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Do Bank-Based Financial Systems Reduce Macroeconomic Volatility by Smoothing Interest Rates?

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EUROSYSTEM

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Editorial

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Do Bank-Based Financial Systems Reduce Macroeconomic Volatility by Smoothing Interest Rates?*

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January 2006

Abstract

This paper investigates the business cycle implications of limited pass-through to retail interest rates based on a calibrated sticky price model. Although limited interest rate pass-through can in principle reduce output and inflation volatility at the same time, large reductions in output volatility are likely to be accompanied by a more volatile inflation rate. Limited pass-through gives rise to two counteracting effects: It partially insulates the economy from adverse liquidity shocks and thereby leads to lower output volatility. However, it also reduces the stabilizing effect of monetary policy which implies higher inflation volatility.

Keywords: Financial Systems, Interest Rate Pass-Through, Business Cycle

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1 Introduction

Retail interest rates appear to be sticky and less volatile than money market rates (see e.g. de Bondt and Mojon, 2005; de Bondt, 2005; Mojon, 2000; Cottarelli and Kourelis, 1994). To the extent that interest rate volatility feeds back into the real economy, limited pass-through to retail rates may have implications for business cycle volatility. The financial sector may contribute to macroeconomic stability by insulating the economy from interest rate shocks, or more generally liquidity shocks. This issue appears to be particularly relevant for bank-based financial systems where retail rates play an important role (see Allen and Gale, 2000).[1] Moreover, Kwapil and Scharler (2006) compare the euro area and the US as examples of bank-based and market-based financial systems and find that interest rate pass-through is substantially lower in the euro area. Along these lines, Issing (2002) argues that since relationship lending is relatively widespread in the euro area, business cycles should be smoother.

The purpose of this paper is to explore this issue in a calibrated sticky price model. Despite a large body of empirical evidence on interest rate pass-through, the macroeconomic consequences have been largely ignored. In addition, it remains an open issue whether the establishment of long-term relationships between financial intermediaries and their clients represents an advantage of bank-based systems over market-based systems (Allen and Gale, 2000, 2004). Hence, the present paper also contributes to the literature in this respect.

Theoretically, it is not entirely clear why we observe limited pass-through in the data. Several studies suggest that limited pass-through may be inter-

[1] De Fiore and Uhlig (2005) report that the ratio of bank finance to bond finance is 7.3 in euro area and 0.74 in the US.

preted as an implicit contract between financial institutions and their customers that arises as a consequence of long-term relationships (Berger and Udell, 1992; Allen and Gale, 2004). That is, banks with close ties to their customers offer relatively stable retail interest rates despite the occurrence of shocks that give rise to volatile market interest rates. Alternatively, limited interest rate pass-through may arise due to adjustment costs (see e.g. Hannan and Berger, 1991; Hofmann and Mizen, 2004). However, both theoretical arguments imply that retail rates should be less volatile than market rates.

Despite its implications for the volatility of retail rates, limited pass-through may also lead to instability since it might interfere with the stabilizing role of monetary policy. Moreover, central banks typically implement monetary policy according to a target for the overnight interest rate. Some central banks rely on standing facilities which guarantee that the overnight rate fluctuates only within a rather small band (see Woodford, 2003, chapter 3). Consequently, the amount of liquidity in the market for overnight funds adjusts endogenously to ensure that the interest rate remains close to the target. Hence, the operating procedures of central banks provide a substantial degree of liquidity smoothing. Thus, it is not clear how limited pass-through to retail rates can improve macroeconomic outcomes in such an environment. However, limited interest rate pass-through may help to stabilize the economy when a working capital channel is present in the sense that production costs depend on the nominal interest rate. To include this channel, the analysis is based on a business cycle model in which liquidity shocks arise due to the assumption that firms have to borrow a stochastic fraction of the wage bill in advance of production. Similar assumptions are standard in the class of limited participation models (e.g. Christiano et al., 1997), and also in the literature on the cost channel transmission of monetary policy (Ravenna and Walsh, 2005; Chowdhury et al., 2005).

