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Abstract

This paper investigates whether monetary policy impulses have asymmetric effects on output growth in seven countries of the euro area (Germany, France, Italy, Spain, Austria, Belgium and the Netherlands). First, it is shown that these seven countries share the same business cycle. Next, strong evidence is presented that area-wide monetary policy impulses, measured as the contribution of monetary policy shocks to the short-term interest rate in a simple VAR for the euro area economy, have significantly larger effects on output growth in recessions than in booms. These differences are most pronounced in Germany, France, Italy, Spain, and Belgium, while they are much smaller in Austria and the Netherlands.
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1 Introduction

This paper investigates whether the effects of monetary policy on economic activity in the euro area depend on the state of the economy. There are at least two strands of the literature which predict that monetary policy is more effective in a recession than during a boom.[1] The first class of theories is based on credit market imperfections.[2] In these models, asymmetric information between borrowers and lenders gives rise to agency costs. These agency costs are reflected in an external finance premium, which typically depends on the net worth of the borrower. A borrower with higher net worth is able to post more collateral and can thereby reduce its cost of external financing. As emphasised by Bernanke and Gertler (1989), the dependence of the external finance premium on the net worth of borrowers creates a "financial accelerator" propagation mechanism. For example, when an economy is hit by a recession, the net worth of firms will typically also fall. This leads to an increase in the cost of external financing, which in turn may aggravate the effects of the initial shock. In response to a monetary policy shock, this propagation mechanism is likely to be weaker during expansions than during recessions. During an expansion, firms can largely finance themselves with retained earnings. Moreover, as their balance sheets are strong, the external finance premium is likely to be relatively low. As a result, monetary policy changes have only a limited impact on this premium. In contrast, in a recession, when cash flows are low, firms are more dependent on external finance and collateral values are depressed, the external finance premium will be much more sensitive to changes in the interest rate. Monetary policy is therefore likely to have much stronger effects on economic activity.

A second class of theories that predicts that monetary policy will have a stronger effect on economic activity in recessions is based on a convex short-run aggregate supply curve. Convexity implies that the slope of the supply curve is steeper at higher levels of capacity utilisation and inflation then at lower levels. As a result shifts in aggregate demand that are driven by changes in monetary policy will have a stronger effect on output and a weaker effect on inflation in recessions and the reverse in expansions. Several classes of models give rise to a convex short-run aggregate supply curve.[3] A first model is the so-called capacity constraint model, which assumes that as the economy expands, more firms find it difficult to increase their capacity to produce in the short run. As a result inflation becomes more sensitive to shifts in aggregate demand at higher rates of capacity utilisation. This is consistent with the early empirical work on the Phillips curve, including Phillips (1958), which assumed that the relationship was non-linear. A second class of models is based on the presence of menu costs. For example, Ball and Mankiw (1994) show that as the level of inflation rises, and as firms adjust the timing and the size of price changes, aggregate demand shocks will have less effect on output and more effect on the price level.

In this paper we do not attempt to distinguish between these various theories.[4] Instead, we want to document empirically whether monetary policy in the euro area indeed has different effects in recessions versus booms. To do so, we employ a multivariate extension of Hamilton's (1989) two-state Markov Switching Model (MSM). This methodology allows us to endogenously determine whether the euro area economy is in a boom or a recession and to test whether the effects of pol-

1 *See, for example, Kakes (1998). In the empirical work below a recession will be a period of negative or below average growth, while a boom is a period of higher and positive growth.*

2 *An example is the "financial accelerator" model developed in Bernanke and Gertler (1989).*

3 *One could think of many other reasons why the elasticity of aggregate supply rises as output and employment rise. For example, the elasticity will also rise if the quality of the marginal hire falls as the stock of unemployed falls.*

4 *In Peersman and Smets (2000b), we perform a more disaggregated industry analysis which allows us to potentially distinguish between the various hypotheses. One could also try to distinguish between both sets of theories by analysing the effect on manufacturing prices. The financial accelerator theories say that a given interest rate change has more impact on aggregate nominal demand when output is low than when it is high. The second set of theories predict that when output is low, a given change in aggregate nominal demand has more impact on output and less on prices.*

icy are significantly different in the two states of the economy. The multivariate MSM methodology has previously been used by Garcia and Schaller (1995), Kakes (1998) and Dolado and Maria-Dolores (1999) to examine similar questions in the United States, a group of five countries including the United States, Germany, the United Kingdom, Belgium, the Netherlands, and Spain respectively. In this paper we apply the methodology to eight countries of the euro area: Germany, France, Italy, Spain, the Netherlands, Belgium, Austria and Finland.[5]

The novelty of the paper is that we take an euro area-wide approach. To do so, we proceed in various steps. In the first step (Section 2), we test whether there has indeed been a common cycle in those eight countries that now form part of the European Monetary Union (EMU). In other words, we ask whether before the start of EMU their business cycles were sufficiently synchronised, so that we can assume that the underlying state (boom or recession) was identical in each of these economies. In doing so, we do allow for different mean growth rates in each of the economies. In the estimation we use quarterly data on the growth of industrial production from 1978 till 1998. With the exception of Finland, we find that we can not reject the hypothesis that there was a single business cycle in each of these countries. In the rest of the analysis we therefore exclude Finland. These results confirm the findings of Artis, Krolzig and Toro (1999) who, using both univariate and multivariate MSMs, also find support for a common European cycle.[6] This Section is of independent interest because it suggests that at least for a large part of the euro area differences in cyclical situation are not likely to complicate monetary policy.

In Section 3 we then extend the multivariate MSM to test whether monetary policy impulses have different effects on euro area industrial activity in booms versus recessions. Rather than using domestic monetary policy impulses in each of the seven countries, we analyse the effects of an area-wide change in monetary policy. We think this is a useful exercise not only because it more closely resembles the current single monetary policy in the euro area, but also because during most of the sample domestic monetary policies in those seven countries were to a large extent coordinated through the participation in the ERM and other fixed exchange rate mechanisms.[7] In order to avoid the simultaneity bias which may result from the fact that through the central banks' reaction function short-term interest rates depend on economic activity, we use an area-wide VAR (based on Peersman and Smets, 2000a) to identify area-wide monetary policy shocks. The VAR is estimated over the same period as the MSM analysis (1978-1998) and includes area-wide real GDP, consumer prices, the real effective exchange rate and a short-term 3-month interest rate as endogenous variables and commodity prices, the US short-term interest rate and US real GDP as exogenous variables. Using a standard Choleski identification scheme, we show that a monetary policy tightening leads to an immediate rise in the short-term interest rate and an appreciation of the exchange rate. Subsequently, this tightening of monetary conditions has a significant negative impact on output and prices.

In Section 3.2. we then use the contribution of these policy shocks to the euro area interest rate as our measure of monetary policy impulses and estimate the effects of a policy tightening in the two states of the economy. Like Garcia and Schaller (1995), Kakes (1999) and Dolado and Maria-Dolores (1999), we find that, in the euro area too, monetary policy has considerably larger effects on activity when the economy is in a recession. These results are robust to using the change in the average euro area short-term interest rate as a measure of monetary policy.

