# Financial Systems and the Cost Channel Transmission of Monetary Policy Shocks*

Sylvia Kaufmann† Johann Scharler‡

March 2007

**Abstract**

We study the role of financial systems for the cost channel transmission of monetary policy in a calibrated business cycle model. We characterize financial systems by the share of bank-dependent firms and by the degree of the pass-through from policy to bank lending rates, for which we provide empirical estimates for the euro area and the US. For plausible calibrations of the dynamics of the lending rate we find that the cost effects directly related to interest rate movements have only a limited effect on the transmission mechanism.

Keywords: Financial Systems, Interest Rate Pass-Through, Cost Channel

JEL codes: E40, E50

*The views expressed in this paper are those of the authors and do in no way commit the Oesterreichische Nationalbank or the Eurosystem.

†Oesterreichische Nationalbank, Economic Studies Division, Otto-Wagner-Platz 3, POB 61, A-1011 Vienna, Austria, Phone (+43-1) 404 20-7222, Fax (+43-1) 404 20-7299, e-mail: sylvia.kaufmann@oenb.at.

‡Department of Economics, University of Linz, Altenbergerstrasse 69, A-4040 Linz, Austria, Phone (43-732) 2468-8360, Fax (73-732) 2468-9679,
e-mail: Johann.Scharler@jku.at.

# 1 Introduction

According to the cost channel transmission of monetary policy, firms have to borrow working capital to finance production (see Barth and Ramey, 2000). As a consequence, the nominal interest rate enters the cost function of the firm and influences production plans, price-setting behavior, and ultimately, output and the inflation rate on an aggregate level. Thus, in addition to the traditional aggregate demand channel monetary policy exerts an effect on the economy via the cost-side. Although a monetary contraction, for instance, lowers the inflation rate through a reduction in aggregate demand, borrowing costs increase due to higher interest rates. Since firms take the increase in borrowing costs into account when setting prices, a counteracting effect on the inflation rate is introduced. It follows that the price response is dampened by the presence of a cost channel and the real effects of monetary policy are amplified. Ravenna and Walsh (2006) argue that the presence of a cost channel has important consequences for optimal monetary policy. If a cost channel exists, any shock to the economy generates a trade-off for the monetary authority. Thus, the scope for macroeconomic stabilization policy appears to be relatively limited in the presence of sizeable cost channel effects.

Empirical evidence for the cost channel is mixed. Gaiotti and Secchi (2006) and Dedola and Lippi (2005) report evidence in favor of cost channel effects based on firm and industry-level data. Using aggregate data, Tillmann (2006) finds that the cost channel adds to the explanation of inflation dynamics, especially during high inflation episodes. Rabanal (2003), in contrast, does not find a significant cost channel neither in the euro area nor in the US.

In this paper we use a calibrated sticky price model to analyze the role of financial system characteristics for the cost channel transmission of monetary policy shocks. We capture differences in financial systems by varying the share of firms which depend on banks to obtain finance for working capital and by varying the degree of the pass-through from policy to retail interest rates, i.e. the degree of interest rate smoothing. Several studies document, that retail interest rates evolve relatively smoothly as compared to market interest rates (see e.g. De Bondt and Mojon, 2005; Sander and Kleimeier, 2004; De Bondt, 2005; Mojon, 2000; Cottarelli and Kourelis, 1994). Put differently, the pass-through from market interest rates to retail interest rates is limited. A potential explanation for this empirical result is that banks with close ties to their customers may offer implicit interest rate insurance (Berger and Udell, 1992). That is, banks charge relatively low rates during periods of a monetary tightening, or periods of high market rates more generally, and vice versa. Moreover, since this type of liquidity smoothing is typical for bank-based financial systems, in which close customer relationships develop over time (see Allen and Gale, 2000), it appears conceivable that the degree of interest rate pass-through and hence the strength of the cost channel vary across financial systems.

As a first step in our analysis, we estimate the interest rate pass-through in the euro area and the US and find that the pass-through from money market to corporate lending rates is indeed faster and more complete in the US. Hence, we confirm the conventional wisdom that the degree of interest rate pass-through differs between bank-based and market-based financial systems. Nevertheless, it is important to interpret these differences from the point of view of a theoretical model, as such an analysis allows us to quantity the business cycle implications. More specifically, we use the model to investigate whether these differences in the pass-through processes give rise to sizeable differences in the monetary transmission mechanism. To do so, we calibrate the model according to the empirical estimates. Our simulations indicate that cost effects associated with monetary policy shocks play a relatively small role in the transmission mechanism once we take financial system characteristics into account. The aggregate demand channel turns out to be substantially more relevant. Moreover, we also find that cost effects should be largely symmetric across financial systems.