Liquidity shocks increase production costs and therefore influence price setting. Thus, an adverse liquidity shock leads to higher inflation via borrowing costs in the short run. If the monetary authority responds by raising the interest rate, borrowing costs increase even further and thereby amplify the initial shock. In this environment the banking sector can potentially dampen the impact of the shock by responding only sluggishly to monetary policy.

The main result of the paper is that limited interest rate pass-through is likely to reduce output volatility only to a modest extent as long as the pass-through is complete at least in the long run. Larger volatility reductions are obtained if final pass-through is incomplete. In this case the financial system insulates the economy from the consequences of liquidity shocks even in the long run. However, limited final pass-through also implies that output volatility is reduced at the cost of higher inflation volatility. Monetary policy becomes less stabilizing in this case and therefore the inflation rate becomes relatively unstable.

The remainder of the paper is structured as follows: Section 2 describes a simple business cycle model which will be the framework for the analysis. Section 3 presents the calibration of the model and some simulations while Section 4 discusses the results and their implications. Section 5 concludes the paper.

2 Model

The model is a standard New Keynesian business cycle model closely related to Clarida et al. (1999) and Woodford (2003), hence the description will be brief. The model consists of firms, a financial intermediary sector, households and a monetary authority.

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 β is a discount factor, C_t is consumption of a composite good in period t and 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 $i \in (0,1)$, consumed: $C_t = \left(\int_0^1 C_t(i)^{\frac{\epsilon-1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}}$. 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 savings in the form of deposits at the financial intermediary which earn a gross interest rate of $R_t^d = 1 + r_t^d$. Furthermore, households supply L_t units of labor at a nominal wage of W_t. The households' own nominal assets, A_t, which evolve according to: $A_t = A_{t-1} + W_t L_t + r_t^d D_t - P_t C_t$. Moreover, transactions in the financial markets have to be completed before the goods market opens. Hence, households face the following liquidity constraint: $P_t C_t \leq A_{t-1} - D_t + W_t L_t$. The log-linearized necessary conditions associated with the households' optimization problem are:

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

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

where 'hatted' variables denote percentage deviations from the steady state and $\pi_t = \log P_t - \log P_{t-1}$ is the inflation rate.

2.2 Firms

The business sector of the economy consists of a continuum of monopolistically competitive firms normalized to have unit mass. Firms are subject to two types of shocks: An idiosyncratic productivity shock and a liquidity shock that is common to all firms. Each firm $i \in (0,1)$ produces a differentiated consumption good according to $Y_{it} = \chi_i H_{it}^{1-\alpha}$, where $\alpha \in (0,1)$ and H_{it} denotes labor. The parameter χ_i represents an idiosyncratic shock, in particular $\chi_i = 1$ with probability q and $\chi_i = 0$ with probability $1-q$. Hence, firms can only repay their debt with probability q. In case of default, firms can walk away from their debt obligations. The realizations of χ_i are not publicly observable, only the financial intermediaries have access to a monitoring technology that allows verification of the realizations of χ_i. Due to the assumption that a fraction of the wage bill is paid in advance of production, firms have to borrow working capital. Since the realizations of the idiosyncratic shocks are not public knowledge, firms have an incentive to misreport their output and to default on bonds owned by households. Consequently, firms are not able to obtain loans from the households and have to borrow from the financial intermediaries at the interest rate R_t^l. Firms must finance $\zeta_t \in (0,1)$ of the wage bill in advance of production (see Christiano and Gust, 1999). Here, ζ_t follows an autoregressive process

$$\log \zeta_t = (1-\rho_\zeta)\log \zeta + \rho_\zeta \log \zeta_{t-1} + \epsilon_{\zeta,t}, \tag{4}$$

where $\epsilon_{\zeta,t}$ is interpreted as a mean zero liquidity shock. Cost minimization implies

$$\zeta_t R_t^l \frac{W_t}{P_t} = mc_t(1-\alpha)\frac{Y_{it}}{H_{it}}, \tag{5}$$

where mc_t denotes marginal cost.

