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THE INDUSTRY EFFECTS OF MONETARY POLICY IN THE EURO AREA*

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We first estimate the effects of a euro area-wide monetary policy change on output growth in eleven industries of seven euro area countries over the period 1980–98. On average the negative effect of an interest rate tightening on output is significantly greater in recessions than in booms. There is, however, considerable cross-industry heterogeneity in both the overall policy effects and the degree of asymmetry across the two business cycle phases. We then explore which industry characteristics can account for this cross-industry heterogeneity. Differences in the overall policy effects can mainly be explained by the durability of the goods produced in the sector. This can be regarded as evidence for the conventional interest rate/cost-of-capital channel. In contrast, differences in the degree of asymmetry of policy effects are related to differences in financial structure, in particular the maturity structure of debt, the coverage ratio, financial leverage and firm size. This suggests that financial accelerator mechanisms can partly explain cross-industry differences in asymmetry.

Recent research (Garcia and Schaller, 1995; Kakes, 1998; Dolado and Maria-Dolores, 1999; Peersman and Smets, 2001*b*) has highlighted that monetary policy has stronger effects on economic activity in recessions than in expansions. However, these studies do not distinguish between various explanations for this asymmetry. In this paper we shed some light on this question by analysing which industries are relatively more affected in downturns. We proceed in two steps. First, we estimate the effects of a common monetary policy shock on eleven manufacturing industries in seven countries of the euro area (Austria, Belgium, France, Germany, the Netherlands, Italy and Spain) and document the cross-industry heterogeneity of the output effects of an area-wide monetary policy innovation. We show that in line with the literature mentioned above most industries are more strongly affected in cyclical downturns than in booms. There are, however, considerable cross-industry differences in the degree of asymmetry across business cycle phases.

Second, we try to explain the cross-industry heterogeneity on the basis of individual industry characteristics. Following Dedola and Lippi (2000), it is useful to distinguish between two broad channels: the interest rate channel and the broad credit channel. As proxies for the determinants of the interest rate channel, we use an industry dummy for the durability of the goods produced by the sector, industry measures of investment intensity and the degree of openness to capture exchange rate sensitivity. As the traditional interest rate channel is expected to be operative both in booms and recessions, one should not expect significantly different explanatory power of these industry characteristics in different stages of the business cycle.

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As proxies for the determinants of the broad credit channel, we construct a number of indicators that may be associated with the strength of financial accelerator effects. These indicators include proxies for the size of the firms in the industry and the financial structure of the industry such as financial leverage, the maturity structure of debt, the financing need for working capital and the ratio of cash-flow over interest rate payments. In contrast to the traditional interest rate channel, financial accelerator theories typically predict that monetary policy will have larger output effects in a recession than during a boom.[1] The reason is that the external finance premium, which depends on the net worth of the borrower, will be more sensitive to monetary policy actions during a recession when cash flows are low, firms are more dependent on external finance and collateral values are depressed. In sum, we expect the proxies for the traditional interest rate channel to have a significant influence on the overall impact of policy, but not on the differential effect across booms and recessions. In contrast, the indicators of financial structure are likely to explain why some industries are relatively more sensitive to monetary policy changes in recession versus booms.

This paper is related to at least three strands of the empirical literature on the monetary transmission mechanism. First, a number of papers such as Ganley and Salmon (1997), Hayo and Uhlenbrock (2000) and Dedola and Lippi (2000) have recently examined the industry effects of monetary policy shocks. All these papers find considerable cross-industry heterogeneity in the impact of monetary policy. Ganley and Salmon (1997) and Hayo and Uhlenbrock (2000) examine the industry effects in respectively the UK and Germany. Our study follows most closely Dedola and Lippi (2000) who systematically analyse 20 industries in five OECD countries (Germany, France, Italy, the UK and the US). They find that the cross-industry distribution of policy effects is similar across countries and that these patterns are systematically related to industry output durability and investment intensity, and to measures of firms' borrowing capacity, size and interest payment burden. In this study we focus on seven countries of the euro area. In addition, we also analyse explicitly business cycle asymmetries in the industry effects of monetary policy, which is the main contribution of the paper.

Second, as mentioned above, our study is related to the literature that examines whether monetary policy has different effects in booms versus recessions (Garcia and Schaller, 1995; Kakes, 1998; Dolado and Maria-Dolores, 1999; and Peersman and Smets, 2001*b*). In a variety of countries, those studies show that monetary policy has stronger output effects in recessions than in expansions. These studies are, however, not able to distinguish between various explanations for this asymmetry. In particular, it is not clear whether the asymmetries are driven by asymmetric financial accelerator effects or by the fact that the short-run aggregate supply curve is convex as in the so-called capacity constraint model. In the latter model, 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. Using the

[1] See, for example, Bernanke and Gertler (1989), Gertler and Hubbard (1988), Azariadis and Smith (1998), Kocherlakota (2000).

cross-industry variation, our study is able to test whether indicators of financial structure and average size can explain the degree of asymmetry.

Finally, our study also sheds light on the empirical literature that tries to test the empirical implications of financial accelerator theories more directly. A number of studies find that investment of small firms, which are assumed to have less access to alternative forms of finance, has more liquidity constraint during downturns. For example, Kashyap *et al.* (1994) find for the US that the inventory investment of firms without access to public bond markets was significantly liquidity-constrained during the 1981–2 and 1974–5 recessions, in which tight money also appears to have played a role. In contrast, such liquidity constraints are largely absent during periods of looser monetary policy. Gertler and Gilchrist (1994), who examined movements in sales, inventories and short-term debt for small and large manufacturing firms, confirm that the effects of monetary policy changes on small-firm variables are greater when the sector as a whole is growing more slowly. Non-linearity is also detected by Oliner and Rudebusch (1996), who find that cash flow effects on investment are stronger after periods of tight money. Finally, for the four largest euro area economies, Vermeulen (2002) provides evidence that weak balance sheets are more important in explaining investment during downturns than during upturns.

The rest of the paper is structured as follows. In Section 1, we first discuss our methodology for estimating the industry effects of a euro area-wide monetary policy change (Section 1.1). This requires a measure of the euro area wide monetary policy stance. In addition, we also need a business cycle indicator for the euro area to test whether the policy effects are different in booms versus recessions. For both variables we rely on earlier work. We, then, present the estimation results and discuss to what extent the effects of policy vary across countries, sectors and business cycle phases (Section 1.2). Next, in Section 2 we discuss the industry characteristics that we use (Section 2.1) and present the results of the regression analysis (Section 2.2). We perform a number of robustness checks in Section 3. The main conclusions of our analysis can be found in Section 4.

1. The Industry Effects of Monetary Policy

In this Section we estimate and describe the effects of a euro area-wide monetary policy shock on output in eleven manufacturing industries in seven euro area countries (Austria, Belgium, France, Germany, Italy, the Netherlands and Spain). A list of the manufacturing industries considered is provided in the Appendix. We also examine to what extent these effects are different in booms versus recessions.

1.1. *Methodology*

In order to derive the output effects of monetary policy, we estimate for each individual industry i of country j the following linear regression equation:

$$\begin{aligned}\Delta y_{ij,t} = {} & (\alpha_{ij,0} p_{0,t} + \alpha_{ij,1} p_{1,t}) + \phi_{ij,1} \Delta y_{ij,t-1} + \phi_{ij,2} \Delta y_{ij,t-2} \\ & + (1 - \phi_{ij,1} - \phi_{ij,2})(\beta_{ij,0} p_{0,t-1} MP_{t-1} + \beta_{ij,1} p_{1,t-1} MP_{t-1}) + \varepsilon_{ij,t}\end{aligned} \quad (1)$$

where $\Delta y_{ij,t}$ is the quarterly growth rate of production in industry i of country j, MP_t is the monetary policy indicator and $p_{0,t}$ and $p_{1,t}$ are the probabilities of being in respectively a recession or an expansion at time t ($p_{0,t} + p_{1,t} = 1$).[2]

This reduced-form output equation is inspired by the Markov-Switching model estimated in Peersman and Smets (2001*b*). Peersman and Smets (2001*b*) show that this model is able to capture the effects of monetary policy innovations on output in the seven euro area countries considered in this study. Compared to the VAR approach used in Ganley and Salmon (1997), Hayo and Uhlenbrock (2000) and Dedola and Lippi (2000), the biggest advantage of this specification is its simplicity. The single equation approach makes it easy to extend the model to distinguish between business cycle phases. The parameters β_0 and β_1 give the long-run effects of monetary policy on the industry's output in a recession and an expansion respectively.[3]

In contrast to Dedola and Lippi (2000) who use domestic monetary policy impulses, we want to analyse the effects of a euro area-wide change in monetary policy on the various industries. We think this is a useful exercise not only because it more closely resembles the current policy regime with a single euro area-wide monetary policy but also because during most of the sample period domestic monetary policies in the seven countries considered were to a large extent coordinated through the participation in the ERM and other fixed exchange rate mechanisms.[4]

In order to avoid the simultaneity bias which may result from the fact that short-term interest rates depend on economic activity through the central banks' reaction function, we follow Peersman and Smets (2001*b*) and use the contribution of monetary policy shocks to the euro area interest rate in an identified VAR as our measure of monetary policy impulses.[5] The identified VAR we use is described in Peersman and Smets (2001*a*). Figure 1 plots the historical contribution of the monetary policy shocks together with the short-term interest rate. From the Figure 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.

