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

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Abstract

In this paper we study the role of financial systems for the cost channel transmission of monetary policy in a calibrated business cycle model. We analyze the different effects that monetary policy has on the economy, in particular on output and inflation, which are due to differences in country-specific financial systems. For a plausible calibration of the model, differences in financial systems have a rather limited effect on the transmission mechanism and do not appear to give rise to cross country differences in the strength of the cost channel.

Keywords: Financial Systems, Cost Channel, Transmission Mechanism

JEL codes: E40, E50

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1 Introduction

According to the cost channel transmission of monetary policy, nominal interest rates partially determine the cost of working capital (see Barth and Ramey, 2000; Ravenna and Walsh, 2005). 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. As long as, the impact of monetary policy on borrowing costs faced by firms varies across countries, it seems conceivable that the strength of the cost channel also varies across countries. Chowdhury et al. (2005) present empirical evidence in favor of cross country differences in the transmission mechanism along these lines. The purpose of this paper is to analyze whether differences in financial systems across countries should be expected to result in quantitatively significant differences in the effects that monetary policy has on the economy via the cost channel.

Financial factors are also emphasized by the literature on the bank lending channel which holds that banks and therefore retail interest rates play a special role in the transmission mechanism. Put differently, the pass-through from policy to retail interest rates should be larger and faster since monetary policy has a more direct influence on retail interest rates than on corporate bond yields. Thus, according to this view, one would expect a stronger cost channel effect in economies characterized by a so called bank-based financial system.[1] However, intermediated loans also differ in some other, institutional aspects from directly placed corporate debt instruments. Berger and Udell (1992) argue that banks with close ties to their customers may offer implicit interest rate insurance. That is, banks charge relatively low rates during periods of a monetary tightening, or periods of high market rates more generally, and vice versa (see also Dell'Ariccia and Marquez, 2004). Hence, lending rates will be adjusted less frequently and in smaller

[1] For a discussion and classification of financial systems see Allen and Gale (2000).

steps. Along these lines, De Bondt (2005) argues that retail interest rates in the euro area are sticky in the short run. Although the pass-through from policy to retail interest rates is nearly complete in the long run, it is only about one half in the short run. Thus, as emphasized in Ehrmann et al. (2003) among others, the reaction of bank lending to monetary policy might not be as strong as expected by the proponents of the bank lending channel, simply because liquidity shocks are smoothed by the banking sector.[2]

Our analysis will be based on a simple New Keynesian business cycle model that is characterized by two elements. Differences in financial systems will be captured 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. A bank-based system, which is characteristic for the euro area, will be calibrated by a higher share of bank-dependent firms and a higher degree of interest rate smoothing than a market-based system (which is thought to characterize the US). In both setups, the cost of working capital represents an additional channel for the transmission of monetary policy, due to the assumption that labor has to be paid prior to production. This second feature of the model relates the paper to the literature on the cost channel transmission of monetary policy.

Cross-country, and hence financial system, comparisons in the magnitude of responses in variables like nominal interest rates, prices and real activity to monetary policy shocks are, in general, inconclusive. Most empirical studies based on vector autoregressions find that the qualitative responses of output and prices are similar across countries, but these results have to be interpreted with caution, as generally, the confidence bands around the mean response estimates are large.[3] Moreover, Angeloni et al. (2003)

[2] As pointed out in Allen and Gale (2000), liquidity smoothing is typical for bank-based financial systems, in which close customer relationships develop over time.

[3] Among others, Christiano et al. (1999), Cushman and Zha (1997), Fung and Kasumovich (1998), and Grilli and Roubini (1996) apply the identified VAR approach to a

survey empirical evidence on the transmission mechanism in the euro area and conclude that the bank lending channel is not as substantial as one would have thought given the prominent role of banks as providers of finance in the euro area. More recently, Dedola and Lippi (2005) find evidence of significant cross-industry differences in the effects of monetary policy, which is partly related to the cost of working capital. However, they also find that cross-country heterogeneity is hardly detectable in the data.

Our results are in line with this empirical evidence. Generally, we find that the cost channel plays only a limited role for explaining differences across countries in the transmission of monetary policy shocks to output and prices. Differences in the characteristics between the financial system of the euro area and the US do not appear to be large enough to result in sizeable differences of the cost channel effects. One explanation may be that interest rate smoothing compensates the higher degree of bank-dependence in the euro area.

