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The Transmission of Monetary Policy in the Euro Area: Are the Effects Different Across Countries?*

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Abstract

This paper analyses whether the effects of the monetary policy of the European Central Bank (ECB) may be different across Euro area countries. First, the limitations in the current empirical literature are highlighted. The paper then suggests how to deal with these limitations and provides new empirical evidence on the effects of a common monetary policy shock across individual member countries. Surprisingly, very similar output effects are found across countries.

I. Introduction

The Eurosystem has faced and continues to face important challenges since the euro was introduced on 1 January 1999. The main task of the European System of Central Banks (ESCB) is to conduct monetary policy for the Euro area. There remains, however, considerable uncertainty regarding the impact and timing of a monetary policy shift on the final objectives. To be successful in conducting monetary policy, the monetary authorities must have an accurate assessment of the effects of their policy on the economy. This requires a good understanding of the transmission mechanism through which monetary policy

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affects the economy. A number of studies assess the different channels of monetary transmission in the Euro area. Dedola and Lippi (2000) and Peersman and Smets (2002) analyse the relative importance of the individual channels in the transmission process. Angeloni *et al.* (2002) summarize a number of research papers, provided by the staff of the ESCB, on different transmission channels in Euro area countries.

The challenge is even more complicated for the Euro area because while the European Central Bank (ECB) may conduct monetary policy based on union-wide aggregates, the impact of its policy can be different across the member countries. Specifically, under EMU, member countries will be subject to common monetary policy shocks. Given the diversity in economic and financial structures across the economies, common monetary policy shocks can be expected to have a different impact in terms of timing, magnitude and distributional effects. Little is known about what differences might arise, given the absence of any historical experience in Europe with a common monetary policy. Moreover, the creation of the Eurosystem constitutes a regime shift, which can change the transmission mechanism, making the task of the ECB even more difficult.

There exists, currently, a large body of empirical evidence on the impact of monetary policy shocks in each of the individual countries of the Euro area.[1] Making cross-country comparisons based on separate estimations for each individual country, however, has a number of important problems.[2] In the context of EMU, there is an important difference between a monetary policy shock at the individual country level and a common monetary policy shock because of large trade linkages between the member countries. The simulation of a common monetary policy shock could be much more similar across countries than a shock at the country level because of spillover effects between countries. Another problem is that the size of the estimated monetary policy shock differs across countries, making a comparison among countries very difficult. Moreover, even with the same shock, the monetary policy responses would not be harmonized because a different monetary policy reaction function is estimated across countries (the endogenous component of monetary policy), which can significantly alter the results. Some studies set a pre-specified path for the interest rate to try to overcome this,[3] which is equivalent to hitting the model with a sequence of appropriately chosen

[1]See Kieler and Saarenheimo (1998), Guiso *et al.* (2000) and, Mojon and Peersman (2001) for an overview of this empirical evidence. Vector autoregressions (VARs) are typically used to study the effects of an unexpected change in policy-controlled interest rates. The use of VARs for the analysis of monetary policy started with the seminal work of Sims (1980). Christiano, Eichenbaum and Evans (1998) have reviewed what one has learned from the extensive literature regarding the monetary transmission mechanism in the United States.

[2]See also Guiso *et al.* (2000) for a discussion of some of these problems.

[3]For example Gerlach and Smets (1995).

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shocks. To justify this, however, we have to assume that the estimated parameters of the model are invariant to the specification of the policy rule, and are confronted with the Lucas (1976) critique. Finally, even if we take into account these difficulties,[4] we still have no information on the statistical significance of the asymmetries across countries. Uncertainty about the estimates, reflected in the confidence bands around impulse response functions, is typically very high in this literature.

In this paper, we provide new empirical evidence for seven core countries of the Euro area that takes into account most of the problems in the existing literature. The above-mentioned problems can largely be solved by looking at the impact of a common monetary policy shock on each of the individual countries using an extension of a block structured near-vector autoregression, where we make a distinction between blocks with area-wide variables and blocks with variables of the individual countries. The advantage of this approach is that we have the same monetary policy shocks and reaction function across countries (the common block), and that we take into account the spillover effects between countries (there is a feedback of the common block to the individual countries). The contribution of this approach is also the statistical assessment of asymmetries in the monetary transmission mechanism because we are able to formally test cross-country differences within this framework. We find a similar impact of an area-wide monetary policy shock on output in the individual countries. The impact is somewhat weaker in the Netherlands, but the difference is only slightly significant. The evidence of the point estimates is broadly consistent with what we expect based on the underlying economic and financial structures of the countries.

The rest of the paper is structured as follows. In section II, we discuss the existing empirical evidence and its limitations. We also provide new evidence based on our alternative methodology in section III. The results of a monetary policy simulation exercise in the context of the Euro area are presented in section IV. Finally, section V presents some conclusions.

II. Existing empirical evidence and its limitations

There is already a large body of empirical evidence examining differences in the impact of monetary policy across individual countries of the Euro area. These studies use a variety of techniques, ranging from single-equation estimations to large macroeconomic models. Cross-country comparisons are mainly based on the response of output to a monetary policy shock. Table 1 provides an overview for the countries included in our analysis. Cross-country

[4]For example Sala (2001) and, Clements, Kontomelis and Levy (2001) take into account a lot of these difficulties by looking at the effects of common monetary policy shocks identified as a German policy shock.

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TABLE 1

Effect of monetary policy on output in Euro area countries

	DE	*FR*	*IT*	*ES*	*AT*	*BE*	*NL*
BIS: NCB's†	−0.37	−0.36	−0.44	−0.25	−0.14	−0.23	−0.18
BIS: FRB multi-country†	−0.72	−0.70	−0.44				
van Els *et al.*†	−0.33	−0.28	−0.60	−0.62	−0.49	−0.20	−0.27
Gerlach and Smets 1	−0.28	−0.19	−0.31				
Gerlach and Smets 2†	−1.00	−0.50	−0.50				
Ramaswamy and Sloek	−0.75	−0.48	−0.50	−0.28	−0.70	−0.95	−0.60
Barran *et al.*	−0.65	−0.46	−0.30	−0.55	−0.48		−0.35
Britton and Whitley	−0.60	−0.62					
Ehrmann*	−0.90	−0.40	−0.42	−0.22	−0.05	−0.36	−0.10
Dornbusch *et al.*	−1.40	−1.54	−2.14	−1.54			
Mihov	−0.55	−0.35	−0.40		−0.30		−0.30
Ciccarelli and Rebucci	−1.41	−1.35	−1.51	−0.90			
Mojon and Peersman	−0.20	−0.20	−0.12	−0.14	−0.25	−0.32	−0.45
Dedola and Lippi*‡	−1.61	−0.66	−1.07				
Peersman and Smets	−0.87	−1.15	−1.85		−0.93	−1.80	−1.00
Sala*	−0.60	−0.30	−0.16	−0.60	−0.32	−0.32	−0.30
Clements *et al.*	−0.80	−2.20	−1.10	−1.30	−1.00	−1.40	−1.10

Notes:
Maximum impact; data not comparable across studies.
DE = Germany, FR = France, IT = Italy, ES = Spain, AT = Austria, BE = Belgium, NL = Netherlands.
*Effect of monetary policy on industrial production.
†Effect of a 100 basis point, eight-quarters sustained increase of the interest rate.
‡Effect of a 1 percentage point increase in the short-term rate.