As in Calvo (1983), each period, a fraction $(1-\theta)$ of the firms is able to readjust prices. Moreover, only a fraction $(1-\omega)$ of firms, that can set prices in the current period, resets prices optimally (Galí et al., 1999, 2001). 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 a percentage deviation from the steady state) set by firms that are able to adjust their price in period $t-1$. Thus, the aggregate price level evolves according to $\hat{P}_t = \theta \hat{P}_{t-1} + (1-\theta)\hat{P}^*_t$. As shown in Galí et al. (2001), combining these assumptions on the price setting behavior, a Phillips curve of the following form is obtained:

$$\hat{\pi}_t = \delta \widehat{mc}_t + \beta\theta\phi^{-1} E_t \hat{\pi}_{t+1} + \omega\phi^{-1}\pi_{t-1}, \tag{6}$$

where $\delta = \frac{(1-\theta)(1-\theta\beta)(1-\alpha)(1-\omega)}{(1+\alpha(\epsilon-1))}\phi^{-1}$ and $\phi = \theta + \omega(1-\theta(1-\beta))$.

2.3 Financial Intermediaries

Financial intermediaries play a dual role in this environment: They eliminate idiosyncratic default risk by lending to an infinite number of borrowers (Diamond, 1984), and they smooth liquidity shocks that might otherwise give rise to large swings in retail rates (Berger and Udell, 1992). 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 and the rest is invested in a risk-free intra-period bond. Bond holdings are denoted by B_t. The financial intermediaries maximize $q\Psi^l_t R^l_t L_t + R^b_t B_t - \Psi^d_t R^d_t D_t$, where $\Psi^l_t < 1$ represents the cost of managing a loan portfolio and $\Psi^d_t > 1$ is the cost associated with the management of deposit accounts. R^l_t and R^b_t are the gross returns on loans and bonds. To introduce an incentive for the financial intermediary to smooth retail interest rates, intermediation costs are modeled as increasing functions of the change in interest rates: $\Psi^l_t = \bar{\psi}_l \left(\frac{R^l_t}{R^l_{t-1}{}^{\nu_l}}\right)^{\psi^l}$ and $\Psi^d_t = \bar{\psi}_d \left(\frac{R^d_t}{R^d_{t-1}{}^{\nu_d}}\right)^{\psi^d}$. This is a simple and tractable way of incorporating a motive for interest rate smoothing without explicitly introducing microfoundations. The log-linearized necessary conditions are:

$$\hat{R}^l_t = \lambda^l_0 \hat{R}^b_t + \lambda^l_1 \hat{R}^l_{t-1}, \tag{7}$$

$$\hat{R}^d_t = \lambda^d_0 \hat{R}^b_t + \lambda^d_1 \hat{R}^d_{t-1}, \tag{8}$$

where $\lambda^i_0 = \frac{1}{1+\psi_i}, i = l, d$ denotes the short-run or immediate pass-through from the bond yield to retail rates and $\lambda^i_1 = \nu_i \psi_i \lambda^i_0, i = l, d$ determines the persistence. Note that (7) and (8) are similar to the regression equations typically estimated in the empirical literature which simplifies the calibration of the model. Note furthermore that for $\nu_l = \nu_d = 1$, lending and deposit rates follow partial adjustment processes. Thus, although the pass-through from the bond yield to retail interest rates may be incomplete in the short run, it will be complete in the long run. For $\nu_l < 1$ and $\nu_d < 1$, pass-through may be incomplete even in the long run.

2.4 Monetary Authority

Monetary policy is assumed to target the interest rate on bonds, R^b_t and follows the rule

$$\hat{R}^b_t = \rho \hat{R}^b_{t-1} + (1-\rho)(\kappa_\pi \hat{\pi}_t + \kappa_y \hat{y}_t), \tag{9}$$

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.