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 results and presents the results. Section 5 summarizes and concludes the paper.

2 Model

2.1 Households

Households maximize their expected lifetime utility

$$E_0 \sum_{t=0}^{\infty} \beta^t u(C_t, L_t), \tag{1}$$

range of countries. More recently, Mojon and Peersman (2003) present evidence for the countries in the euro area and Peersman and Smets (2003) use data for the euro area economy as a whole.

where β is a discount factor, C_t is consumption of a composite good in period t, L_t denotes labor supply in period t, and

$$u(C_t, L_t) = \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{L_t^{1+\eta}}{1+\eta}. \tag{2}$$

The composite consumption good, C_t, is a CES aggregate of the quantities of differentiated goods, $C_t(i)$, where $i \in (0, 1)$:

$$C_t = \left(\int_0^1 C_t(i)^{\frac{\epsilon-1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}}. \tag{3}$$

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. The model abstracts from explicitly modeling money by assuming that the economy approaches its cashless limit as in Woodford (2003). Moreover, it is assumed that transactions in the financial markets have to be completed before the households can enter the goods market. Hence, the households face the following liquidity constraint:

$$P_t C_t \leq A_{t-1} - D_t - B_t + W_t L_t. \tag{4}$$

The representative household owns the firms and the financial intermediaries and receives dividends. Hence, the household's nominal assets, A_t, evolve according to:

$$A_t = A_{t-1} + W_t L_t + r_t^D D_t + r_t^B B_t - P_t C_t + \Pi_t, \tag{5}$$

where Π_t are dividends distributed at the end of the period. The household solves the dynamic programming problem:

$$V(A_{t-1}) = \max_{C_t, L_t, D_t, B_t} \{u(C_t, L_t) + \beta E_t V(A_t)\} \tag{6}$$

subject to (4), (5) and the usual transversality condition. The necessary conditions associated with this maximization problem are:

$$\beta E_t\left(R_t^D\frac{C_{t+1}^{-\sigma}}{P_{t+1}}\right)=E_t\left(\frac{C_t^{-\sigma}}{P_t}\right), \tag{7}$$

$$\beta E_t\left(R_t^B\frac{C_{t+1}^{-\sigma}}{P_{t+1}}\right)=E_t\left(\frac{C_t^{-\sigma}}{P_t}\right), \tag{8}$$

$$\frac{W_t}{P_t}=\frac{L_t^{\eta}}{C_t^{-\sigma}}. \tag{9}$$

Log linearizing this system around the steady state gives

$$\hat{C}_t=-\frac{1}{\sigma}(\hat{R}_t^B-E_t(\hat{\pi}_{t+1}))+E_t(\hat{C}_{t+1}), \tag{10}$$

$$\hat{W}_t-\hat{P}_t=\eta\hat{L}_t+\sigma\hat{C}_t, \tag{11}$$

$$\hat{R}_t^D=\hat{R}_t^B, \tag{12}$$

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 (10) is a standard Euler equation, (11) is the labor supply equation and (12) is an arbitrage relationship between 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:

$$Y_{it}=\chi_i H_{it}^{1-\alpha}, \tag{13}$$

were $\alpha\in(0,1)$. The parameter χ_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 χ_i are not for $i \in (0, \lambda)$, only the financial intermediaries have access to a monitoring technology that allows verification of realizations of χ_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

$$R_t^L \frac{W_t}{P_t} = mc_t^F (1 - \alpha) \frac{Y_{it}}{H_{it}} \tag{14}$$

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

$$R_t^B \frac{W_t}{P_t} = mc_t^B (1 - \alpha) \frac{Y_{it}}{H_{it}} \tag{15}$$

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. In particular, we assume that 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 $t-1$ (see equation (16) below). 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

$$\hat{P}_t^* = (1-\omega)(\lambda \hat{P}_t^F + (1-\lambda)\hat{P}_t^B) + \omega \hat{P}_t^b. \tag{16}$$

Under Calvo pricing, the optimal price reset in period t can be expressed as:

$$\hat{P}_t^F = (1-\beta\theta) \sum_{k=0}^{\infty} (\beta\theta)^k E_t \widehat{mc}_{t+k}^F. \tag{17}$$

