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Will EMU Generate Asymmetry? Comparing Monetary Policy Transmission Across European Countries

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Will EMU Generate Asymmetry?

Comparing Monetary Policy Transmission

Across European Countries

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Abstract

This paper re-evaluates the estimation of monetary policy transmission. Within the Structural VAR framework, five methodological points are identified, recognition of which can help to improve the reliability and credibility of estimates. The findings of the methodological analysis are then applied to the estimation of models for thirteen European countries. Results show that considerable differences in the transmission mechanism exist between these economies, mainly in intensity, but also in timing.

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1   Introduction

At the beginning of 1999, when the European System of Central Banks will start its operations, the economic environment within Europe will change substantially in many aspects. For the participating economies a major change will be their being subject to a centralised monetary policy. It is of crucial importance to understand how such a monetary policy will affect each economy. If the timing and intensity of the effects which a European Central Bank (ECB) action can trigger will differ between the participants, asymmetric shocks will be the outcome of EMU. As is well known, *ceteris paribus* countries should not form a currency union if they are subject to asymmetric shocks, so incurring them as a result of the union itself would represent a serious negative side-effect of EMU.

Although numerous empirical studies of the monetary transmission mechanism exist, only a few of them are comparative. Among these are Sims (1992), Gerlach and Smets (1995), Barran, Coudert and Mojon (1996) and Smets (1995 and 1997). However, estimates of monetary policy effects are prone to a high degree of uncertainty - and what is true for research on single countries holds even more for comparative studies. Hence, additional research in this field is needed to provide a wider and thus more reliable basis for conclusions about whether the heterogeneity of monetary transmission patterns in Europe is big enough to constitute a significant cause for concern.

This paper discusses the basic methodological issues that are involved in an empirical analysis of monetary policy and the special features of a comparative study. By making explicit the underlying concepts of the Structural Vector Autoregression (SVAR) framework, five methodological points are identified, recognition of which helps to improve the reliability and credibility of the estimates. In the light of this, estimates of SVARs for thirteen European countries are provided, with the finding of considerable heterogeneity in monetary policy transmission. However, it is argued that the main existing differences, i.e. those in the magnitude of responses, will mainly disappear with the start of EMU. The remainder of the paper is organised as follows: Section 2 develops some background considerations that have to be borne in mind for empirical research. Section 3 describes the concept of SVARs, and some of the criticisms of this approach; whereas section 4 introduces the five methodological points which allow us to provide improved estimates. Section 5 provides the empirical results which are discussed and interpreted for each country and subsequently compared across countries. Section 6 concludes.

2   The Identification Problem in Analyses of Monetary Policy

Any study of the influence of monetary policy instruments on goal variables has to be aware of a simultaneous opposite effect of goal variables on policy instruments via CB reactions to variations in goal variables. Standard correlation analysis is therefore inadequate, since it is impossible to disentangle the unidirectional effects. Thus, unless the instrument variable turns out to be weakly exogenous, [1] an identification problem arises.

Interestingly, this identification problem was first found in research on the CB reaction function. There, the opposite effect is of interest, namely how the setting of monetary policy is influenced by variations in the goal variables, yet the identification problem, i.e. the need to disentangle the two effects, remains the same.[2]

One way to do so is to restrict the analysis to effects caused by exogenous shocks to the instrument variable.[3] Then it is clear that a change in the monetary policy setting is not caused by changes in the goal and hence the causality goes from instruments to goals.

However, it is important to ensure that the monetary policy shocks on which the analysis is based are not simply error terms in the econometric model, but represent actual shocks in the economic sense. That is, first of all, that they have to be of an unsystematic nature. If any systematics, e.g. co-movements with another variable, can be found, the identification problem has not been solved. Eventually, the relevant variable has to be added to the information set.

Furthermore it is important to condition on variables which affect both instruments and goals simultaneously. The 1987 stock market crash provides a useful example: Some CBs, fearing lower output growth, reacted by injecting liquidity. Subsequent output variations were thus positively influenced by the CB actions, but also negatively by the crash itself. Without conditioning on the crash, econometric inference would underestimate the effects of monetary policy. A correction of the effect can be achieved by either adding stock market indices or an appropriate dummy variable to the model. Assuming that CBs do not systematically react to stock market indices, a dummy variable is preferable, however, because it removes the particular incident completely from the analysis without estimating the parameters for the variable over the whole sample.

A frequently used approach to overcome the identification problem is a narrative approach. It uses qualitative data such as the minutes of CB board

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[1] This is not found for most models of this paper; see appendix for test results. The adequate econometric approach if weak exogeneity and further conditions hold is described in Banerjee, A. *et al.* (1997).

[2] See Fisher, D. (1972).

[3] This focus on shocks to the model goes back to Barro, R.J. (1977), who decomposed monetary policy effects into anticipated and unanticipated ones for the first time.

meetings to identify periods of contractionary or expansionary monetary policy and accordingly constructs an ordinal variable.[4] For a comparative study, however, the underlying shocks have to be standardised with respect to their size, which is possible only if the shock is measured cardinally. Such an approach is found with the SVAR framework, which will be discussed in detail in the next section.

3   Structural Vector Autoregressions

The origins of SVAR models lie in Vector Autoregression (VAR) models. In the VAR framework, it is assumed that the economy can be described by a dynamic, stochastic, linear model of the form:

$$A_0 X_t = A_1 X_{t-1} + ... + A_k X_{t-k} + \mu_t = A(L)X_{t-1} + \mu_t \text{, with } \mu_t \sim iid\ N(0, \Sigma_\mu) \qquad (3.1)$$

where X_t represents an $nx1$-vector of endogenous variables, including one or several instrument variables, and L denotes the lag operator. The estimation proceeds with the reduced form

$$X_t = C_1 X_{t-1} + ... + C_k X_{t-k} + \varepsilon_t = C(L)X_{t-1} + \varepsilon_t \text{, with } C_i = A_0^{-1}A_i \text{ and } \varepsilon_t = A_0^{-1}\mu_t. \qquad (3.2)$$

Estimates can be found for the coefficient matrices C_i and the variance-covariance matrix of the disturbances $\varepsilon_t, \Sigma_\varepsilon$. However, of interest are the parameters in the matrices A_i and Σ_μ, which are exactly identified if n^2 parameters are restricted. A first set of restrictions is found by the assumption of uncorrelated structural errors (i.e. Σ_μ diagonal) and by normalising the diagonal elements to unity, yielding $\Sigma_\mu = E(\mu_t \mu_t') = I_n$,[5] which altogether gives $n(n+1)/2$ restrictions. Hence, a further $n(n-1)/2$ restrictions are needed.

The first to use VAR analysis to investigate monetary policy effects was Sims (1980). He wrote the model in a Wold causal form, thus gaining a recursive structure and $n(n-1)/2$ zero-restrictions. In this case, the role of monetary policy depends on the position of the equation explaining the instrument variable. Monetary policy looks at contemporaneous values of all the variables above in the VAR (but does not simultaneously influence these variables), whereas it is not

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[4] See Romer, C.D., Romer, D.H. (1989).

[5] Neither restriction is particularly stringent. Uncorrelated errors are not very restrictive because contemporaneous effects between all the variables are allowed for in the A_0-matrix, whilst the normalisation turns out to be harmless. Instead of normalising the diagonal elements to one, it would also be possible to leave them unrestricted. In that case the diagonal elements in A_0 would be set to one.

influenced by, but influences, the contemporaneous values of all the variables ordered below it in the VAR. However, $n!$ different orderings are possible, and very many of these have usually been reported. This arbitrary ordering gave rise to the criticism of VARs being atheoretical. Unless the data frequency is relatively high (at least monthly data such as in Dale and Haldane (1995) or better daily data, as in Hamilton (1997)), recursive economic structures are not plausible anyway, and if results are, furthermore, sensitive to the ordering, then their interpretation becomes difficult.

As a result of this criticism, later research has used SVARs, the identification restrictions of which have an economic foundation. Restrictions on all matrices of the system are possible, and they do not have to be zero-restrictions, so that a recursive structure need not result.[6]

The focus of SVARs on estimating only the effects of shocks has attracted two kinds of criticism. Firstly, it has been argued that it treats CBs as random number generators. This is certainly not the case. All that is needed is some policy change that is not perfectly in line with the overall CB reaction function. One can imagine several reasons why this could happen: the CB has to base its policy decisions on the available macroeconomic data. Some data might still not be available at the decision time, whereas many others are preliminary and will be revised later. Adherence to the rule in such a case will *ex post* cause errors.[7] Furthermore, a CB rule is never specified in such a narrow way that it would not allow for deviations (maybe within certain margins), e.g. to take into account the personal beliefs of the board members (after all, the rule is not implemented by a machine, but by human beings!).

Secondly, the restriction of the analysis to exogenous shocks has led to the criticism that the CB's influence will be underestimated, since the bulk of its influence is found in the systematic part of monetary policy (see Cagan (1989)). This criticism is true, but stems from a misperception of the scope of SVAR analyses. They cannot give any insight into the size of a CB's influence; their role is limited to the provision of estimates of the monetary transmission.

Additionally, it has to be discussed to what extent SVAR models are subject to the Lucas critique. It could theoretically apply twice, within the sample because an artificial experiment is conducted by impulse response analyses and out of sample if SVARs are used for policy advice.

Within the sample, the Lucas critique does not apply. It is true that the experiment conducted with the impulse responses represents a policy variation that has not actually occurred. However, it is not an unprecedented event with

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[6] For example, assuming that monetary policy has neither immediate effects on output nor permanent effects on real GDP, Gerlach and Smets (1995) combine short- and long-run restrictions.

[7] That this type of error is useable for a SVAR analysis is proved in the appendix of Bernanke, B., Mihov, I. (1996).

respect to its size or form. On the contrary, it constitutes a standard event of the sample period, and as such is not subject to the Lucas critique.

On the other hand, the Lucas critique applies if SVARs are used for policy advice. The estimated parameters are usually not invariant to policy changes.[8] Obviously, out of sample policy advice is not a task that can be performed with SVAR models; they should merely be used for empirical descriptions of the transmission mechanism within a given monetary policy framework. In order to fulfil this task it is important that the SVAR is estimated over a sample period which covers only one monetary policy regime, since otherwise mixed evidence results.[9] To what extent the results of a SVAR analysis will change if the economies proceed to a different monetary regime (as in the case of EMU) has to be discussed separately; the SVAR analysis can merely give an indication of the diversity of the different economies at the start of the new regime.

Since with the start of EMU all structures will undergo major changes, it might be asked what purpose a retrospection can serve. However, from the very beginning of EMU, the ECB will have to implement a centralised monetary policy. As Dornbusch *et al.* (1998) put it: "Yet it is unhelpful to tell the ECB that the only way to learn is by experimenting."[10] Furthermore, it can be expected that not all the structures will change immediately and completely. Differences across economies very often reflect historical developments. Path-dependencies, however, will not be obsolete quickly, but will have to be adapted to the new environment. It could easily be that it will take several decades for some parts of the structure to change.

4 Methodological Concepts for Valid Inference in SVARs
4.1 Congruency of the SVAR

Congruency[11] (i.e. the accordance of a model with all the available evidence from all possible sources) is generally a necessary condition for solid econometric inference, but in the SVAR framework its recognition is even more important. Firstly, mis-specification tests can give indications as to whether the error terms are free of systematic patterns, a basic prerequisite for the construction of monetary policy shocks. Secondly, SVAR models are built on the assumption that the structural errors arise from independent sources. Only a well-specified model can possibly comprise all relevant variables and thus make the orthogonality assumption realistic.

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[8] In most models of this paper the instrument variables are not found to be weakly exogenous. Weak exogeneity is a necessary condition for super exogeneity, and thus for the estimated parameters to be invariant to policy changes; see, e.g., Hendry, D.F., Favero, C. (1992).
[9] Cf. Bagliano, F.C., Favero, C.A. (1998), p. 1074.
[10] Dornbusch, R., Favero, C.A., Giavazzi, F. (1998), p. 30.
[11] For a definition of the concept of congruency see Mizon, G.E. (1989), pp. 172 - 178.

4.2   Inclusion of Dummy Variables

As shown in section 2, the inclusion of dummy variables for special events is necessary to achieve a valid picture of the transmission mechanism. The omission of dummies where needed not only worsens the statistical fit of the model, but at the same time affects the economic interpretability of the shocks to the system.

4.3   Choice of Variables / Data Characteristics

The choice of variables that are to be included in the model has to be carried out carefully. Not only are their economic meaningfulness and interpretability important, but also their time series properties. The major point to consider along these lines is the stationarity of the variables. A common finding of unit root tests is that the CPI is I(2). In such a case, it is necessary to ensure that either second differences enter a standard VAR, or first differences (i.e. inflation rates) enter a Vector Error Correction Model (VECM)). The latter should be opted for if cointegration relations hold, because they contain valuable information which should not be ignored. Furthermore, as will be seen in section 4.5, cointegration relations give rise to identification restrictions that do not have to be imposed according to *a priori* beliefs, but result from data characteristics.