2.5 The Linearized Model

The equilibrium dynamics of the log-linearized system are summarized by:

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

$$\hat{\pi}_t = \delta\gamma \hat{Y}_t + \beta\theta\phi^{-1} E_t \hat{\pi}_{t+1} + \omega\phi^{-1}\hat{\pi}_{t-1} + \delta \hat{R}^l_t + \delta\hat{\zeta}_t, \tag{11}$$

$$\hat{R}^l_t = \lambda^l_0 \hat{R}^b_t + \lambda^l_1 \hat{R}^l_{t-1}, \tag{12}$$

$$\hat{R}^d_t = \lambda^d_0 \hat{R}^b_t + \lambda^d_1 \hat{R}^d_{t-1}, \tag{13}$$

where $\gamma = \frac{1+\eta}{1-\alpha} - 1 + \sigma$, together with the law of motion for ζ in (4) and the monetary policy rule in (9). For $\lambda^d_0 = \lambda^l_0 = 1$ and $\lambda^d_1 = \lambda^l_1 = 0$, the model collapses to a standard business cycle model featuring an interest rate augmented New Keynesian Phillips curve as in Ravenna and Walsh (2005) and Chowdhury et al. (2005). Note that the liquidity shock $\hat{\zeta}_t$ enters as an additive shock to the Phillips curve in (11) and can therefore be interpreted as a cost shock as in Clarida et al. (1999).

3 Calibration and Simulation Results

In this section, the model is simulated with different degrees of interest rate pass-through and standard deviations of the simulated output, inflation and interest rate series are computed.

3.1 Calibration

The euro area is generally thought to be an example of a bank-based financial system where limited interest rate pass-through appears to be particularly relevant. Therefore, the model is calibrated to match characteristics of this economy. For the time discount factor $\beta = 0.99$ is chosen. The coefficients σ and η which determine the inter-temporal elasticity of substitution and the labor supply elasticity, are both set equal to 2. ϵ is set to 11 which corresponds to a steady-state mark-up of ten percent. The capital share α is set to 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 four quarters, therefore $\theta = 0.75$. This calibration of the price setting behavior is roughly in line with the recent empirical evidence (see Leith and Malley, 2005). Following Christiano and Gust (1999), ρ_ζ is set to 0.95. The interest rate rule is calibrated according to the parameter estimates presented in Gerdesmeier and Roffia (2004) for the euro area: $\kappa_\pi = 2$, $\kappa_y = 0.3$ and $\rho = 0.8$.

For the simulations, a series of shocks, $\epsilon_{\zeta,t}$, of length $T = 10,000$ is drawn from a normal distribution with standard deviation 0.001. All results are reported relative to the case where immediate pass-through is complete: $\lambda_0^l = \lambda_0^d = 1$ and $\lambda_1^l = \lambda_1^d = 0$.

3.2 Limited Pass-Through to the Lending Rate

Consider first the case where the banking system partially isolates the business sector of the economy from the consequences of liquidity shocks. Since the focus of the paper is on liquidity shocks which primarily impact upon the business sector, this appears to be a natural starting point for the analysis. The deposit rate moves together with the policy rate, that is $\lambda_0^d = 1$ and $\lambda_1^d = 0$. Moreover, assume for now that the final pass-through to the lending rate is complete, $\lambda_0^l/(1 - \lambda_1^l) = 1$.

Table 1 reports the relative standard deviations for output, inflation and interest rates for various values of λ_0^l. According to be first line of the table, limited immediate pass-through to the lending rate is associated only with negligible reductions in output volatility. For all values of λ_0^l considered, output volatility is reduced by less than half a percent compared to the benchmark calibration. A similar conclusion emerges for inflation volatility. Here, we observe slightly larger volatility reductions for extremely low values of λ_0^l. The last three lines of the table display the relative interest rate volatilities. Clearly, lending and deposit rates are basically as volatile as the policy rate, which is consistent with the result that the reduction in aggregate volatility is negligible.

In the simulations discussed so far, only the immediate pass-through was varied, whereas final pass-through was complete. Next, the model is simulated under incomplete final pass-through. Thus, the financial sector not only smoothes the impact of shocks over time, but partially absorbs these shocks even in the long run. For these simulations immediate pass-through is set to the empirically plausible value of 0.5 (see de Bondt, 2005). Table 2 displays the results. We see that limited final pass-through is indeed associated with lower output volatility. However, volatility declines only slowly with λ_1^l. Similarly, inflation volatility turns out to be lower in an environment where interest rate pass-through is less complete in the long run. The standard deviation of the lending rate is substantially lower under imperfect long-run pass-through. Moreover, the lending rate is substantially less volatile than the policy rate. Overall, allowing for imperfect final pass-through results in lower macroeconomic volatility. However, the dampening effect still appears to be rather small.