Similarly, bond issuing firms set prices according to

$$\hat{P}_t^B = (1-\beta\theta) \sum_{k=0}^{\infty} (\beta\theta)^k E_t \widehat{mc}_{t+k}^B. \tag{18}$$

Furthermore, these assumptions on the price setting behavior of firms can be combined to obtain

$$\hat{\pi}_t = \delta \widehat{mc}_t + \beta\theta\phi^{-1} E_t \hat{\pi}_{t+1} + \omega\phi^{-1}\pi_{t-1}, \tag{19}$$

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.[4]

2.3 Financial Intermediaries

At the beginning of the period, financial intermediaries receive deposits from the households. Part of the total amount of loanable funds, D_t, is used to provide loans, L_t, to firms which cannot borrow from households directly

[4]For a detailed derivation see for instance Galí et al. (2001).

and the rest is kept as reserves. In contrast to households, financial intermediaries can observe the realization of idiosyncratic shocks and are therefore able to enforce debt contracts. At the end of the period, the financial intermediaries receive payments from their solvent borrowers and return deposits with interest to the households. The remaining profits are paid to the households as dividends.

There is a clear role for financial intermediaries in this environment since without the intermediaries, bank-dependent firms would have no opportunity to borrow working capital and would be cut off from production. Furthermore, the financial intermediaries can eliminate idiosyncratic default risk by lending to an infinite number of borrowers (Diamond, 1984).

We assume that banks can 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. This setup of the banking sector is similar to Christiano et al. (2004), with the difference that in their model excess reserves enter into the production function for loans. Note that it is assumed that Ψ_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 that banks face.

Moreover, we assume that banks smooth out liquidity shocks that might otherwise give rise to large swings in lending rates. We model this interest rate smoothing motive by assuming that the amount of loans that is generated from a given amount of deposits is a function of the change in interest rates. In particular, we assume that $\Psi_t = \psi_0 \left(\frac{R_t^L}{{R_{t-1}^L}^{\nu}} \right)^{\psi}$, where $\psi_0 > 0$ and $\psi > 0$. The parameter ν indexes the importance of interest smoothing. For $\nu = 0$ the amount of loans that banks can generate depends only on the current lending rate. According to this specification, financial intermediaries are able to increase lending in times of rising interest rates even if the amount of deposits does not increase. 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 the constraint $L_t = \psi_0 \left(\frac{R_t^L}{{R_{t-1}^L}^\nu} \right)^\psi D_t$.

An interior solution to this problem is characterized by

$$qR_t^L \psi_0 \left(\frac{R_t^L}{{R_{t-1}^L}^\nu} \right)^\psi = R_t^D \tag{20}$$

Taking a log linear approximation to this equation gives

$$\hat{R}_t^L = \frac{1}{1+\psi} \hat{R}_t^D + \frac{\psi\nu}{1+\psi} \hat{R}_{t-1}^L. \tag{21}$$

Note that this specification appears to be broadly consistent with some empirical regularities on retail interest rates. The pass-through is less than perfect in the short run and lending rates display some persistence.

2.4 Monetary Authority

As in Woodford (2003), it is assumed that the economy approaches its cashless limit and that the monetary authority can control nominal interest rates through interventions in the interbank money market. The policy instrument is the deposit rate since this interest rate is most closely related to a money market rate. It is assumed that monetary policy can be described by the rule

$$\hat{R}_t^D = \rho \hat{R}_{t-1}^D + (1-\rho)(\kappa_\pi \hat{\pi}_t + \kappa_y \hat{y}_t) + u_t, \tag{22}$$

where ρ determines the degree of monetary policy inertia and κ_π, κ_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.

2.5 Equilibrium

A stationary competitive equilibrium for the model economy is characterized by stochastic sequences of allocations and prices such that: (i) The household's optimality conditions are satisfied. (ii) The necessary conditions that determine optimal borrowing for bank-dependent firms as well as for bond-issuing firms hold. (iii) The markets for labor, goods, loans and bonds clear.