In our analysis we isolate the direct cost effects associated with changes in market and retail interest rates. Nevertheless, additional noninterest cost effects might be at work. If, for instance, banks ration the amount of credit they provide by tightening lending standards in response to a monetary contraction, then the lending rate may not fully reflect the cost of working capital. In such a case, monetary policy may exert additional supply side effects beyond those present in our model. This point is also emphasized in Chowdhury et al. (2006) who present empirical estimates based on New Keynesian Phillips Curves for the G7 countries and find significant cost channel effects which vary across countries. They argue that their estimated coefficients are summary measures for financial frictions in a broad sense that either amplify or dampen the effect of interest rates on prices. Our analysis differs from the model in Chowdhury et al. (2006) mostly in the sense that we explicitly link the cost channel to interest rate pass-through and the relative importance of the banking sector. This allows us to interpret the coefficients related to the cost channel in a more structural way. In conjunction with the empirical findings reported in Chowdhury et al. (2006), our results suggest that indirect cost effects, beyond those directed associated with interest rates, may indeed be relevant.

Our paper is also closely related to Hülsewig et al. (2006) who analyze the implications of a monopolistically competitive banking sector in the context of the cost channel. They find that banks mitigate the strength of the cost channel by sheltering firms from monetary policy which is consistent with our results.

The remainder of the paper is organized as follows. Section 2 describes the setup of the model. Empirical estimates of the interest rate pass-through are provided in Section 3. Section 4 discusses the calibration of the model and presents the results. Section 5 summarizes and concludes the paper.

# 2 Model

## 2.1 Households

Households maximize their expected lifetime utility

$$E_0 \sum_{t=0}^{\infty} \beta^t \left( \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{L_t^{1+\eta}}{1+\eta} \right), \tag{1}$$

where $\beta$ is a discount factor, $C_t$ is consumption of a composite good in period $t$, $L_t$ denotes labor supply in period $t$. The composite consumption good, $C_t$, is a CES aggregate of the quantities of differentiated goods, $C_t(i)$, where $i \in (0,1)$: $C_t = \left( \int_0^1 C_t(i)^{\frac{\epsilon-1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}}$. The associated aggregate price index is $P_t = \left( \int_0^1 P_t(i)^{1-\epsilon} di \right)^{\frac{1}{1-\epsilon}}$, where $P_t(i)$ denotes the price of good $i$.

Households enter each period with nominal assets, $A_{t-1}$ and decide on consumption and savings, either in the form of deposits at a financial intermediary, $D_t$, or bonds issued by firms, $B_t$. Deposits yield a gross interest rate of $R_t^D = 1 + r_t^D$ and the bond yield is denoted by $R_t^B = 1 + r_t^B$. Furthermore, households supply $L_t$ units of labor at a nominal wage of $W_t$. As in Woodford (2003) we abstract from explicitly modeling money. Transactions in the financial markets have to be completed before the households can enter the goods market. Hence, the households face the constraint: $P_t C_t \leq A_{t-1} - D_t - B_t + W_t L_t$. The representative household owns the firms and the financial intermediaries and receives dividends. Hence, the household's nominal assets, $A_t$, evolve according to: $A_t = A_{t-1} + W_t L_t + r_t^D D_t + r_t^B B_t - P_t C_t + \Pi_t$, where $\Pi_t$ are dividends distributed at the end of the period. The log-linearized necessary conditions associated with the household's maximization problem are:

$$\hat{C}_t = -\frac{1}{\sigma}(\hat{R}_t^B - E_t(\hat{\pi}_{t+1})) + E_t(\hat{C}_{t+1}), \tag{2}$$

$$\hat{W}_t - \hat{P}_t = \eta \hat{L}_t + \sigma \hat{C}_t, \tag{3}$$

$$\hat{R}_t^D = \hat{R}_t^B, \tag{4}$$

where hatted variables denote percentage deviations from the steady state and $\pi_t = \log P_t - \log P_{t-1}$ is the inflation rate. Equation (2) is a standard Euler equation, (3) is the labor supply equation and (4) is an arbitrage relationship linking the returns on deposits and bonds.

