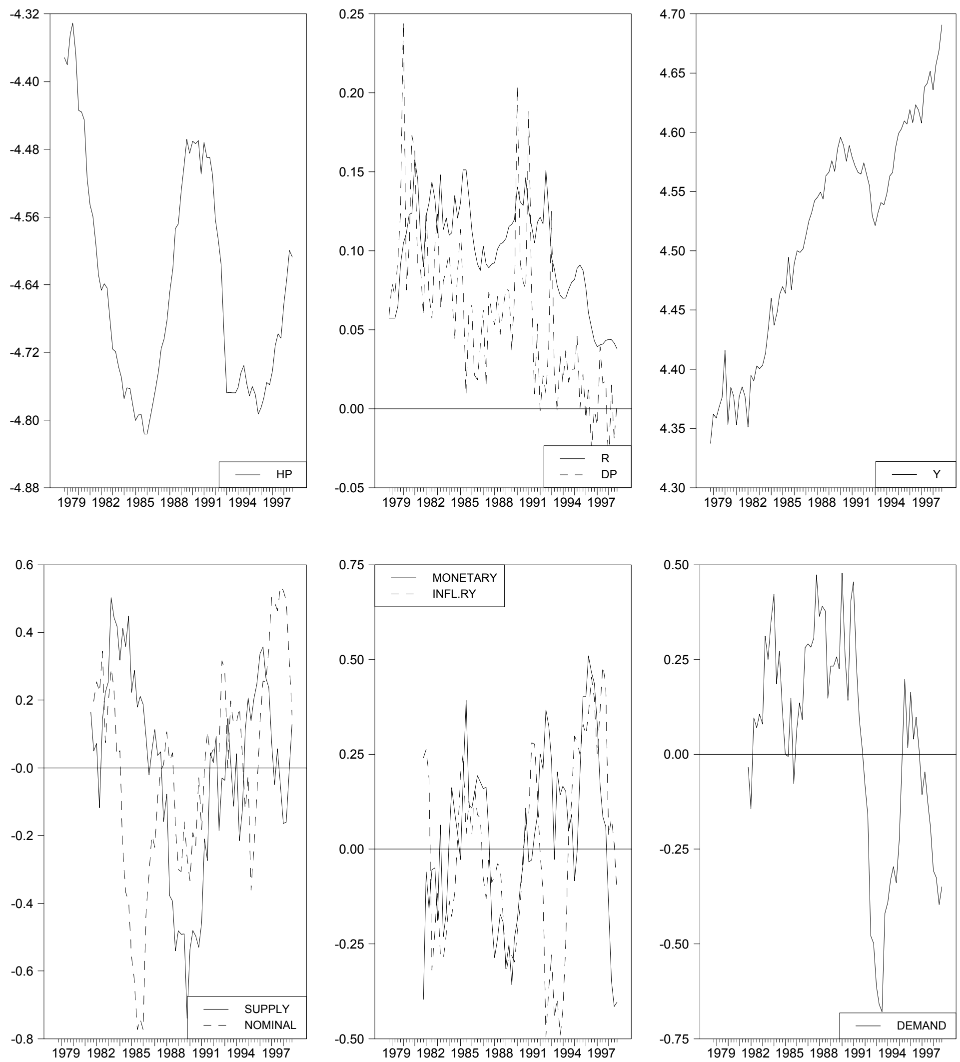

Figure 15

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

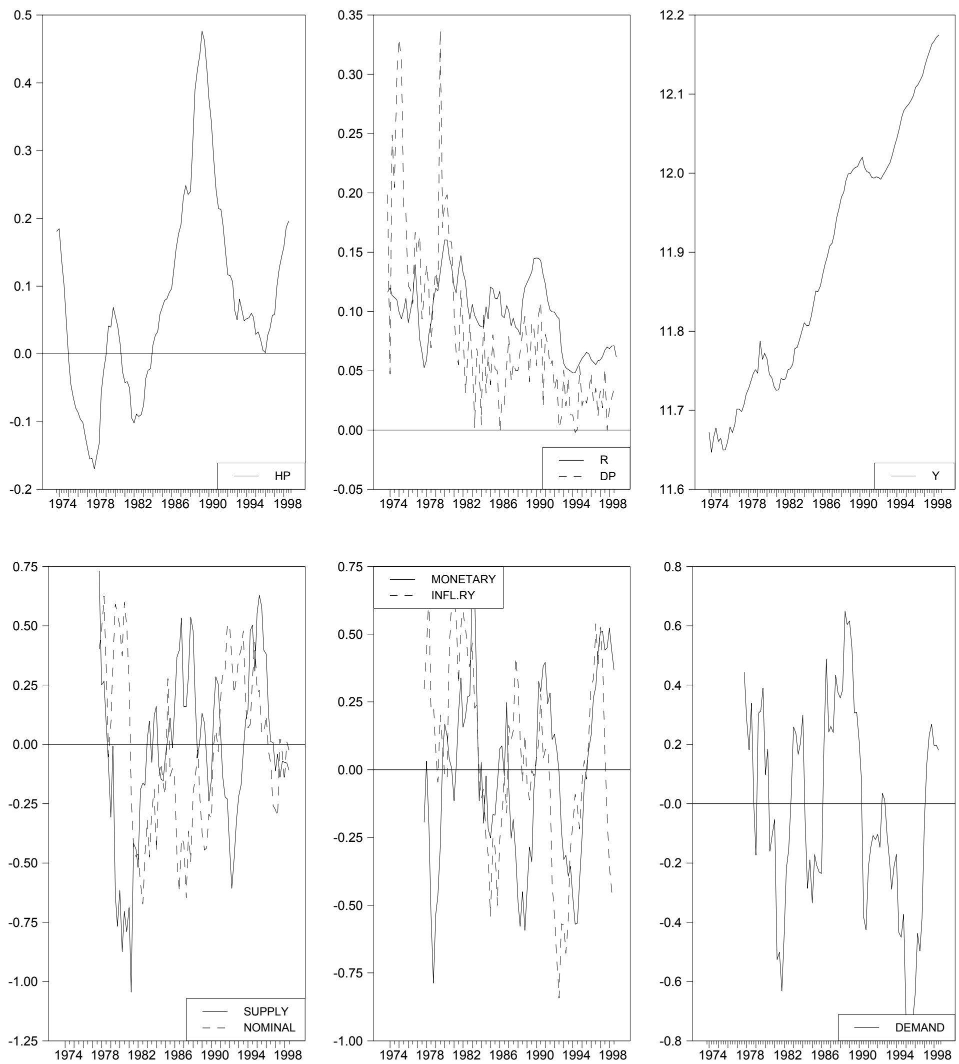

Figure 16