Additionally, it has to be ensured that a variable in the SVAR is able to deliver meaningful impulse responses. Difficulties in this respect can arise with variables that are not originally measured at the time frequency of the SVAR analysis. A variable that is measured at a lower frequency (e.g. annually) has to be distributed[12] over a higher frequency (e.g. quarterly). It has been shown that distribution of data series over a higher frequency can change the persistence properties of the data,[13] and it can be doubted whether the resulting series preserve the interest rate elasticity.   Hence it might not be advisable to increase the data frequency, as several studies do by breaking down US GDP from quarters to months, using the Chow-Lin (1971) procedure.[14]

Furthermore, the underlying measurement process of the time series has to be investigated. Quarterly GDP is in some countries measured rather crudely, thus possibly exhibiting imprecise interest rate elasticity and persistency properties. On top of this, some countries publish only seasonally adjusted data and apply very strong filters that do not leave much of the quarterly variability in the data. The use of quarterly GDP data for a European comparison could

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[12] Distribution is the process by which a flow variable (like GDP) is broken down from a low frequency to a higher frequency, whereas interpolation refers to stock variables.
[13] See Jaeger, A. (1990), Dezhbakhsh, H., Levy, D. (1994).
[14] Bernanke, B., Mihov, I. (1995), Leeper, E.M., Sims, C.A., Zha, T. (1996), Bagliano, F.C., Favero, C.A. (1998).

therefore present a pitfall, with industrial production as preferable alternative for the output variable.

4.4 Allowing for Heterogeneity

The few comparative SVAR studies published to date estimate an identical model for each country in order to ensure that observed differences between countries cannot arise as "artefacts of the econometric methodology",[15] but reflect actual differences. However, modelling all countries as identical is equivalent to saying that the countries actually can fully be described by the same information set. The only heterogeneity that can come into play are differences in the parameters of the respective variables. The finding that the transmission mechanism is quite similar between countries therefore comes as no surprise. Instead, I propose to allow for heterogeneity in the models. The scope of this heterogeneity, however, is limited, because the models have to be comparable. It is obvious that for a comparison of the monetary policy transmission mechanism both instrument and goal variables have to be identical. Since all European CBs use short-term interest rates as their main tool, it is no limitation to impose a common feature in this respect.[16] The various CBs have different reaction functions, however, hence heterogeneity is a reasonable assumption for the information variables. This should be built into the models, be it by including the variables themselves or appropriate dummies (see section 2). Again, it comes as no surprise that Smets (1995), who used heterogeneous large-scale macroeconometric models set up by CBs to simulate the transmission process found significant differences across countries.

4.5 Cointegration as an Identification Device - the KPSW Approach

As King, Plosser, Stock and Watson (1991 - from now on KPSW) have shown, cointegration properties of the data can be used for identification purposes. A cointegrated VAR model, which is in its Vector Error Correction format:[17]

$$\Delta X_t = \alpha \beta' X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \varepsilon_t, \qquad (4.1)$$

has the Granger representation

$$X_t = C \sum_{i=1}^{t} \varepsilon_i + C^*(L) \varepsilon_t + A, \qquad (4.2)$$

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[15] Gerlach, S., Smets, F. (1995), p. 3.
[16] See Borio, C. (1997), p. 2.
[17] See Johansen, S. (1995), pp. 45 - 49.

where A depends on initial values ($\beta' A = 0$), and $C = \beta_\perp (\alpha_\perp ' \Gamma \beta_\perp)^{-1} \alpha_\perp '$ with $\Gamma = I - \sum_{i=1}^{k-1} \Gamma_i$. (4.2) shows clearly that the model can be decomposed into two parts, the non-stationary common trends $\alpha_\perp ' \sum_{i=1}^{t} \varepsilon_i$ and the stationary part of $C*(L)\varepsilon_t$.

It is therefore obvious that by a rotation of the system we can find $n-r$ (with r denoting the number of cointegration relations) shocks which shift the process permanently, and r transitory shocks, the influence of which causes merely a temporary shift of the process. The persistent shocks are found by the common trends, whereas the transitory shocks have to satisfy an orthogonality condition towards the C-matrix, such that the random walk component of (4.2) disappears. The idea behind KPSW is that it is possible to identify the system partially: Either the transitory or the persistent shocks can be identified, or both.[18]

The number of identification restrictions that have to be imposed can thus be reduced significantly. If only the shocks with permanent effects are of interest, then $(n-r)(n-r-1)/2$ identification restrictions are needed, compared to the normal $n(n-1)/2$ restrictions. In particular, where there are $r = n-1$ cointegration relations, no additional identification restrictions have to be imposed. Should the shocks of interest be the transitory ones, then $r(r-1)/2$ restrictions are sufficient. Even if one is interested in tracing the effects of all shocks, the number of identification restrictions is smaller than in the standard methods. In this case, the KPSW procedure reduces the restrictions needed by $rn - r^2$.[19]

5   Empirical Results[20]
5.1   The Empirical Models

The empirical analysis is performed for 13 member states of the European Union. Greece could not be included because no appropriate interest rate series are available. For the case of Luxembourg a separate analysis was not performed, given that no asymmetry problems have arisen from the monetary union with Belgium.

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[18] In this respect KPSW are in line with Blanchard and Quah (1989). They explain fluctuations in GNP and unemployment by two disturbances, one with persistent and one with transitory effects, but without referring to cointegration properties. For the analytical derivation of the KPSW procedure see their original article or Warne, A. (1993).

[19] $rn - r^2 > 0$, since the existence of cointegration relations and common trends it is assumed, i.e. $0 < r < n$.

[20] The estimation of the model, the diagnostic tests and the test for cointegration relations were performed with PcFIML9.0, the estimation of SVAR and the impulse response functions were performed on RATS4.2, with the econometrics code based heavily on code by Anders Warne and Henrik Hansen.

The models consist of 5 variables, 4 of which are common to all countries. A short-term interest rate (with the exception of Portugal and Finland all three month interest rates) serves as instrument variable. The reason for this choice is that the main tools the respective CBs use for implementing their monetary policy consist in the interest rates at which they make liquidity available and other measures that relatively directly influence short-term interest rates. Real industrial production and inflation (measured by consumer prices in all countries but the UK, where RPIX-inflation is used instead) are the goal variables. The fourth variable in each model, an exchange rate (except for Austria, where the exchange rate against the DM is basically a flat line), is chosen according to the CB orientation (e.g. for Germany the DM/$ rate, for France the Franc/DM rate, etc.). The fifth, an information variable, differs from country to country and is chosen to fit the respective CB's behaviour.[21] All data are quarterly and (if available) not seasonally adjusted. To correct for seasonality, a set of centred dummies is included in each model. All series are in natural logarithms (with inflation as $\Delta^4 \ln(CPI)$), except for the interest rates.

Mis-specification tests reveal structural breaks around 1984 for nearly all countries, coinciding with the emergence of the "hard" EMS. To ensure that models are stable and well-specified, the sample is thus restricted to 1984 to 1997 for most countries.[22] This very small sample seems to be the price to pay for economic meaningfulness. With the chosen sample size it is ensured that only one monetary regime is modelled, whereas by including data points before 1984, the picture would be distorted.[23]

The lag length was found according to the LSE general-to-specific modelling strategy. It turns out that for all models a lag length of two is sufficient.

Common to all models is the interpretation of the cointegration relations. Each SVAR is a model of monetary policy, covering the systematic relations at work. Therefore, it has to be expected that one of the relations found in the model is a CB reaction function or policy rule. Hence one cointegration relation of each

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[21] For detailed descriptions of each country's model see appendix. It turns out that a commodity price index, stated in US$, is often a helpful information variable. Since they are determined in auction markets, commodity prices react much faster to news about future inflation than industrial or consumer prices. Econometric evidence finds strong evidence for commodity prices as good leading indicators of inflation (see Boughton, J.M., Branson, W.H. (1991)). Because the bulk of commodity trading is denominated in US$, a conversion to other currencies would distort the price signals due to exchange rate movements.

[22] This sample size is in line with the one used by Juselius, K. (1996 and 1997).

[23] However, for the UK this is not the case (see Artis and Lewis (1991)), because the sample includes periods of money targeting (abolished in 1986), exchange rate targeting (first informal, then explicit with ERM membership) and inflation targeting. Given that there is no way around the inclusion of more than one monetary regime to achieve a reasonable sample size, the estimation results have to be interpreted with caution.

model is interpreted as a CB reaction function, shocks to which are the monetary policy shocks under investigation.

Monetary policy shocks in the framework of these models are thus expected to be transitory.[24] Therefore the shocks to be identified are the transitory ones. Since two to three cointegration vectors are found for all the models, the number of transitory shocks is also either two or three. The number of identification restrictions, $r(r-1)/2$, turns out to be one or three. With two transitory shocks, one of these is interpreted as a demand shock. It is not restricted, i.e. it is allowed to affect all variables immediately. The second transitory shock is found to be the monetary policy shock. It is identified by a contemporaneous zero-restriction on output, which corresponds to an assumption that monetary policy cannot affect industrial production within one quarter.

5.2   Impulse Responses for Each Country

The impulse response functions for all thirteen countries are given in figures 1 to 13. They are responses to a 1σ (negative, i.e. expansionary) monetary policy shock and provided with $\pm 2\sigma$ error bounds.

The error bounds for most countries are relatively wide, with mostly insignificant impulse responses. This makes their interpretation harder, but not redundant. Especially the fact that all models find some sort of hump shaped output response and that the error bounds converge quickly for longer horizons restores the interpretability of the results. After all, this shows that monetary policy shocks do not have very large effects on the real economy - a conclusion which is furthermore supported by the low degree of price level stickiness found.