What is the intuition behind these results? A liquidity shock raises the borrowing needs of firms. Since the cost of working capital affects the pricing decision of the firm it leads to an increase in prices via the Phillips curve. The increase in inflation leads to an increase in the policy interest rate, which in turn leads to an increase in lending rates and increases costs even further by making working capital more expensive. Thus, the response of monetary policy tends to amplify the shock. Interest rate smoothing by the banking sector dampens the increase in inflation and therefore also leads to a smaller increase in policy rates.

Nevertheless, this increase in the policy interest rate also leads to higher deposit rates which influence the consumption and saving decisions of households. Put differently, the response of the central bank to the liquidity shock induces an adverse demand shock and in the model this reduction in aggregate demand has larger effects than the original liquidity shock. Thus, even if the liquidity shock itself is either smoothed or absorbed by the banking sector, it is the reaction of the deposit rate that largely drives the response of aggregate variables in the model. Consequently, aggregate volatility might depend crucially on the pass-through to retail interest rates relevant for the household sector. This claim is evaluated in the remainder the section.

3.3 Limited Pass-Through to Lending and Deposit Rates

To study the implications of imperfect pass-through to the deposit rate, the model is now simulated with $\lambda_0^l < 1$. For the simulations described in the remainder of this section only symmetric pass-through to the lending and deposit rate is considered: $\lambda_0 = \lambda_0^l = \lambda_0^d$ and $\lambda_1 = \lambda_1^l = \lambda_1^d$. This parameterization is mainly chosen for simplicity. The results are presented for perfect final pass-through in Table 3 and for less than perfect final pass-through in Table 4.

The results reported in Table 3 for complete long run pass-through show that the standard deviations of output and inflation are reduced to a somewhat larger extent relative to those reported previously. This is especially true for inflation. For $\lambda_0 = 0.5$, inflation is around 2 percent less volatile than in the benchmark case. Output volatility is reduced by around 1 percent. Thus, even allowing for limited pass-through in the short run to the deposit rate does not appear to substantially reduce volatility of the key variables in the model.

Table 4 shows the results for parameter combinations that imply limited final pass-through. Immediate pass-through is again set to $\lambda_0 = 0.5$. Interestingly, the standard deviation of output is reduced by a considerable amount even for small deviations from perfect long-run pass-through. Even more strikingly and in contrast to the results so far, output volatility is reduced at the cost of a more volatile inflation rate.

This result can be understood in terms of how imperfect interest rate pass-through alters the stability properties of the model. According to the Taylor principle, the nominal interest rate has to respond sufficiently to an increase in inflation to raise the real interest rate (see e.g. Woodford, 2003). Otherwise, the equilibrium is indeterminate and fluctuations resulting from self-fulfilling revisions in expectations become possible. Intuitively, if nominal rates do not adjust sufficiently, a rise in expected inflation leads to a decrease in the real interest rate which stimulates aggregate demand. However, higher aggregate demand results in an increase in inflation and consequently the initial expectation is confirmed. If interest rate pass-through is incomplete, the influence of monetary policy on aggregate demand is weakened. It follows that the nominal rate has to respond stronger to have a stabilizing effect. Note that in the model, R_t^d is the relevant interest rate for the determination of aggregate demand. Figure 1 displays the frontier that divides the parameter space (λ^d, κ_π), where $\lambda^d = \lambda_0^d/(1 - \lambda_1^d)$, into regions corresponding to determinate and indeterminate equilibria. Points to the right of the frontier correspond to parameter combinations that are consistent with a determinate equilibrium. Points to the left lead to indeterminacy. For $\kappa_y = 0$, the lower bound on κ_π corresponds to $1/\lambda^d$. The intuition is straightforward: For low values of λ^d, changes in the policy interest rate are to a large extent absorbed by the intermediaries and not passed on to households. Hence, if expected inflation increases, monetary policy has to be tightened considerably to have a stabilizing effect on aggregate demand. For $\kappa_y > 0$ the link between inflation and output has to be taken into account as discussed in Woodford (2003). Clearly, lower long run pass-through requires a stronger response of monetary policy to inflation to ensure determinacy. What matters is the long-run effect on aggregate demand, therefore only the final pass-through is relevant.