The equilibrium dynamics of the log linear approximation of the model around the steady state are determined by:

$$\hat{Y}_t = -\frac{1}{\sigma}(\hat{R}_t^B - E_t(\hat{\pi}_{t+1})) + E_t(\hat{Y}_{t+1}), \tag{23}$$

$$\hat{\pi}_t = \delta(\lambda \hat{R}_t^L + (1-\lambda)\hat{R}_t^B) + \delta\gamma\hat{Y}_t + \beta\theta\phi^{-1}E_t\hat{\pi}_{t+1} + \omega\phi^{-1}\hat{\pi}_{t-1}, \tag{24}$$

$$\hat{R}_t^B = \hat{R}_t^D, \tag{25}$$

$$\hat{R}_t^L = \frac{1}{1+\psi}\hat{R}_t^D + \frac{\psi\nu}{1+\psi}\hat{R}_{t-1}^L \tag{26}$$

$$\hat{R}_t^D = \rho\hat{R}_{t-1}^D + (1-\rho)(\kappa_\pi\hat{\pi}_t + \kappa_y\hat{y}_t) + u_t, \tag{27}$$

where $\gamma = \frac{1+\eta}{1-\alpha} - 1 + \sigma$.

3 Empirical Estimates of Pass-Trough and Persistence

In this section we present empirical evidence on interest rate pass-through and persistence for the euro area countries and the US. The empirical equation is obtained by taking first differences of (26):

$$\Delta R_{it}^L = \tau_0\Delta R_{it}^D + \tau_1\Delta R_{it-1}^L, \tag{28}$$

where $\tau_0 = \frac{1}{1+\psi}$ and $\tau_1 = \frac{\psi\nu}{1+\psi}$. Note that we only estimate the reduced form coefficients τ_0 and τ_1 and do not attempt to identify the structural parameters underlying these coefficients. We estimate (28) 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.[5] Depending on the availability of data, we use as a proxy for the policy rate either the three month Treasury

[5]The samples differ somewhat for the individual countries.

Bill rate (Belgium, Germany, Spain, France and Italy) or the money market rate (Finland, Ireland, Netherland and Portugal).

Table 1 reports the results from estimating (28) separately for each country. For the euro area countries the estimates for the pass-through coefficient fall between 0.23 for Portugal and 0.75 for Belgium. The null hypothesis of perfect pass-through in the short run, $H_0 : \tau_0 = 1$, can be rejected for each euro area country in our sample. The persistence coefficients range from 0.11 (Belgium) to 0.51 (Finland). Note that the estimates for τ_1 are statistically different from zero at least at the 10 percent level for each country. The table also displays panel estimates for the euro area country in our sample.[6] Overall, the instantaneous pass-through in the euro area appears to be around 0.5 and the coefficient describing the persistence of the lending rate shows a value of 0.25.

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 τ_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 τ_1 is not significantly different from zero. In addition, the null hypothesis of equal estimates for τ_0 and τ_1 for the euro area and the US is rejected at a high level of significance. Thus, it appears that the interest rate pass-through process differs substantially between both regions.

In general, countries characterized by a high instantaneous pass-through also tend to display relatively little persistence in the lending rate. For five euro area countries (Belgium, Germany, Finland, France, Portugal) and the US, the null hypothesis $H_0 : \tau_0 + \tau_1 = 1$ can not be rejected at the usual levels of statistical significance. Thus, for these countries, the lending rate

[6] It is well known that including a lagged dependent variable in a panel regression may lead to a downward bias in small samples. Although our sample appears to be sufficiently large, we have re-estimated the equation using the Arellano and Bond (1991) GMM estimator. The results turn out to be almost identical.

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 recent literature. Angeloni and Ehrmann (2003) estimate the pass-through from policy rates to retail interest rates. For the period 1999 - 2002 they report that on impact, the pass-through from policy to retail interest rates is around 0.4 for the euro area and 0.7 for the US. De Bondt (2002) estimates a short-run pass-through to retail interest rates of 0.5 in the euro area. Our estimations for the US report an almost complete pass-through from policy to lending rates in the short run. For the euro area countries, we find that the short run pass-through is incomplete and substantially lower than in the US. Besides being in line with the results reported in the literature, this finding is consistent with the idea that European banks, in contrast to US banks, typically absorb liquidity shocks to some extent and smooth out retail interest rates (see Ehrmann et al. (2003)). Moreover, our results indicate that corporate lending rates in the euro area display a high degree of persistence in contrast to the US.