comparisons started with work done by the Bank for International Settlements (BIS, 1995). They report the results of a monetary policy simulation. Two tools are used: the macroeconomic models developed by the National Central Banks (NCBs) and the multi-country model of the Federal Reserve Board (FRB). The former experiment is also done in a more recent study of van Els *et al.* (2001) for most Euro area countries. The effects of a temporary 100 basis points increase in the policy rate for eight quarters, after which the policy rate would return to baseline are reported in the first three rows of Table 1. In the same study of the BIS, Gerlach and Smets (1995) use a VAR approach with a combination of short- and long-run restrictions for the G-7 countries. Only three variables are included in their VAR: output, price level and the interest rate. Table 1 reports the maximum effects of monetary policy on output for two variants of their model. The first variant is a one-standard deviation, one-period shock and the second is a 100 basis points, 2-year sustained increase of the interest rate. Also Ramaswamy and Sloek (1997) estimate a simple three-variable VAR for the EU countries; Barran, Coudert and Mojon (1997) estimate a VAR with more variables

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(including credit variables) using the recursive Choleski identifying assumption for nine European countries; Britton and Whitley (1997) simulate a variant of the Mundell–Flemming model to analyse the transmission mechanism in the UK, France and Germany. It is evident from this table that there are not only considerable differences across countries, but also across studies. Different rankings of the potency of monetary policy are presented. Some countries are documented to be more sensitive to a monetary policy shock in one study but less in another. For example, Barran *et al.* (1997) find the largest impact in Germany and the least impact in Italy, while the monetary policy experiment from the NCB's macroeconomic models predicts the largest impact in Italy.

There are, however, a number of important problems with cross-country comparisons in this traditional literature. The first problem is related to the variables included for each individual country. Typically, the same model is estimated for each individual country (except for the NCB's macroeconomic models). Using the same explanatory variables tends to be misleading because different countries have different economic structures and have had a different monetary policy regime within the European Monetary System (EMS). To try to capture the specific features of each country, for instance, Ehrmann (2000) includes country-specific variables that are believed to affect the transmission mechanism or the central bank's reaction function. Further, Dornbusch, Favero and Giavazzi (1998), Mihov (2001) and, Ciccarelli and Rebucci (2001) include the German short-term interest rate in the reaction function of the other countries to describe the role of Germany as an anchor of the Exchange Rate Mechanism (ERM). The intuition of their assumptions is that some shifts in the policy-controlled interest rates are considered as an exogenous monetary policy shock if you omit the German rate, while it is actually an endogenous reaction to a shift in the German interest rate to keep the exchange rate fixed. Mojon and Peersman (2001) go one step further and model groups of 'monetary policy regime-like countries' depending on their monetary integration with Germany to avoid the implausible uniformity of approaches. Using such an approach, differences in the effects of monetary policy across countries may be precisely attributed to differences in modelling strategies and the question remains unsolved.

A second problem with cross-country comparisons is that the size of the estimated monetary policy shock differs across countries. In Mojon and Peersman (2001), for example, a one-standard deviation monetary policy shock is a rise in the short-term interest rate of 26 basis points for Germany, while it is 59 basis points for Italy, and 84 basis points for Spain. Some studies normalize the shocks across countries (e.g. Dedola and Lippi, 2000; Mihov, 2001). However, this is not straightforward if the size of the shocks differs

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dramatically across countries. As Lucas (1972, 1973) identified: the higher the variability of monetary policy impulses, the smaller the effects on output. Moreover, separate estimations imply that each country has its own monetary policy reaction function. Thus, even if the same initial disturbance is analysed, the monetary policy responses would not be harmonized (Guiso *et al.*, 2000). Countries that have, on average, large monetary policy shocks are typically characterized by a steep reaction of the interest rate afterwards (e.g. Spain and Italy), while a small one-standard deviation monetary policy shock is mostly associated with a smoother reaction function of the interest rate (e.g. Germany). This complicates the normalization of the shocks even more. In general, cross-country differences can be found simply because of differences in the reaction function, even if the transmission mechanism is the same. This is illustrated by the two variants of Gerlach and Smets (1995). In the first case (a one-standard deviation monetary policy shock), the response of output looks similar across Germany, France and Italy, while in the second case (a one percentage point, eight-quarters sustained increase of the interest rate), German GDP moves by twice as much as that of France and Italy. The latter is equivalent to hitting the model with a sequence of appropriately chosen shocks. Again, to justify this type of analysis, it is necessary to assume that the estimated parameters of the model are invariant to the specification of the policy rule (Guiso *et al.*, 2000). This is probably not a serious problem if you make small adjustments to the reaction function, but could be with significant changes.

Another problem with these approaches, in the context of the Euro area, is that there is an important difference between a domestic monetary policy shock and a common monetary policy shock because there are large trade linkages between the member countries. It is possible that the simulation of a common monetary policy shock could be more similar across countries than a domestic monetary policy shock because of spillover effects between countries. In contrast, cross-country linkages are not directly captured by separate estimations for each individual country. Moreover, with the latter approach, differences in the effects of monetary policy may be due to shifts in the intra-EMU exchange rates, which is not possible in the current monetary union.

Dornbusch *et al.* (1998) and, Ciccarelli and Rebucci (2001) partly model trade links and spillovers of a domestic monetary policy shock. Peersman and Smets (1999) and Sala (2001) allow cross-border linkages, and estimate the effects of common monetary policy shocks and a common central bank reaction function, while Clements *et al.* (2001) estimate the common monetary policy impact without trade effects. These three studies consider German monetary policy innovations as common shocks to all countries in their analysis because of a history of fixed bilateral exchange rates, with the

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German Bundesbank de facto playing the anchor role. However, some difficulties might arise when the effects of German shocks are used to do cross-country comparisons. First, during the ERM-period, all exchange rate realignments were devaluations of other countries vis-a-vis Germany (and some other countries). This can reinforce the estimated effects in Germany and weaken the effects in other countries. Clements *et al.* (2001) try to capture this by simulating the effects of a monetary policy shock when the bilateral exchange rate with Germany remains fixed. Secondly, these studies use the Bundesbank reaction function as the common monetary policy rule. This implies that the common monetary policy stance only reacts to German variables when doing the impulse response analyses, and not to Euro area aggregates. The implicit assumption being that not only is the area-wide monetary policy rule the same as the German rule, but also the reaction of other variables in the system (output, prices, …) to monetary policy shocks is assumed to be the same in the Euro area as in Germany. The latter assumption is not obvious, especially if you analyse cross-country differences in the reaction to monetary policy shocks. A reaction to Euro area aggregates, however, is necessary for replicating the current monetary policy regime. Thirdly, Mojon and Peersman (2001) find a puzzling behaviour of the response of output in Germany to a monetary policy shock for the sample period 1980–98, probably because of the influence of German unification. This puzzle disappears when a larger sample period is considered because of a lower weight of this unification. As a consequence, it is presumably better to use a weighted average of the individual country interest rates as the common monetary policy instrument.