In order to distinguish booms from recessions, we again follow an area-wide approach and use the filtered recession probabilities derived in Peersman and Smets (2001*b*). Peersman and Smets (2001*b*) estimate a MSM model jointly for each of the seven countries in our analysis and show that those seven countries

[2] We will treat both the monetary policy innovations and the recession probabilities as exogenous to output growth in the individual industry. Results of estimating a Markov-switching model (and recession probabilities) at the individual industry level are not plausible for a majority of the industries.

[3] Due to the number of parameters included, estimating an MS-VAR (in order to estimate the impact in recessions and booms) for all 77 individual industries is not possible. The single-equation approach will also allow us to do the analysis of the cross-industry heterogeneity of the policy effects in one step using a panel data approach. See Section 4 below.

[4] 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.

[5] We use the contribution of the shocks to the interest rate rather than the shocks themselves because this allows us to cut down on the number of lags in the Markov-switching model. In order to check the robustness of the results, in Section 3.2, we also report the results when 3 lags of the monetary policy innovations are included as an alternative.

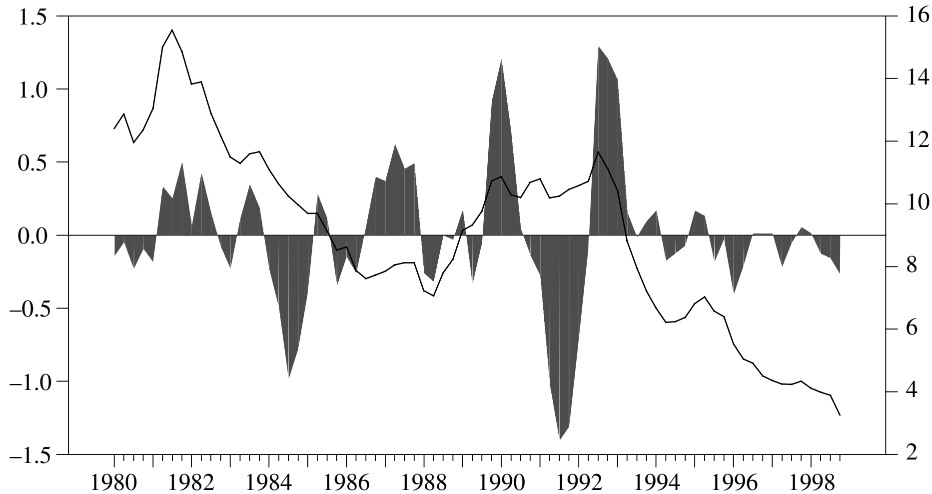

Fig. 1. *Contribution of the Monetary Policy Shock to the Short-term Interest Rate*
Note: The shaded area is the contribution of the monetary policy shocks to the short-term interest rate (left axis); the solid line is the short-term interest rate itself (right axis).

share the same business cycle. Figure 2 plots the smoothed probabilities ($p_{0,t}$ and $p_{1,t}$), together with the de-trended industrial output level in each of the seven countries. 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.

1.2. *Estimation Results*

We estimate (1) individually for 74 manufacturing industries in the euro area over the period 1980–98. The quarterly growth rates of industry output are taken from the OECD database 'Indicators of Industrial Activity'.[6]

Figure 3 plots the distribution of the β-estimates in a boom and a recession, their difference and a weighted average where the weights are based on the unconditional probability of being in a recession versus in a boom.[7] The weighted average is a proxy for the overall policy effect. In a recession, 60 out of 74 industries are negatively affected by a policy tightening, whereas in an expansion only 41 industries are negatively affected. While the average difference between the effect in a recession versus a boom is clearly negative at -0.48, there are 20 industries in which the policy effect in a recession is not larger than in an expansion. The correlation between the policy effects in downturns and those in expansions is surprisingly low at 0.07.

[6] Estimates are obtained for 11 industries from 7 countries. 3 industries (all in Belgium) are excluded because data are only available for a much shorter sample period. Also see the Appendix for a discussion of the data.

[7] The weighted average of the policy effects in booms and recessions is equal to the estimated policy effects in a regression similar to (1) where we do not take into account different business cycle phases.

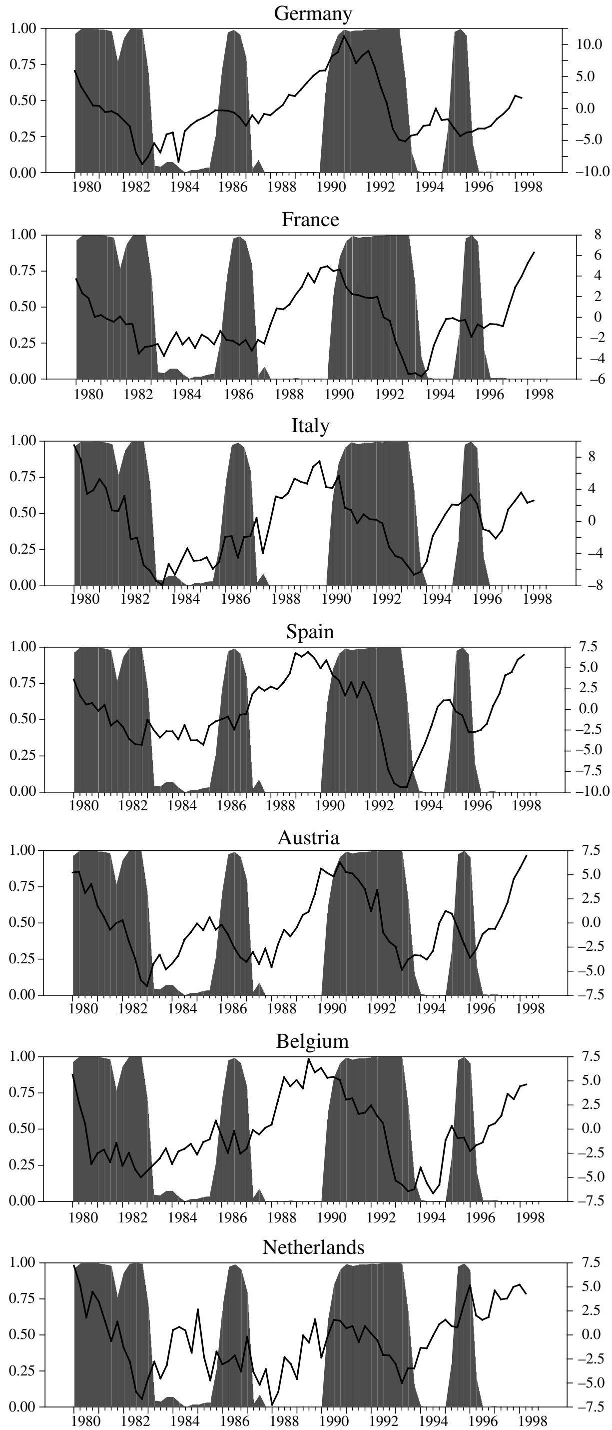

Fig. 2. *De-trended Industrial Production and the Probability of Being in a Recession*
Note: Right axis: de-trended industrial production. The shaded areas denote the probability of being in a recession (left axis).