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[24] Neither GDP nor inflation are generally believed to be affected permanently by nominal shocks (and the same holds true for the information variables added for each country). Underlying is the implicit assumption that prices adjust to changes in the money stock. If the money stock doubled, then prices would adjust and eventually end up being doubled. Then the monetary injection would be digested, and *ceteris paribus* inflation would go down to the pre-shock level again. Any effects on real variables can also only take place in the interim period.
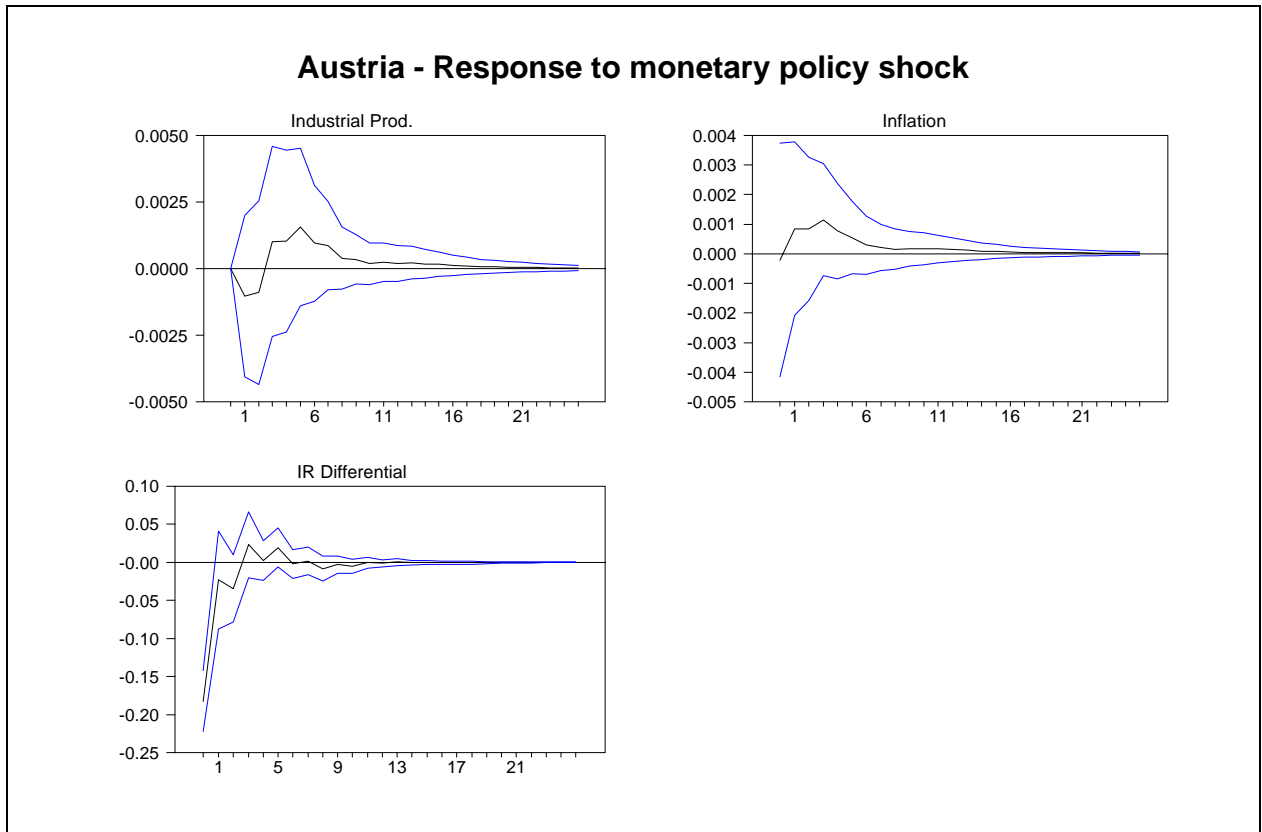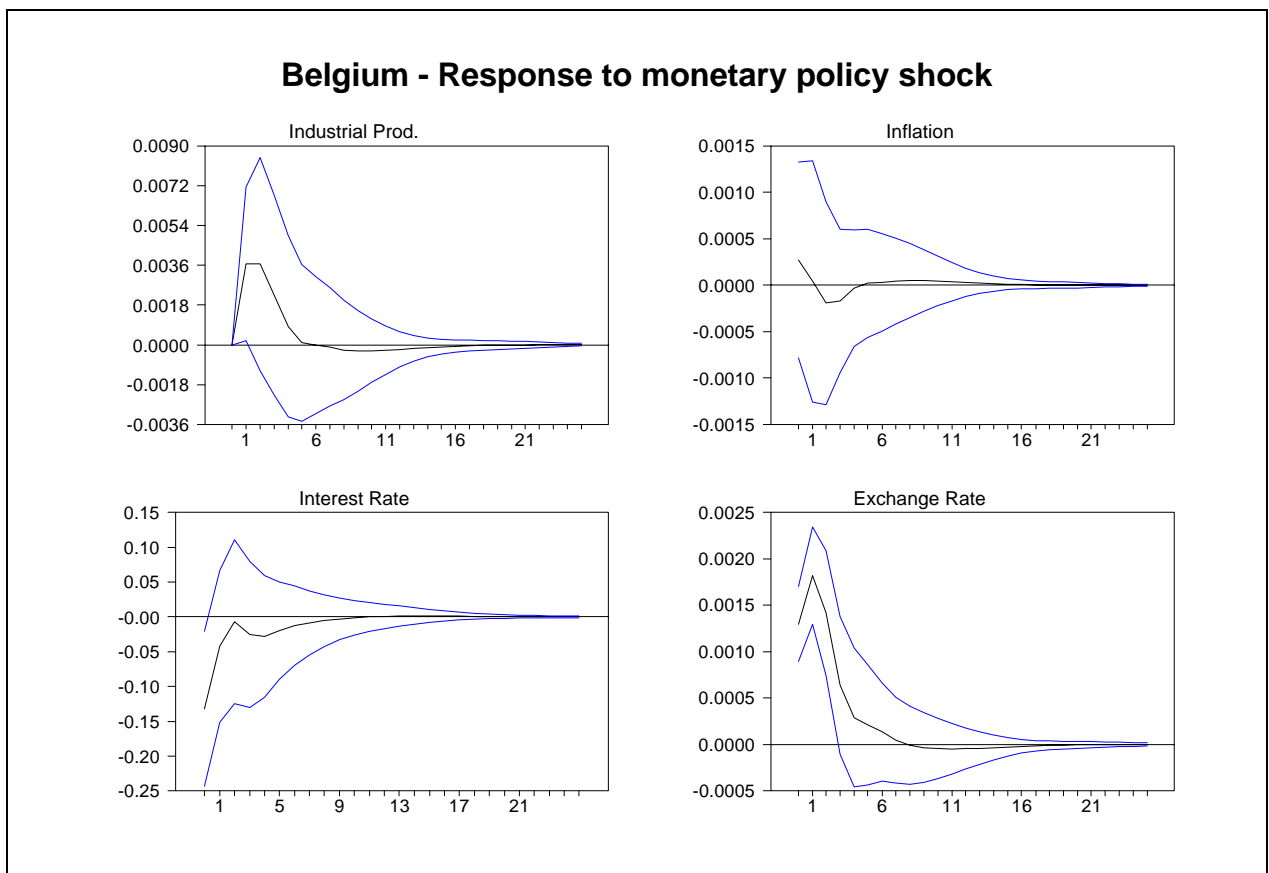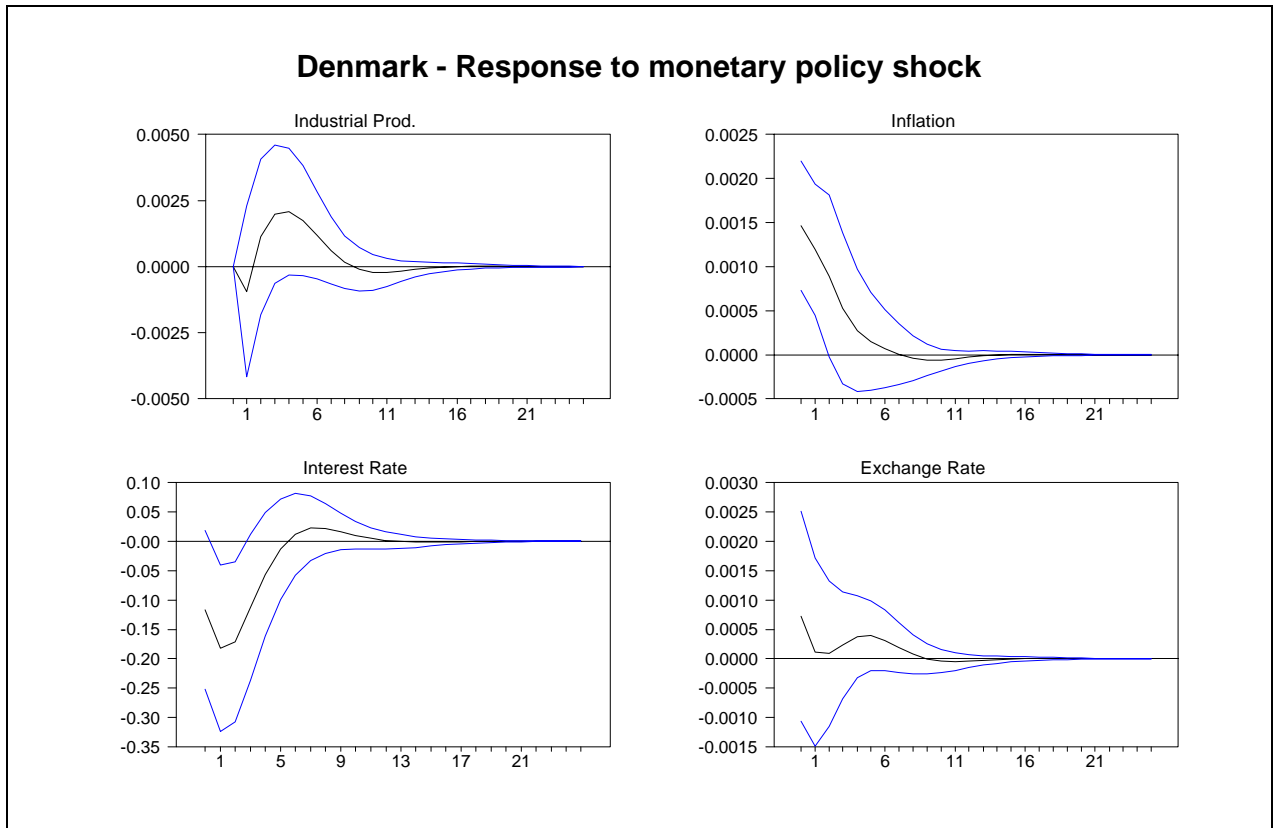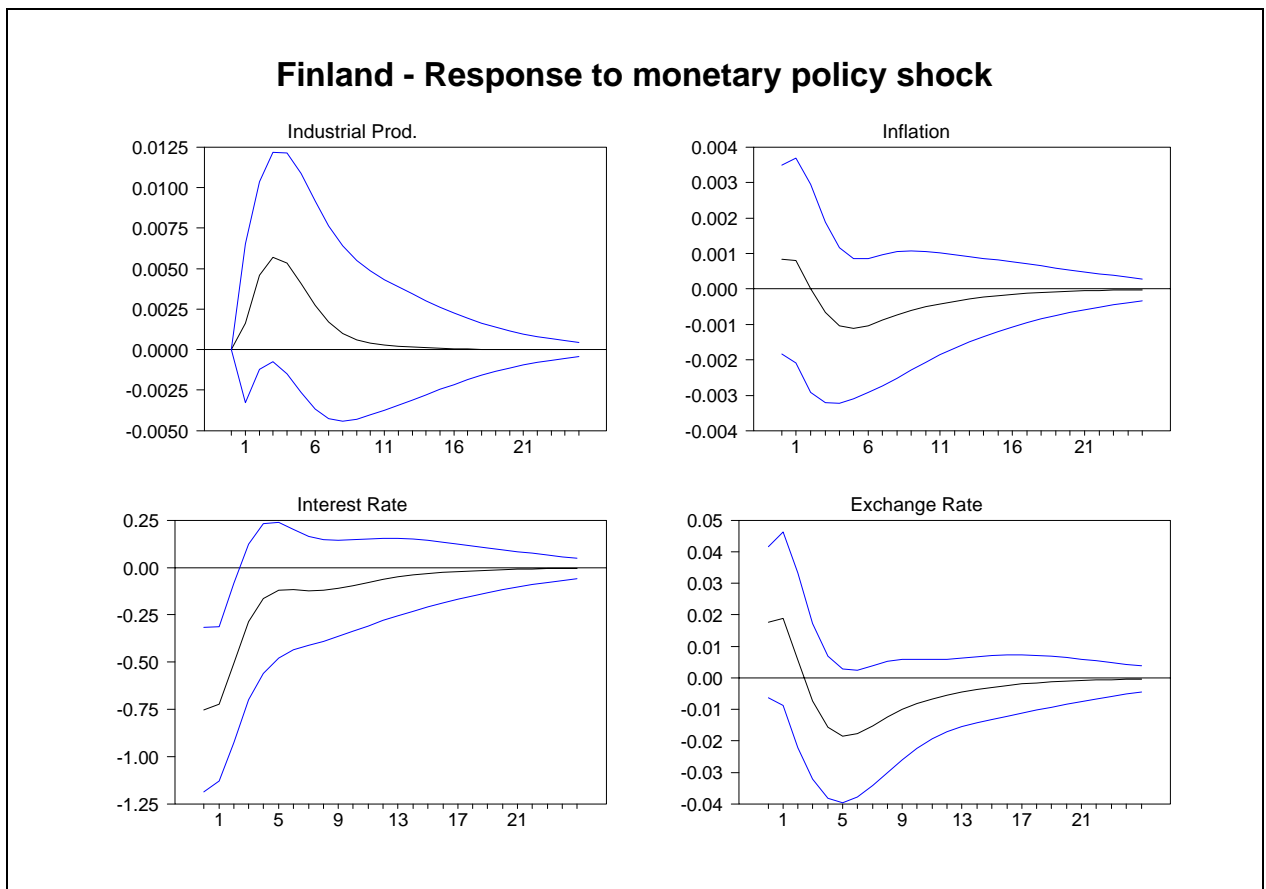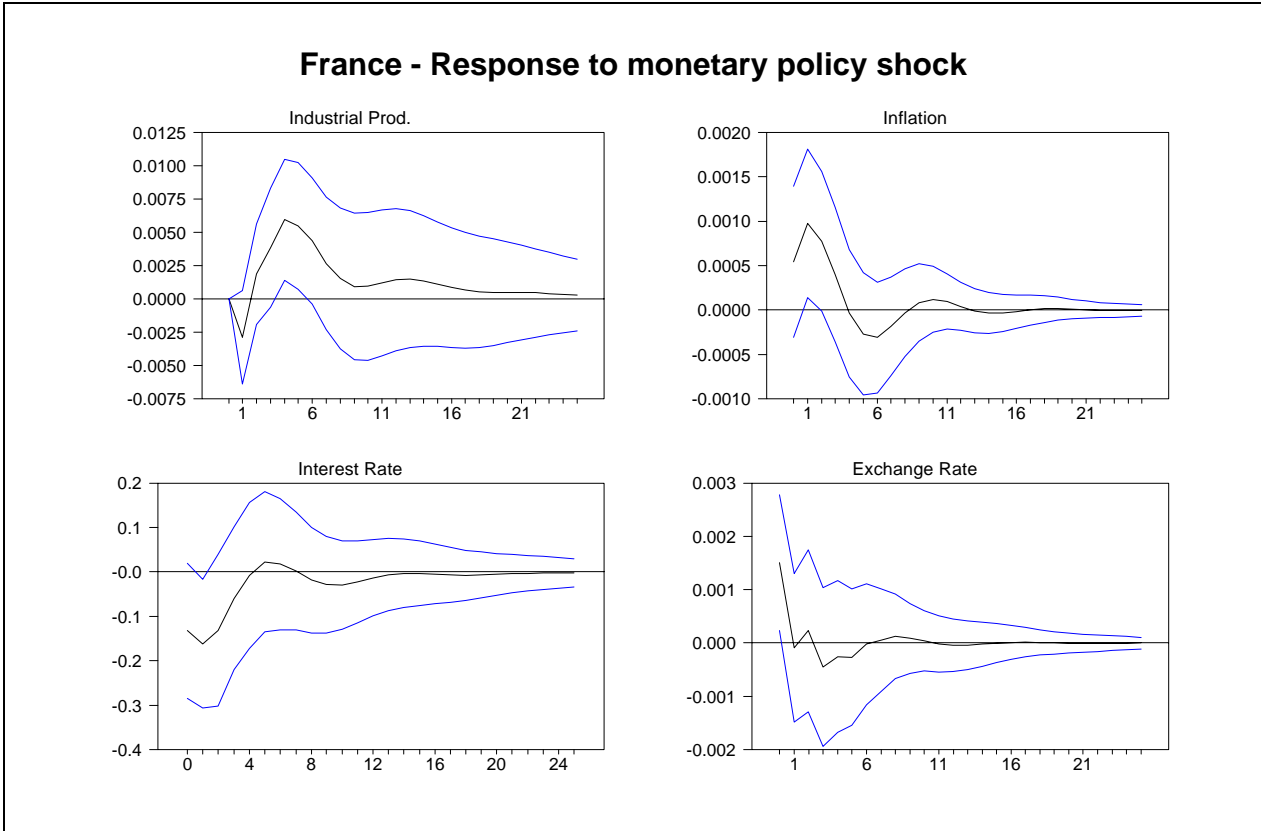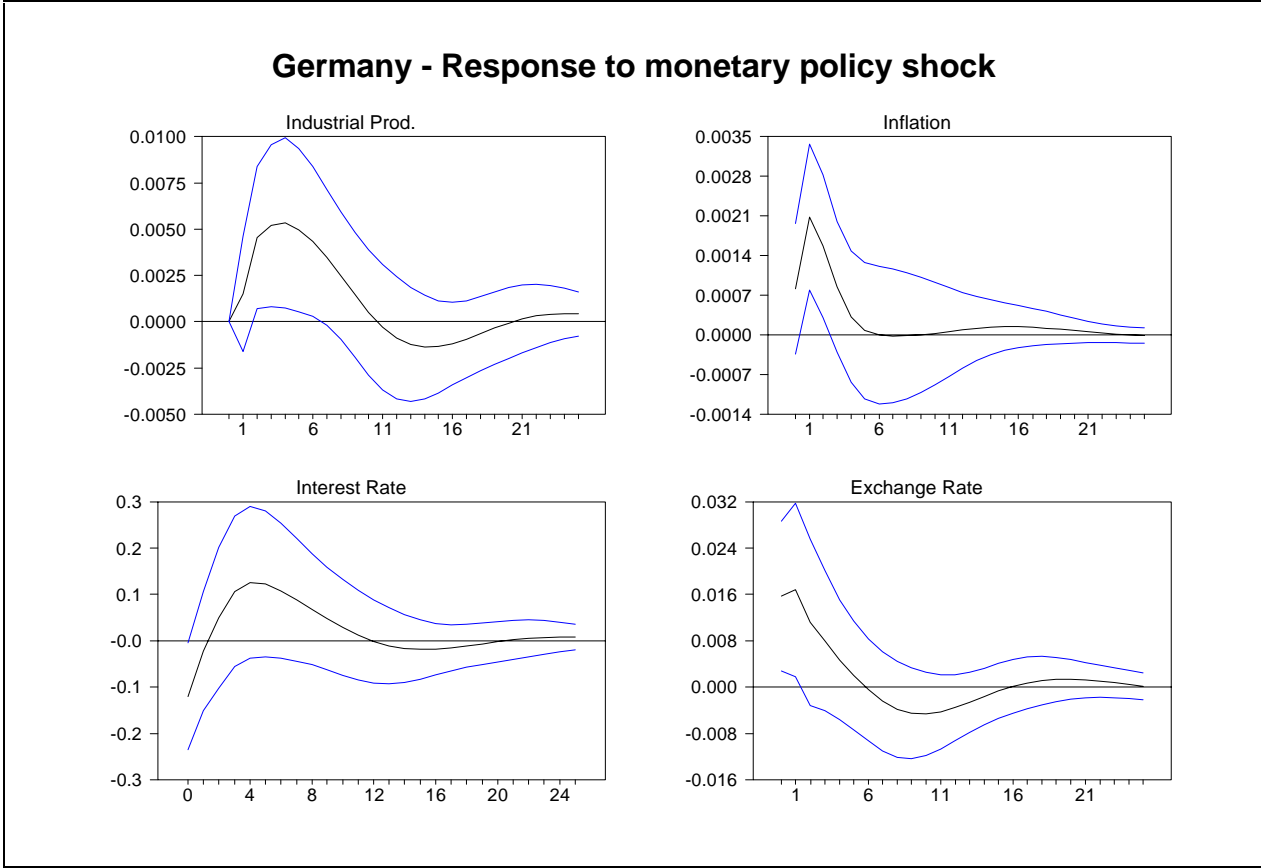
Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6
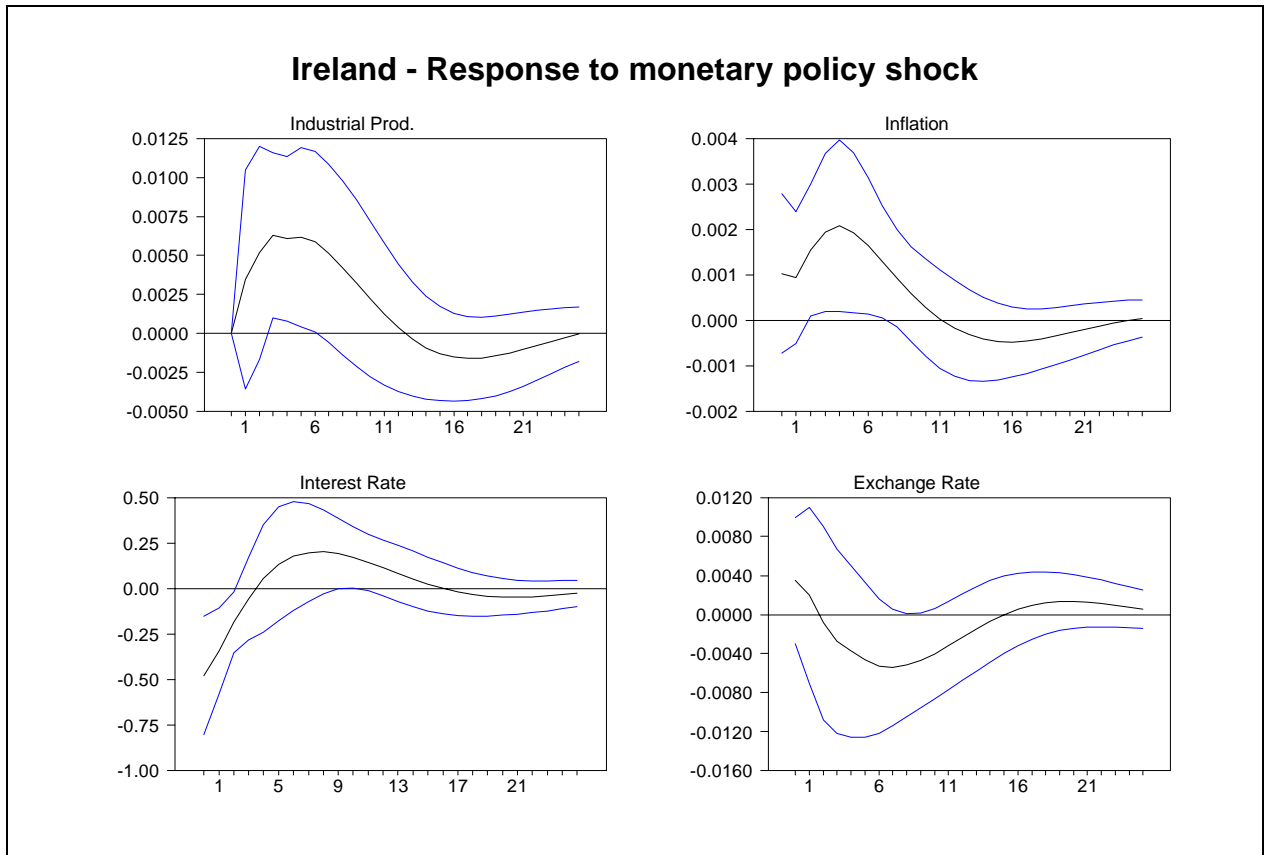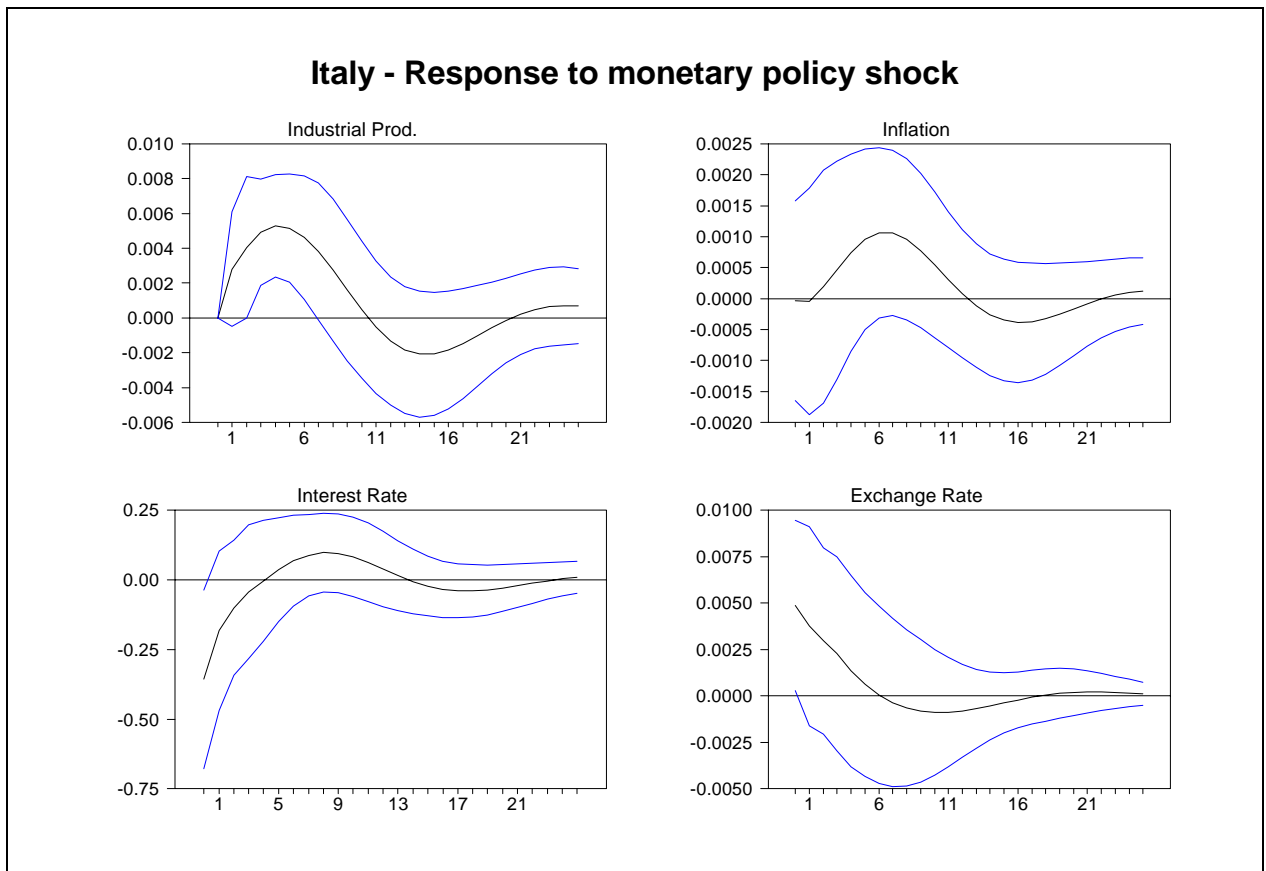
Figure 7