5 *Because of data limitations, we did not consider Portugal, Ireland, Luxemburg and Greece, the remaining countries participating in EMU.*

6 *Artis, Krolzig and Toro (1999) include the United Kingdom and Portugal in their analysis, but not Finland.*

7 *This is definitely the case for Germany, France, Austria, Belgium and the Netherlands. It is less clear-cut for Italy and Spain who went through various periods of floating exchange rate regimes during the sample. However, even in this case a large component of monetary policy innovations is likely to be common with the other countries.*

In Section 4, we examine whether these asymmetries in the effects of monetary policy are similar across countries. We find that the asymmetries are the most pronounced in Germany, France, Spain, Italy and Belgium. We also find that the effects of the monetary policy shock are much larger in Germany than in the other countries. To some extent this may be due to the large weight of the German economy in our estimates of the common monetary policy shock. Finally, in Section 5, we ask whether monetary policy shocks also affect the probability of switching from a boom to a recession and conversely. We find only weak evidence that a tightening of monetary policy reduces the probability of staying in a boom and no evidence that it increases the probability of going from a recession to a boom. We conclude with some final remarks in Section 6.

2 Is there a common cycle in the euro area?

In order to test whether monetary policy in the euro area has different effects in booms versus recessions it is necessary to determine the likely timing of switches in the state of the euro area business cycle. Hamilton's (1989) MSM approach provides a natural framework to use in this context, because it allows to endogenously determine the most likely switching dates between the two regimes. One option is to estimate Hamilton's MSM model on synthetic euro area output growth data and test whether there are indeed two regimes, one with a low or negative growth rate and one with a high growth rate. There are two problems with this euro area-wide approach. First, because of data availability the sample of quarterly observations is relatively small. As a result, the limited degrees of freedom make it quite difficult to distinguish empirically between the two regimes.[8] Second, by using the synthetic euro area data one implicitly assumes that the state of the economy is identical in each of the countries participating in EMU. If this is not the case, the results may be biased against finding two different regimes. A second option is to estimate the MSM model jointly for each of the countries participating in EMU. Joint estimation has the advantage that because of the higher degrees of freedom the estimates are likely to be more precise. In addition, it allows us to test whether the countries indeed share the same business cycle.[9]

In this paper we therefore follow the second approach. For each country *i*, out of *n* countries, we estimate the following equation:

$$[1] \quad \Delta y_{i,t} - \mu_{i,s_t} = \phi_1(\Delta y_{i,t-1} - \mu_{i,s_{t-1}}) + \phi_2(\Delta y_{i,t-2} - \mu_{i,s_{t-2}}) + \varepsilon_{i,t}$$

where

$$[2] \quad \begin{bmatrix} \varepsilon_{1,t} \\ \vdots \\ \varepsilon_{n,t} \end{bmatrix} \sim i.i.d.\, N\left(\begin{bmatrix} 0 \\ \vdots \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_{11} & \cdots & \sigma_{1n} \\ \vdots & \ddots & \vdots \\ \sigma_{1n} & \cdots & \sigma_{nn} \end{bmatrix} \right) = N(0, \Omega)$$

$\Delta y_{i,t}$ is the quarterly growth rate of industrial production in country i. μ_{i,s_t} is the mean growth rate conditional on country i being in state s_t. In this model, we assume that the state of the economy is identical in each of the n countries. Following Hamilton (1989), we assume that the autoregressive parameters (ϕ_1,ϕ_2) are independent of the state and the country.[10] s_t is assumed to follow a two-state Markov chain with the following transition probability matrix:[11]

8 *One reason for using industrial production indices rather than GDP figures is that the former show a stronger cyclical pattern, making it easier to identify the state of the business cycle.*

9 *See Hamilton and Perez-Quiros (1996) for an application of such a joint MSM model to different leading indicators.*

10 *An alternative model would be ,* $\Delta y_{i,t} = \mu_{i,s_t} + \phi_1 \Delta y_{i,t-1} + \phi_2 \Delta y_{i,t-2} + \varepsilon_{i,t}$ *in which case the shift in mean affects the growth rate immediately. We follow Hamilton (1989) and the previous literature by assuming a gradual adjustment to the new mean in equation (1). In principle one could test whether the autoregressive parameters are different across states and across countries. However, the limited degrees of freedom prevented us from estimating such an alternative model. Finally, we restricted the model to two lags, because further lags turned out to be insignificant.*

11 *In accordance with the usual typology of the business cycle in booms and recessions, we assume that there are only two states. Due to limited degrees of freedom we can not test whether more than two states would be appropriate.*

[3] $$P = \begin{bmatrix} p_{00} & p_{01} \\ p_{10} & p_{11} \end{bmatrix}$$

where

[4] $p_{ij} = \Pr[s_t = j \mid s_{t-1} = i]$, with $\sum_{j=0}^{1} p_{ij} = 1$ for all i.

We assume that these transition probabilities are constant over time and take the following logistic form:

[5] $$p_{00} = \Pr[s_t = 0 \mid s_{t-1} = 0] = \frac{\exp(\theta_0)}{1+\exp(\theta_0)}$$

[6] $$p_{11} = \Pr[s_t = 1 \mid s_{t-1} = 1] = \frac{\exp(\theta_1)}{1+\exp(\theta_1)}$$

For $Y_t = [\Delta y_{1,t} \ \cdots \ \Delta y_{n,t}]'$, the vector of observations on output growth, this model implies that the conditional density takes the form:

[7] $$f(Y_t \mid Y_{t-1},...,Y_1, s_t) = (2\pi)^{-1} |\Omega|^{-1/2} \exp\left[-\tfrac{1}{2}(Y_t - h_{t,s_t})' \Omega^{-1} (Y_t - h_{t,s_t})\right]$$

where

[8] $$h_{t,s_t} = \begin{bmatrix} \mu_{1,s_t} - \phi_1 \mu_{1,s_{t-1}} - \phi_2 \mu_{1,s_{t-2}} + \phi_1 \Delta y_{1,t-1} + \phi_2 \Delta y_{1,t-2} \\ \vdots \\ \mu_{n,s_t} - \phi_1 \mu_{n,s_{t-1}} - \phi_2 \mu_{n,s_{t-2}} + \phi_1 \Delta y_{n,t-1} + \phi_2 \Delta y_{n,t-2} \end{bmatrix}$$

With these assumptions, we also obtain a sequence of joint conditional probabilities $\Pr(s_t = i,...,s_{t-r} = j \mid \Phi_t)$ which are the probabilities that the series is in state *i* or *j* at times *t, t-1*, until *t-r* respectively, conditional upon the information available at time t. By summing these joint probabilities, we can obtain the filtered probabilities, which are the probabilities of being in state 0 or 1 at time *t*, given the information available at time *t*:

[9] $$\Pr(s_t = j \mid \Phi_t) = \sum_{i=0}^{1} \ldots \sum_{k=0}^{1} \Pr(s_t = j, s_{t-1} = i,..., s_{t-r} = k \mid \Phi_t) \quad i, j,..., k = 0,1$$

These probabilities provide information about the regime in which the series is most likely to have been at every point in the sample.

We estimate the model given by equations [1] to [9] using quarter-to-quarter growth rates of deseasonalised industrial production in eight of the eleven euro area countries: Germany, France, Italy, Spain, Austria, Belgium, the Netherlands and Finland. Graph 1 shows (de-trended) industrial production for each of these countries.