## 2.2 Firms

The business sector of the economy consists of a continuum of monopolistically competitive firms normalized to have unit mass. Each firm $i \in (0, 1)$ produces a differentiated consumption good. Furthermore, the firms are of two types, depending on whether their output is subject to idiosyncratic shocks. Each firm $i$ hires labor, $H_{it}$, and produces output according to:

$$Y_{it} = \chi_i H_{it}^{1-\alpha}, \tag{5}$$

were $\alpha \in (0, 1)$. The parameter $\chi_i$ represents an idiosyncratic shock, in particular

$$\chi_i = \begin{cases} 1 & \text{with probability} \quad q \\ 0 & \text{with probability} \quad 1-q \end{cases}$$

for $i \in (0, \lambda)$ and $\chi_i = 1$ for $i \in (\lambda, 1)$. Hence, firms in the interval $(0, \lambda)$ can only repay their debt with probability $q$. In case of default, firms can walk away from their debt obligations. While $i$ is publicly observable, the realizations of $\chi_i$ are not for $i \in (0, \lambda)$, only the financial intermediaries have access to a monitoring technology that allows verification of realizations of $\chi_i$. Due to the assumption that labor is paid in advance of production, firms have to borrow working capital in order to finance the wage bill. In principle, each firm has two sources of credit. They can either issue nominal bonds which are sold directly to the households and are redeemed at the end of the period, or they can enter into debt contracts with a financial intermediary. However, since the realizations of the idiosyncratic shocks are not public knowledge, firms in the interval $(0, \lambda)$ have an incentive to misreport their output and to default on bonds owned by households. Consequently, these firms will not be able to issue bonds in the first place and will be forced to borrow from the financial intermediaries instead. Let $R_t^L$ denote the interest rate charged on bank loans. Due to the financial frictions in the model, the pricing decision depends on whether the firm can directly issue bonds or has to borrow from a financial intermediary. Optimality requires that

$$R_t^L \frac{W_t}{P_t} = mc_t^F (1 - \alpha) \frac{Y_{it}}{H_{it}} \tag{6}$$

holds for bank-dependent firms in the interval $(0, \lambda)$ and that

$$R_t^B \frac{W_t}{P_t} = mc_t^B (1 - \alpha) \frac{Y_{it}}{H_{it}} \tag{7}$$

holds for the bond-issuing firms, that is $i \in (\lambda, 1)$, where $mc_t^F$ and $mc_t^B$ denote the marginal cost faced by the bank-dependent and bond-issuing firms, respectively. Furthermore, staggered price setting is introduced. As in Calvo (1983), each period, a fraction $(1 - \theta)$ of the firms is able to adjust its price. Moreover, we follow Galí et al. (1999) and Galí et al. (2001) and allow inflation to depend on its own history by introducing firms that follow a backward looking pricing rule. Only a fraction $(1 - \omega)$ of both, bank-dependent and bond-issuing, firms which can set prices in the current period, resets prices optimally. The remaining firms follow the backward looking rule: $\hat{P}_t^b = \hat{P}_{t-1}^* + \pi_{t-1}$, where $\hat{P}_{t-1}^*$ denotes the average price (as percentage deviation from the steady state) set by firms that are able to adjust their price in period $t-1$. The aggregate price level evolves according to $\hat{P}_t = \theta \hat{P}_{t-1} + (1-\theta)\hat{P}_t^*$. Let $\hat{P}_t^F$ denote the price set by a firm that borrows from financial intermediaries and let $\hat{P}_t^B$ denote the price set by a bond issuing firm. Thus, $\hat{P}_t^* = (1-\omega)(\lambda \hat{P}_t^F + (1-\lambda)\hat{P}_t^B) + \omega \hat{P}_t^b$. The assumptions on the price setting behavior of firms can be combined to obtain

$$\hat{\pi}_t = \delta \widehat{mc}_t + \beta\theta\phi^{-1} E_t \hat{\pi}_{t+1} + \omega\phi^{-1}\pi_{t-1}, \tag{8}$$

where $\delta = \frac{(1-\theta)(1-\theta\beta)(1-\alpha)(1-\omega)}{(1+\alpha(\epsilon-1))}\phi^{-1}$, $\phi = \theta + \omega(1-\theta(1-\beta))$ and $\widehat{mc}_t = \lambda \widehat{mc}_t^F + (1-\lambda)\widehat{mc}_t^B$ denote the percentage deviation of average real marginal cost from its steady state value.

## 2.3 Financial Intermediaries

In contrast to households, financial intermediaries can observe the realization of idiosyncratic shocks and are therefore able to enforce debt contracts. We assume that financial intermediation is perfectly competitive and financial intermediaries create loans by using deposits as input: $L_t = \Psi_t D_t$, where $\Psi_t \in (0,1)$ determines the amount of loans that can be generated from a given amount of deposits (see Christiano et al., 2004, for a similar setup of the banking sector). Note that $\Psi_t$ is strictly less than unity so that banks have to hold reserves, which can be motivated as a reduced form way of modeling the risk of unexpected withdrawals.