Finally, even if differences across countries are found, it is still not clear whether these differences are statistically significant, given the relatively wide confidence bands around the responses. Hence, a formal test for cross-country differences is necessary. Peersman and Smets (1999) test the difference between the response of the individual country and a weighted average response of all countries. They find only a slightly significant larger impact in Italy. Ciccarelli and Rebucci (2001) estimate a dynamic panel of pooled data and show that the cumulative impact on economic activity is not significantly different across Germany, France, Italy and Spain.

Given that cross-country differences in the transmission mechanism are not very robust across studies, and because of the number of problems in the context of the Euro area and criticisms on the limited power of quantitative comparisons of impulse responses, it is very hard to conclude that there is a differential impact of monetary policy across the member countries of the Euro area. In the following sections, we present new empirical evidence that tries to take into account most of the above mentioned problems of

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the current literature. Moreover, we formally test the significance of the differences.

III. New empirical evidence

In this section, we provide new empirical evidence on the effects of common monetary policy shocks in the individual countries of the Euro area. As discussed in section II, the pre-EMU empirical evidence regarding cross-country differences in the effects of monetary policy is mixed. There are, however, a number of important problems with most of these studies, which we now try to take into account. One problem is that it is difficult to predict how the transmission mechanism works under the new monetary regime. Nevertheless, the establishment of the ESCB is not a completely new policy environment, a gradual process of monetary convergence has preceded it. In particular, France and Germany and some of their neighbours have had fixed exchange rates with occasional parity adjustments since the end of the Bretton Woods system, especially during the ERM period. We therefore focus on the seven core countries of the ERM-system (Germany, France, Italy, Spain, Austria, Belgium and the Netherlands),[5] and consider the sample period 1980–1998 (quarterly data).[6] The basic model and results are discussed and a robustness analysis provided in the sections that follow.

Basic model

By looking at the impact of a common monetary policy shock on the individual countries within a period of relatively fixed exchange rates, we avoid a lot of the above-mentioned problems. The main advantage is that we have the same monetary shock and reaction function across countries, and that it is possible to take into account spillover effects between countries. To do this, following the majority of the empirical literature on the monetary transmission mechanism, we use an extended version of a structural VAR. In particular, we estimate a Euro area block structured near-VAR departing from the basic model of Peersman and Smets (2001). In that paper, we estimated an area-wide VAR model using synthetic Euro area data and found plausible results, qualitatively consistent with those for the US and with disaggregated results at the national level. Our model has the following representation:

[5]Some care should be taken in interpreting the results of Spain and Italy because of realignments in the exchange rate at the beginning of the sample period.

[6]Individual country data were obtained from the ESCB network on the monetary transmission mechanism. Area-wide data were taken from the ECB AWM data set.

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$$\begin{bmatrix} X_t \\ Y_t^1 \\ Y_t^2 \\ Z_t^1 \\ Z_t^2 \\ \vdots \\ Z_t^n \end{bmatrix} = \begin{bmatrix} A(L) & 0 & 0 & 0 & 0 & \cdots & 0 \\ B(L) & C(L) & D(L) & 0 & 0 & \cdots & 0 \\ E(L) & F(L) & G(L) & 0 & 0 & \cdots & 0 \\ H(L) & 0 & I(L) & J(L) & 0 & \cdots & 0 \\ K(L) & 0 & M(L) & 0 & N(L) & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ P(L) & 0 & Q(L) & 0 & 0 & \cdots & R(L) \end{bmatrix} \begin{bmatrix} X_{t-1} \\ Y_{t-1}^1 \\ Y_{t-1}^2 \\ Z_{t-1}^1 \\ Z_{t-1}^2 \\ \vdots \\ Z_{t-1}^n \end{bmatrix} + S \begin{bmatrix} \varepsilon_t^x \\ \varepsilon_t^{y_1} \\ \varepsilon_t^{y_2} \\ \varepsilon_t^{z_1} \\ \varepsilon_t^{z_2} \\ \vdots \\ \varepsilon_t^{z_n} \end{bmatrix}.$$

The variables included in the model can be divided into a number of blocks.[7] The first three blocks of variables, X_t, Y_t^1 and Y_t^2, are obtained from Peersman and Smets (2001).[8] X_t contains a number of exogenous variables: a world commodity price index (cp_t), US real GDP (y_t^{US}), and the US short-term nominal interest rate (s_t^{US}):[9]

$$X_t' = [\text{cp}_t \quad y_t^{\text{US}} \quad s_t^{\text{US}}]$$

These are included to control for changes in world demand and inflation. As this group of variables is exogenous to the rest of the VAR model, there is no feedback from the other variables to these variables (Peersman and Smets, 2001). The two blocks of endogenous variables of the model, Y_t^1 and Y_t^2, consist of real GDP (y_t), consumer prices (p_t), the money stock (m_t), the domestic nominal short-term interest rate (s_t), and the real effective exchange rate (x_t) for the Euro area:

$$\begin{aligned} Y_t^{1\prime} &= [y_t^{\text{EMU}} \quad p_t^{\text{EMU}}] \\ Y_t^{2\prime} &= [m_t^{\text{EMU}} \quad s_t^{\text{EMU}} \quad x_t^{\text{EMU}}]. \end{aligned}$$

The VAR-model is estimated in levels. In this paper, we do not perform an explicit analysis of the long-run behaviour of the economy. By doing the analysis in levels we allow for implicit co-integrating relationships in the data, and still have consistent estimates of the parameters (Sims, Stock and Watson, 1990). A more explicit analysis of the long-run behaviour of the various variables is limited by the relatively short sample available.[10]

In the basic model of Peersman and Smets (2001), the area-wide monetary policy shock is identified through a standard Choleski decomposition with the blocks, and endogenous variables within the blocks, ordered as mentioned above. The underlying assumption is that policy shocks have no contemporaneous impact on output, prices and the money stock, but may affect the

[7]All variables included in the VAR are measured in logs and seasonally adjusted, except the interest rates, which are in levels.

[8]Note that Y_t^1 and Y_t^2 are considered as one block, Y_t, in Peersman and Smets (2001). We need, however, a somewhat different representation for our analysis.

[9]This exogenous block also contains a constant and a linear trend.

[10]Coenen and Vega (1999) estimate a Vector Error Correction Model (VECM) model for the Euro area for a longer sample period.

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exchange rate immediately. The policy interest rate, however, does not respond to contemporaneous changes in the effective exchange rate. This assumption is appropriate for a large, relatively closed, economy such as the Euro area as a whole. In Peersman and Smets (2001), we show that the results are robust to changes in the identification strategy. A robustness analysis with respect to alternative identifying restrictions is also provided in the section 'Robustness of the results'.