Empirical estimates for κ_π of around two for the euro area (Gerdesmeier and Roffia, 2004) fall well within the determinate region for any value of λ^d considered here. Especially, since retail rates determine the interest rate-sensitive part of GDP only to a certain extent whereas the rest is influenced by market rates. Thus, sunspot fluctuations do not appear to be feasible. However, for low values of λ^d the economy moves closer to the indeterminate region and is therefore likely to be relatively unstable in response to fundamental shocks (see also Clarida et al., 2000). Intuitively, lowering the long-run interest rate pass-through while keeping the interest rate rule fixed implies that monetary policy becomes more accommodating. Hence, the inflation rate becomes more volatile. Put differently, lower long-run pass-through to the deposit rate has similar consequences as reducing κ_π in (9), whereas reducing the immediate pass-through while keeping the long-run pass-through at unity is similar to increasing policy inertia.

3.4 Discussion

Overall, the described simulations suggest that interest-rate smoothing is likely to reduce business cycle volatility to a considerable extent only at the cost of a more volatile inflation rate. Does a bank-based financial system like the euro area indeed contribute to macroeconomic stability to a greater extent than a market-based system? Agresti and Mojon (2003) report that output and inflation are less volatile in the euro area than in the US. Of course, this finding has to be attributed to a number of reasons, e.g. different rigidities, different types and magnitudes of shocks and their propagation mechanism. However, the question remains if differences in business cycle volatility may be due to differences in financial systems and interest rate pass-through. According to de Bondt (2005) final pass-through is incomplete for most categories of retail rates. A precise quantitative evaluation of the role of the financial system appears difficult since it is not clear which interest rate is most relevant as a determinant of aggregate demand. Moreover, only a fraction of the households and firms in the economy rely on the financial intermediaries, whereas the rest participate in financial markets directly. However, keeping these caveats in mind, the simulations in this paper indicate that any reduction in output volatility relative to a more market-based system should be rather small and is likely to be associated with a more volatile inflation rate.

4 Concluding Remarks

This paper analyzes the implications of limited interest rate pass-through for the transmission of liquidity shocks. A financial system which is characterized by limited interest rate pass-through is found to reduce macroeconomic volatility only to a limited extent as long as the final pass-through to retail interest rates is complete. If final pass-through is incomplete, output volatility is reduced to a greater extent, albeit at the cost of higher inflation volatility.

Note that liquidity shocks as they are modeled here are isomorphic to cost shocks (see e.g. Clarida et al., 1999). It follows that the simulations presented in this paper are also a description of how monetary policy and the financial system may contribute to the transmission of cost shocks more generally. Bernanke et al. (1997) emphasize basically the same mechanism for the transmission of oil price shocks (see also Hamilton and Herrera, 2004).

Overall, the results described here are in line with empirical evidence presented by Ferreira da Silva (2002) who finds that although financial development matters for output volatility, the financial system *per se* does not appear to influence business cycle volatility. Nevertheless, additional empirical analysis of the link between financial systems and business cycle properties appears to be an interesting avenue for future research.

It is well known that cost shocks give rise to a trade-off between output and inflation volatility (see e.g. Clarida et al., 1999). Ravenna and Walsh (2005) argue that the presence of a cost or working capital channel has important implications for optimal monetary policy. The analysis in this paper suggests that the impact of cost shocks may depend on the underlying financial system of an economy. Thus, the implications of financial system aspects for optimal monetary policy appear to be another promising area for future research.