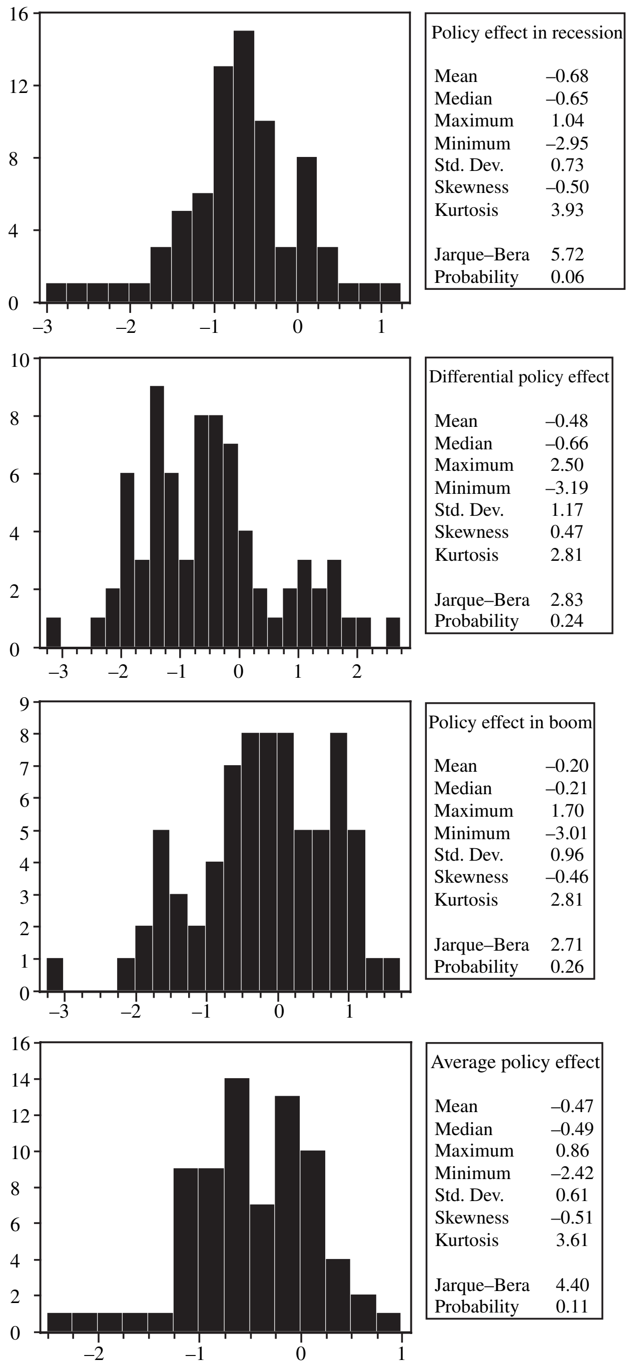

Fig. 3. *Cross-industry Heterogeneity in Monetary Policy Effects* Beta-estimates

Table 1

The Industry and Country Effects of Monetary Policy

	β_0	β_1	$\beta_0 - \beta_1$	β
Average	−0.66	−0.22	−0.44	−0.47
	(10.4)	(2.46)	(4.11)	(8.58)
Germany	−0.41	0.30	−0.71	−0.09
	(2.58)	(1.73)	(4.01)	(0.65)
France	−0.16	0.24	−0.39	0.01
	(1.28)	(1.57)	(1.79)	(0.19)
Italy	0.24	−0.33	0.57	−0.01
	(1.67)	(2.48)	(2.73)	(0.09)
Spain	0.01	−0.27	0.27	−0.12
	(0.03)	(0.82)	(0.73)	(0.70)
Austria	−0.14	0.25	−0.39	0.02
	(1.17)	(1.36)	(1.61)	(0.26)
Belgium	0.32	−0.32	0.64	0.05
	(1.46)	(1.09)	(2.00)	(0.24)
Netherlands	0.14	0.13	0.01	0.14
	(1.01)	(0.62)	(0.04)	(1.25)
310	0.59	0.72	−0.12	0.65
	(4.07)	(3.50)	(0.75)	(4.14)
320	−0.02	0.51	−0.52	0.21
	(0.06)	(2.22)	(2.11)	(1.06)
330	−0.03	0.44	−0.47	0.18
	(0.16)	(1.49)	(1.17)	(1.36)
340	0.38	0.13	0.25	0.28
	(2.21)	(0.49)	(1.06)	(1.48)
350	−0.12	−0.35	0.23	−0.22
	(1.00)	(1.64)	(1.05)	(1.70)
360	−0.23	0.75	−0.98	0.20
	(1.26)	(4.56)	(3.17)	(2.35)
370	0.08	−0.67	0.75	−0.25
	(0.29)	(3.15)	(2.61)	(1.25)
381	−0.41	−0.12	−0.29	−0.29
	(2.73)	(0.64)	(0.97)	(3.86)
382	0.28	−0.44	0.72	−0.03
	(2.09)	(1.34)	(1.75)	(0.24)
383	0.47	−0.16	0.63	0.19
	(2.85)	(0.50)	(1.52)	(1.40)
384	−1.00	−0.81	−0.19	−0.92
	(3.36)	(1.75)	(0.36)	(3.40)
R^2	0.71	0.41	0.46	0.66

Note: White heteroscedasticity consistent t-statistics in parenthesis. Country and industry coefficients are deviations from overall mean.

How different are the policy effects across industries and countries? Table 1 provides an estimate of the country and industry effects by regressing the β estimates on a set of country and sector dummies.[8] We also report the effects on the difference and the weighted average discussed above. The parameters on the country and sector dummies report the deviations from the mean effect. A number of patterns are clear. First, it appears that both in recessions and in booms the

[8] We estimated the effect of the country and sector dummies on the policy multipliers in booms and recessions jointly using SURE methods. Standard errors are White heteroscedasticity consistent. In order to avoid perfect collinearity, we impose the restriction that the sum of the coefficients on respectively country and industry dummies is zero.

average policy multiplier is significantly negative. The average effect over the business cycle is about −0.47. In addition, the degree of asymmetry in booms versus recessions is very significant. This confirms the results of Peersman and Smets (2001*b*) who find a significant degree of asymmetry using country data.

Second, focusing on the country effects, it appears that the overall output effects of the common monetary policy shock do not seem to differ significantly from the average effect in the euro area. In contrast, the degree of asymmetry is significantly higher in Germany and lower in Italy and Belgium. It is important to note that this is the case even though we control for the industry composition.[9] The higher asymmetry of Germany is consistent with the findings of Peersman and Smets (2001*b*). It is interesting to see that controlling for the industry composition, Austria and the Netherlands are no longer negative outliers in the degree of asymmetry, as was found in Peersman and Smets (2001*b*).

Third, looking at the industry effects, it is clear that the overall policy effects are small in the food, beverages and tobacco (310) and non-metallic mineral products (360) industries. In contrast, the overall effects are significantly larger in the fabricated metal products (381), transport equipment (384) and to a lesser extent, the chemicals (350) sectors. These results are broadly consistent with the findings in Ganley and Salmon (1997), Hayo and Uhlenbrock (2000) and Dedola and Lippi (2000). Overall these studies suggest that the durability of the output produced by the sector is an important determinant of its sensitivity to monetary policy changes. This is mainly because the demand for durable products, such as investment goods, is known to be much more affected by a rise in the interest rate through the usual cost-of-capital channel than the demand for non-durables such as food. For example, Dedola and Lippi (2000) report that an industry dummy which captures the degree of durability is highly significant in explaining cross-industry effects. As will be shown in the next Section, this durability dummy is also highly significant in our data set.

Table 1 also shows that there is evidence that the degree of asymmetry in the policy effects differs systematically across sectors. The textile (320) and non-metallic mineral products (360) appear to be much more sensitive to monetary policy in recessions than in booms. On the other hand, there is some weak evidence of cyclical asymmetries in the basic metal (370) and machinery, except electrical (382) industries.

2. Industry Characteristics and the Monetary Policy Effects

In this Section, we analyse whether cross-industry differences in the effects of monetary policy in booms and recessions can be explained by a number of industry characteristics. Section 2.1. describes the industry characteristics that we will use. In Section 2.2. we discuss the regression specification and the estimation results. In Section 3, we will discuss the robustness of these results.