4 Calibration and Simulation Results

The model is calibrated to analyze the question whether cost channel effects are different between 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 β is set to 0.99. The coefficients in the utility function, σ and η, are both set equal to 2, which is standard in the literature. The elasticity of substitution between differentiated goods, ϵ, is set to 11. For α 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 price setting behavior is roughly in line with recent empirical evidence.[7]

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.[8] Hence, λ is set to 0.2 for the US and 0.5 for the euro area. Recall that ψ and ν 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: $1/(1+\psi)$ is set to 0.48 for the euro area and to 0.92 for the US. We set $\nu\psi/(1+\psi)$ to 0.25 for the euro area and 0.05 for the US.

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 in equilibrium. However, allowing marginal costs to be directly influenced by the interest rate, due to the assumption that firms have to borrow working

[7] See for instance Leigh and Malley (2005).

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

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. 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 to monetary policy shock which appears to be entirely dominated by the aggregate demand channel. Thus, we may conclude that differences in financial systems are not sizeable enough to lead to quantitatively significant differences in the transmission mechanism in our framework.

Figure 3 compares the impulse responses of the inflation rate in more detail. It appears that the different financial system calibrations yield only small differences in the response of inflation. Even the calibrated higher persistence in lending rates in Europe 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 countries.

How do these findings compare with the existing literature? Note that the Phillips curve (19) can be rewritten as

$$\hat{\pi}_t = \delta\left(\frac{\lambda}{1+\psi} + (1-\lambda)\right)\hat{R}_t^D + \frac{\delta\lambda\psi\nu}{1+\psi}\hat{R}_{t-1}^L + \delta\gamma\hat{Y}_t + \beta\theta\phi^{-1}E_t\hat{\pi}_{t+1} + \omega\phi^{-1}\hat{\pi}_{t-1}. \quad (29)$$

Thus, the interest rate enters the Phillips curve contemporaneously with a coefficient that is determined by the financial system, $\frac{\lambda}{1+\psi} + (1-\lambda)$.[9] When calibrated to US data this coefficient is 0.98. For the euro area, the calibration implies a slightly smaller coefficient of 0.74, which explains why the model delivers rather similar results in both cases. Ravenna and Walsh (2005) and Chowdhury et al. (2005) provide estimates of this coefficient for the US. Ravenna and Walsh (2005) use a purely forward looking specification and estimate a value of 1.276. They cannot reject the hypothesis that the coefficient is equal to unity. Chowdhury et al. (2005) report a coefficient estimate around 1.3.[10] In addition, their coefficient estimates for the European countries in their sample tend to be lower than the corresponding estimate for the US. Thus, the parameter values assumed in our simulation exercise appear to be roughly in line with empirical evidence on cost channel effects in New Keynesian Phillips Curve models.

5 Concluding Remarks

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 cost channel plays only a limited role for explaining differences across countries 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. Moreover, 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 system, we find that cost channel effects are rather similar in both cases.

[9]Multiplied by δ, a parameter that is determined by the calibration of price setting behavior.

[10]Using CPI inflation rate as dependent variable they find a lower value of 0.8.

The reason is that interest rate smoothing compensates the higher degree of bank-dependence in the euro area. Thus, in line with Angeloni et al. (2003), we find that bank-lending is not necessarily a relatively powerful channel for monetary transmission in the euro area. Our findings are also consistent with Dedola and Lippi (2005) who find no evidence in favor of cross-country differences in the effects of monetary policy, despite significant cross-industry differences.

Our results also have implications for the monetary policy of the ECB. Since we find that differences in the financial systems that characterize the euro area and the US give rise to only modest differences in the transmission mechanism, one may conclude that the relatively small degree of heterogeneity in financial systems across the euro area member countries should not be a source of asymmetric cost channel effects.

The scope of this paper is limited to the analysis of cost channel effects that arise from bank lending rates and therefore abstracts from the broad credit channel that may give rise to indirect effects as argued by Chowdhury et al. (2005). Thus, incorporating potential indirect effects of interest rates on the price setting behavior of firms appears to be an interesting avenue for future research. In addition, we have introduced interest rate smoothing into the model in a highly stylized and reduced form way. Providing explicit micro-foundations as well as empirical evidence for the behavior of banks in different financial systems may lead to interesting further insights for the transmission of monetary policy through the banking sector of an economy.