Figure 8

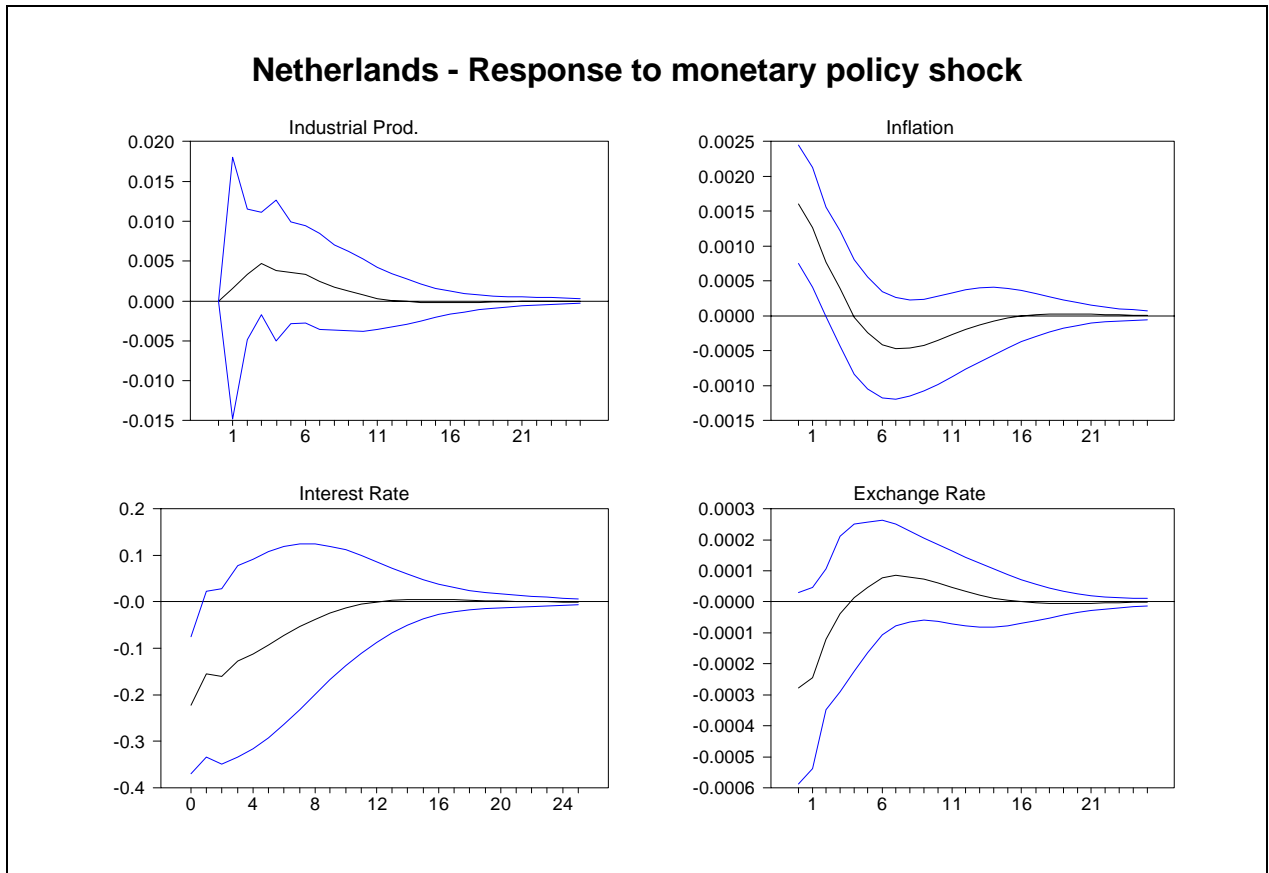**Netherlands - Response to monetary policy shock**
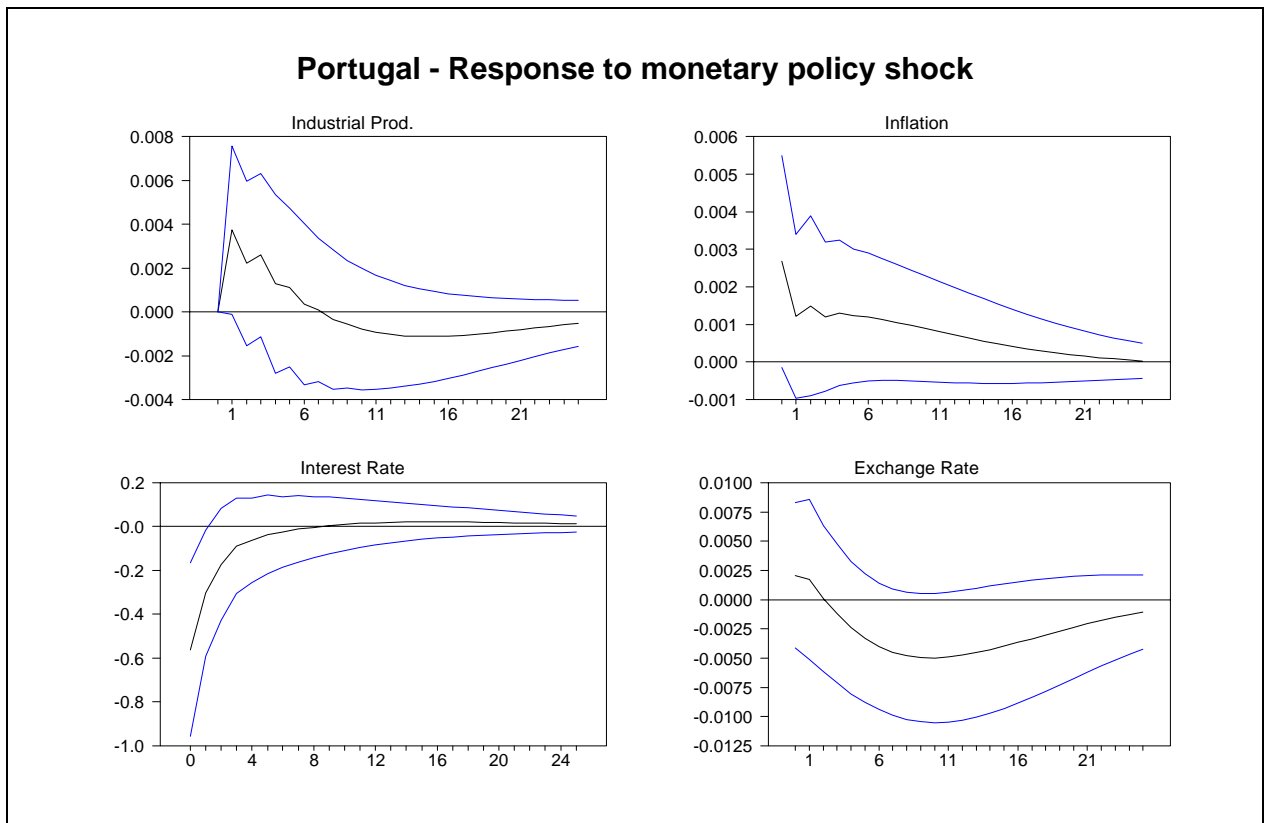
Figure 9

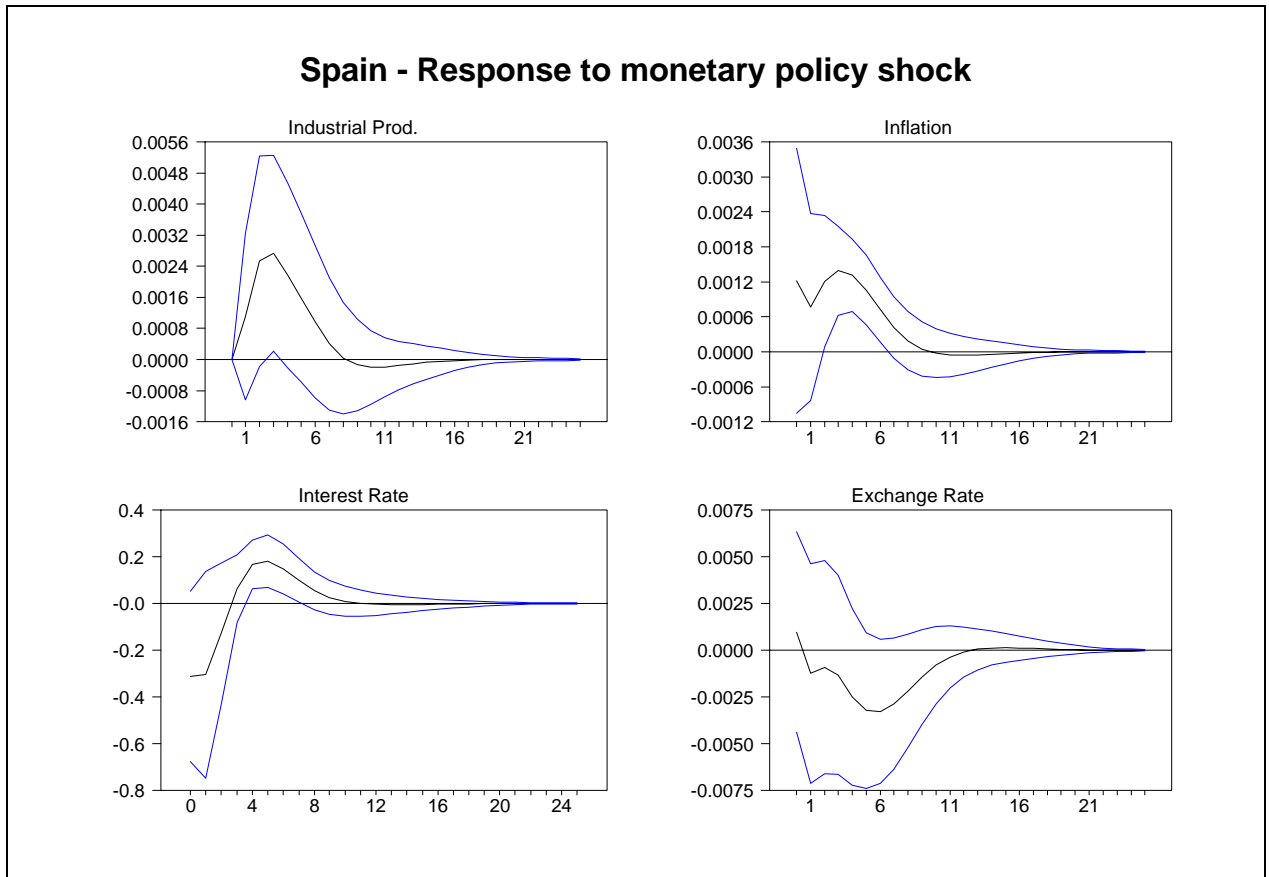**Portugal - Response to monetary policy shock**
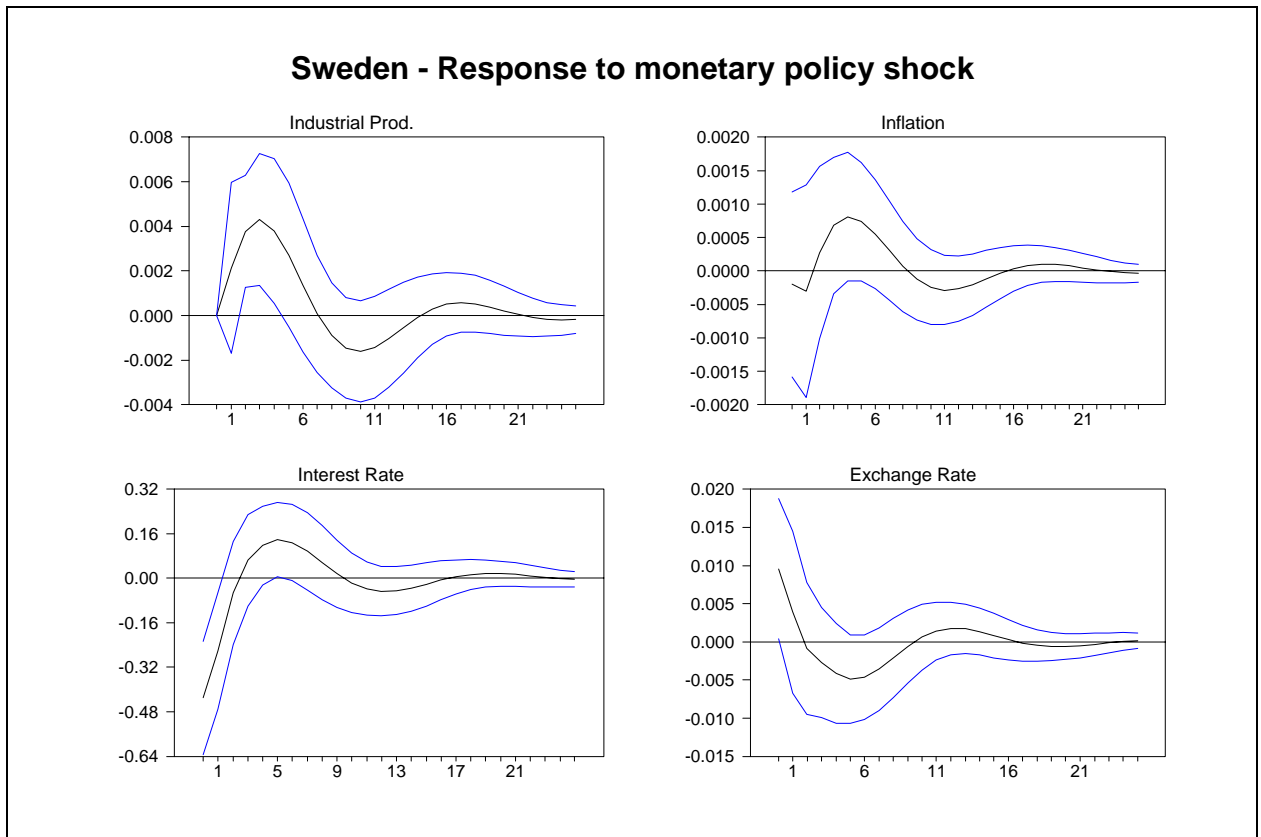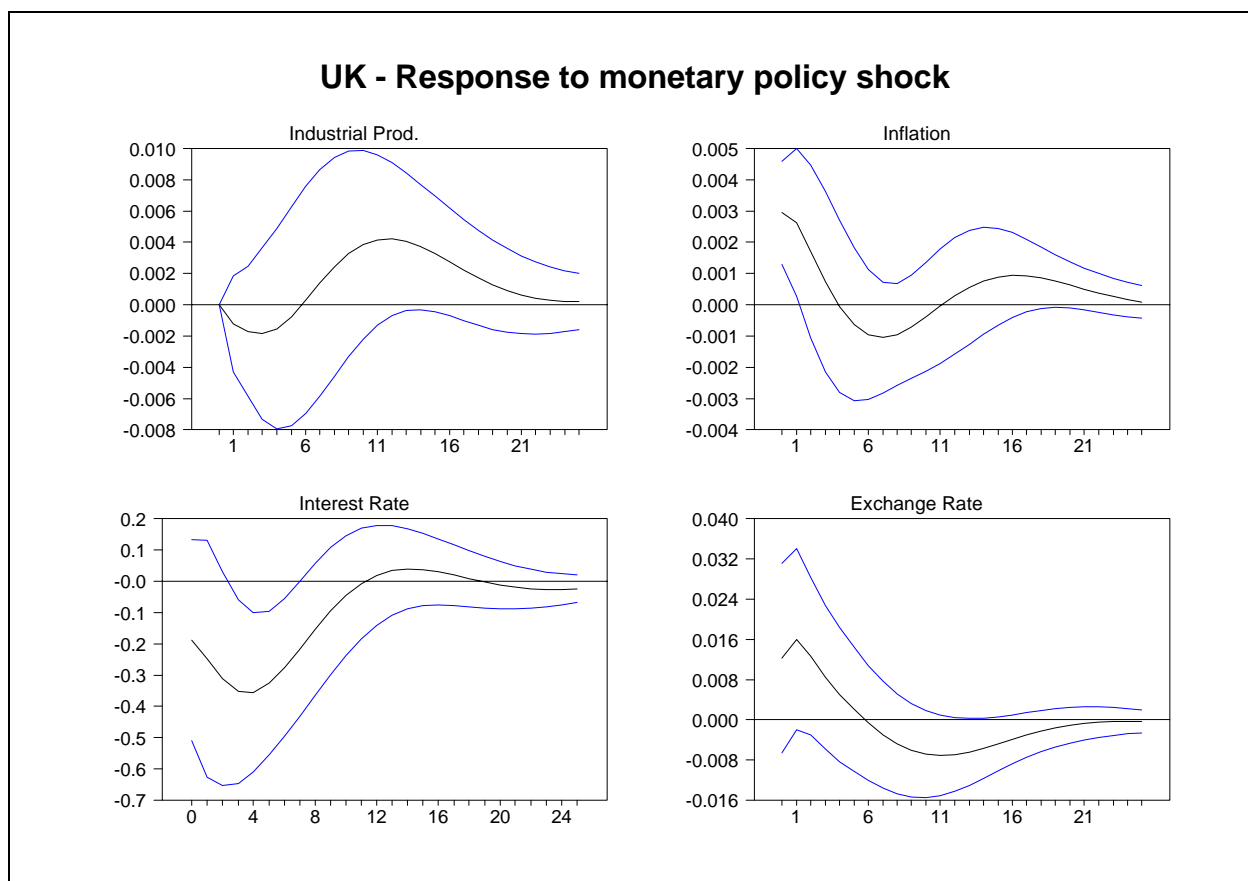
Figure 10