[9] Note that Belgium is the only country for which three of the eleven sectors are missing.

2.1. *Industry Characteristics*

In this Section we describe the industry characteristics that we will use to try to explain the cross-industry heterogeneity in policy effects. Since the coefficients $\beta_{ij,0}$ and $\beta_{ij,1}$ are averages of the industry behaviour over the estimation period, the industry-specific variables are also measured as averages over the available period.[10]

2.1.1. *The conventional interest rate channel*

As already mentioned, a first variable that we include to proxy the interest rate/cost of capital channel is a durability dummy obtained from Dedola and Lippi (2000), which is 1 if the industry produces durable goods.[11] We expect a stronger effect of monetary policy on these industries because the demand for durable goods, such as investment goods, is known to be much more affected by a rise in the interest rate than the demand for non-durables.

Apart from the durability dummy, we use one characteristic, the industry's investment intensity (*INV*), to describe the strength of the conventional interest rate/cost of capital channel. This characteristic, measured as the ratio of gross investment over value added, has also been used by Hayo and Uhlenbrock (2000) and Dedola and Lippi (2000). It captures the capital intensity of the industry. Industries that are more capital-intensive are expected to be more sensitive to changes in the user cost of capital, which itself will depend on changes in interest rates. Table 2 shows that in our sample the average investment intensity is about 14%. There are, however, considerable differences in investment intensity both across countries and sectors. The investment intensity appears to be particularly low in Spain. It is also lower than average in the textile industry and, more surprisingly in the fabricated metal products and machinery sector. In contrast, investment intensity is relatively high in the basic metal and transport equipment industries.

In addition, we also use, as a proxy for the degree of openness of an industry (*OPEN*), the ratio of exports and imports over value added. It is not clear what the expected sign is of the effect of this indicator on the strength of the monetary policy effect. On the one hand, a more open sector will be less affected by the slowdown in the domestic economy caused by the tightening of monetary policy. On the other hand, a policy tightening will generally lead to an exchange rate appreciation, which reduces the competitiveness of the sector and may have a negative effect on external demand. One important drawback of the indicator used is that it includes both euro area and non-euro area trade. As we are analysing the effect of an area-wide monetary policy innovation, the ideal indicator should only include non-euro area trade. However, we have not yet been able to break down

[10] This is also done by Dedola and Lippi (2000). The sample period of the estimation is 1980–98. However, the indicators from BACH are averages over the period 1989–96 (the largest 'common' sample for all industries). This methodology means that we implicitly assume that the ranking of the industries with respect to these variables is constant over time. A calculation of the rank correlation for the period 1989–96 gives us values of 0.88, 0.80, and 0.92 for respectively the working capital, the coverage and the leverage ratio. For some of the firm size variables, we only have data available for all industries for 1996.

[11] For an explanation of the durability dummy, see the Appendix.

Table 2

Industry Characteristics: Country and Industry Averages

	INV	*OPEN*	*FIN*	*WOC*	*COV*	*LEV*	*SIVAS*	*SIVAL*
Average	0.14	2.20	0.72	0.73	3.53	0.55	0.12	0.67
	(47.98)	(18.63)	(119.47)	(44.34)	(35.68)	(82.2)	(18.99)	(82.23)
Germany	−0.02	−0.88	0.06	−0.09	−0.30	−0.12	−0.06	0.11
	(4.67)	(4.18)	(3.66)	(3.17)	(1.96)	(5.69)	(5.06)	(6.95)
France	0.00	−0.89	−0.06	0.00	0.65	0.03	0.00	−0.01
	(0.33)	(4.58)	(4.46)	(0.03)	(2.99)	(3.46)	(0.35)	(0.38)
Italy	0.03	−0.99	0.09	0.33	−1.06	0.09	−0.05	−0.05
	(4.72)	(4.87)	(7.96)	(9.91)	(6.92)	(6.40)	(3.29)	(3.12)
Spain	−0.06	−1.28	0.06	0.07	−0.99	0.01	−0.03	0.03
	(9.40)	(5.58)	(4.45)	(1.40)	(5.61)	(0.32)	(2.89)	(1.32)
Austria	0.01	−0.03	−0.01	0.06	1.01	0.00	−0.02	−0.03
	(1.59)	(0.17)	(0.44)	(1.19)	(3.19)	(0.03)	(1.40)	(2.05)
Belgium	0.03	2.14	−0.05	−0.20	−0.79	0.02	0.09	−0.10
	(2.85)	(4.35)	(4.36)	(6.40)	(3.86)	(1.84)	(4.39)	(3.74)
Netherlands	0.02	1.93	−0.10	−0.17	1.49	−0.03	0.07	0.06
	(1.85)	(5.10)	(5.40)	(3.95)	(3.96)	(1.69)	(3.02)	(2.07)
310	0.00	−0.73	0.02	0.05	0.55	−0.01	−0.05	0.09
	(0.39)	(2.47)	(1.70)	(0.59)	(1.57)	(0.74)	(2.83)	(4.14)
320	−0.04	1.00	0.04	0.19	−0.76	0.03	0.09	−0.26
	(6.22)	(1.91)	(2.81)	(6.26)	(3.70)	(2.20)	(4.80)	(9.93)
330	−0.02	−0.86	−0.06	−0.14	0.10	0.02	0.07	−0.12
	(1.77)	(3.42)	(2.48)	(3.09)	(0.39)	(0.89)	(3.84)	(3.75)
340	0.03	−1.01	−0.06	−0.14	0.10	0.02	0.07	−0.12
	(2.55)	(2.87)	(2.48)	(3.09)	(0.39)	(0.89)	(3.84)	(3.75)
350	0.02	0.51	−0.02	−0.06	0.84	−0.09	−0.10	0.20
	(2.00)	(2.63)	(0.93)	(1.11)	(2.62)	(5.22)	(4.35)	(6.92)
360	0.03	−1.15	−0.07	−0.12	1.16	−0.08	0.00	−0.04
	(5.17)	(4.11)	(6.48)	(4.13)	(3.90)	(3.62)	(0.26)	(2.02)
370	0.04	0.74	−0.07	0.09	−0.83	−0.01	−0.10	0.24
	(3.70)	(2.51)	(3.68)	(1.41)	(3.64)	(0.33)	(4.81)	(8.96)
381	−0.03	−0.96	0.07	0.04	−0.29	0.05	0.08	−0.18
	(3.37)	(3.46)	(5.55)	(1.19)	(1.09)	(4.79)	(3.16)	(8.64)
382	−0.05	0.72	0.07	0.04	−0.29	0.05	0.08	−0.18
	(5.80)	(3.28)	(5.55)	(1.19)	(1.09)	(4.79)	(3.16)	(8.64)
383	−0.02	−0.25	0.03	0.08	−0.43	−0.02	−0.07	0.16
	(3.42)	(1.07)	(1.10)	(1.55)	(1.22)	(1.09)	(4.64)	(11.98)
384	0.04	1.97	0.04	−0.03	−0.14	0.03	−0.08	0.21
	(3.96)	(2.79)	(1.49)	(0.38)	(0.26)	(0.86)	(4.60)	(5.81)

Note: Figures in each column are obtained by regressing the characteristics on a constant and a set of country and industry dummies. t-statistics in parenthesis. For an explanation of the variables, see the Appendix. Country and industry data are deviations from overall mean.

industry trade by country of destination and therefore could not construct such an indicator. As can be seen from Table 2, the implication of this drawback is that the openness indicator is on average much larger for the smaller countries (Belgium and the Netherlands) than for the larger countries. It is nevertheless useful to include this indicator in the regression analysis, because the country effects will be picked up by the country dummies that we include in the regression.

As there are no strong *a priori* reasons why the conventional interest rate channels would work differently in booms versus recessions, we expect the durability dummy, investment intensity and openness to have similar effects over the business cycle.