Moreover, we assume that $\Psi_t = \psi_0 \left( \frac{R_t^L}{{R_{t-1}^L}^{\nu}} \right)^{\psi}$, where $\psi_0 > 0$ and $\psi > 0$, and $\nu$ indexes the importance of interest smoothing. That is, financial intermediaries are able to increase lending in times of rising interest rates even if the amount of deposits does not increase. Hence, they are able to smooth liquidity shocks that might otherwise give rise to large swings in lending rates. The financial intermediaries maximize profits, given by $qR_t^L L_t - R_t^D D_t$, by the choice of loans and deposits subject to $L_t = \psi_0 \left( \frac{R_t^L}{R_{t-1}^L{}^\nu} \right)^\psi D_t$. Taking a log linear approximation to this equation gives

$$\hat{R}_t^L = \frac{1}{1+\psi} \hat{R}_t^D + \frac{\psi\nu}{1+\psi} \hat{R}_{t-1}^L. \tag{9}$$

The specification encompasses the one used in Chowdhury et al. (2006) who do not allow for persistence in the lending rate. We obtain their specification when $\nu = 0$. Note that while we model interest rate smoothing in a rather reduced-form fashion without providing micro foundations, our specification for the dynamics of the lending rate is broadly consistent with empirical regularities reported in the literature. The pass-through is less than perfect in the short run and lending rates display some persistence.

## 2.4 Monetary Authority

The policy instrument is the deposit rate since this interest rate is most closely related to a money market rate. Monetary policy is described by the rule

$$\hat{R}_t^D = \rho \hat{R}_{t-1}^D + (1-\rho)(\kappa_\pi \hat{\pi}_t + \kappa_y \hat{y}_t) + u_t, \tag{10}$$

where $\rho$ determines the degree of monetary policy inertia and $\kappa_\pi$, $\kappa_y$ characterize the response of the policy rate to inflation and output. $u_t$ is a serially uncorrelated monetary policy shock with an expected value of zero.

# 3 Empirical Estimates of the Pass-Trough Process

In this section we present empirical evidence on interest rate pass-through and the persistence of lending rates for the euro area countries and the US. The empirical equation is obtained by taking first differences of (9):

$$\Delta R_{it}^{L} = \tau_0 \Delta R_{it}^{D} + \tau_1 \Delta R_{it-1}^{L}, \tag{11}$$

where $\tau_0 = \frac{1}{1+\psi}$ and $\tau_1 = \frac{\psi\nu}{1+\psi}$. Given the estimates for $\tau_0$ and $\tau_1$ we may recover the structural parameters $\psi$ and $\nu$ to calibrate the model. We estimate (11) for the US and the euro area countries except Austria, Greece and Luxembourg which are excluded due to data limitations. We use quarterly data on money market rates, three month Treasury Bill rates and prime rates from the International Financial Statistics from 1990:1 to 2005:1, where samples differ somewhat for the individual countries. Depending on the availability of data, we use as a proxy for the policy rate either the three month Treasury Bill rate (Belgium, Germany, Spain, France and Italy) or the money market rate (Finland, Ireland, Netherland, Portugal and the US).

We estimate (11) for each country by OLS and as a panel, where we allow for country-fixed effects. Since including a lagged dependent variable in a panel regression may lead to a downward bias in small samples we also estimate the equation using the Arellano and Bond (1991) GMM estimator. The results turn out to be almost identical and we therefore only report the OLS results. Adding additional lags of dependent and independent variables shows that the specification in (11) is sufficient to capture the dynamics of the lending rate for most countries in our sample. Hence, we impose this specification for all countries. If short-term market interest rates and bank lending rates are cointegrated, then the short run dynamics of the lending rate can be more efficiently estimated within an error-correction framework. We find that including an error-correction term in the single-country estimations has only a minor influence on the short run dynamics. Moreover, our sample is rather short for a meaningful analysis of long-run equilibrium relationships and therefore we focus on (11) without an error-correction term.

Table 1 reports the results. For the euro area countries the estimates for the immediate pass-through coefficient, $\tau_1$, fall between 0.23 for Portugal and 0.75 for Belgium. Interestingly, within a panel framework, the test for equal pass-through coefficients in Finland, France, Germany and Portugal is not rejected and estimated to be 0.25. Belgium, Italy, Netherlands and Spain form the other group of countries with a higher pass-through coefficient of 0.66. Ireland falls in-between these two groups. For all euro area countries the null hypothesis of perfect pass-through in the short run, $H_0 : \tau_0 = 1$, can be rejected.

The estimates for the persistence coefficients, $\tau_1$, range from 0.11 (Belgium) to 0.51 (Finland). The estimates for $\tau_1$ are statistically different from zero at least at the 10 percent level for each euro area country.