Figure 11

Figure 12

Figure 13

Austria

The Austrian CB maintained a credible peg of the Schilling to the DM. The exchange rate is therefore basically flat, and thus without informational content for the econometric model. It was therefore discarded to maintain degrees of freedom. As a consequence of the peg, Austrian interest rates followed those of Germany very closely. Obviously, the short-term interest rate cannot be regarded as a policy instrument. It is hence redefined as the interest rate differential with respect to Germany, and the German short-term interest rate included as information variable. However, the magnitude and number of independent and unsystematic Austrian monetary policy actions is so limited that the small effects found are furthermore subject to very wide standard error bounds. After all, this result is not surprising. Having given up the independence of monetary policy, no major influences on real variables can be expected. A similar pattern is found for the Netherlands, too, but to a lesser extent.

Belgium

Belgium delivers surprising results. Monetary policy shocks have a significant impact on industrial production, the magnitude of which is relatively large. That no significant impact on inflation is found might have to do with the widespread use of indexation over parts of the sample period. Also in the case of

Belgium, the German short-term interest rate is a natural candidate for the fifth variable in the model. Interest rate differentials with Germany have been small, especially before the widening of the ERM-exchange rate bands.

Denmark

For Denmark as a small open economy it is obvious that the CB has to watch external developments very closely. Danish interest rates are strongly influenced by international factors, which is why the long-term interest rate performs very well as information variable for the Danish monetary policy framework. Given that Denmark's monetary policy in the 1980s was mainly concerned with the fiscal and external position, it did not focus as strongly on the exchange rate against the DM as, say, the Netherlands or Austria did. The hump-shaped response of output to monetary policy shocks is therefore stronger.

Finland

The Finnish CB's concern about the recession of 1990-94 is mirrored in the impulse responses. In the first quarter of 1990, Finland's worst post-war recession initiated, leading to a fall in GDP by 15%, and driving unemployment up from 3.5 to 19%. The recession furthermore was very long-lasting, finding an end only four years later, in 1994:I. Accordingly, monetary policy shocks hardly influence inflation, whereas the influence on output is very close to being significant. This recession can also explain why the interest rate trajectory follows such a smooth path in Finland. Being concerned about the economic performance, the interest rate changes by the CB turned out to be much more persistent than in other countries.

France

Of interest in the model for France is the fact that there is no "price puzzle". Most studies of France (with the exception of Smets (1997)) have been unable to get rid of this perverse reaction of French prices to monetary policy shocks.[25] The persistence of the price puzzle in France seems to be caused by the choice of the output variable. All studies with GDP as output variable encounter the problem, contrary to Smets and the present study where industrial production data are used. Preliminary versions of this paper with GDP as the output variable always found puzzling evidence, no matter what variables were included into the SVARs. As soon as industrial production was used instead, the impulse responses looked much more reasonable. It happens to be that French GDP is published on a seasonally adjusted basis only, hence the points made in paragraph 5.3 directly apply. Either the data measurement process or the seasonal

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[25] See Sims, C.A.(1992), Gerlach, S., Smets, F. (1995), Levy, J., Halikias, I. (1997).

adjustment make French GDP data inappropriate for impulse response analyses in a monetary policy framework.

Germany

For Germany the responses to a monetary policy shock are relatively strong, and subject to narrower error bounds, indicating that such shocks are relatively effective in comparison with the other countries under study. Even though the DM was a member of the ERM and no capital controls were in place in the sample period, the Bundesbank was able to pursue a relatively independent policy. This is due to the size of Germany and the role of the DM as anchor currency in the ERM. The latter gave the Bundesbank one more degree of freedom. It concentrated on fewer goals, thus being more effective in each area. With the Bundesbank's major concern being inflation, a fifth variable in the model is preferably one that can give indications of inflationary pressure, like for example a commodity price index. The exchange rate in the model is the DM/$ rate, given that the sample includes both the Plaza and Louvre accords.

Ireland

In the sample period, Ireland was a member of the ERM, which meant that the CB of Ireland had to focus on the exchange rate against the DM. At the same time, it looked closely at the exchange rate against the Pound Sterling, because the UK is still the main trading partner for Ireland (albeit with decreasing importance).[26] Because the UK was for most of the sample period not a member of the ERM itself, stable exchange rates within the ERM did not automatically stabilise the exchange rate against Sterling. Accordingly, the CB of Ireland did not have many degrees of freedom to pursue independent policy goals other than exchange rate stabilisation. As a consequence, the magnitude of both the output and inflation responses is very small.

Italy

The output effects of monetary policy shocks in Italy at first sight seem surprisingly significant, given that the Bank of Italy very often had to focus its attention on maintaining a stable exchange rate to the DM. This can be explained with the capital controls that were in place up to 1990, i.e. for half of the sample period, and with Italy's wider exchange rate bands of ±6% in the ERM. Inflation responses are insignificant, possibly due to indexation practices over parts of the sample. Another feature of the Italian impulse responses that will be seen in the direct comparison of magnitudes between all countries is that the effects are

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[26] That the Irish Punt is still strongly influenced by the Pound Sterling, even though it is a member of the ERM, could be seen in 1996/97. When the Pound Sterling appreciated against the ERM currencies, the Irish Punt followed suit, thus appreciating itself against ERM currencies.

relatively small. This finding, however, is not very surprising. Italy's huge public debt is mainly held within the country. An interest rate change will therefore at the same time affect private income via interest payments on public debt. Interest rate decreases lower the interest income of economic agents, which counteracts and partly offsets the monetary policy effects.

Netherlands

Given the peg of the Guilder to the DM, the German short-term interest rate is an obvious candidate for the information variable, like in the case of Austria. Dutch monetary policy was mainly determined by the Bundesbank, such that monetary policy shocks do not exert any significant effects on output. The findings for the exchange rate resemble an exchange rate puzzle, but can be neglected, firstly because the reaction is not significant, and secondly because the magnitudes involved are tiny, comparable in size only to those of Austria.

Portugal

The model for Portugal shows significant responses to monetary policy shocks. Up to 1992, capital controls enabled the Portuguese CB to exert some influence over the economy. Overall, monetary policy impulses are transmitted quickly and efficiently. The price responses are basically immediate, with the bulk in the first quarter. Also the output reaction is very quick: the peak is reached in the second quarter after the monetary policy impulse.

Spain

Spain is an outstanding country in this study with respect to the fifth, information, variable in the SVAR. The focus of the CB on ALP, a money aggregate which measures active liquidity in the private sector seems to be so strong that the estimation results improve markedly if ALP is included as information variable. Therefore Spain represents the only country in this study where the inclusion of a money aggregate is necessary to describe the settings of monetary policy. The pattern of the resulting transmission mechanism is as expected, with no particular idiosyncratic characteristics.

Sweden

A mixed picture results for Sweden. Whereas the interest rates are amongst the fastest in Europe to return to baseline, Sweden falls into the slow group with respect to the inflation response. Regarding output, Sweden is again a fast transmitter. Compared to Finland, several similarities occur. But there, too, the evidence is not clear: in terms of persistence of the output trajectory, Sweden and Finland are very diverse.

United Kingdom

The impulse responses for the UK deliver surprising results because they do not show a quick reaction of output to monetary policy measures. Economic agents in the UK are very vulnerable to interest rate changes because mortgages outstanding are much higher than in the other countries and furthermore mainly issued with variable interest rates. Interest rate increases immediately lower agents' income because of higher interest payments to make. This income effect should magnify the direct monetary policy effect, and thus lead to a strong and immediate reaction of output. The impulse responses here confirm a strong reaction, but do not find it to be immediate. This finding (which is also reported by Barran *et al.* (1996, p. 12)) can be explained firstly, as has been mentioned earlier, because several monetary policy regimes are covered by the sample period, thus giving a distorted picture. Secondly, industrial production might not be the sector of the economy that is affected most if agents have to reconsider their spending decision.

One word concerning the inflation measure: for the UK, the price basis on which inflation is defined is not the consumer prices, but RPIX, retail prices on all items excluding mortgage interest. Otherwise, the inflation response to an interest rate shock could have been distorted: consumer prices in the UK include mortgage interest payments. As said above, these play a major role and thus increase inflation measures following an interest rate increase. A price puzzle would result. The Bank of England itself has declared RPIX as the relevant price measure which it targets; hence it makes sense to judge monetary policy according to this measure. The impulse responses show that by choosing RPIX-inflation it was possible to avoid a price puzzle.

5.3   Extension to GDP Responses

In order to investigate to what extent the results of section 5.2 can carry over if industrial production is replaced by GDP, the model for Germany is re-estimated. German GDP is available on an original, not seasonally adjusted basis, which can be taken as an indication that the data can be used meaningfully in a quarterly impulse response analysis, without suffering from the problems of section 4.3. Industrial production is more capital-intensive than, say, services are and thus GDP is. Therefore it can be expected to be more interest rate elastic than GDP. Additionally, the share of tradables in industrial production is higher than in GDP. As a consequence, industrial production should show the stronger and quicker reactions to monetary policy shocks, due to a direct interest rate channel and an exchange rate channel.[27] This is indeed the case, as can be seen in figure 14.

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[27] This stylised fact is for example found for the UK by Ganley and Salmon (1997).
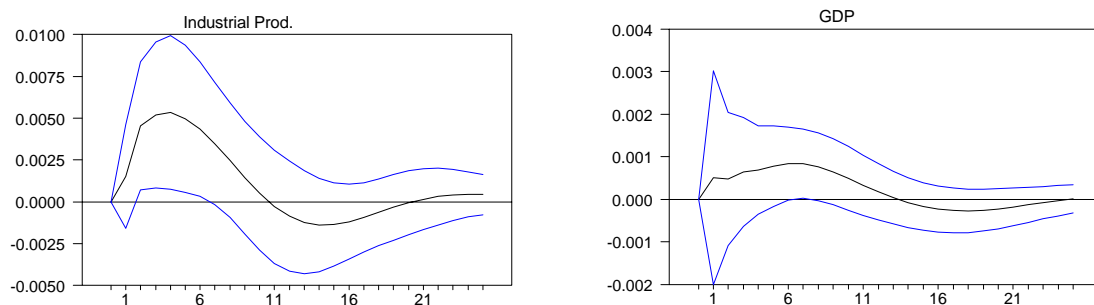
Figure 14: Responses of German industrial production vs. GDP to a monetary policy shock

5.4   European Comparison

In order to compare the transmission mechanism across countries it is important to standardise the size of the respective monetary policy shocks. In section 5.2 each shock was calculated with respect to its own standard deviation. Obviously, the size of the corresponding interest rate impulse differed greatly from country to country. For example, a shock in France and Germany amounted to a 12 basis point change in the interest rates, whereas in Finland the interest rate jumped by 75 basis points. In the following, the shocks will be standardised with respect to their magnitude, namely to a 10 basis point change.