2.1.2. *The financial accelerator channel*

The financial accelerator theory of the monetary transmission mechanism states that asymmetric information between borrowers and lenders gives rise to 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. A policy tightening, will not only increase the cost of capital through the conventional interest rate channel, it will also lead to a fall in collateral values and cash flow, which will tend to have a positive effect on the external finance premium. Moreover, because collateral values and cash flows are typically low in a recession, the sensitivity of the external finance premium to changes in interest rates will be higher in recessions. Monetary policy is therefore likely to have stronger effects in recessions than in booms.[12]

In order to test whether differences in agency costs can partly explain the observed cross-industry heterogeneity in policy effects, we use four balance sheet indicators and two indicators capturing the average size of the firms in the industry. The four financial indicators are a leverage ratio, a coverage ratio, an indicator of the maturity structure of debt and an indicator of the need for working capital. We discuss each of them in turn.

Financial leverage (*LEV*, i.e. total debt over total assets) is a basic indicator of the balance sheet condition that is commonly used by financial analysts. However, it is not entirely clear what sign to expect in the analysis below. On the one hand, firms with high leverage ratios are likely to face greater difficulties obtaining new, additional funds on the market, especially during recessions. Based on this argument we expect that there is a positive influence of the leverage ratio on the differential impact of monetary policy.[13] On the other hand, a high leverage ratio may also be an indication of the indebtedness capacity of firms. For example, Dedola and Lippi (2000) interpret the leverage ratio as an indicator of borrowing capacity, consistent with the findings that more leveraged firms tend to get loans at better terms. In that case, highly-leveraged firms could be less sensitive to monetary policy changes.

Our second indicator is the coverage ratio (*COV*, i.e. gross operating profits over total interest payments), which measures the extent to which cash flow is sufficient to pay for financial costs and is therefore related to credit worthiness. Firms with a higher coverage ratio are therefore expected to be less sensitive to monetary policy changes. However, also in this case high interest payments could be a signal of high borrowing capacity.

The ratio of short-term over total debt (*FIN*) attempts to measure the extent to which a firm has to finance itself short term rather than long term and is therefore

[12] See, for example, Bernanke and Gertler (1989), Gertler and Hubbard (1988), Azariadis and Smith (1998), Kochlerlakota (2000).

[13] The ratio of financial leverage that we use is total debt divided by total assets. The coverage ratio is gross operating profits divided by total interest payments. The results are however robust to alternative definitions of both variables.

related to its access to long term finance. With imperfect capital markets, we expect the spending of firms with a higher short-term debt to be more sensitive to interest rate changes in particular in a recession. Finally, a related indicator is the working capital ratio (*WOC*), defined as the ratio of working capital (current assets minus creditors payable within one year excluding short-term bank loans) over value added. The working capital ratio captures the extent to which the firm depends on financing for its current assets. As these assets typically cannot be used as collateral, this variable proxies the short-term financial requirement of the industry. We expect the financial accelerator to be stronger in industries with a higher level of working capital.

The balance sheet data used to calculate the financial ratios discussed above are taken from the European Commission BACH-database. This database is constructed through the aggregation at the industry level of a large quantity of individual firm data.[14] An extensive, detailed discussion of the definitions and the sources of all the variables is in the Appendix. Table 2 gives an idea of the average value of those indicators and their differences across countries and sectors. It is worth noting that because accounting data are typically not fully harmonised across countries, it may be difficult to compare those ratios across countries. In the analysis below, such systematic differences should be picked up by the country dummies.

Finally, the size of a firm is often used as an indicator for the degree of asymmetric information problems in lending relationships. Agency costs are usually assumed to be smaller for large firms because of the economies of scale in collecting and processing information about their situation. As a result, large firms can more easily finance themselves directly on financial markets and are less dependent on banks. Greater diversification of large firms can also be reflected in a smaller external finance premium. We thus expect that industries with a higher average firm size are likely to do relatively better in downturns and be less exposed to the financial accelerator. In the benchmark model, we use two size indicators. The first indicator gives the share of firms with a turnover of less than 7 million ECU in total industry value added (*SIVAS*). The second indicator focuses more on the importance of large firms and is given by the share of firms with a turnover in excess of 40 million ECU in total industry value-added (*SIVAL*). Of course, both indicators are highly correlated. Table 2 shows that on average the share of small firms in total value added is about 12%, while that of large firms is 67%. On average, the share of small firms appears to be relatively larger in Belgium and the Netherlands than in the other countries. It is quite low in Germany. Regarding the industry composition, the food sector has the largest share of small firms and the lowest share of large firms, while the opposite is the case for the basic metal, electrical machinery and transport equipment industries.

Finally, Table 3 gives the correlation matrix of the various industry characteristics discussed above. A number of features are worth mentioning. First, there is a positive correlation between investment intensity and the share of large firms in

[14] This dataset is also used by Vermeulen (2002).

Table 3

Industry Characteristics: Correlations

	INV	*OPEN*	*SIVAS*	*SIVAL*	*FIN*	*LEV*	*COV*	*WOC*
INV	1.00	–	–	–	–	–	–	–
OPEN	0.33	1.00	–	–	–	–	–	–
SIVAS	−0.18	0.16	1.00	–	–	–	–	–
SIVAL	0.29	0.11	−0.81	1.00	–	–	–	–
FIN	−0.45	−0.29	−0.17	−0.07	1.00	–	–	–
LEV	0.06	−0.03	0.00	−0.25	0.17	1.00	–	–
COV	0.17	0.08	0.08	0.14	−0.27	−0.44	1.00	–
WOC	−0.11	−0.20	−0.30	−0.05	0.47	0.33	0.42	1.00

the industry. Capital intensive industries also feature a smaller share of short-term debt in total debt. Second, there does not appear a strong correlation between the size measures and any of the balance sheet indicators. Finally, as expected, the maturity structure of debt and the working capital ratio are highly correlated. Also the leverage ratio and the coverage ratio are highly correlated.

2.2. *Specification and Results*

In this Section we analyse more systematically the extent to which the industry characteristics discussed above can explain the cross-country heterogeneity in the β coefficients estimated in Section 2.[15] To do so, we estimate the following system of two equations using SURE methods to account for the correlation in the residuals:

$$\beta_{ij,0} = \alpha_0 + \alpha_{i,1} dum_i + \alpha_{j,2} dum_j + \alpha_{k,3} characteristic_{ij,k} + \eta_{ij,0} \quad (2)$$

$$\beta_{ij,1} = \alpha_0 + \alpha_{i,1} dum_i + \alpha_{j,2} dum_j + \alpha_{k,3} characteristic_{ij,k} + \eta_{ij,1} \quad (3)$$

where dum_j and dum_i are respectively country and industry-dummies. In all regressions we include country and industry dummies to take into account country-specific and industry-specific effects. This is important because our methodology may give rise to spurious industry and country-specific effects. For example, the monetary policy effects may differ systematically across countries because our area-wide monetary policy shock is more appropriate for some countries than for others.[16] Similarly, industry-specific effects are important to

[15] This two-step methodology is comparable to the one used by Dedola and Lippi (2000). As a first step, they estimate the total impact of monetary policy on individual industries using VARs. In the second step, this impact is regressed on typical balance sheet characteristics of the industries. One difference here is that we estimate the effects on the policy multipliers in booms and recessions jointly.

[16] For example, it could be argued that to the extent that the common monetary policy shock is dominated by the changes in the German interest rate, such a shock could have been accompanied by a depreciation of the bilateral DM exchange rate of the currencies of some of the other euro area countries. In that case, one would expect a stronger effect in Germany than in those other countries.

control for the possibility that the business cycle of that industry is not fully synchronised with the common cycle.

In addition, we also estimate separately a similar set of equations for the difference between the policy effects in a boom versus a recession and a weighted average of those effects. Obviously, this is just a linear combination of (2) and (3) above. However, it allows us to assess directly which characteristics have a significant impact on the total effects and which characteristics affect the asymmetry in the policy effects across business cycle phases.