To test whether these eight countries indeed share the same business cycle, we estimate the joint model for seven of the eight countries and the eighth country separately. A comparison of the sum of the log likelihoods with the log likelihood of the eight-country model, can then be used to assess whether that country indeed has the same business cycle as the other seven. In Table 1 we report the log likelihoods as well as the corresponding Schwarz and Akaike statistics. Based on a visual inspection of Graph 1, we started with Finland as the country that was most likely not to share the same business cycle with the other countries. Column 2 of Table 1 shows indeed that the sum of the log likelihood of the Finnish model and the common model for the other seven countries is higher than the log likelihood of the common model for the eight countries (bottom row), so that we can reject the hypothesis that Finland is sharing the same business cycle with the other countries. The same exercise is then done for the other individual countries in column 3. The log likelihood of the individual country models and the common model for the other six countries are compared with a common model for the remaining seven countries. For these seven countries, we can not reject the hypothesis that they share the business cycle.[12] In the rest of the analysis we proceed with these seven countries.

The results of the estimation of our common model are reported in the first column of Table 2. A number of features are noteworthy. In each of the seven countries the mean growth rate in the first state (μ_0) is negative, ranging from –0.50 percent in Germany to –0.03 in the Netherlands. This state therefore corresponds to an euro area recession. Only in Germany, France and Belgium the growth rate in a recession is significantly different from zero. The probability of staying in a recession is relatively high at 0.85, which implies that the mean duration of a recession is about 6 to 7 quarters. In each of the seven countries, the mean growth rate in the second state (μ_1) is significantly positive, ranging from 0.66 percent in the Netherlands to 1.5 percent in Austria. This state therefore corresponds to an euro area expansion. The average duration of an expansion is longer than that of a recession at about 10 quarters.

The smoothed probabilities of being in a recession, together with the de-trended output level (respectively together with the output growth) are plotted in Graph 2 (respectively Graph 3). The shaded area is the smoothed probability of being in a recession. The main recessionary periods are from 1980 till 1982 and from 1990 till 1993. Somewhat more surprisingly also in 1986 and in the second half of 1995 the probability of being in a recession is relatively high.

3 The asymmetric effects of area-wide monetary policy shocks

In this Section we test whether monetary policy in the euro area has different effects on output when the economy is in a recession or an expansion. As our measure of the monetary policy stance in the euro area we take a weighted average of the three-month interest rate in each of the eleven countries participating in EMU. However, in order to avoid the simultaneity bias which may result from the fact that through the central banks' reaction function short-term interest rates depend on economic activity, we use monetary policy innovations derived from an identified VAR.[13] Section 3.1. presents the VAR results. In Section 3.2, we then extend the multivariate MSM model of Section 2 to include the effects of those monetary policy shocks.

3.1 A monetary policy VAR for the euro area

To derive the euro area-wide monetary policy shocks we follow Peersman and Smets (2000a). They estimate the following block-recursive VAR model over the period 1978-1998:

$$[10] \quad \begin{bmatrix} X_t \\ Y_t \end{bmatrix} = \begin{bmatrix} A(L) & 0 \\ B(L) & C(L) \end{bmatrix} \begin{bmatrix} X_{t-1} \\ Y_{t-1} \end{bmatrix} + \begin{bmatrix} a & 0 \\ b & c \end{bmatrix} \begin{bmatrix} \varepsilon_{X,t} \\ \varepsilon_{Y,t} \end{bmatrix},$$

12 *A border case is the Netherlands, where the Schwartz criterium of the six-plus-one model is marginally below the joint business cycle model.*

13 *More correctly, we will use the historical contribution to the interest rate of the monetary policy shocks as our benchmark measure. See Section 3.1. below.*

where X_t is a vector of exogenous variables comprising a world commodity price index, the US short-term interest rate and US real GDP and Y_t is a vector of endogenous euro area data including real GDP, consumer prices, the nominal 3-month short-term interest rate and a real effective exchange rate. The monetary policy shocks are identified through a recursive Choleski decomposition with the variables ordered as mentioned above.[14] The identifying assumptions are thus that monetary policy shocks do not have a contemporaneous impact on output and prices. A monetary policy shock does have an immediate impact on the exchange rate, but the central bank does not respond to changes in the exchange rate within the quarter.

The results of the VAR analysis are shown in Graph 4. This Graph summarises the effect of a one-standard deviation monetary policy shock on real GDP, consumer prices, the real effective exchange rate and the short-term interest rate together with a 90 percent confidence band. From the Graph it is clear that a typical monetary policy tightening in the euro area gives rise to a temporary increase of the nominal interest rate and a temporary appreciation of the real exchange rate. This tightening of monetary conditions leads to a significant, temporary fall in output after about two quarters. Prices respond more sluggishly and fall significantly below zero after about two years.

In the next Section we will use the historical contribution of the monetary policy shocks to the euro area interest rate, as depicted in Graph 5, as our benchmark measure of monetary policy impulses in the extended MSM model.[15] The advantage of using the historical contribution to the interest rate rather than the monetary policy shocks themselves is that fewer lags need to be used in the MSM, as the historical contribution is itself a moving average of the monetary policy shocks. From Graph 5, which plots the historical contribution of the monetary policy shocks together with the short-term interest rate, it is clear that the years 1982, 1987, 1990 and 1992-93 are identified as periods of relatively tight monetary policy, whereas in 1984 and 1991 policy is estimated to be relatively loose.[16]

3.2 Monetary policy shocks in the multivariate MSM model

In order to test whether there are asymmetric effects of monetary policy on output growth depending on the state of the business cycle at the moment the monetary policy stance changes, we extend the basic model of Section 2 as follows:

$$[11] \quad \Delta y_{i,t} - \mu_{i,s_t} = \phi_1(\Delta y_{i,t-1} - \mu_{i,s_{t-1}}) + \phi_2(\Delta y_{i,t-2} - \mu_{i,s_{t-2}}) + \beta_{s_{t-1}} MP_{t-1} + \varepsilon_{i,t} \;,$$

where β_{s_t} is the coefficient on the monetary policy indicator (MP_t) in a recession (s_t=0) or an expansion (s_t=*1*). In this specification we assume that the β-coefficients are identical across countries. The other variables are the same as in equation [1].

The results are reported in the second column of Table 2. It is clear that a tightening of monetary policy has a significant negative impact in both states of the euro area economy. However, as expected, the effects on economic activity are significantly larger in a recession compared to those in an expansion. Graph 6 (upper panel) plots the impulse response function of output to a one-standard deviation monetary policy shock in respectively a recession (full line) and an expansion (dotted line). As in the VAR the maximum impact is after 3 to 4 quarters, but while in a recession

14 These identifying assumptions are similar to the ones used by Eichenbaum and Evans (1995) for the United States.

15 The historical contribution of the monetary policy shock to the short-term interest rate consists of the cumulated effects of current and past monetary policy shocks on the interest rate.

16 As the identification of monetary policy shocks is a controversial matter, we will also use the change in the short-term interest rate as an alternative monetary policy indicator in Section 3.2.

the maximum impact on output is more than 50 basis points, the impact in an expansion is only about 30 basis points.

In order to test the robustness of our results, we re-estimate the model assuming that the effects of a monetary policy action on output growth depend on the current state of the economy. In this case, the following model is estimated:

$$[12] \quad \Delta y_{i,t} - \mu_{i,s_t} = \phi_1(\Delta y_{i,t-1} - \mu_{i,s_{t-1}}) + \phi_2(\Delta y_{i,t-2} - \mu_{i,s_{t-2}}) + \beta_{s_t} MP_{t-1} + \varepsilon_{i,t}$$

These results are reported in the third column of Table 2. In this case the difference between the monetary policy effects in a recession and an expansion are smaller, though still significant. This is also reflected in the middle panel of Graph 6. Finally, the fourth column of Table 2 reports the results when we use the first difference of the interest rate as our monetary policy indicator. Again, we find a significantly larger effect of monetary policy in a recession versus an expansion. The bottom panel of Graph 6 plots the impulse response functions to a monetary policy shock in both regimes.