The other blocks of the system are variables at the individual country level. For each individual country, i, we include real GDP (y_t^i), the price level (p_t^i), the difference between the short-term nominal interest rate and a weighted average of the short-term nominal interest rates of all the other countries of the Euro area ($s_t^i - s_t^{-i}$), and Euro area output and prices excluding domestic output and prices of country i (y_t^{-i} and p_t^{-i}):

$$Z_t^{i\prime} = [\, y_t^i \quad p_t^i \quad s_t^i - s_t^{-i} \quad y_t^{-i} \quad p_t^{-i} \,].$$

We assume there is no impact across the individual country blocks in the system. However, we do assume there is an impact among the variables within a country block. Furthermore, we allow for an influence of the aggregated block with money, interest rate and exchange rate (Y_t^2) and exogenous variables on the individual countries. This allows us to have enough degrees of freedom and enables us to estimate the whole system.[11] Spillover effects across countries are captured by the aggregate variables in Y_t^2 and through the aggregates excluding domestic output and prices (y_t^{-i} and p_t^{-i}) in the individual blocks. For example, if output falls after a monetary policy shock in several individual countries of the Euro area, the aggregate level of output excluding domestic output will fall. The impact on the individual country through trade is then captured by the lagged coefficients of the aggregate variables excluding domestic values in the individual country block. However, it is not necessary to allow for feedback of the individual countries on the blocks of area-wide variables (Y_t^1 and Y_t^2), because the individual countries are part of the aggregated variables. These movements are then directly reflected in the aggregates. This structure ensures that the aggregate estimates are not influenced by the country-specific variables and the number of individual country blocks. The same results for the Euro area as a whole are found when the aggregate block only is estimated separately, without the individual country blocks (which is done in Peersman and Smets, 2001).

As we assume there is no contemporaneous impact of a monetary policy shock on output and prices at the Euro area level, we also assume there is no contemporaneous impact at the individual country level. This ensures that we are not confronted with simultaneity problems. For instance, there could be

[11] This implies that the maximum number of endogenous variables for an individual country equation is limited to eight variables, and three exogenous variables.

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problems for the contemporaneous individual country and aggregate output and price variables. However, we do not have to solve this problem because we are only interested in the impact of a monetary policy shock and not in the impact of other shocks. The results for monetary policy shocks are, however, not influenced by the identification of the other shocks (Bernanke and Mihov, 1998; Christiano *et al.*, 1998). In addition, we include the difference between individual country interest rates and a weighted average of interest rates of all other countries. We allow for a contemporaneous impact of a monetary policy shock on this interest differential. This enables us to check whether there was a systematic deviation of the stance of monetary policy in the individual country relative to the other member countries after a common monetary policy shock, which might bias the estimated asymmetries.[12]

As we have a near-VAR system, we estimate the model using seemingly unrelated regression (SUR) methods developed by Zellner (1962).[13] Standard likelihood ratio tests are used to determine the lag-order of the VAR, which turns out to be of order 2. The advantage of estimating the individual country and Euro area aggregates simultaneously (and the aggregates excluding domestic values) is that it allows us to assess the statistical evidence of asymmetries in the monetary policy transmission mechanism. We obtain very similar results if we estimate the system by OLS or if we estimate a traditional VAR for each individual country separately, which includes the aggregates and individual country variables. The disadvantage of the latter approach is that the aggregate monetary policy shocks are then not invariant to the country chosen, which makes cross-country comparisons complicated.[14]

It is important to note that there still might be some caveats with our approach. In particular, the interest rate equation of a VAR is regarded as a reduced-form representation of a policy reaction function. It is not possible to have this interpretation in the current paper because there was no single monetary policy regime in the pre-EMU period.[15] We have to be very careful in interpreting the results and should consider the identified shocks more as shocks to a weighted average of individual country interest rates instead of common monetary policy shocks. This also implies that the problem of

[12]With this representation, it is also convenient to do the simulations of section IV. In addition, the results are robust if we include the ECU exchange rates of the individual countries instead of the interest differential.

[13]Because there is no feedback between country-specific blocks, we only allow for correlation between the area-wide blocks and the individual country block. Specifically, we do a joint estimation of the area-wide blocks and country-specific block for each country separately, i.e. X_t, Y_t^1, Y_t^2 and Z_t^i.

[14]These results are available upon request.

[15]If individual country reactions functions are substantially different, then the aggregated reaction function will not have shocks as residuals. More specifically, the residuals will also contain country-specific components that normally enter the individual country reaction functions. This could be a limitation unless we accept the assumption that cross-country variation in the reaction functions is limited.

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normalization of shocks across countries might not fully be solved. More specifically, a weighted average can still mean a different size of the shocks across countries.[16] However, this is also the case in the current monetary policy regime. Given differences in macroeconomic conditions across member countries, the stance of monetary policy is not identical for all countries. This also implies that the size of monetary policy shocks in the current regime is not identical across countries and could still be, for example, restrictive in one country and expansionary in another. Given this, our approach closely resembles the current single Euro area-wide monetary policy regime but some care in interpreting the results is necessary.

Estimation results

The results for the block of area-wide variables are reported in Figure 1. Impulse response functions for a monetary policy shock are plotted, together with 90% bootstrapped confidence bands. As a result of the construction of the blocks, these results are similar to the results of Peersman and Smets (2001). The only difference is that our model is estimated using SUR. A one-standard deviation monetary policy shock (rise in the interest rate of 30 basis points) is followed by an appreciation of the real exchange rate and a temporary fall in output after two quarters. The effect on output reaches a peak after five quarters, then returning to baseline. The responses of prices and M3 are more sluggish and start to fall significantly below zero only some quarters after output. These effects are also more persistent.

The first three columns of Figure 2 plot the responses of the individual country variables to the common monetary policy shock. We find very similar

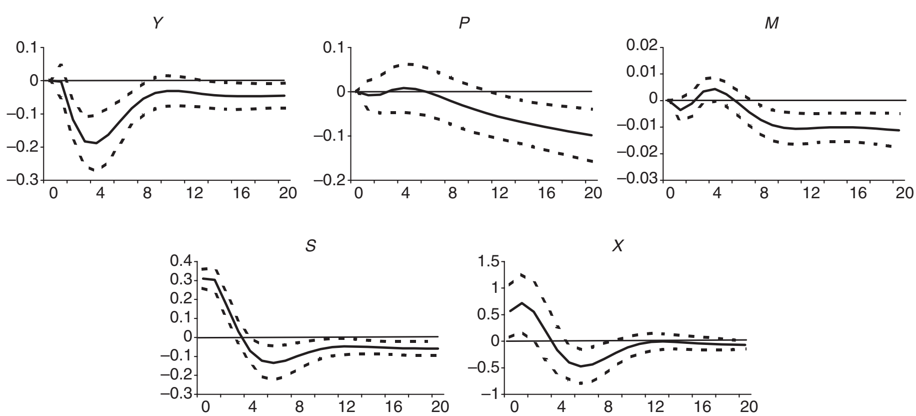

Figure 1. Impulse responses to a monetary policy shock: Euro area
Note: 90% confidence bands.

[16]Section IV presents the results of a simulation exercise, which tries to take this into account.