Results for the US are shown in the last column of Table 1. For the US, we find that the pass-through is basically complete even in the short run. The point estimate $\tau_0$ is 0.92 and not significantly different from unity at the 10 percent level. Moreover, the US lending rate does not appear to display persistence, since the estimate for $\tau_1$ is not significantly different from zero. In addition, the null hypothesis of equal estimates for $\tau_0$ and $\tau_1$ for the euro area and the US is rejected at a high level of significance.

For three euro area countries (Italy, Netherlands and Spain) and the US, the null hypothesis $H_0 : \tau_0 + \tau_1 = 1$ cannot be rejected at the usual levels of statistical significance. Thus, for these countries, the lending rate appears to be well described as a weighted average of the current money market rate and the lagged lending rate, which implies that pass-through is complete in the long run.

Our results are in line with the empirical literature. Angeloni and Ehrmann (2003) estimate an immediate pass-through of 0.4 for the euro area and of 0.7 for the US. A relatively high pass-through in the US is also reported in Moazzami (1999). De Bondt (2005) finds a short-run pass-through of 0.5 in the euro area and an almost complete long run pass-through (see also Sander and Kleimeier, 2006, 2004). Besides being in line with the results reported in the literature, our findings are consistent with the idea that European banks, in contrast to US banks, typically absorb liquidity shocks to some extent and smooth retail interest rates (see e.g. Ehrmann et al., 2003)).

# 4 Calibration and Simulation Results

We now calibrate the model to analyze the question whether cost channel effects are different in bank-based and market-based financial systems. Therefore, all parameters not related to financial system characteristics are calibrated to match features of the euro area in all simulations. The time discount factor $\beta$ is set to 0.99. The coefficients in the utility function, $\sigma$ and $\eta$, are both set equal to 2, which is standard in the literature. The elasticity of substitution between differentiated goods, $\epsilon$, is set to 11. For $\alpha$ we choose 0.33. Furthermore, $\omega = 0.3$, which means that 30 percent of the firms follow a backward looking pricing rule. Prices are assumed to be fixed on average for 4 quarters, therefore $\theta = 0.75$. This calibration of the price setting behavior is roughly in line with recent empirical evidence (see e.g. Leith and Malley, 2005).

The interest rate rule parameters are chosen according to the estimates presented in Gerdesmeier and Roffia (2004) for the euro area. We set $\kappa_\pi = 2$, $\kappa_y = 0.5$ and $\rho = 0.8$.

The remaining parameters are calibrated to match financial structure characteristics of the euro area and the US, since these two economies are generally thought to be examples of bank-based and market-based financial systems respectively. Cecchetti (2001) reports that bank loans account for approximately 20 percent of all forms of finance in the US and for 50 percent in the euro area.[1] Hence, $\lambda$ is set to 0.2 for the US and 0.5 for the euro area. Recall that $\psi$ and $\nu$ determine the pass-through from the deposit rate to the lending rate and the degree of persistence in the lending rate, respectively. These parameters are calibrated to Table 1. For the euro area financial system we set $1/(1+\psi)$ and $\nu\psi/(1+\psi)$ to 0.45 and 0.32 respectively, which correspond to the average values (taken over EA low and EA high) obtained for $\tau_0$ and $\tau_1$. For the US financial system we set $1/(1+\psi) = 0.92$ and $\nu\psi/(1+\psi) = 0.05$.

Figures 1 and 2 show the impulse responses to a monetary policy shock in the euro area and the US. The monetary policy shock gives rise to an increase in the deposit rate of one percentage point in both economies. In the euro area, the lending rate reacts by less than in the US, albeit the response of the lending rate is more persistent in the euro area, in line with the characteristics of a bank-based financial system. The increase in interest rates leads to a decline in output and inflation.

Intuitively, a positive innovation to the interest rate rule induces households to postpone consumption and thereby decreases demand. The decline in aggregate demand will be reflected in lower inflation since firms adjust prices to the lower marginal cost associated with the lower quantity produced

[1] The number for the euro area is calculated as a population weighted average.

in equilibrium. However, allowing marginal costs to be directly influenced by the interest rate, due to the assumption that firms have to borrow working capital, partly counteracts this effect. Put differently, the higher borrowing costs induce an adverse supply shock which partly offsets the decline in inflation and, on the other hand, amplifies the negative effect on output.