4 Are the monetary policy effects different across countries?

In Section 3 we assumed that the effects of the euro area-wide monetary policy shocks were different across states of the economy, but identical across countries. In order to test whether this is indeed the case, we allow the β-coefficients in equation [11] to vary across countries. Table 3 reports the results of this exercise. The upper and middle panel report the estimates of β_0 and β_1 for each of the countries as well as the differences across countries. The lower panel reports the estimates of the difference between β_0 and β_1.

Several results are noteworthy. First, in all cases the effect of monetary policy on output growth is negative. In a recession the effect varies from –0.60 in the Netherlands to –1.44 in Germany and (with the exception of the Netherlands) is always significant. This compares with an average effect of –0.89 in the restricted model of Section 3. The effect on output during downturns is significantly larger in Germany than in the other countries. In an expansion, the effect ranges from –0.21 in France to –0.76 in Austria, compared to –0.52 in the restricted model of Section 3.

Second, with the exception of the Netherlands, the effect of policy is always greater in downturns than in booms. The difference is high and significant in Germany, France, Spain and Belgium and high, but less significant in Italy. There is little evidence of asymmetries in Austria and the Netherlands. In the latter case, this may be due to the fact that the Dutch business cycle was not completely in line with the euro area one. Overall, there appears little evidence of significant differences in asymmetries across countries.

These results are confirmed in the impulse response analysis presented in Graph 7.

5 Does monetary policy change the likelihood of a recession?

In this final Section we follow Garcia and Schaller (1995) and Dolado and Maria-Dolores (1999) in testing whether changes in monetary policy also affect the transition probabilities of going from one state to the other. In the MSM models of Sections 2 and 3 these probabilities were assumed to be constant. To do so, we modify the logit functions [5] and [6] determining the transition probabilities as follows:

$$[14] \quad p_{00} = \Pr[s_t = 0 | s_{t-1} = 0] = \frac{\exp(\theta_{00} + \theta_{01} MP_t)}{1 + \exp(\theta_{00} + \theta_{01} MP_t)}$$

$$[15] \quad p_{11} = \Pr[s_t = 1 | s_{t-1} = 1] = \frac{\exp(\theta_{10} + \theta_{11} MP_t)}{1 + \exp(\theta_{10} + \theta_{11} MP_t)}$$

Moreover, in order to isolate the effect of the shocks on the transition probabilities from the linear effect examined above, we constrain the β-coefficients to be equal to zero as in equation [1]. Based on equations [14] and [15], we would expect θ_{01} to be positive as a monetary policy tightening is likely to increase the probability of staying in a recession. In contrast, θ_{11} is expected to be negative as a monetary policy tightening is expected to reduce the probability of staying in an expansion.

Table 4 reports the results when we use both the monetary policy shock and the first difference of the interest rate as our measure of changes in the monetary policy stance. From these results, it is clear that θ_{01} is insignificant suggesting that monetary policy shocks have no effect on the probability of staying in a recession. We do find that θ_{11} is negative, but it is only significantly different from zero at the 10% confidence level.

6 Conclusions

In this paper we have investigated whether monetary policy impulses have asymmetric effects on the growth rate of industrial production in seven countries of the euro area (Germany, France, Italy, Spain, Austria, Belgium and the Netherlands). In particular, we have analysed whether these effects are stronger in recessions than in expansions. Such asymmetric effects could arise in models with a convex short-run aggregate supply curve (e.g. due to capacity constraints) or in models in which the financial accelerator propagation mechanism is more potent when the economy is in a recession.

We have first shown that one can not reject the hypothesis that these seven countries share the same business cycle. This result is of interest in itself because it suggests that in a large part of the euro area cyclical differences have not been an important factor in the past twenty years. Next, we have found strong evidence that area-wide monetary policy impulses, measured as the contribution of monetary policy shocks to the short-term interest rate in a simple VAR for the euro area economy, have significantly larger effects on output growth in recessions than in booms. Impulse response functions show that on average the maximum impact of a standardised monetary policy shock on output is about 20 basis points larger in a recession than in a boom. These differences are most pronounced in Germany, France, Spain, Italy and Belgium, while they are not significant in Austria and the Netherlands. Finally, we have also analysed whether monetary policy shocks also affect the probability of going from one state to another. We do not find strong evidence that this is indeed the case.

The results of this paper confirm that it may be useful to investigate in future research which factors give rise to these asymmetries. In Peersman and Smets (2000b) we try to make a first step in that direction by analysing asymmetries across industries in the euro area. Differences in asymmetries in the impact of monetary policy across industries can then be related to industry-specific factors such as financial and economic structure, which may give important insights in which factors drive those asymmetries.