In Table 4, we report the results of the estimation when we include the durability dummy, the other interest rate channel characteristics, the balance sheet indicators and the size variables separately. In each of these also the country and sector dummies are included but not reported. Several results are worth noting. First, industries producing durables and industries producing non-durables both

Table 4

Explaining Cross-industry Heterogeneity in the Effects of Monetary Policy

	β_0	β_1	$\beta_0 - \beta_1$	β
Interest rate channel: durability dummy				
Non-durables	−0.45	0.03	−0.48	−0.24
	(4.98)	(0.25)	(4.45)	(2.58)
Durables	−0.78	−0.36	−0.41	−0.60
	(9.38)	(3.04)	(2.67)	(9.33)
Durability dummy	−0.33	−0.39	0.07	−0.36
	(2.72)	(2.33)	(0.36)	(3.29)
Other interest rate channel characteristics				
INV	0.61	−5.40	6.01	−1.96
	(0.22)	(1.43)	(1.22)	(0.89)
OPEN	0.17	0.01	0.17	0.10
	(2.45)	(0.07)	(1.43)	(1.25)
Balance sheet indicators				
FIN	−4.12	3.55	−7.68	−0.85
	(2.73)	(1.58)	(2.74)	(0.67)
WOC	−0.29	−0.51	0.22	−0.36
	(0.54)	(0.60)	(0.26)	(0.66)
COV	0.26	−0.23	0.48	0.05
	(2.91)	(1.66)	(2.99)	(0.68)
LEV	−1.47	3.71	−5.19	0.81
	(1.02)	(1.90)	(2.09)	(0.71)
Various industry size indicators(separate estimates)				
SIVAS	−2.43	3.56	−5.99	0.22
	(1.71)	(2.04)	(2.92)	(0.18)
SIVAL	3.57	−2.35	5.91	0.95
	(3.47)	(1.47)	(3.16)	(1.03)
SIEM50	0.95	0.08	0.88	0.57
	(4.99)	(0.16)	(1.73)	(2.38)
SIEM100	0.54	−0.36	0.90	0.15
	(2.68)	(1.14)	(2.39)	(0.86)
SITU30	0.54	0.02	0.53	0.32
	(2.26)	(0.05)	(1.16)	(1.64)

Note: White heteroscedasticity consistent t-statistics in parenthesis.

react significantly to monetary policy shocks and have a significant degree of asymmetry.[17] Focusing on the durability dummy, we find that this dummy is highly significant in explaining the average impact of monetary policy. Sectors producing durable products are more sensitive to monetary policy changes. This evidence in favour of the cost-of-capital channel is consistent with the findings of Hayo and Uhlenbrock (2000) and Dedola and Lippi (2000). Moreover, this effect is economically significant. The elasticity of industries producing durable goods is almost three times as high as the elasticity of industries producing non-durable goods: respectively −0.60 and −0.24. Table 4 also shows that the durability dummy has no significant impact on the degree of asymmetry. This finding is in agreement with our conjecture that this determinant of the strength of the traditional interest rate channel should not have different effects in booms versus recessions.

Consistent with the findings of Dedola and Lippi (2000), we do not find a significant impact of the other interest rate channel characteristics. Investment intensity and openness do not seem to be important in explaining cross-industry differences in the overall impact of monetary policy. We only find a significant effect of the degree of openness in recessions. Sectors with a higher degree of openness appear to be less affected than more closed sectors. This effect is, however, relatively small. A 10 percentage point increase in openness, measured as exports and imports over value added, reduces the absolute value of the β coefficients by only 0.02. To some extent, this small effect may be due to the fact that our measure of openness also includes trade within the euro area, as discussed before. The impact of both variables on the degree of asymmetry is, however, insignificant. We therefore cannot reject our hypothesis that the interest rate channel works similarly whatever the state of the business cycle.

Second, in contrast to some of the interest rate channel characteristics, we find no significant effect of the balance sheet indicators on the total policy effects. However, consistent with the financial accelerator hypothesis, we do find that weaker balance sheets imply a significantly stronger policy effect during recessions than during booms. The financial variables that seem to work most consistently with the financial accelerator hypothesis are the ratio of short debt over total debt and the coverage ratio. While these variables have no explanatory power during booms, they do explain cross-industry differences during recessions. Moreover, these effects are economically significant. The difference in ratio between the industry with the highest short-term debt and the one with the lowest is about 0.14. According to the estimates reported in Table 4 this could account for a difference in the estimated policy effects in a recession of about 0.58, which itself has a standard deviation of about 0.71. Differences in the coverage ratio can explain similar magnitudes.

A higher leverage ratio also appears to increase the degree of asymmetry between policy effects in a recession versus a boom. However, in contrast to the other

[17] In these equations, only country-specific dummies, industry-specific dummies and a durability dummy are included. To avoid perfect collinearity between the latter and the industry-specific dummies, we impose the restriction that the sum of the coefficients in each subgroup of industries (durables, non-durables) is zero. Coefficients and standard errors for durables and non-durables (reported in Table 4) can easily be calculated *ex post*.

financial indicators, this is mainly a result of a perverse effect on the policy effects during a boom (although only at the 10% significance level). In particular, industries with a higher leverage ratio (i.e. higher debt relative to total assets) appear to be less sensitive to monetary policy innovations during a boom. To some extent, this perverse effect may be the result of the fact that high leverage maybe an indicator of good credit standing and high borrowing capacity as mentioned above.

Finally, the bottom panel of Table 4 reports the results of the various size indicators. Our preferred size indicators (*SIVAS* and *SIVAL*) fail to have any significant effect on the average impact of monetary policy. This is in contrast to the findings of Dedola and Lippi (2000), who do find a significant effect in their sample on the total effects. In order to check the robustness of these results, Table 4 also reports estimates with alternative size indicators. *SIEM50 (SIEM100*) is a dummy variable which takes on the value of one when the average employment of the firms in the sector is greater than 50 (100). These variables are more comparable to the size variable of Dedola and Lippi (2000), who also used an indicator based on employment, but less reliable than the others because we had to use two different data sets to construct this variable for all countries in our sample (see the data appendix). *SITU30* is a dummy variable, which takes the value of one when the average turnover of the firms in the sector is greater than 30 million ECU. We do find a significant impact of *SIEM50* on the overall impact, but this evidence does not appear to be very robust.

The effect of size on the degree of asymmetry is, however, significant in most cases (only significant at the 10% level for *SIEM50* and insignificant for *SITU30*). This is the result of a highly significant effect in recessions and an insignificant effect in booms.[18] This is a confirmation of the financial accelerator hypothesis. Industries with firms of a smaller size are more negatively affected by a policy tightening in recessions versus booms. Again, this is also economically very significant for all size indicators. For example, the elasticity to a monetary policy shock in a recession is, for industries with average employment less than 100 or a turnover less than 30 million ECU, 0.54 higher than other industries, while the average impact in a recession is −0.68.

Table 5 shows that these results are robust when we include all characteristics in the same regression equation. Columns (1) to (3) report the results when *SIVAS, SIVAL* and *SIEM50* respectively are included as a proxy for size. The only difference is that we find some evidence for a significant influence of the investment intensity and durability dummy on the differential impact of monetary policy.

3. Robustness of the Results

In this Section, we provide a robustness analysis of the results. Four alternatives are considered. The first is based on a one-step methodology and is discussed in the next subsection. The three others, discussed in Section 3.2, are alternatives based on some modifications of the basic model: using alternative monetary policy shocks, including 3 lags of policy innovations instead of the contribution of these

[18] For *SIVAS*, however, we also find a significant perverse effect in booms.

Table 5

Explaining Cross-industry Heterogeneity in Policy Effects (Joint Estimation)

	(1)		(2)		(3)	
	$\beta_0 - \beta_1$	β	$\beta_0 - \beta_1$	β	$\beta_0 - \beta_1$	β
Durability dummy	0.27	−0.38	0.17	−0.42	0.32	−0.37
	(1.82)	(3.62)	(1.11)	(3.76)	(2.01)	(3.67)
INV	8.11	−2.30	7.54	−2.95	8.92	−2.93
	(1.97)	(0.98)	(1.83)	(1.20)	(2.21)	(1.23)
OPEN	0.08	0.12	0.07	0.11	0.08	0.08
	(0.90)	(1.43)	(0.80)	(1.25)	(0.81)	(0.87)
FIN	−6.46	−0.56	−6.81	−0.37	−7.35	−0.66
	(2.37)	(0.53)	(2.49)	(0.34)	(2.80)	(0.52)
WOC	−0.24	−0.53	0.17	−0.44	0.19	−0.10
	(0.35)	(0.99)	(0.25)	(0.87)	(0.31)	(0.25)
COV	0.46	0.02	0.45	0.02	0.45	0.00
	(3.28)	(0.33)	(3.33)	(0.26)	(3.22)	(0.03)
LEV	−5.31	0.84	−4.32	1.36	−5.34	1.54
	(2.44)	(0.83)	(1.90)	(1.39)	(2.58)	(1.39)
SIVAS	−4.56	0.24	–	–	–	–
	(2.74)	(0.22)				
SIVAL	–	–	3.63	1.21	–	–
			(2.38)	(1.28)		
SIEM50	–	–	–	–	0.43	0.62
					(1.18)	(2.79)
R^2	0.64	0.69	0.64	0.70	0.62	0.73

Note: Each regression also includes country and sector dummies. White heteroscedasticity consistent t-statistics in parenthesis.

innovations to the interest rate and elaborating the common dynamics of the individual industries.