A comparison also has to consider that in the original estimations the interest rate trajectories differ across countries, whereas in EMU all countries will face the same interest rate, and thus an identical trajectory. To allow for this, the following analysis is based on a standardised interest rate trajectory, namely the German one. This may sound critical, because national feedback mechanisms are restricted to be identical. However, the results are basically unchanged by this standardisation exercise.
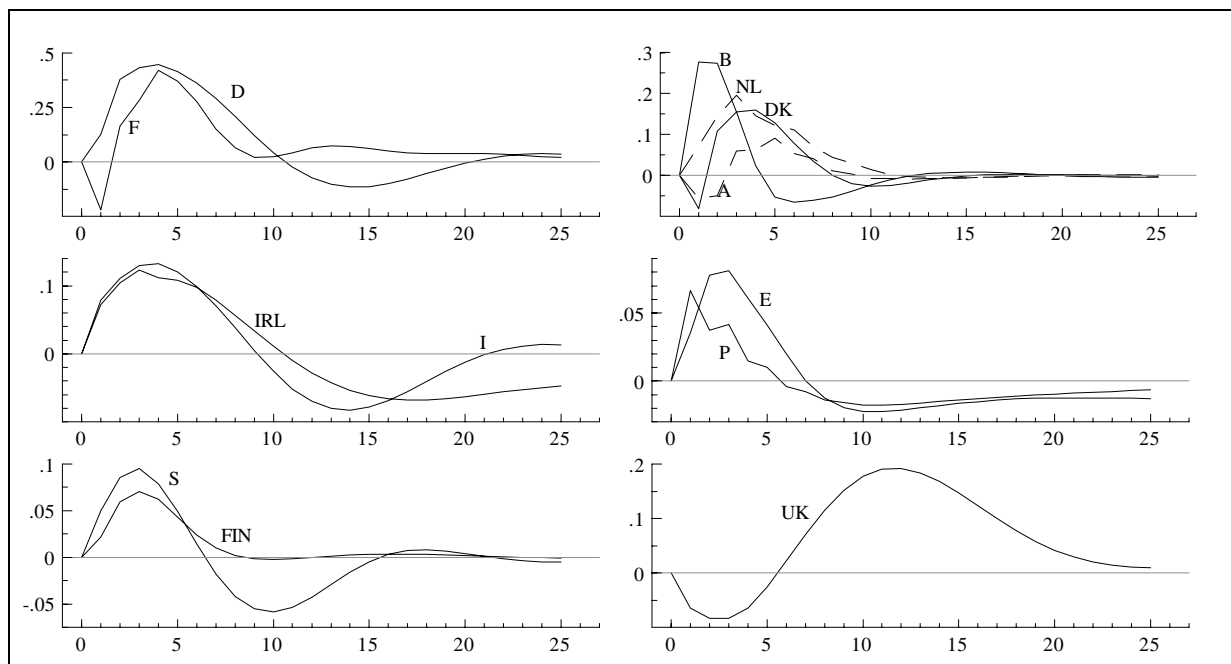
Figure 15: Output responses to a monetary policy shocks in 13 countries
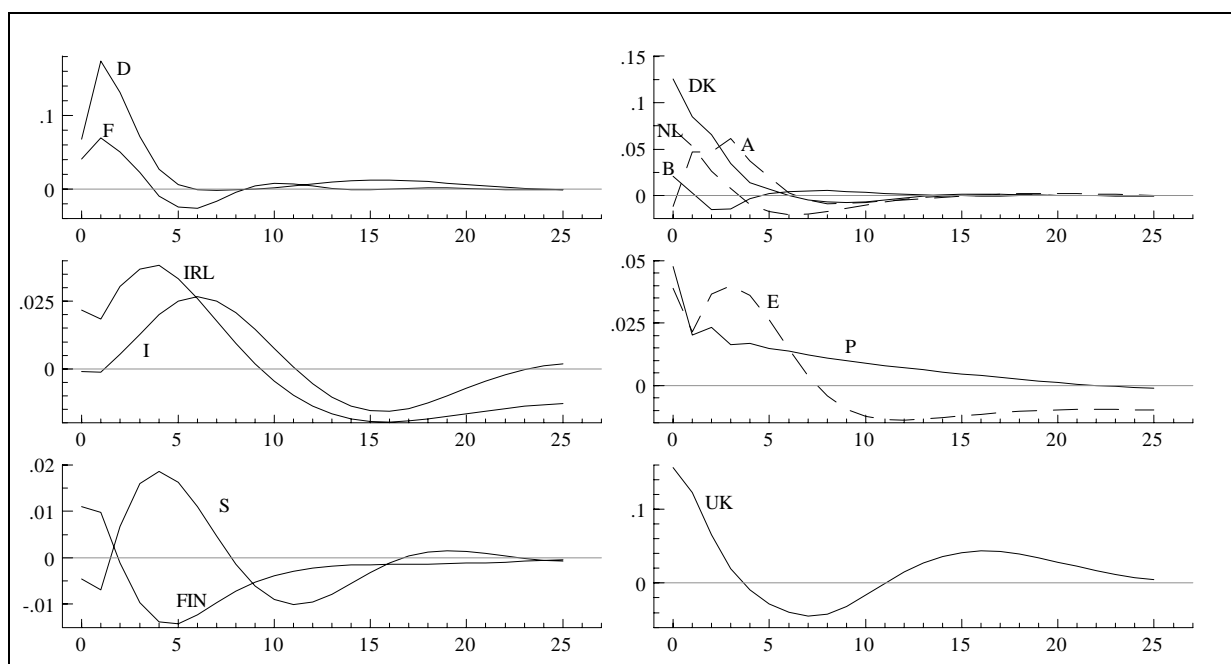
Figure 16: Inflation responses to a monetary policy shock in 13 countries

Figures 15 and 16 provide the outcome of the comparative analysis. The formation of the groups is firstly based on the magnitude of the output effects, to prevent responses from being scaled down to invisibility, and secondly on their similarity. The emerging picture comes very close to *a priori* beliefs: France and Germany show a similar pattern. The small neighbours Austria, Belgium, Denmark and the Netherlands form a group. So do Ireland and Italy, which very often are believed to be a bit more peripheral with respect to the core. The Southern European countries Portugal and Spain are very homogeneous, as are

the Scandinavian countries Finland and Sweden. The same groups do not always deliver homogeneous patterns for the inflation response, however.

For a closer look at the time pattern, two criteria can be considered. Firstly the time it takes the impulse to reach its maximum effect, and secondly how long it takes the impulse to die out. The pattern for the output response is provided in figure 17, which plots both criteria against each other. Most countries fall into one core group. Within this group, only Belgium and Portugal are relatively distant. The United Kingdom, however, clearly constitutes an outlier. The effects of monetary policy shocks intensify for much longer and die out later than in the other countries.

Time Pattern of Output Response
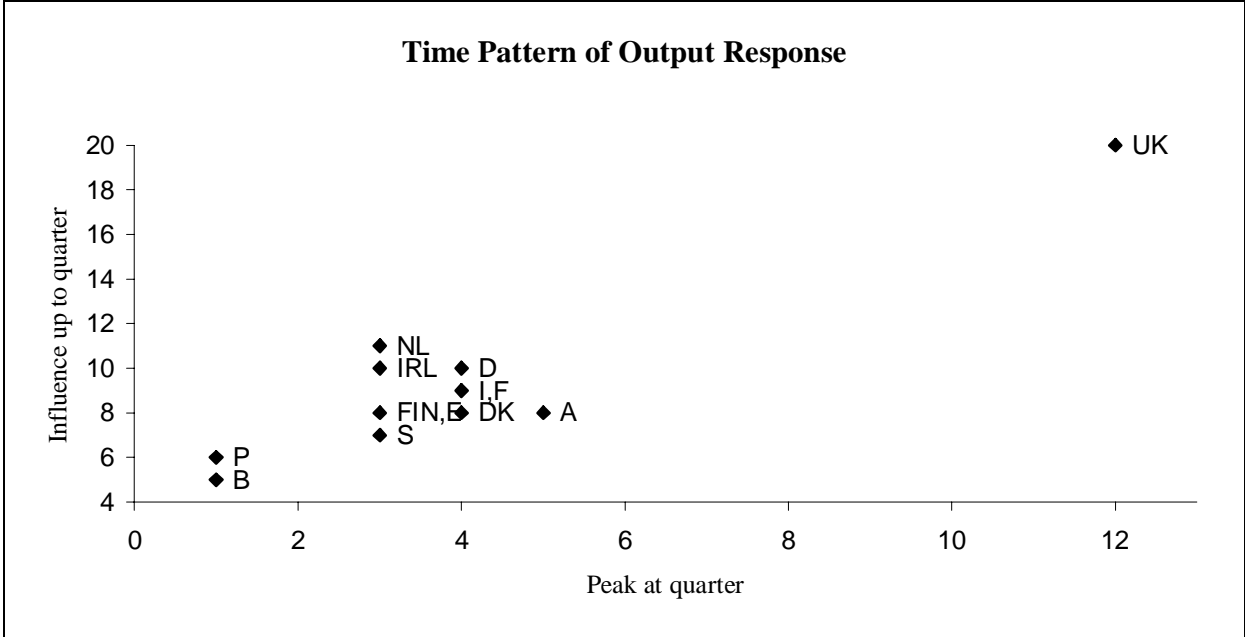
Figure 17

The picture with respect to the inflation response in figure 18 shows more heterogeneity. Germany, the Netherlands, Denmark, Belgium and France (which *a priori* beliefs would certainly put into the European core) are very homogeneous, whereas Austria is relatively distant.[28] Once again, the inflation responses do not confirm the *a priori* beliefs.

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[28] It has to be considered that the model for Austria might not be perfectly comparable with the others, since it is based on the interest rate differential as policy instrument.

Time Pattern of Inflation Response

Figure 18

Another important criterion for a comparison is the magnitude of responses to a monetary policy shock. We look at the size of the peak rather than of the sum of all responses over time, because the range of uncertainty is lower for the maximum response (which is usually significant) than if all other (mostly in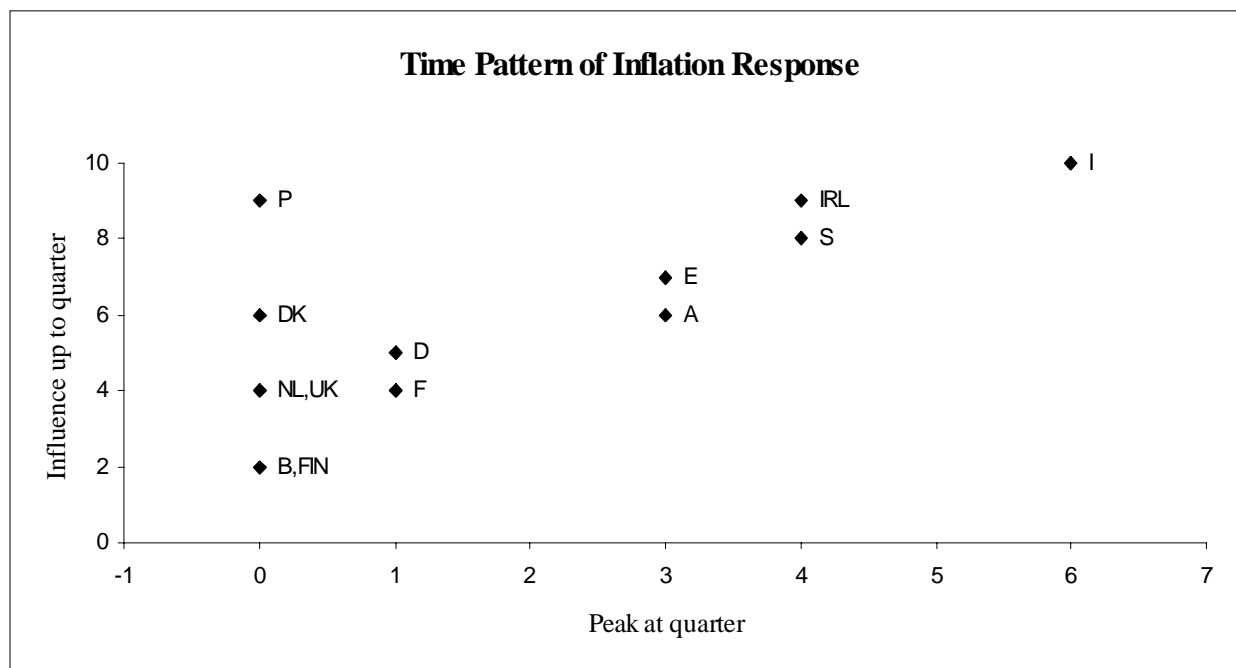significant) responses were added. However, the results are not altered if all reactions are added up. Both the output and the inflation response are plotted against each other in figure 19. Germany appears as the country with the strongest responses.[29] The pattern emerging here points *inter alia* to the size of an economy, given that France and the UK show relatively large responses. Even though other factors have to be accounted for, the intensity of responses seems to be positively linked to the size of the country.

The differences in magnitude are huge, with German monetary policy shocks yielding more than five times as strong effects than the country with the weakest responses.[30] This indicates that major asymmetries could be brought about by EMU, since the same interest rate change by the ECB would lead to vastly different effects across the single economies.

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[29] These results are basically in line with Sims, C.A. (1992) and Smets, F. (1995). Sims finds the German response stronger than the French and British, with the latter being approximately of the same size. Smets finds stronger reactions in Germany, France, Italy and the UK than in the Netherlands and Belgium, and the weakest responses in Austria.