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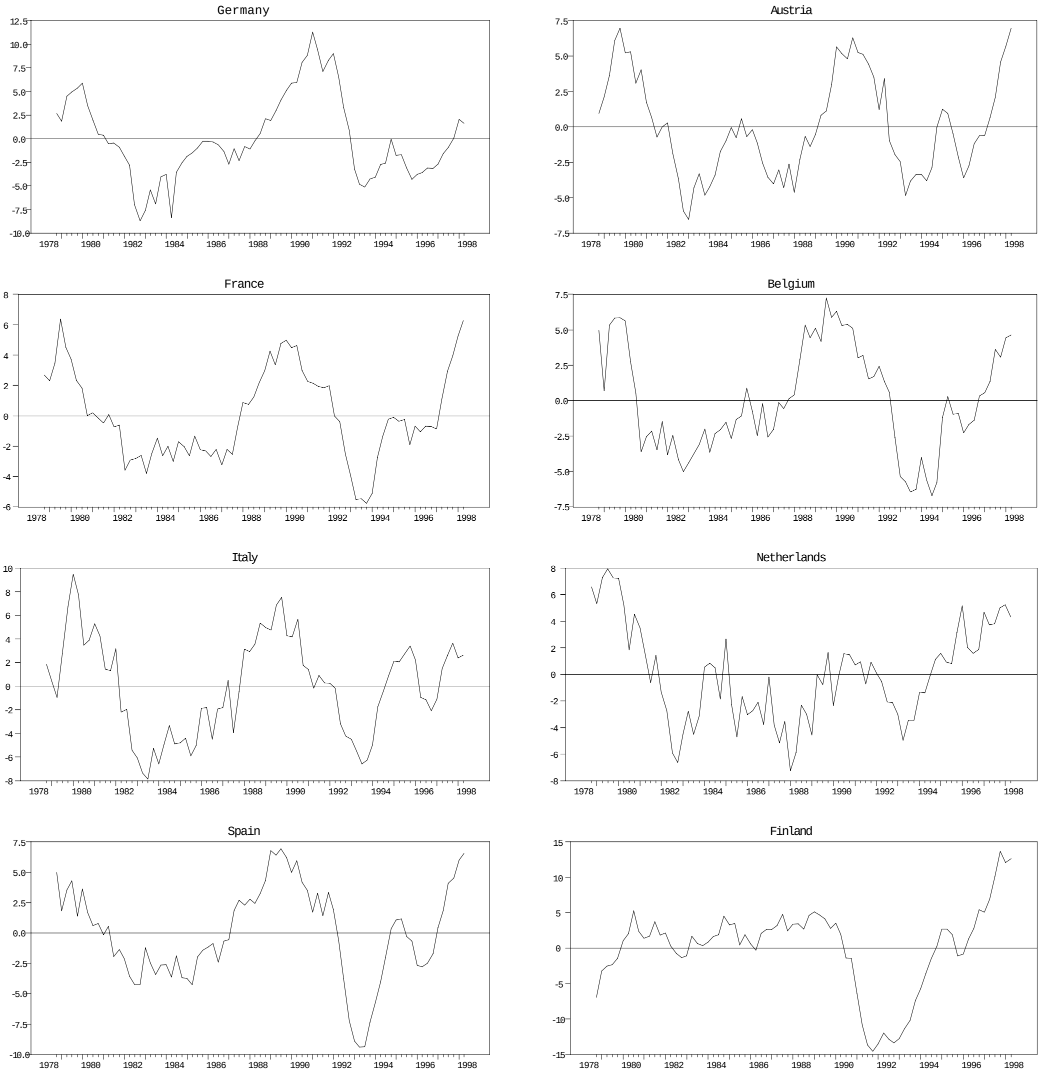
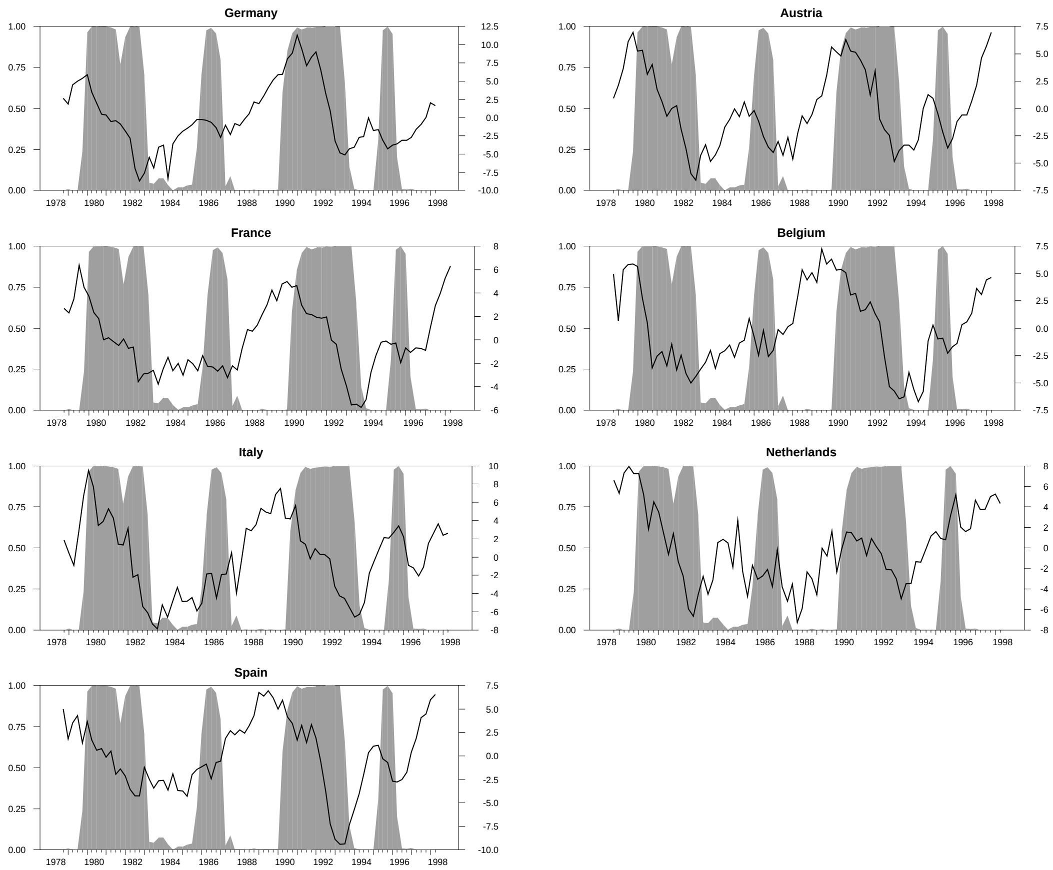
Graph 1
De-trended industrial production in eight euro-area countries



Graph 2

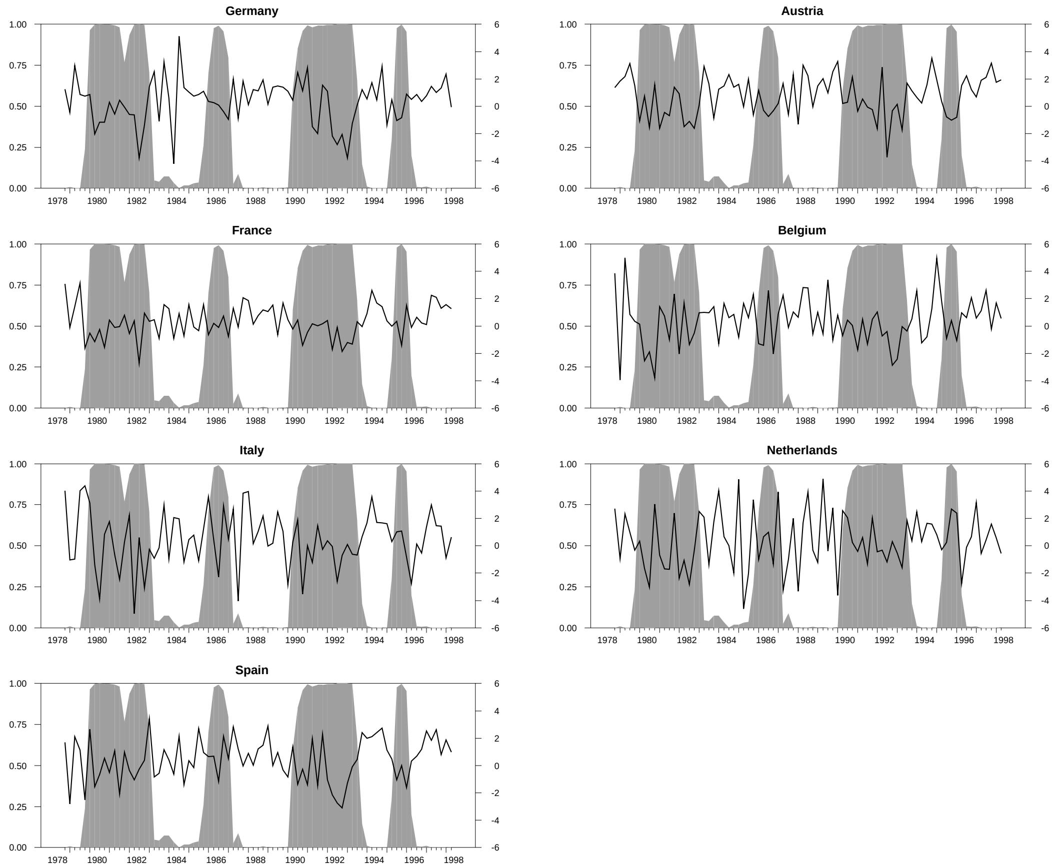
De-trended industrial production and the probability of being in a recession



Note: Right axis: detrended industrial production. The shaded areas denote the probability of being in a recession (Left axis)