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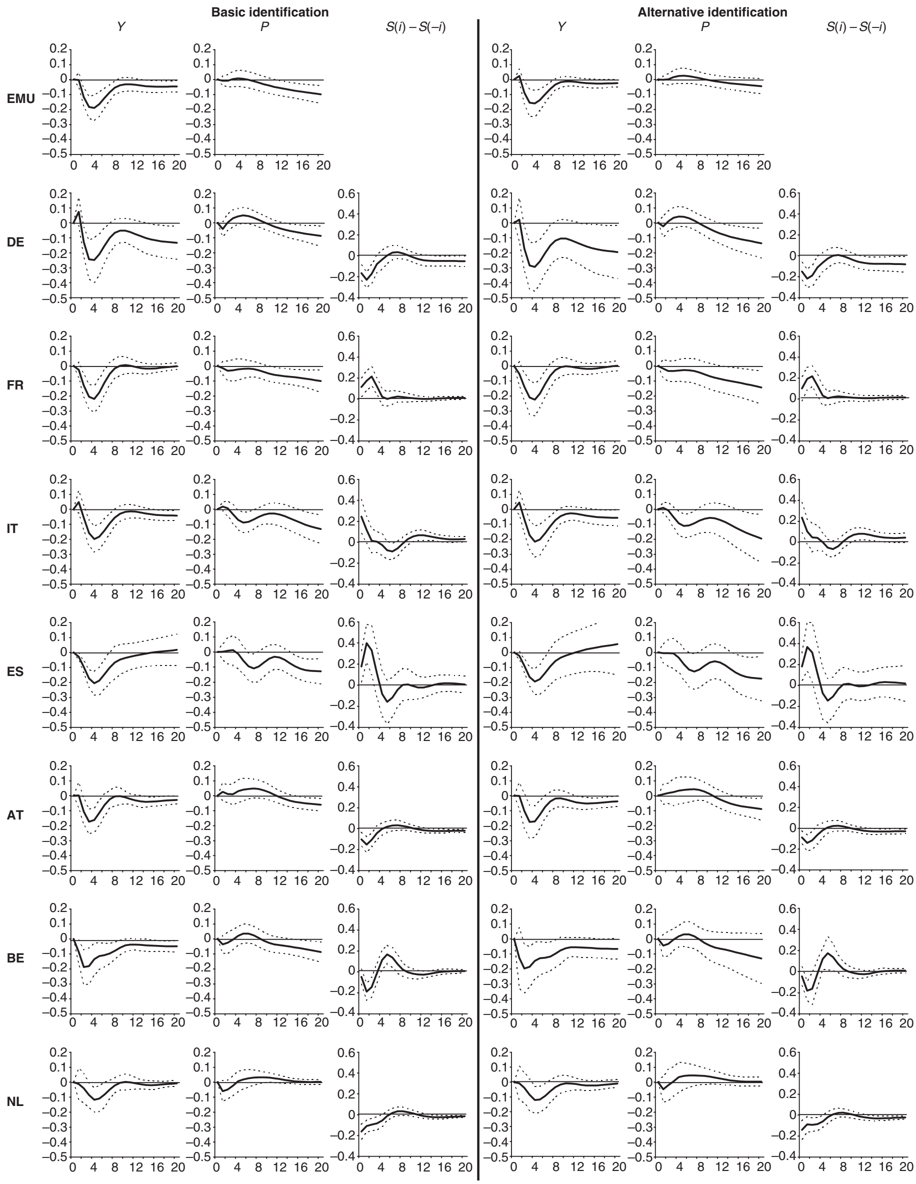

Figure 2. Responses to a common monetary policy shock in the individual countries
Note: 90% confidence bands.

output responses across countries. The first column of Table 2 reports the maximum impact of a common monetary policy shock on output in the individual countries, and the second column the accumulated impact on the level of output (sum of first 12 quarters after the shock). We find the

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strongest impact in Germany and the weakest in the Netherlands for both measures. The responses of the other countries are in-between. This does not mean, however, that the differences across countries are significant, given the width of the confidence bands. Therefore, in Figure 3, we plot the difference of the response of output in the individual country (y^i) with the area-wide output excluding domestic output (y^{-i}) responses in the first column, with 90% bootstrapped confidence bands.[17] From a statistical point of view, the differences in the impulse responses are not significant for most countries. It is slightly significant for Germany during two quarters, i.e. the third and fourth quarter after the shock. However, the impact is significantly smaller in the Netherlands during two quarters. Somewhat surprisingly, although an insignificant difference of the maximum impact, we find a significant faster impact in Belgium and a significant faster return to baseline in Austria. For all other countries, there are no significant cross-country differences.

An important reason for finding almost no significant differences across countries are the relative wide confidence bands around the impulse responses. However, we can still check whether the point estimates, being consistent estimates of the true responses, make sense. It is beyond the scope of this paper to analyse all individual channels of the monetary transmission mechanism and accompanying industrial and financial characteristics across the countries under investigation.[18] Nevertheless, our results are plausible if we compare them with the underlying economic structures. We find the strongest maximum and cumulative impact in Germany (Table 2) and the weakest impact in the Netherlands. This is consistent with the expectation of respectively a strong and weak interest rate channel for these countries in the study of Carlino and DeFina (1998b). They find that the shares of manufacturing and construction in the gross state product have an important influence on observed differences in the impact of monetary policy across states in the US.[19] This share is the largest for Germany and the smallest for the Netherlands among the countries analysed in this paper. All other countries are in between. Peersman (2001) constructs relative grades across Euro area countries for the overall impact of monetary policy, going from the more sensitive (A) to the less sensitive (D). The grades are

[17]The differences with the area-wide responses themselves are available upon request, but do not alter the general conclusions.

[18]Carlino and DeFina (1998a) and Mihov (2001) provide a formal statistical analysis for the US regions and a set of European countries, respectively, but the number of observations in our study is too limited.

[19]This is mainly because the demand for these products, typically durable and investment goods, is known to be much more affected by a rise in the interest rate through the usual cost-of-capital channel. Also Dedola and Lippi (2000) and Peersman and Smets (2002) find strong evidence that the durability of the produced goods has a very significant influence on the overall impact of monetary policy in a panel of European industries.

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TABLE 2

Estimated impact of a common monetary policy shock

	Model 1						*Model 2*					
	Basic model			*Alternative*			*Basic model*			*Alternative*		
	Y		*P*	*Y*		*P*	*Y*		*P*	*Y*		*P*
	Max	*Cum*	*Max*	*Max*	*Cum*	*Max*	*Max*	*Cum*	*Max*	*Max*	*Cum*	*Max*
Germany	−0.25	−1.31	−0.09	−0.29	−1.91	−0.14	−0.22	−0.97	−0.06	−0.26	−1.50	−0.10
France	−0.22	−0.93	−0.10	−0.22	−1.04	−0.14	−0.17	−0.47	−0.08	−0.17	−0.56	−0.12
Italy	−0.20	−0.91	−0.13	−0.22	−1.09	−0.19	−0.21	−0.95	−0.14	−0.23	−1.17	−0.20
Spain	−0.21	−1.13	−0.13	−0.19	−0.99	−0.17	−0.17	−0.98	−0.13	−0.16	−0.84	−0.18
Austria	−0.17	−0.71	−0.06	−0.17	−0.83	−0.09	−0.17	−0.70	−0.04	−0.17	−0.80	−0.06
Belgium	−0.19	−1.16	−0.09	−0.20	−1.37	−0.13	−0.19	−1.15	−0.09	−0.20	−1.36	−0.13
Netherlands	−0.12	−0.53	−0.06	−0.12	−0.61	−0.05	−0.13	−0.60	−0.07	−0.14	−0.68	−0.06

Notes:
Model 1: estimated impact of a common monetary policy shock.
Model 2: results of a simulation exercise: interest differential within the Euro area equal to zero.
Max = maximum impact of a common monetary policy shock.
Cum = cumulative impact (welfare loss/gain) of a common monetary policy shock on output.

a subjective weighting of the individual channels based on the theoretical and empirical literature on the monetary transmission mechanism. According to these, a larger than average effect is expected in Germany and a weaker effect in the Netherlands, which is again consistent with our results. Finally, Cecchetti (1999) reports an index based on an evaluation of a number of important factors determining the credit channel, such as balance sheet characteristics of firms and banks. He predicts a stronger influence of a credit channel in Italy, Germany and France. However, the credit channel is expected to be weak in Belgium and the Netherlands. Despite the small number of observations, our results are not inconsistent with the expectations of the literature based on underlying structures of individual countries.