The question remains, whether differences in financial systems lead to quantitatively non-negligible differences in the transmission mechanism. Table 2 compares the impact responses of output and inflation for the euro area and the US financial system calibration and for the case where the cost channel is inactive. Overall, the impact responses differ only modestly for the three different calibrations. From the lower panel of the table we can see that relative to the inactive cost channel calibration, the negative inflation response is somewhat muted in the euro area as well as in the US financial system. On impact, it is damped by approximately eight percent in the US and by seven percent in the euro area. The impact response of output is basically the same for all three calibrations considered. Thus, although the dynamics of the inflation rate are to some extent influenced by the cost channel, its quantitative influence on the overall transmission mechanism is rather limited. This is especially true for the response of output which appears to be entirely determined by the aggregate demand channel.

Figure 3 compares the impulse responses of the inflation rate in more detail. The two different financial system calibrations yield only small differences in the response of inflation. Even the calibrated higher persistence in lending rates in the euro area financial system does not lead to a longer lasting propagation of shocks. Thus, the cost channel per se does not appear to be an important source of differences in inflation persistence across financial systems.

Why do we find only small cost channel effects? The Phillips curve (8) can be rewritten as

$$\hat{\pi}_t = \delta \left( \frac{\lambda}{1+\psi} + (1-\lambda) \right) \hat{R}^D_t + \frac{\delta \lambda \psi \nu}{1+\psi} \hat{R}^L_{t-1} + \delta \gamma \hat{Y}_t + \beta \theta \phi^{-1} E_t \hat{\pi}_{t+1} + \omega \phi^{-1} \hat{\pi}_{t-1}. \quad (12)$$

The interest rate enters the Phillips curve contemporaneously with a coefficient that is determined by $\delta$, $\lambda$ and $\psi$. Given that the standard calibration of the price setting behavior yields a rather small value for $\delta$, one would need a financial system that strongly amplifies policy shocks, for instance a strong financial accelerator, to obtain sizeable cost channel effects. However, strong amplification is at odds which the dynamics of interest rates observed in the data, in particular with the limited pass-through to retail rates. Moreover, the difference between the euro area and the US financial system is not large enough to have a substantial effect on the transmission mechanism. In other words, for a calibration of the financial system that allows for plausible lending rate dynamics, the aggregate demand channel is far more important than the cost channel for the transmission of monetary policy shocks.

Note, however, that our approach takes only the direct effect of market and retail interest rates on the price setting behavior of the firms into account. If interest payments are only a part of the total cost of working capital, then monetary policy shocks might be amplified via these other factors, as for instance lending standards and credit constraints.

Our calibration of the US financial system yields somewhat smaller cost channel effects than those reported in the literature.[2] When calibrated to US data, we obtain a value of 0.98 for $\frac{\lambda}{1+\psi} + (1-\lambda)$. For the euro area, our

[2]We are not aware of comparable numbers for the euro area. Chowdhury et al. (2006) report estimates for some euro area countries. They find that in Italy the cost channel is even stronger than in the US, whereas it is small or insignificant in France and Germany.

calibration implies a slightly smaller coefficient of 0.74. Based on estimations of the New Keynesian Phillips curve using US data, Ravenna and Walsh (2006) and Chowdhury et al. (2006) report point estimates for the coefficient on the interest rate of around 1.30 which gives rise to larger cost channel effects than our calibration of this parameter suggests. This discrepancy may indicate that the direct interest rate effects that our analysis focuses on, only partly capture the supply side effects of monetary policy. However standard errors reported in the literature are rather large and Ravenna and Walsh (2006) cannot reject the hypothesis that the coefficient is equal to unity in the US, which is in line with our calibration of the US financial system. When using the CPI inflation rate instead of the GDP deflator, Chowdhury et al. (2006) report a point estimate of 0.80 for the coefficient on the interest rate, which is even below what we obtain based on the estimated interest rate pass-through.

# 5 Summary

This paper studies the quantitative implications of financial system characteristics for the cost channel transmission of monetary policy. We find that for a reasonable calibration of financial systems, the direct cost effects of monetary policy shocks play only a limited role in the transmission of monetary policy shocks to output and prices. Although inflation dynamics are somewhat influenced by the presence of a cost channel, the model suggests that the output response is almost completely dominated by the aggregate demand channel. In addition, financial systems do not appear to be heterogenous enough to result in sizeable differences in the transmission mechanism across countries. Comparing the euro area and the US financial systems, our results suggest that the direct cost effects associated with movements in interest rates should be of similar orders of magnitudes in both financial systems.

## References


Allen, F., Gale, D., 2000. Comparing Financial Systems. MIT Press, Cambridge, MA.

Angeloni, I., Ehrmann, M., 2003. Monetary transmission in the euro area: Early evidence. Economic Policy 18, 469–501.

Arellano, M., Bond, S., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Review of Economic Studies 58, 277–297.

Barth, M. J. I., Ramey, V. A., 2000. The cost channel of monetary transmission. Working paper, NBER.