3.1. *One-step Estimation*

In the Sections above we have used a two-step methodology whereby, in the first step, we estimate the policy effects and, in the second step, we try to explain the cross-industry differences on the basis of industry characteristics. In this Section we check the robustness of this two-step methodology by performing the estimation in one step using standard panel data techniques.

Since $p_{1,t-1} = 1 - p_{0,t-1}$, we can rewrite (1) as follows:

$$\begin{aligned}\Delta y_{ij,t} = {} & (\alpha_{ij,0} - \alpha_{ij,1})p_{0,t} + \alpha_{ij,1} + \phi_1 \Delta y_{ij,t-1} + \phi_2 \Delta y_{ij,t-2} \\ & + (1 - \phi_1 - \phi_2)[(\beta_{ij,0} - \beta_{ij,1})p_{0,t-1}MP_{t-1} + \beta_{ij,1}MP_{t-1}] + \varepsilon_{ij,t}\end{aligned} \quad (4)$$

where we also have assumed that the autoregressive parameters are the same across industries. We can now substitute (2) and (3) directly into (4) and estimate this equation in one step for all industries simultaneously.[19] Table 6 reports the results of a Feasible GLS estimator, which allows for heteroscedasticity and cross-sectional

[19] In order to have a balanced panel data set, we excluded Belgium from the analysis. This leaves us with 66 industries and 79 periods.

Table 6

Panel Data Estimation – Feasible GLS

	β_0	β_1	$\beta_0 - \beta_1$
Durability dummy	−0.31	−0.45	0.14
	(3.44)	(4.02)	(0.93)
INV	−0.42	−2.93	2.51
	(0.20)	(1.15)	(0.76)
OPEN	0.13	−0.01	0.14
	(2.06)	(0.16)	(1.42)
FIN	−2.61	1.85	−4.46
	(1.96)	(1.13)	(2.09)
WOC	−0.27	−0.33	0.05
	(0.67)	(0.65)	(0.08)
COV	0.28	−0.09	0.37
	(3.20)	(0.87)	(2.67)
LEV	−0.56	4.18	−4.74
	(0.49)	(3.02)	(2.63)
SIVAS	0.01	4.00	−3.99
	(0.01)	(3.33)	(2.55)
SIVAL	2.99	−1.21	4.20
	(2.81)	(1.40)	(3.04)

Note: t-statistics in parenthesis.

correlation of the residuals. The latter is appropriate as output growth is likely to be correlated across industries.

Table 6 shows that the results obtained above are generally robust. We still find that the durability of the goods produced mainly affect cross-industry differences in the overall policy effects, whereas the balance sheet indicators significantly affect the differential policy effect in recessions versus booms. There are two slight differences from the results reported above. First, using the panel data techniques the leverage ratio has a significant effect in a boom. A higher leverage is associated with a smaller sensitivity to monetary policy shocks in a boom. As discussed above, this may be due to the fact that firms with a high leverage are also firms with a good credit standing. This finding is consistent with the finding of Dedola and Lippi (2000). The negative effect on the degree of asymmetry, is consistent with our conjecture that it is difficult for these firms to get *additional* loans in a recession. Second, one of our two preferred size variables (*SIVAS*) is significantly wrongly signed in a boom. This would indicate that large firms are more sensitive to monetary policy shocks in a boom. This finding is puzzling and we do not have an explanation for it.

3.2. *Some Modifications to the Basic Model*

In the basic model, the monetary policy shocks are obtained from a VAR using a standard Choleski decomposition comparable to the one in Christiano *et al.* (1998) for the US. Peersman and Smets (2001*a*) also present the results for an alternative identification strategy, similar to Sims and Zha (1998), which allows for a contemporaneous interaction between the interest rate and the exchange rate. Moreover, monetary authorities do not react within the period to output and price movements because of information lags. The results of the estimates, when we use the contribution of these monetary policy shocks to the interest rate, are presented in the first columns of Table 7.[20]

The conclusions are very similar to our basic analysis. The durability of the goods produced is again an important determinant for the total impact of monetary policy and balance sheet characteristics of the firms have a significant influence on the degree of asymmetry. The significance of some variables is, however, slightly less. This is the case for the debt (*FIN*) and leverage ratio on the degree of asymmetry. These variables are only significant at the 10% level.[21]

So far, following Peersman and Smets (2001*b*), we have always used the contribution of the monetary policy shocks to the euro area interest rate as our measure of monetary policy impulses to keep the number of lags in the Markov-switching model manageable. This measure, however, also contains a forecastable compo-

Table 7
Results With Modifications to the Basic Model

	Other monetary policy shocks		Policy shocks included instead of contribution to interest rate		Extending common dynamics of industries	
	$\beta_0 - \beta_1$	β	$\beta_0 - \beta_1$	β	$\beta_0 - \beta_1$	β
Non-durables	−0.45	−0.20	−0.54	−0.10	−0.54	−0.28
	(4.49)	(2.38)	(3.85)	(1.21)	(5.42)	(2.97)
Durables	−0.71	−0.41	−0.22	−0.49	−0.52	−0.63
	(5.73)	(6.37)	(1.31)	(8.61)	(3.17)	(9.32)
Durability dummy	−0.26	−0.21	0.33	−0.39	0.02	−0.35
	(1.65)	(2.04)	(1.50)	(3.94)	(0.11)	(3.08)
INV	2.02	−1.95	−0.39	−0.78	7.20	−2.59
	(0.54)	(1.03)	(0.07)	(0.41)	(1.40)	(1.16)
OPEN	0.13	0.11	0.10	0.14	0.17	0.12
	(1.34)	(1.59)	(0.78)	(2.80)	(1.58)	(1.36)
FIN	−4.46	−1.48	−9.12	−0.44	−7.53	−0.85
	(1.82)	(1.20)	(3.31)	(0.36)	(2.31)	(0.64)
WOC	0.26	−0.37	−1.90	0.49	0.87	−0.30
	(0.42)	(0.62)	(1.48)	(1.13)	(0.92)	(0.50)
COV	0.36	0.08	0.46	0.12	0.52	0.07
	(2.87)	(1.18)	(3.09)	(1.75)	(3.15)	(0.89)
LEV	−3.52	0.73	−5.52	1.81	−5.15	0.75
	(1.76)	(0.64)	(1.95)	(1.58)	(1.61)	(0.63)
SIVAS	−3.64	−0.19	−6.79	0.40	−5.88	0.07
	(2.24)	(0.19)	(3.30)	(0.39)	(2.92)	(0.05)
SIVAL	4.04	0.96	6.97	0.31	5.67	1.24
	(3.00)	(1.16)	(3.51)	(0.35)	(2.79)	(1.32)

Note: White heteroscedasticity consistent t-statistics in parenthesis.

[20] We only report the results for the degree of asymmetry and the average impact. The coefficients in recessions and expansions are, however, available on request.