Turning to the price responses, we do find some differences across countries (second column of Figures 2 and 3). The response is insignificant in the Netherlands. Consequently, the response is also significantly smaller than the area-wide response. Also for Austria, we find a significant weaker response in the long run.[20] The reaction of prices to a monetary policy shock in Italy and Spain is larger in the short run, and again in the very

[20]Note that the significance of the output responses is only important at short horizons, as the area-wide response is only significant between the second and the eight quarter. On the contrary, the aggregate price response starts only to fall significantly below zero after eight quarters, and is still significant in the long run.

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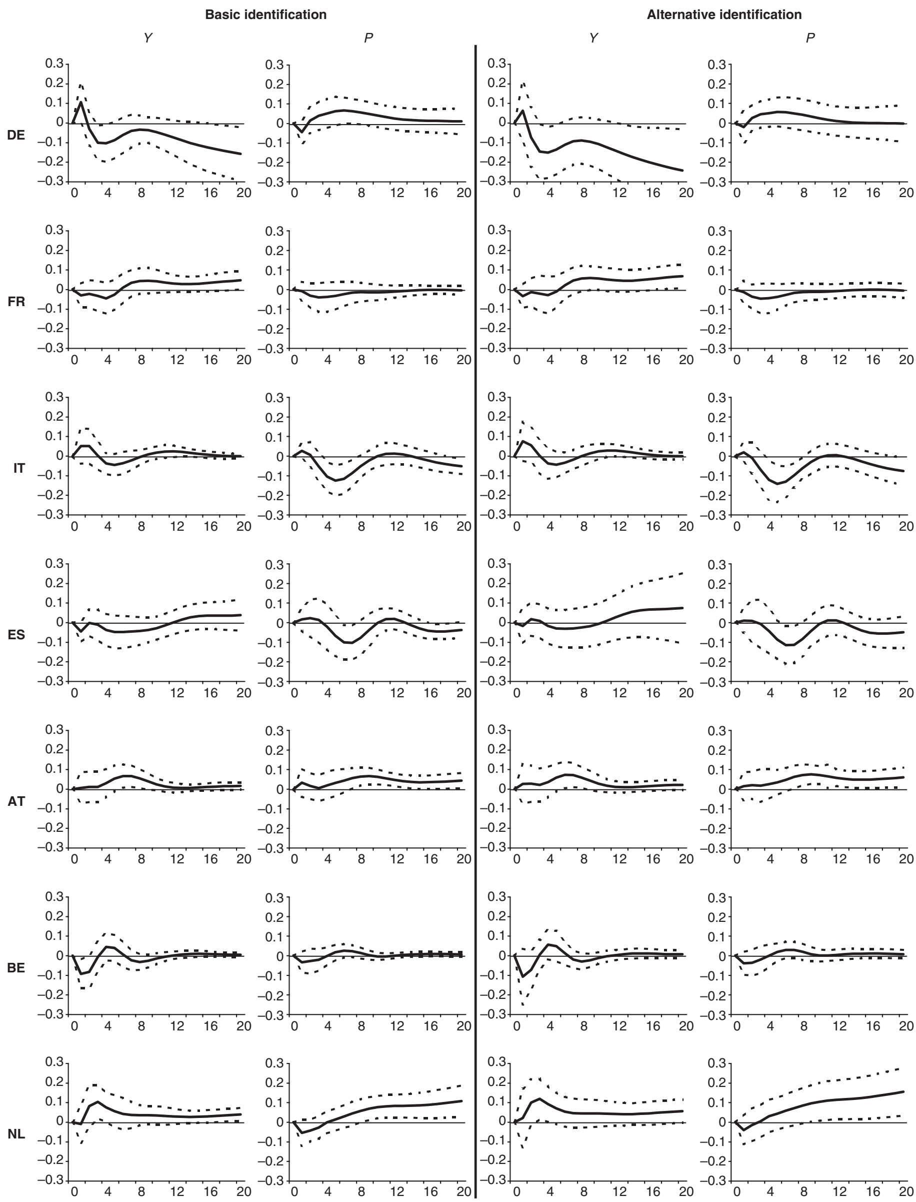

Figure 3. Asymmetries of output and prices responses

Notes: Columns 1 and 3: Difference of domestic output response with response of all other countries; columns 2 and 4: Difference of prices response with response of all other countries; 90% confidence bands.

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long run (after 20 quarters). On the contrary, we find a small (insignificant) price puzzle in Germany, Belgium and Austria. The latter result illustrates that we have to be cautious about these findings. The probability of finding significant differences across counties is relatively large when the initial price response is positive in one country and negative in another country.

An interesting result emerges from the responses of the interest differentials within the Euro area (third column of Figure 2). These responses turn out to be significant for all countries. The interest differential is negative for Germany and the countries with a close peg of the exchange rate vis-a-vis Germany during the sample period: Austria, Belgium and the Netherlands. On the other hand, the differential is positive for France, Italy and Spain. This indicates that a common monetary policy shock has a larger impact on interest rates in the latter countries than in Germany, Austria, Belgium and the Netherlands. This also implies that the results of a number of studies, which identify a common monetary policy shock as a German interest rate shock, may be biased for a number of countries. The effects could then be overestimated for Germany and underestimated for France, Italy and Spain, among others. The significant response of the interest rate differentials may, however, also bias our estimates. Cross-country differences may be mitigated without a shift of this internal interest rate differential. This is analysed in more detail in section IV.

Robustness of the results

It is well known that impulse response functions in VAR analysis can be sensitive to alternative identification schemes. In Peersman and Smets (2001), we show that the results at the area-wide level are very similar when other identification strategies are used. In this section, we check the robustness of our results across the individual countries by using a more general identification method suggested by Bernanke (1986) and Sims (1986) and applied by, for example, Sims and Zha (1998) and Kim and Roubini (2000).[21] More specifically, they allow for a contemporaneous interaction between the short-term interest rate, the exchange rate and the money aggregate. If μ_t are the residuals from the reduced-form estimation of the area-wide block in the

[21]The results of this paper are robust when an alternative ordering of the variables, i.e. the exchange rate before the interest rate, is used for the Choleski decomposition. These results are not shown in this paper but available upon request. Peersman and Smets (2001) also illustrate the robustness at the area-wide level when a mixture of short- and long-run restrictions is used in order to identify monetary policy shocks as proposed by Gali (1992). The latter strategy is not very useful within our framework because this would imply zero long-run restrictions across different blocks of the VAR, i.e. long-run neutrality of monetary policy on individual output levels. In that case, the monetary policy shocks are not invariant anymore of the individual countries included in the VAR.