Graph 3

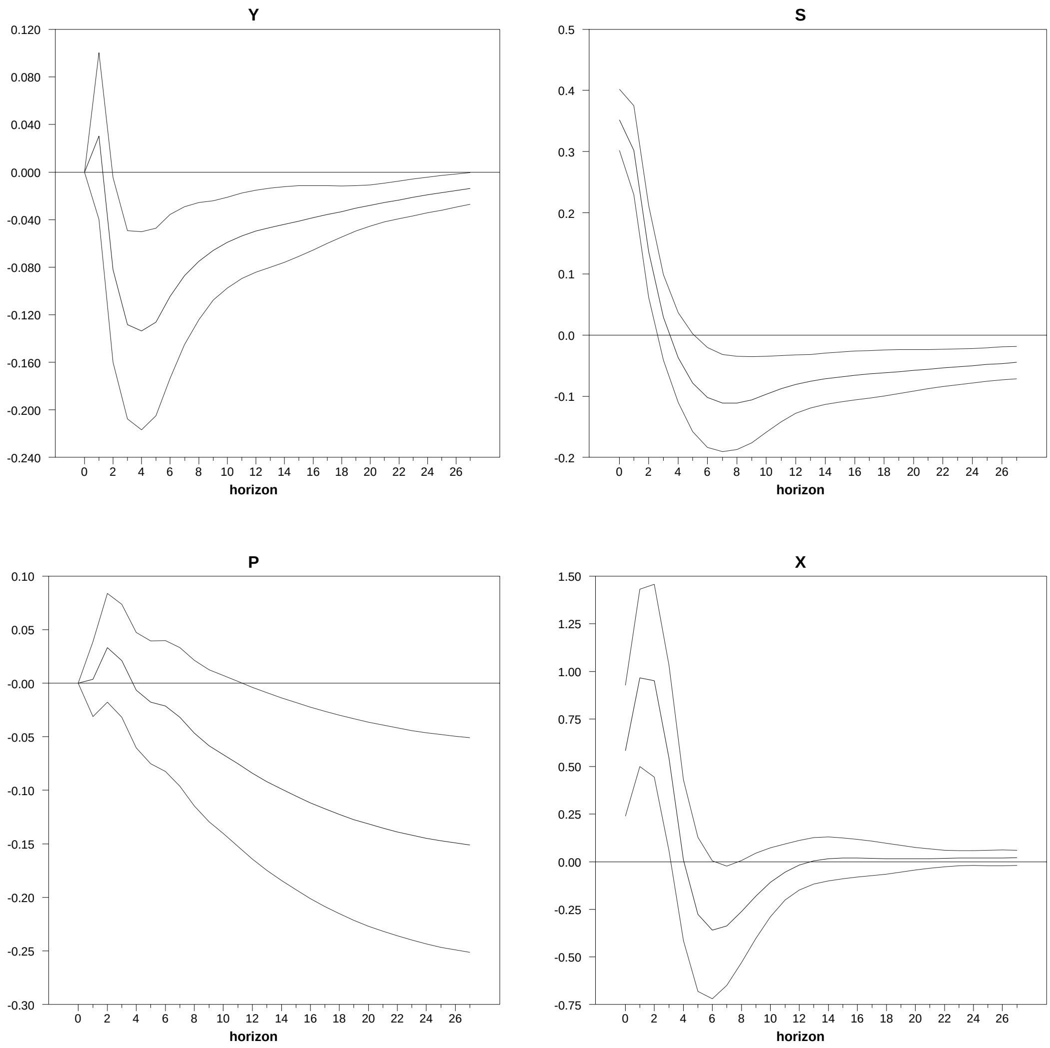
Industrial production growth and the probability of being in a recession



Note: Right axis: industrial production growth. The shaded areas denote the probability of being in a recession (Left axis)

Graph 4

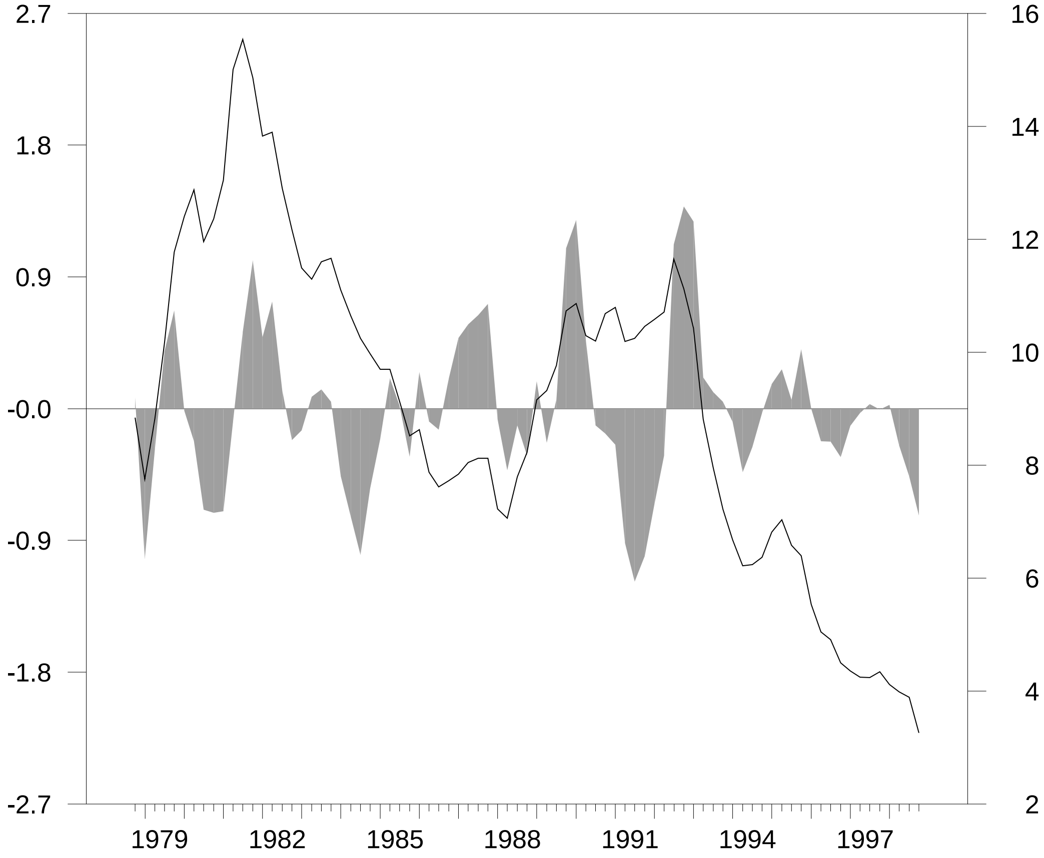
Impulse responses to a monetary policy shock in the euro area



Notes: Y is real GDP, S is the short-term nominal interest rate, P is the consumer price level and X is the real effective exchange rate.