[21] The ratio of short-term over total debt (*FIN*) is, however, still highly significant in a recession, but not reported in the Table.

nent of monetary policy, which can have an influence on the results. As a third robustness check, we therefore also estimate the following variant of (1):

$$\begin{aligned}\Delta y_{ij,t} = {} & (\alpha_{ij,0}p_{0,t} + \alpha_{ij,1}p_{1,t}) + \phi_{ij,1}\Delta y_{ij,t-1} + \phi_{ij,2}\Delta y_{ij,t-2} \\ & + (1 - \phi_{ij,1} - \phi_{ij,2})[p_{0,t}(\beta_{ij,01}MP_{t-1} + \beta_{ij,02}MP_{t-2} + \beta_{ij,03}MP_{t-3}) \\ & + p_{1,t}(\beta_{ij,11}MP_{t-1} + \beta_{ij,12}MP_{t-2} + \beta_{ij,13}MP_{t-3})] + \varepsilon_{ij,t}\end{aligned} \quad (5)$$

where the monetary policy measure (MP) is now three lags of the structural shocks instead of the contribution of these shocks to the interest rate.[22] The monetary policy impact in a recession and an expansion, included in the second step of the estimation, is then respectively $\beta_{ij,0} = \beta_{ij,01} + \beta_{ij,02} + \beta_{ij,03}$ and $\beta_{ij,1} = \beta_{ij,11} + \beta_{ij,12} + \beta_{ij,13}$.

The results are reported in columns 3 and 4 of Table 7. Again, these are also very similar to the results obtained from the basic model. The durability dummy is highly significant in explaining the total impact of monetary policy and the term structure of debt, the coverage ratio, financial leverage and the size indicators explain the degree of asymmetry between both business cycle phases. The difference with our basic results is that we now also find a significant impact of the degree of openness and the coverage ratio for the average effect of monetary policy (β). The latter, also found by Dedola and Lippi (2000), is however only significant at the 10% level.

Finally, we investigate the robustness of our basic specification when we relax the restriction of common output dynamics in each of the individual industries. The only common dynamic feature across industries in (1) is the two-regime Markov chain. This can be extended as follows:

$$\begin{aligned}\Delta y_{ij,t} = {} & (\alpha_{ij,0}p_{0,t} + \alpha_{ij,1}p_{1,t}) + \phi_{ij,1}\Delta y_{ij,t-1} + \phi_{ij,2}\Delta y_{ij,t-2} + \lambda_{ij,1}\Delta y_{j,t-1} + \lambda_{ij,2}\Delta y_{j,t-2} \\ & + \left(1 - \phi_{ij,1} - \phi_{ij,2}\right)\left(\beta_{ij,0}p_{0,t-1}MP_{t-1} + \beta_{ij,1}p_{1,t-1}MP_{t-1}\right) + \varepsilon_{ij,t}\end{aligned} \quad (6)$$

Equation (6) also contains lagged country-wide growth rates (Δy_j) as additional regressors to capture the country-specific cycles more properly. In addition, estimation is simultaneous for all industries i across countries, allowing for cross-sectional correlation of the residuals (SURE).

The results are reported in the last two columns of Table 7. We again find little differences with our baseline results. All coefficients and standard errors are very comparable. The only difference is an insignificant effect of financial leverage on the degree of asymmetry. In general, we can conclude that our results are robust with respect to alternative specifications of the baseline model. We find an important role for the conventional interest rate channel in explaining cross-industries differences in the total impact of monetary policy, and an important

[22] Results are very similar with two or four lags of monetary policy shocks included in the estimation. Note also that the impact is measured conditional on the state of the economy at time t ($p_{0,t}$,$p_{1,t}$) because it was not possible to estimate the Markov-switching model with lags up until $t-3$. Results are, however, also robust when total impact is measured conditional on state of economy at $t-1$ ($p_{0,t-1}$,$p_{1,t-1}$), as in (1).

role for balance sheet characteristics in explaining the effects in recessions and the degree of asymmetry.

4. Conclusions

In this paper we have estimated the effects of a euro area-wide monetary policy change on output growth in eleven industries of seven euro area countries over the period 1978–98. We have shown that on average the negative output effects of an interest rate tightening are significantly greater in recessions than in booms. There is, however, considerable cross-industry heterogeneity in both the average policy effects over the business cycle and the differential impact in recessions versus booms.

This paper explores which industry characteristics can account for this heterogeneity. We find evidence that differences in the average policy sensitivity over the business cycle can mainly be explained by the durability of the goods produced in the sector. This can be regarded as evidence for the conventional interest rate/cost of capital channel of monetary policy transmission. These effects are also economically important. The impact of monetary policy on industries producing durable goods is almost three times as high than the impact on non-durable goods. However, these interest rate channel characteristics cannot explain why some industries are more affected in recessions relative to booms than others.

Cross-industry differences in the degree of asymmetry of policy effects over the business cycle seem to be mainly related to differences in financial structure and firm size. In particular, we find that a higher proportion of short-term debt over total debt, a lower coverage ratio, higher financial leverage and smaller firms are associated with a greater sensitivity to policy changes in recessions. These effects are also economically significant. This finding suggests that financial accelerator mechanisms can partly explain why some industries are more affected in recessions than others.

These results are generally robust with respect to alternative methodologies and alternative monetary policy indicators. Overall, our results are in agreement with those of Dedola and Lippi (2000) who conclude that there is role for both traditional cost-of-capital channels and the broad credit channel in explaining the sectoral effects of monetary policy. Moreover, our results suggest that financial accelerator mechanisms work mainly during recessions. This is consistent with some of the literature reviewed in the introduction.

Appendix

A.1. *Data Sources and Definitions*

Industrial data are quarterly for the period 1980–98 from the OECD database: 'Indicators of Industrial Activity'. The following industries of each country are included in our analysis:

- Food, beverages and tobacco (310)
- Textile, wearing apparel and leather industries (320)

- Wood and wood products, including furniture (330)
- Paper and paper products; printing; publishing (340)
- Chemicals; chemical, petroleum, coal, rubber and plastic products (350)
- Non-metallic mineral products (360)
- Basic metal (370)
- Fabricated metal products, except machinery & equipment (381)
- Machinery, except electrical (382)
- Electrical machinery, apparatus, appliances & equipment (383)
- Transport equipment (384)

Our estimates concern these eleven industries for the countries Germany, France, Italy, Spain, Austria, Belgium, and the Netherlands, except for the industries 340, 350 and 383 for Belgium because data are only available for a much shorter sample period.

The first explanatory variable is a durability dummy, which is 1 if the industry produce durable goods. This variable is also used by Dedola and Lippi (2000) and is based on the economic destination of production from the national accounts statistics. According to this criterion, the 'durable' output industries are 330, 360, 370, 381, 382, 383, and 384.

The investment intensity (*INV*) and openness (*OPEN*) ratios are constructed from the STAN-OECD database, which records annual data at the industry level. We use an average for the period 1980–96. They are:

- *INV*: gross investment/value added.
- *OPEN*: (export + import)/value added.

Balance sheet data are from the European Commission BACH-database. It contains aggregated balance sheets and profit and loss account information at the industry level. Most of the industries are matching with the OECD dataset, though, there are some exceptions: Industries 330 and 340 are aggregated in the BACH dataset, as well as industries 381 and 382. For these industries, the values from BACH are assigned to both industries. Balance sheet data are averages over the period 1989–96 (the largest 'common' sample for al industries). The following definitions are used:

- Working capital (*WOC*): the ratio of working capital to value added. Working capital is defined as the asset item 'current assets' minus the liability item 'creditors payable within one year' (except short-term bank loans). In BACH, this is: $(D - F + F2)/T$. Results are similar when we exclude cash and current investment from the ratio, or when we include the short-term bank loans in the ratio.
- Leverage ratio (*LEV*): ratio of total debt (short and long run) to total assets: $F + I$. Similar results are obtained with the ratio of total debt to capital and reserves.
- Coverage ratio (*COV*): ratio of gross operating profits to total interest payments: $U/13$. The results are robust to other specifications of this ratio. Examples are net operating profits or total profits (except depreciations) in the nominator or total debt in the denominator.
- *SIVAS (SIVAL)*: The share of small (large) firms in total industry value added. These are firms with a turnover of less than 7 million ECU (more than 40 million ECU).
- *SITU20 (SITU30, SITU40)*: is a dummy variable which takes on the value of 1 when the average turnover of the firms in the sector is greater than 20 (30, 40) million ECU.
- *SIEM50 (SIEM100)*: average employment per firm of the industry. For this ratio, data are only available for the year 1996 for the industries of Germany, France, Belgium, and Italy. These data are completed with data form OECD 'Industrial Structure

Statistics' for Austria, Spain, and the Netherlands. For the size variable, we constructed a dummy that takes the value 1 for industries with an average size larger than 50 (100).

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