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section 'Basic model', then these residuals can be related to the structural shocks by the following general structural model:

$$A\mu_t = B\varepsilon_t.$$

In our basic, recursive identification strategy, A is assumed to be the identity matrix and B is assumed to be a lower triangular matrix. The policy shock then refers to the shock in the interest rate equation. Sims and Zha (1998) and Kim and Roubini (2000) propose the following restrictions on the A and B matrix:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} & 0 \\ 0 & 0 & a_{43} & 1 & a_{45} \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \begin{bmatrix} \mu_t^y \\ \mu_t^p \\ \mu_t^m \\ \mu_t^s \\ \mu_t^x \end{bmatrix} = \begin{bmatrix} \varepsilon_t^y \\ \varepsilon_t^p \\ \varepsilon_t^m \\ \varepsilon_t^s \\ \varepsilon_t^x \end{bmatrix}.$$

The first two equations represent the sluggish reaction of the real sector (output and prices) to shocks in the monetary sector (money, interest rate and exchange rate). It is assumed that there is no contemporaneous impact of the monetary policy, money demand and exchange rate shock on output and prices. The third equation can be interpreted as a short-run money demand function. Money demand is allowed to respond immediately to innovations in output, prices and the interest rate. Row 4 represents the monetary policy reaction function. The monetary authority sets the interest rate after observing the current money stock and the exchange rate, but does not respond contemporaneously to disturbances in output and the price level. The argument for the latter assumption is that information about output and prices is only available with a lag. Finally, the exchange rate, being an asset price, reacts immediately to all other shocks.

Impulse responses obtained with this alternative identification strategy are shown in the second panel of Figure 2. These are very similar to those of the basic model. The impact on prices is somewhat stronger for most countries and the effect on output is greater in Germany relative to our basic approach (Table 2). We still find the strongest impact on output in Germany and the weakest impact in the Netherlands. The effect on prices is also still larger in Italy and Spain. Also the conclusions for the asymmetries across countries remain. The difference is significantly positive for the Netherlands and negative for Germany, as was found with our basic identification strategy. In sum, our main findings are not altered when an alternative identification strategy is used.

IV. Results of a simulation

In this section, we describe the results of a simulation exercise in the context of the Euro area, building on the results obtained in section III. So far, we have

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compared the impact of monetary policy shocks across countries based on estimations from the ERM period. The difference with the current regime, however, is that central banks had some autonomy in setting domestic interest rates during the ERM period in the presence of exchange rate bands and the possibility that exchange rate parities can be changed. This is reflected in the significant response of the interest rate differential among the Euro area countries under investigation. This, of course, can have an influence on the estimated cross-country differences in the output and price responses. To replicate the current situation more closely, we provide the results of a simulation within our estimated model. More specifically, we restrict the response of the interest rate differential to be equal to zero, which is exactly the case in the current monetary union. We should, however, be careful in interpreting these results because we impose a structure that is somewhat different from the one that generated the data.[22] Small deviations from policy rules can, however, be justified and is not likely to change the relationships dramatically (Leeper, Sims and Zao, 1998).

The impulse responses of this simulation exercise are presented in Figure 4, and the maximum and cumulative impact on the level of output and prices are reported in the last panel of Table 2 for our two alternative identification strategies. The results are only slightly different from the results of the previous section, indicating that interest rate differentials within the Euro area were not very important. We find, however, a greater convergence of responses across countries.[23] The impact on output is now somewhat stronger in the Netherlands and weaker in Germany compared with our basic results. The asymmetry of the latter country is not significant anymore (Figure 5), and the cumulative impact of the former is not the lowest anymore. This confirms our proposition that the impact in Germany is likely to be overestimated if deviations of the stance of monetary policy within the Euro area are possible. Generally, we hardly find any significant difference anymore. The response is only significantly smaller in the Netherlands during one quarter, and consistent with the results of section III, there is a significant faster impact in Belgium. While these results need to be interpreted with care, they support the view that, overall, monetary policy effects on output are relatively similar across countries.

For prices, the results are also only slightly different with the basic results of section III (see Table 2). However, we are confronted with a significant price puzzle in Germany and Austria. In the long run, prices react more in

[22]This is the so-called Lucas (1976) critique.

[23]The cross-country standard deviation of respectively the maximum and cumulated impact on output is 0.041 and 0.271 for the basic results of the section on estimation results. The standard deviation decreases to 0.030 and 0.244, respectively, for the simulation exercise. For the alternative identification strategy, it goes from 0.052 and 0.419 to 0.042 and 0.358, respectively.

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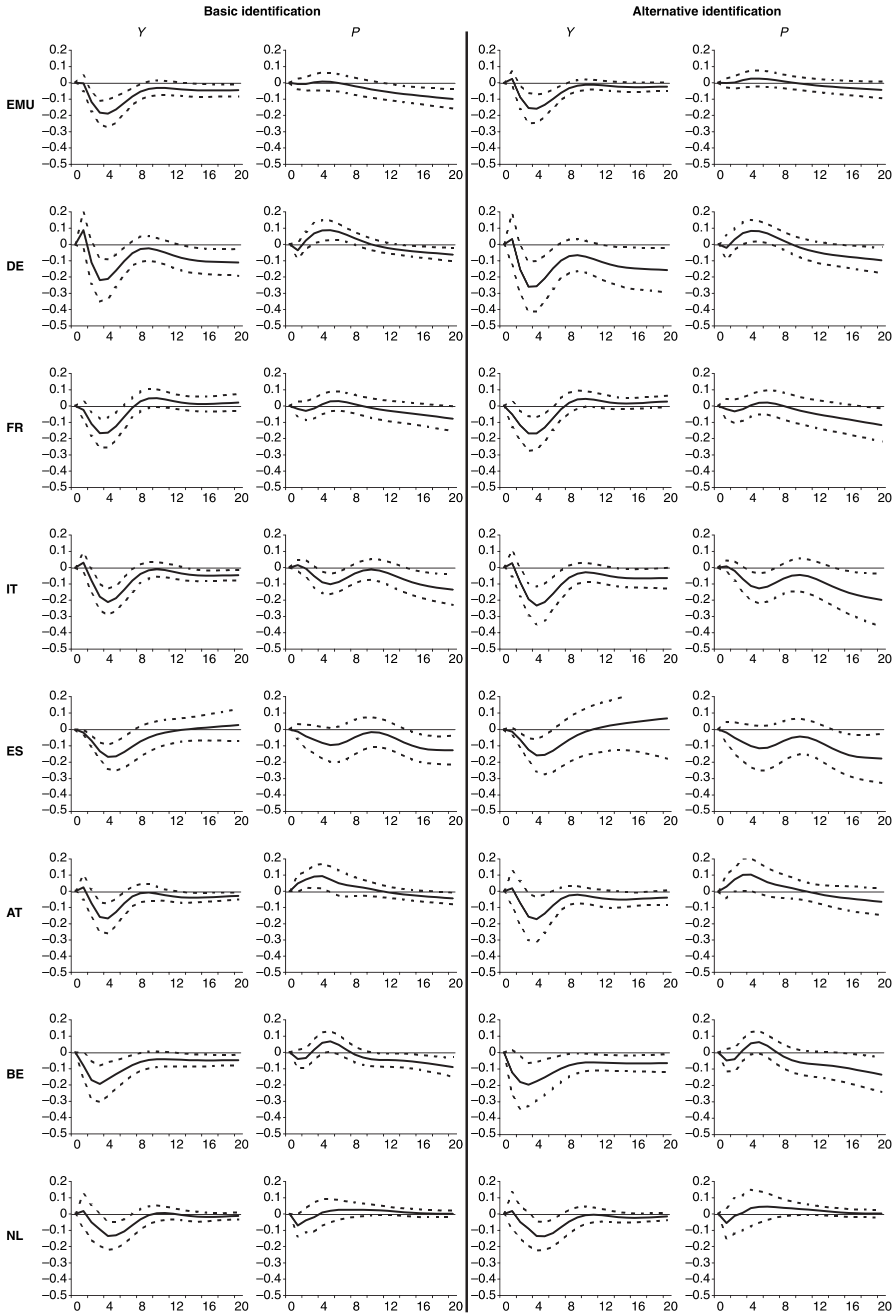