Berger, A. N., Udell, G. F., 1992. Some evidence on the empirical significance of credit rationing. Journal of Political Economy 100, 1047–77.

Calvo, G. A., 1983. Staggered prices in a utility-maximizing framework. Journal of Monetary Economics 12, 383–398.

Cecchetti, S. G., 2001. Legal structure, financial structure and the monetary policy transmission mechanism. In: Deutsche Bundesbank (Ed.), The Monetary Transmission Process. Palgrave, New York.

Chowdhury, I., Hoffmann, M., Schabert, A., 2006. Inflation dynamics and the cost channel of monetary transmission. European Economic Review 50 (4), 995–1016.

Christiano, L., Motto, R., Rostagno, M., 2004. The great depression and the Friedman-Schwartz hypothesis. Working Paper 326, European Central Bank.

Cottarelli, C., Kourelis, A., 1994. Financial structure, bank lending rates, and the transmission mechanism of monetary policy. IMF Staff Papers 41 (4), 587–623.

De Bondt, G. J., 2005. Interest rate pass-through: Empirical results for the euro area. German Economic Review 6 (1), 37–78.

De Bondt, G. J., Mojon, B., 2005. Term structure and the sluggishness of retail bank interest rates in euro area countries. Working paper 518, European Central Bank.

Dedola, L., Lippi, F., 2005. The monetary transmission mechanism: Evidence from the industries of five OECD countries. European Economic Review 49, 1543–1569.

Ehrmann, M., Gambacorta, L., Martinez-Pages, J., Sevestre, P., Worms, A., 2003. The effects of monetary policy in the euro area. Oxford Review of Economic Policy 19 (1), 58–72.

Gaiotti, E., Secchi, A., 2006. Is there a cost channel of monetary policy transmission? an investigation into the pricing benaviour of 2,000 firms. Journal of Money, Credit, and Banking, forthcoming.

Galí, J., Gertler, M., Lopéz-Salido, J. D., 1999. Inflation dynamics: A structured econometric investigation. Journal of Monetary Economics 44, 195–222.

Galí, J., Gertler, M., Lopéz-Salido, J. D., 2001. European inflation dynamics. European Economic Review 45, 1237–1270.

Gerdesmeier, D., Roffia, B., 2004. Empirical estimates of reaction functions for the euro area. Swiss Journal of Economics and Statistics 140, 37–66.

Hülsewig, O., Mayer, E., Wollmershuser, T., 2006. Bank behavior and the cost channel of monetary transmission. Tech. rep.

Leith, C., Malley, J., 2005. Estimated general equilibrium models for the evaluation of monetary policy in the US and Europe. European Economic Review forthcoming.

Moazzami, B., 1999. Lending rate stickiness and monetary transmission mechanism: The case of Canada and the United States. Applied Financial Economics 9, 533–538.

Mojon, B., 2000. Financial structure and the interest rate channel of ECB monetary policy. Working paper 40, European Central Bank.

Rabanal, P., 2003. The cost channel of monetary policy: Further evidence for the united states and the euro area. Working Paper 03-7149, IMF.

Ravenna, F., Walsh, C. E., 2006. Optimal monetary policy with the cost channel. Journal of Monetary Economics 53 (2), 199–216.

Sander, H., Kleimeier, S., 2004. Convergence in euro-zone retail banking? what interest rate pass-through tells us about monetary policy transmission, competition and integration. Journal of International Money and Finance 23 (3), 461–492.

Sander, H., Kleimeier, S., 2006. Expected versus unexpected monetary policy impulses and interest rate pass-through in euro-zone retail banking markets. Journal of Finance and Banking 30 (7), 1839–1870.

Tillmann, P., 2006. Does the cost channel of monetary transmission explain inflation dynamics? Mimeo, University of Bonn.

Woodford, M., 2003. Interest and Prices: Foundations of a Theory of Monetary Policy. Princeton University Press.

Table 1: Interest Rate Pass Through ($\tau_0$) and Persistence of the Lending Rates ($\tau_1$)

| | BE | DE | ES | FI | FR | IR | IT | NL | PT | EA low | EA high | US |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\tau_0$ | 0.75 | 0.31 | 0.70 | 0.26 | 0.27 | 0.56 | 0.60 | 0.73 | 0.23 | 0.25 | 0.66 | 0.92 |
| | (0.04) | (0.06) | (0.10) | (0.02) | (0.03) | (0.02) | (0.06) | (0.12) | (0.08) | (0.07) | (0.06) | 0.04 |
| $\tau_1$ | 0.11 | 0.47 | 0.24 | 0.51 | 0.14 | 0.18 | 0.46 | 0.22 | 0.31 | 0.35 | 0.29 | 0.05 |
| | (0.04) | (0.08) | (0.09) | (0.05) | (0.08) | (0.04) | (0.07) | (0.11) | (0.15) | (0.09) | (0.06) | 0.04 |
| $\bar{R}^2$ | 0.88 | 0.57 | 0.60 | 0.85 | 0.54 | 0.91 | 0.74 | 0.75 | 0.17 | 0.36 | 0.70 | 0.94 |
| $Obs$ | 61 | 54 | 53 | 53 | 59 | 53 | 56 | 36 | 41 | 207 | 206 | 61 |