Graph 5

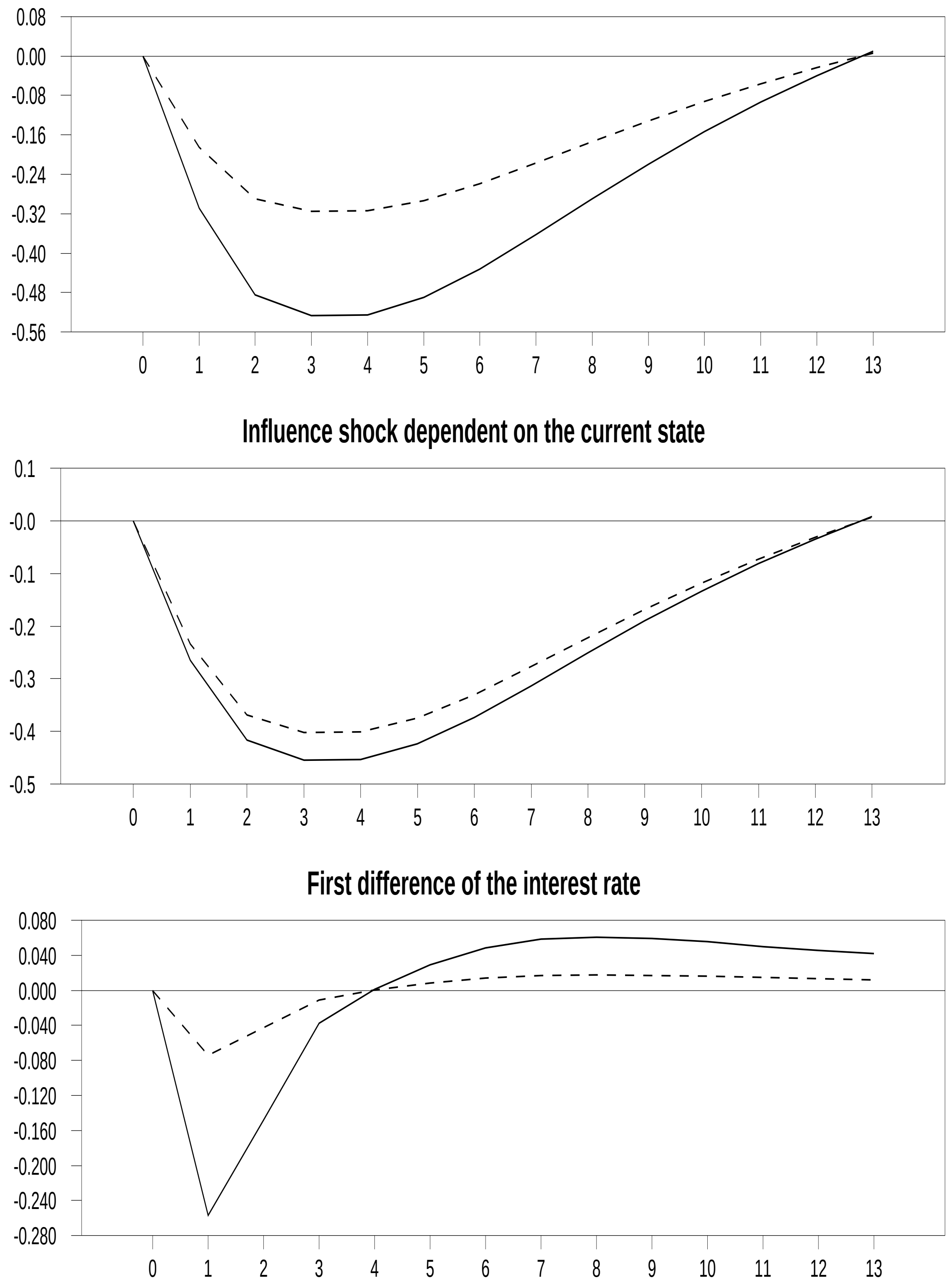
Contribution of the monetary policy shock to the short-term interest rate



Notes: The shaded area is the contribution of the monetary policy shocks to the short-term interest rate (left axis); the solid line is the short-term interest rate itself (right axis).

Graph 6

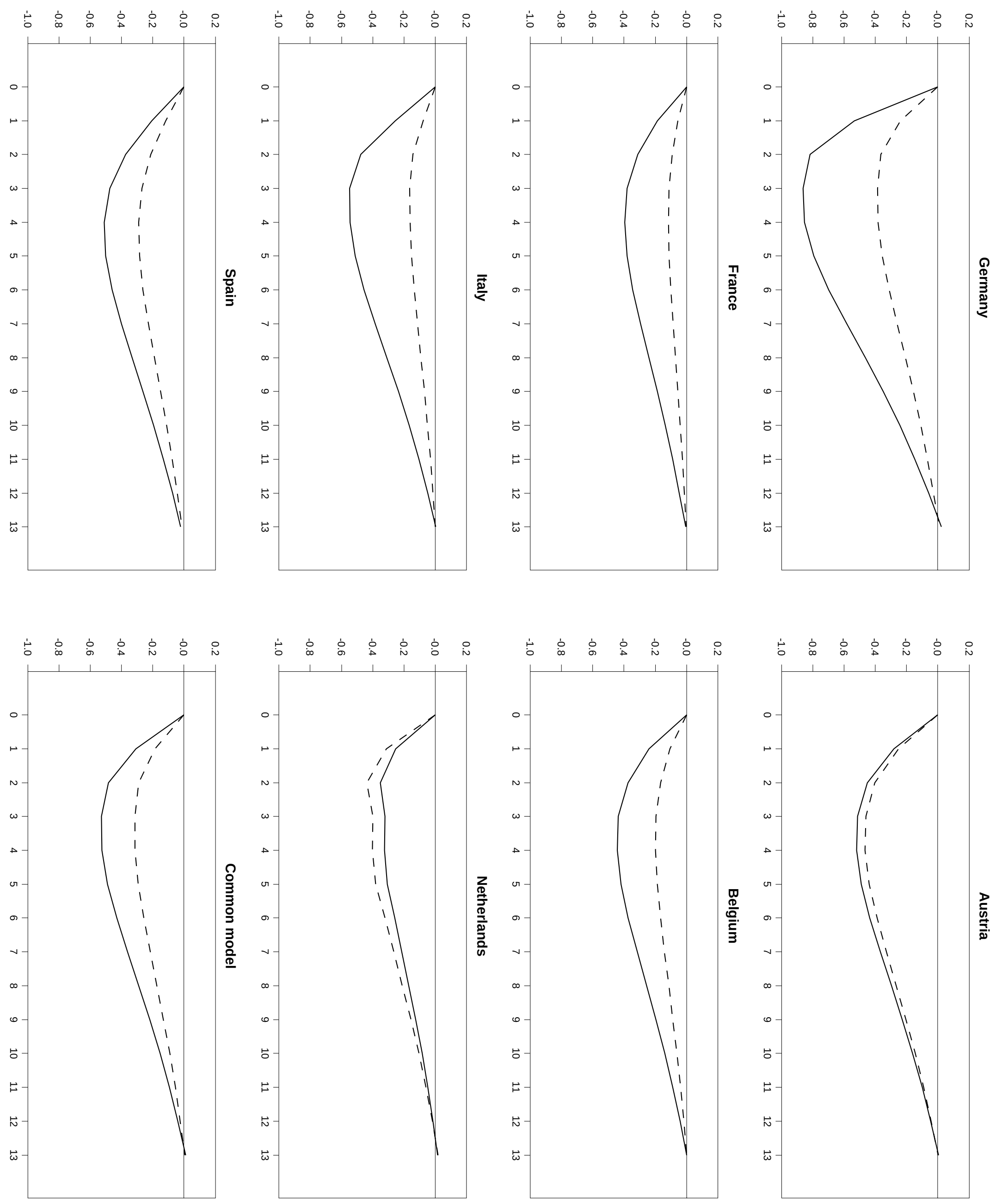
Impulse responses to a monetary policy shock



Notes: Solid line is the effect on production in a recession; dashed line is the effect in a boom

Graph 7

Impulse response to a monetary policy shock: individual countries



Notes: Solid line is the effect on production in a recession; dashed line is the effect in a boom

Table 1

Tests for a common business cycle in the euro area

Countries	7+1 countries			6+1 countries		
	Log lik	Schwarz	Akaike	Log lik	Schwarz	Akaike
DE				-622.83	-718.75	-666.83
FR				-625.71	-721.63	-669.71
IT				-627.87	-723.79	-671.87
ES				-623.62	-719.54	-667.62
AT				-632.43	-728.35	-676.43
BE				-619.55	-715.47	-663.55
NL				-617.31	-713.23	-661.31
FI	-699.36	-814.90	-752.36			

	Log lik	Schwarz	Akaike
DE,FR,IT,ES,AT,BE,NL,FI	-702.09	-824.17	-758.09
DE,FR,IT,ES,AT,BE,NL	-613.32	-713.60	-659.32

Note: The constant term involving 2π has been omitted from all calculations.