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Table 1: Interest Rate Pass Through (τ_0) and Persistence of the Lending Rates (τ_1)

	BE	DE	ES	FI	FR	IR	IT	NL	PT	Euro Area	US
τ_0	0.75	0.31	0.70	0.26	0.27	0.56	0.60	0.73	0.23	0.48	0.92
	(0.04)	(0.06)	(0.10)	(0.02)	(0.03)	(0.02)	(0.06)	(0.12)	(0.06)	(0.06)	(0.04)
τ_1	0.11	0.47	0.24	0.51	0.14	0.18	0.46	0.22	0.31	0.25	0.05
	(0.04)	(0.08)	(0.09)	(0.05)	(0.08)	(0.04)	(0.07)	(0.11)	(0.07)	(0.07)	(0.04)
$\bar{R}^2$	0.88	0.57	0.60	0.85	0.54	0.91	0.74	0.75	0.17	0.68	0.94
DW	2.56	2.24	2.54	2.32	2.45	2.33	2.45	2.55	1.97	2.26	1.91
Obs	61	54	53	53	59	53	56	36	41	466	61

Notes to Table 1: 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 column labeled Euro Area shows the results of a panel OLS regression with data from the euro area countries in the sample. For the panel regression, White standard errors are reported.

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

	Inactive Cost Channel	US	Euro Area
Output	-1.65	-1.66	-1.66
Inflation	-0.41	-0.37	-0.38
	Relative to the Inactive Cost Channel Calibration		
Output	-	1.00	1.00
Inflation	-	0.92	0.93

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

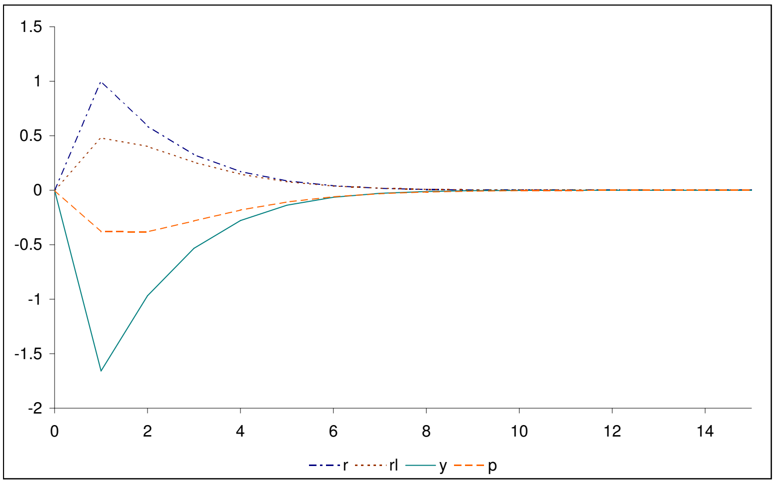

Figure 2: Impulse Responses generated by the model calibrated to match US financial system characteristics

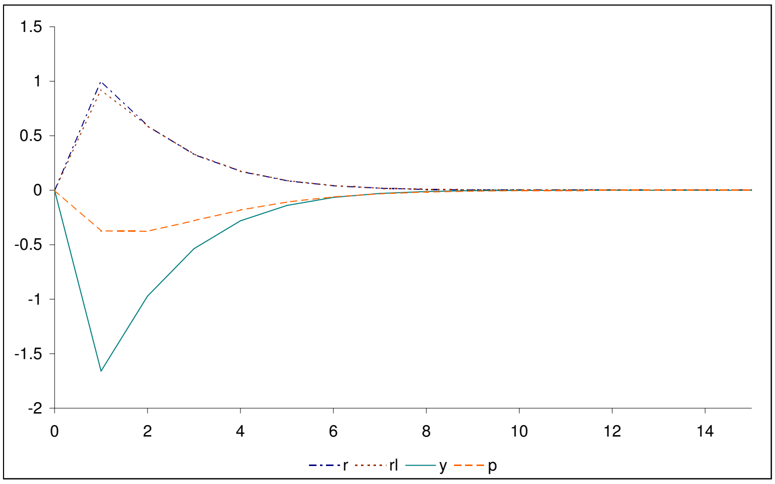

Figure 3: Impulse Response of Inflation for different Calibrations