Figure 4. Responses to a common monetary policy shock in the individual countries: results of a simulation

Note: 90% confidence bands.

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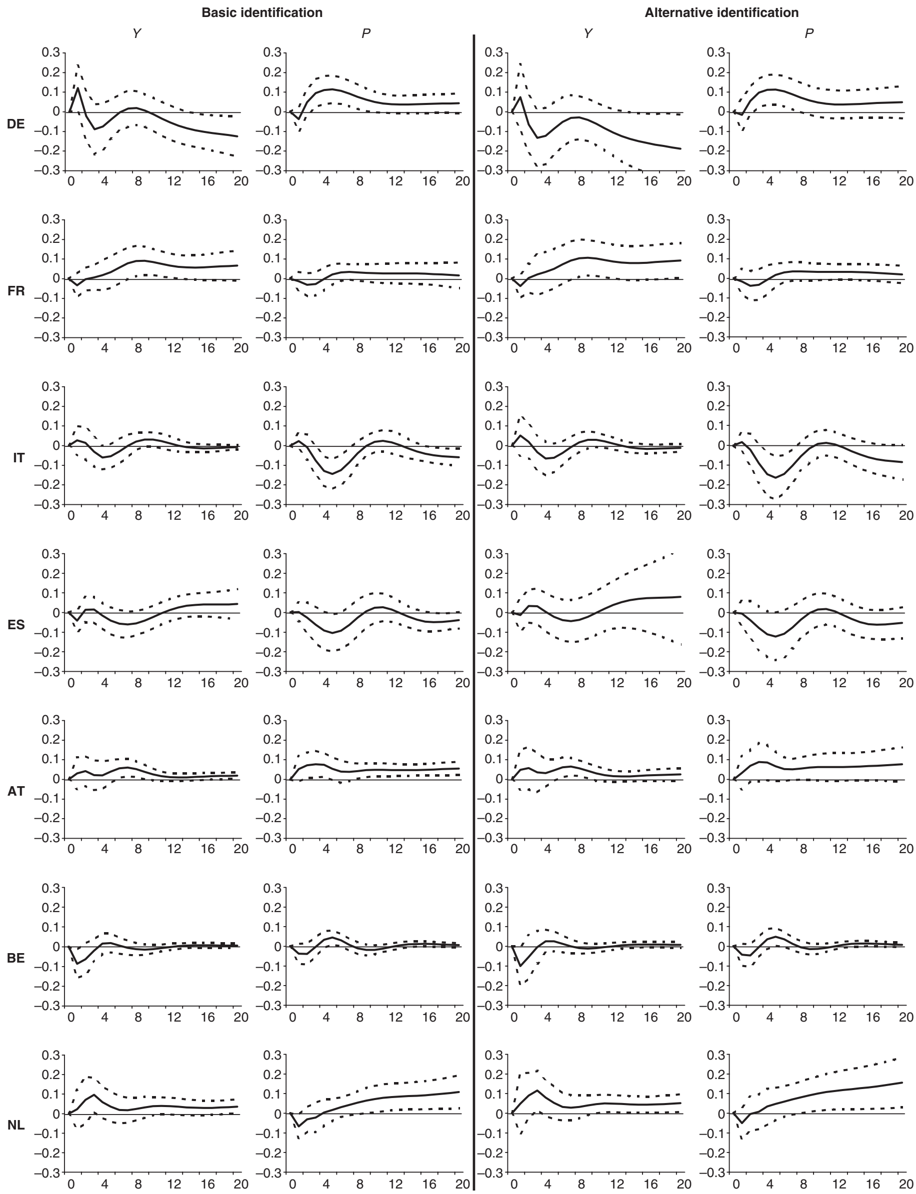

Figure 5. Asymmetries of output and prices responses: results of a simulation

Notes: Columns 1 and 3: Difference of domestic output response with response of other countries; Columns 2 and 4: Difference of prices response with response of other countries; 90% confidence bands.

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Italy and Spain, and less in the Netherlands and Austria. This puzzling result might be due to the omission of important variables in the inflation equation that forecast future inflation.[24] This does not necessarily mean, however, that monetary policy shocks are not correctly identified and that the output effects of a monetary policy shock are altered (Mihov, 2001). The problem might be solved if we add more variables in the country-specific blocks of the VAR. However, this is not possible, given the limited number of degrees of freedom.

V. Conclusions

In this paper, we have provided new empirical evidence on the impact of common monetary policy shocks across individual countries in the Euro-area, reducing the limitations identified with the existing literature. Specifically, we estimated a Euro-area blocked structured near-VAR, making a distinction between a block with area-wide variables and blocks with variables of individual countries. The advantage being that we have the same monetary policy shocks and reaction function across countries, and that we take into account spillover effects between countries. In addition, this approach allows us to formally test the significance of cross-country differences.

We find relatively uniform effects across the whole Euro area. In our basic model and a model with alternative identification strategy, we find somewhat stronger effects in Germany and weaker effects in the Netherlands. When we simulate the monetary policy effects across countries restricting the interest rate differential within the Euro area to be zero, we only find a weaker impact in the Netherlands. The latter results, however, should be taken with more than the usual degree of caution, because we impose a structure that is somewhat different from the one that generated the data. We do find, however, some differences in the impact on prices across countries. The response is stronger in Italy and Spain, and weaker in Austria and the Netherlands, which is robust across both approaches. Again, we have to be careful with the latter results because the price responses in the VARs are implausible in some cases.

When interpreting the results, it is important to note that potential caveats are possible because there was not a single monetary policy regime during our sample period. Our evidence is based on a period characterized by a gradual process of monetary convergence (ERM system), but central banks still had some autonomy in setting the domestic stance of monetary policy, so that identifying monetary policy innovations on the basis of an aggregate monetary policy reaction function may be problematic. Moreover, the creation of the Eurosystem constitutes a regime shift, which can alter the transmission

[24]Italy and Spain typically had high inflation rates during the sample period, in contrast to Austria and the Netherlands. Moreover, the former two countries experienced a serious convergence with the other countries over the sample period in the context of the Maastricht Treaty.

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mechanism. It is therefore important to monitor how these results change as data from the new single monetary policy regime come in. Nevertheless, we consider our results support the view that, overall, monetary policy effects on output are relatively similar across countries.

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