Table 2

The cyclical effects of monetary policy

		Common model	Common model + MP (s_{t-j})	Common model + MP (s_t)	Common model + Δi (s_{t-j})
Germany	μ_0	-0.50 (0.24)	-1.00 (0.16)	-0.97 (0.17)	-1.92 (0.26)
	μ_1	1.03 (0.17)	1.15 (0.12)	1.16 (0.12)	1.01 (0.12)
France	μ_0	-0.35 (0.14)	-0.58 (0.14)	-0.55 (0.14)	-0.97 (0.23)
	μ_1	0.87 (0.13)	0.86 (0.10)	0.86 (0.11)	0.68 (0.10)
Italy	μ_0	-0.28 (0.30)	-0.25 (0.29)	-0.22 (0.30)	-0.90 (0.41)
	μ_1	1.00 (0.24)	0.84 (0.21)	0.85 (0.22)	0.80 (0.20)
Spain	μ_0	-0.28 (0.22)	-0.34 (0.21)	-0.31 (0.22)	-0.99 (0.31)
	μ_1	0.98 (0.17)	0.86 (0.15)	0.87 (0.16)	0.81 (0.14)
Austria	μ_0	-0.24 (0.19)	-0.53 (0.16)	-0.50 (0.16)	-0.71 (0.28)
	μ_1	1.50 (0.15)	1.47 (0.11)	1.48 (0.11)	1.13 (0.15)
Belgium	μ_0	-0.44 (0.22)	-0.57 (0.23)	-0.54 (0.23)	-1.22 (0.32)
	μ_1	1.02 (0.18)	0.93 (0.16)	0.93 (0.17)	0.82 (0.15)
Netherlands	μ_0	-0.03 (0.32)	-0.42 (0.26)	-0.38 (0.27)	-0.63 (0.38)
	μ_1	0.66 (0.23)	0.80 (0.19)	0.81 (0.19)	0.61 (0.18)
Common coefficients	ϕ_1	-0.24 (0.04)	-0.28 (0.04)	-0.28 (0.04)	-0.26 (0.04)
	ϕ_2	-0.07 (0.04)	-0.08 (0.04)	-0.08 (0.04)	-0.08 (0.04)
	p_{00}	0.85 (0.07)	0.78 (0.08)	0.78 (0.08)	0.62 (0.12)
	p_{11}	0.90 (0.05)	0.89 (0.04)	0.88 (0.05)	0.89 (0.04)
	β_0		-0.89 (0.14)	-0.75 (0.14)	-0.73 (0.34)
	β_1		-0.52 (0.15)	-0.66 (0.16)	-0.20 (0.19)
	β_1-β_0		0.37 (0.03)	0.08 (0.04)	0.52 (0.12)

Note: standard errors in parenthesis

Table 3

The cyclical effects of monetary policy in the individual countries

	β_0	NL	AT	BE	DE	ES	FR
NL	-0.60						
	0.37						
AT	-0.89	-0.28					
	0.22	*0.19*					
BE	-0.72	-0.12	0.16				
	0.33	*0.24*	*0.14*				
DE	-1.44	-0.84	-0.55	-0.71			
	0.23	*0.19*	*0.10*	*0.13*			
ES	-0.99	-0.39	-0.10	-0.27	0.44		
	0.32	*0.23*	*0.14*	*0.14*	*0.12*		
FR	-0.65	-0.04	0.23	0.07	0.79	0.34	
	0.20	*0.16*	*0.93*	*0.11*	*0.06*	*0.08*	
IT	-0.88	-0.28	0.00	-0.15	0.55	0.11	-0.23
	0.43	*0.28*	*0.21*	*0.24*	*0.20*	*0.19*	*0.16*

	β_1	NL	AT	BE	DE	ES	FR
NL	-0.74						
	0.43						
AT	-0.76	-0.01					
	0.25	*0.24*					
BE	-0.28	0.46	0.47				
	0.36	*0.30*	*0.18*				
DE	-0.65	0.08	0.10	-0.37			
	0.25	*0.22*	*0.13*	*0.16*			
ES	-0.44	0.30	0.31	-0.15	0.21		
	0.34	*0.28*	*0.18*	*0.17*	*0.15*		
FR	-0.21	0.53	0.54	0.07	0.44	0.23	
	0.22	*0.20*	*0.11*	*0.14*	*0.08*	*0.10*	
IT	-0.24	0.50	0.52	0.04	0.41	0.20	-0.02
	0.47	*0.34*	*0.26*	*0.31*	*0.25*	*0.24*	*0.20*

	$\beta_1 - \beta_0$	NL	AT	BE	DE	ES	FR
NL	-0.14						
	0.35						
AT	0.12	0.27					
	0.11	*0.45*					
BE	0.43	0.58	0.31				
	0.24	*0.58*	*0.33*				
DE	0.78	0.92	0.65	0.34			
	0.11	*0.44*	*0.24*	*0.30*			
ES	0.55	0.69	0.42	0.11	-0.23		
	0.23	*0.54*	*0.32*	*0.32*	*0.27*		
FR	0.43	0.58	0.31	-0.00	-0.34	-0.11	
	0.09	*0.38*	*0.20*	*0.25*	*0.15*	*0.19*	
IT	0.64	0.78	0.51	0.20	-0.14	0.09	0.20
	0.41	*0.66*	*0.48*	*0.56*	*0.46*	*0.44*	*0.37*

Note: standard errors in italics.

Table 4

The effects of monetary policy on state switches

		MP-shock	ΔI
Germany	μ_0	-0.53 (0.22)	-0.75 (0.23)
	μ_1	1.05 (0.17)	1.04 (0.15)
France	μ_0	-0.36 (0.14)	-0.38 (0.15)
	μ_1	0.87 (0.12)	0.77 (0.12)
Italy	μ_0	-0.39 (0.27)	-0.30 (0.31)
	μ_1	1.07 (0.23)	0.89 (0.22)
Spain	μ_0	-0.28 (0.22)	-0.37 (0.23)
	μ_1	0.97 (0.17)	0.91 (0.16)
Austria	μ_0	-0.31 (0.17)	-0.40 (0.18)
	μ_1	1.54 (0.15)	1.43 (0.13)
Belgium	μ_0	-0.49 (0.21)	-0.49 (0.23)
	μ_1	1.05 (0.18)	0.91 (0.17)
Netherlands	μ_0	-0.04 (0.26)	-0.19 (0.29)
	μ_1	0.66 (0.23)	0.69 (0.21)
Common coefficients	ϕ_1	-0.24 (0.04)	-0.24 (0.04)
	ϕ_2	-0.07 (0.04)	-0.06 (0.04)
	θ_{00}	1.72 (0.57)	2.56 (1.00)
	θ_{01}	-0.75 (0.66)	1.86 (1.28)
	θ_{10}	2.10 (0.61)	2.66 (0.71)
	θ_{11}	-1.81 (1.06)	-1.60 (0.99)

Note: standard errors in parenthesis

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