[30] These results are in line with Barran *et al.* (1996), but directly oppose the findings of Dornbusch *et al.* (1998), who find Germany as example of a country with weak reactions (p.48).
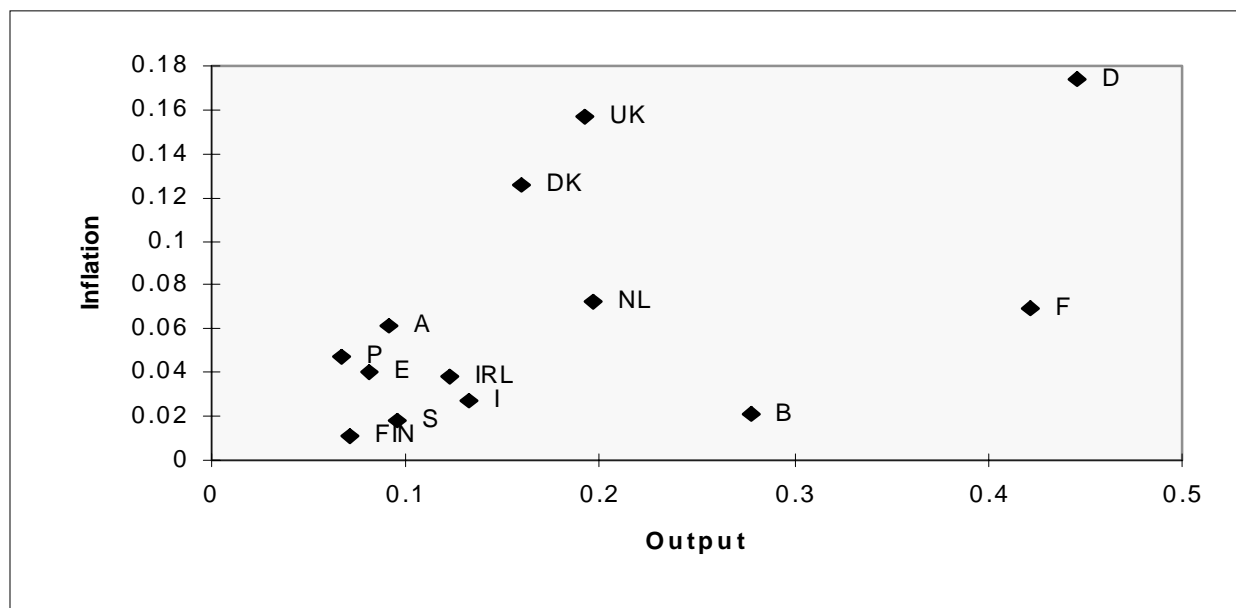
Figure 19: Responses to a monetary policy shock, in %

However, it can be argued that fast convergence with respect to the magnitude of responses will occur. For most countries and over most of the sample period, the setting of monetary policy was determined by a regime of fixed exchange rates within Europe and free capital flows. In such a case, a small country is not able to set interest rates at a different level than interest rate parity allows. Only a large enough economy, like possibly Germany, can influence European interest rates to a certain extent, such that national monetary policy can be effective. With the start of EMU, all countries will create an economic area which will "speak with one voice" with respect to monetary policy and hence can exert some influence on world interest rates; this will make the situation of EMU comparable to the one of Germany in the past years, if EMU will not end up in an even stronger position than Germany.[31] Additionally, the ECB can abandon the focus on keeping intra-European exchange rates stable, thus gaining one degree of freedom. This again makes EMU look similar to Germany, because also the Bundesbank did not have to focus closely on the exchange rate. Considering both effects, we can expect convergence in the magnitude of monetary policy effects: small countries will react more strongly to policy shocks.

Three out of the 13 countries under study will not join EMU from the beginning: Denmark, Sweden and the UK. If the decision not to join was taken because of concerns that the economies might suffer from a centralised monetary policy, it can be stated that for Denmark and Sweden this would not be the case. Neither of the two appears as outlier in any of the comparisons, such that asymmetry will not be the outcome of entering EMU - at least not more asymmetry than for the other member states. The case of the UK is less obvious.

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[31] Obstfeld and Rogoff (1996, p. 689) find: "In general, the smaller the economy, the smaller the maximum output increase that an unexpected monetary expansion can achieve."

Regarding the output response, the UK clearly represents an outlier, with the British response being more pronounced than the average. Unless convergence would come with the participation in EMU itself, asymmetry could be generated by EMU. On the other side, it is only with respect to this single criterion that the UK is an outlier, whereas all other comparisons do not find it in an extraordinary position.

Interestingly, this finding is in line with research on a European business cycle. Artis and Zhang (1997) find that the UK business cycle is asymmetric with respect to most other European countries. It seems to be more closely related to the US than to the European cycles. The results of this paper allow for a different interpretation of this asymmetry: it may not come about because of a strong link of the UK with the US economy, but because UK output reacts differently to European shocks than other European countries.

6   Conclusion

This paper reconsidered the role of SVARs for studies of monetary transmission. By focusing on exogenous shocks to the policy variable the net effects on other variables in the system can be traced, but no assessment of the effectiveness of applied monetary policy rules can be made. Keeping these limitations in mind, SVARs can be fruitfully applied to detecting the intensity and timing of monetary policy effects on the variables under inspection.

Five concepts were pointed out that can help to improve the reliability and credibility of estimates. Solid inference can only be made on the basis of congruent, i.e. well-specified models. Secondly, reduction of the analysis to the error terms is a concept that has to be taken seriously. If outliers occur because of particular events in time, then these have to be dummied out. Thirdly, the data characteristics have to be taken into account. This refers to integratedness as well as to data frequency. For the purpose of impulse response analyses, it is not advisable to increase the data frequency over the one at which the data was originally measured. Furthermore, if comparative studies are performed, then allowing for heterogeneity of the countries is essential. Finally, the models should make use of cointegration properties if applicable. More information can be included in the SVARs by modelling cointegration, and identification restrictions arise naturally.

The estimation of models for 13 European economies yielded impulse responses that properly identified monetary policy shocks, without incurring puzzling evidence. The responses are on average very weak, and for most quarters hardly significant, indicating that monetary policy shocks do not have very strong effects (recall, however, that this does not meant that regular monetary policy is ineffective). They point out considerable differences in the transmission mechanism of monetary policy. Major heterogeneity was found in

the magnitude of responses, with small responses in small economies and larger ones in large countries. However, these results stem from a retrospective analysis and as such do not carry over directly to the situation in EMU. Firstly, several new arbitrage opportunities can be imagined, which lead to some degree of harmonisation. Secondly, it was argued that the differences in the magnitude of responses *inter alia* reflect the countries' influence on European interest rates. EMU will bring about changes in this respect, since the participating economies will "speak with one voice", thus gaining influence on world interest rates. Additionally, the focus on keeping intra-European exchange rates stable can be abandoned, giving European monetary policy an additional degree of freedom. EMU as a whole will therefore much more resemble Germany with respect to its monetary policy effectiveness. Monetary policy effects are expected to be stronger for the SOEs in Europe once EMU is set up, and much of the present heterogeneity disappears.

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Appendix
A1: Model Specification

Country	Variables	Sample Size
A	interest rate differential w.r.t. Germany[1], industrial production, CPI-inflation, German short-term interest rate	84:I - 97:II
B	3 month t-bill rate, industrial production, CPI-inflation, Franc/DM exchange rate, German short-term interest rate	84:III - 97:IV
DK	3 month interbank market rate, industrial production (sa), CPI inflation, Krone/DM exchange rate, long-term interest rate (10 year govt. bonds)	84:I - 97:III
FIN	call money rate, industrial production, CPI-inflation, Markka/US$ exchange rate	84:I - 97:IV
F	3 month money market rate, industrial production, CPI-inflation, French Franc/DM exchange rate, long-term interest rate on govt. bonds	85:III - 97:IV
D	3 month money market rate, industrial production (sa), CPI-inflation, DM/$ exchange rate, IMF commodity price index	79:III - 97:IV
IRL	3 month t-bill rate, industrial production, CPI-inflation, Punt/DM and Punt/Sterling exchange rates	84:I - 97:III
I	3 month t-bill rate, industrial production, CPI-inflation, LIT/DM exchange rate, IMF commodity price index	84:I - 97:IV[2]
NL	3 month interbank market rate, industrial production, CPI-inflation, Guilder/DM exchange rate, German short-term interest rate	84:I - 97:III
P	5 day money market rate, industrial production, CPI-inflation, Escudo/DM exchange rate, German short-term interest rate	84:I - 97:II
E	3 month money market rate, industrial production, CPI-inflation, Peseta/DM exchange rate, real ALP[3]	84:I - 97:IV
S	3 month t-bill rate, industrial production, CPI-inflation, Krona/US$ exchange rate, long-term interest rate (9 year govt. bonds)	84:I - 97:IV
UK	3 month t-bill rate, industrial production, RPIX-inflation, Sterling/US$ exchange rate, IMF commodity price index	76:III - 97:IV

1   calculated on the basis of a 3 month money market rate
2   Strictly speaking, this sample size covers more than one monetary policy regime. Like the UK, Italy left the ERM in 1992. However, unlike the UK, it maintained its focus on a stable exchange rate against the DM
3   ALP is a monetary measure of active liquidity in private hands. It is defined as a broader aggregate than M3. To construct real ALP, the natural logarithm of CPI was subtracted from the natural logarithm of ALP

A2: Dummies

Country	Dummies were included as follows:
A	For the inflation equation: Increase of VAT 1986:I, of indirect taxes in 1996 (in order to achieve the Maastricht criteria). For the industrial production equation: General economic downturn in 1992, outlier in 1995. For the interest rate equation: Tightening of the Austrian CB in 1986:I, which followed a period of massive capital outflows, CB interventions and reserve losses.
B	Exchange rate and interest rate equations: Exchange rate crisis in 1993. After a period of stable exchange rates and a low interest rate differential with Germany, the Belgian Franc came under downward pressure with the widening of the ERM-exchange rate bands to 15%. At the same time, short-term interest rates increased markedly. Industrial production: Output decline in 1987:I. The Belgium CB explained this with the efforts to trim the public deficit and therefore did not take any corrective steps. Inflation: In 1986:I, inflation fell drastically, a decline too high to be explained by the monetary policy framework alone. Indeed, lower fuel prices are mentioned by the Belgian CB as a reason for the marked improvement in the inflation performance. Linear trend, restricted to lie in the cointegration space.
DK	Exchange rate: 1992/93 and 1995 exchange rate crises. Interest Rate: 1992/93 crisis, forex market tensions 1986 and 1989. Inflation: Increase in indirect taxes in 1986. Industrial production: Industrial disputes 1985.
FIN	Inflation: Acceleration 1985:I, substitution of turnover tax by VAT on services 1994:III. Industrial production: Recession 1990 to 1994.
F	Exchange rate: Realignment April 1986, currency crisis 1993, aftermath of the Mexico crisis 1995, when the French Franc came again under speculative pressure. Interest rate: Crises 1993 and 1995. Inflation: Deregulation of prices in 1987.
D	Interest rate: Stock market crash 1987, in the aftermath of which the Bundesbank loosened its monetary policy stance until 1988:III in order to offset some of the consequences of the crash on the real economy. Industrial Production: Strike in 1984:II. Inflation: VAT increase 1979:III, indirect tax increases 1989:I, first round of rent rises in East Germany 1992:I , VAT increase and second round of rent rises in East Germany 1993:I. Linear trend, restricted to lie in the cointegration space to avoid a quadratic trend in the levels.
IRL	Interest rate: Speculative crises 1986 and 1992. Inflation: Increase in excise duties, removal of food subsidies and other taxation measures to reduce the Irish budget deficit 1987:I. Exchange rate: Crises 1992 and 1995, appreciation of the Irish Punt against ERM currencies in 1996:IV, when it was strongly influenced by the appreciation of Pound Sterling. Industrial production: Outlier 1996:I.
I	Exchange rate and interest rate: Crises 1992/93 and 1995. Inflation: Jump in 1990.
NL	Inflation: In 1991:III, dampening effects of the previous years (like the currency appreciation or a VAT decrease) were stopped or reversed, e.g. by the costs of health care shooting up, by legal rents and excise taxes rising. Industrial production: Outlier in 1987:I.
P	Exchange rate: Speculative attacks 1992/93. Inflation: Massive decreases in inflation 1984:IV and 1985:III, when the Escudo appreciated against the US$ and depreciated much less against the European currencies than otherwise. Industrial production: Outlier 1992:III.
E	Exchange rate: Speculative attack 1995. Interest rate: Massive increase in the Bank of Spain lending rate 1987. After an interest rate reduction in 1986, aimed at depreciating the Peseta vs. other European currencies, after an overshooting of ALP by nearly 100% with

	respect to its target and after an increasing government deficit that had to be financed by the Bank of Spain and drove liquidity even further up, the Bank of Spain increased its lending rate from 11.5% in December 1986 to 20.5% in May 1987. Inflation: Indirect tax increases in 1983:IV, 1984:III, 1986:I (introduction of VAT) and 1992:I. Linear trend, restricted to lie in the cointegration space.
S	Exchange rate and interest rate: Crisis 1992/93. The CB of Sweden increased its marginal lending rate to 500% in September 1992. The Krona depreciation in 1992:III turns out to be so strong that is has to be accounted for with a step dummy that is restricted to lie in the cointegration space, too. Also the seasonal pattern changes after 1992:III. Inflation: Tax reform 1990:I, where the VAT base was widened substantially, and the subsequent VAT changes 1991, 1992:I (reduction from 25 to 18%), and 1993:I (increase to 21%).
UK	Industrial production: Miners' strike on 1984:II to 1985:I. Exchange rate: Currency crisis 1992. Inflation: VAT increase 1979:III. Interest rate: In 1985:I, the Bank of England drastically increased interest rates after an exchange rate depreciation to indicate that it was earnest regarding the newly declared change in orientation towards exchange rate goals

A3: Test Results[32]

Country	Unit Root Tests	Cointegration Rank	Weak Exogeneity of Instrument Variable
A	Interest rate differential I(0), all others I(1)	2	No
B	Inflation and exchange rate I(0), all others I(1)	2	No
DK	all I(1)	2	Yes
FIN	all I(1)	2	No
F	all I(1)	2	Yes
D	all I(1)	3	No
IRL	Inflation I(0), all others I(1)	3	No
I	all I(1)	3	Yes
NL	all I(1)	2	No
P	Inflation I(0), all others I(1)	3	No
E	all I(1)	2	No
S	all I(1)	2	Yes
UK	all I(1)	3	No

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[32] To save space, the corresponding test statistics were not included. They are, however, available from the author upon request.