Notes: Coefficients obtained from OLS regressions of the change in the lending rate on the change in the money market rate and the lagged change in the lending rate. Standard errors in brackets. The columns labeled EA low (Finland, France, Germany, Portugal) and EA high (Belgium, Italy, Netherlands, Spain) show the results of panel OLS regressions. For the panel regressions, White standard errors are reported.

Table 2: Impact responses of Output and Inflation to a monetary Policy shock

| | Inactive Cost Channel | US | Euro Area |
|---|---|---|---|
| $\hat{Y}_t$ | -1.65 | -1.66 | -1.66 |
| $\hat{\pi}_t$ | -0.41 | -0.37 | -0.38 |
| | Relative to the Inactive Cost Channel Calibration | | |
| $\hat{Y}_t$ | - | 1.00 | 1.00 |
| $\hat{\pi}_t$ | - | 0.92 | 0.93 |

Notes: Responses of $\hat{Y}_t$ and $\hat{\pi}_t$ to a monetary contraction. In the upper panel of the table, the responses are measured in percentage deviations from the steady state. The lower panel reports the responses relative to the calibration where the cost channel is inactive. In all three experiments, all parameters not related to the financial system are calibrated to match characteristics of the euro area.

Figure 1: Impulse Responses generated by the model calibrated to match euro area financial system characteristics

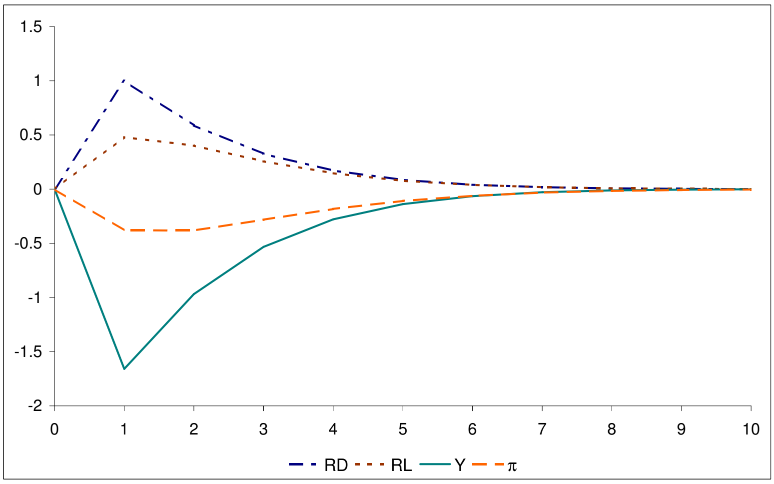

Figure 2: Impulse Responses generated by the model calibrated to match US financial system characteristics

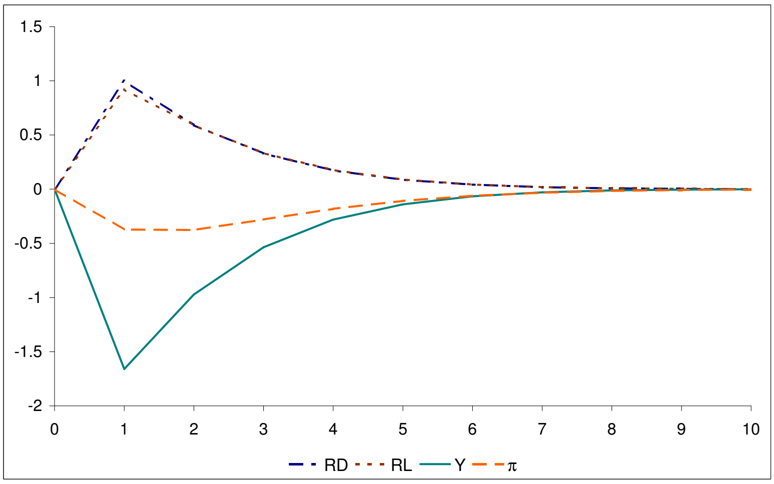

Figure 3: Impulse Response of Inflation in different Financial Systems