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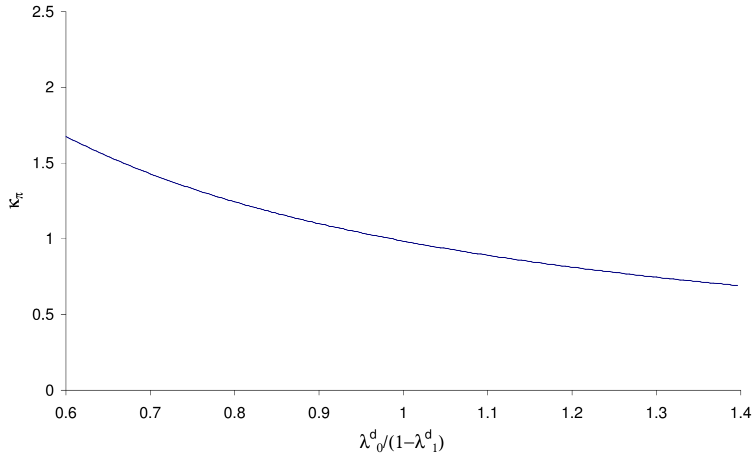
Figure 1: Regions of Determinacy and Indeterminacy



Notes for Figure 1: The frontier divides the parameter space into regions corresponding to determinate and indeterminate equilibria. Points to the right of the frontier correspond to parameter combinations that are consistent with a determinate equilibrium. Points to the left lead to indeterminacy.

Table 1: Relative standard deviations; Limited immediate pass-through to the lending rate

λ_0^l	0.67	0.50	0.33	0.25
λ_1^l	0.33	0.50	0.67	0.75
$\lambda_0^l/(1-\lambda_1^l)$	1.00	1.00	1.00	1.00
$\text{std}(\hat{Y})$	1.00	1.00	1.00	1.00
$\text{std}(\hat{\pi})$	1.00	1.00	1.00	0.99
$\text{std}(\hat{R}^b)$	1.00	1.00	1.00	0.99
$\text{std}(\hat{R}^d)$	1.00	1.00	1.00	0.99
$\text{std}(\hat{R}^l)$	0.99	0.99	0.97	0.95

Notes for Table 1: Standard deviations relative to results obtained for perfect short-run pass-through. Final pass-through to the lending rate is complete. Immediate pass-through to the deposit rate is complete.

Table 2: Relative standard deviations; Limited Final pass-through to the lending rate

λ_0^l	0.5	0.5	0.5	0.5
λ_1^l	0.45	0.38	0.29	0.17
$\lambda_0^l/(1-\lambda_1^l)$	0.90	0.80	0.70	0.60
$\text{std}(\hat{Y})$	0.99	0.99	0.98	0.98
$\text{std}(\hat{\pi})$	0.99	0.99	0.98	0.98
$\text{std}(\hat{R}^b)$	0.99	0.99	0.98	0.98
$\text{std}(\hat{R}^d)$	0.99	0.99	0.98	0.98
$\text{std}(\hat{R}^l)$	0.90	0.80	0.70	0.59

Notes for Table 2: Standard deviations relative to results obtained for perfect immediate pass-through. Final pass-through to the lending rate is incomplete. Immediate pass-through to the deposit rate is complete.

Table 3: Relative standard deviations; Limited immediate pass-through to the lending and the deposit rate

λ_0	0.67	0.50	0.33	0.25
λ_1	0.33	0.50	0.67	0.75
$\lambda_0/(1-\lambda_1)$	1.00	1.00	1.00	1.00
$\text{std}(\hat{Y})$	1.00	0.99	0.99	0.98
$\text{std}(\hat{\pi})$	0.99	0.98	0.96	0.95
$\text{std}(\hat{R}^b)$	0.98	0.96	0.93	0.91
$\text{std}(\hat{R}^d)$	0.97	0.94	0.89	0.85
$\text{std}(\hat{R}^l)$	0.97	0.94	0.89	0.85

Notes for Table 3: Standard deviations relative to results obtained for perfect immediate pass-through. The pass-through is complete in the long run.

Table 4: Relative standard deviations; Limited Final pass-through to the lending and the deposit rate

λ_0	0.5	0.5	0.5	0.5
λ_1	0.45	0.38	0.29	0.17
$\lambda_0/(1-\lambda_1)$	0.90	0.80	0.70	0.60
$\text{std}(\hat{Y})$	0.98	0.96	0.92	0.86
$\text{std}(\hat{\pi})$	1.09	1.23	1.44	1.86
$\text{std}(\hat{R}^b)$	1.18	1.45	1.84	2.63
$\text{std}(\hat{R}^d)$	1.07	1.17	1.31	1.60
$\text{std}(\hat{R}^l)$	1.07	1.17	1.31	1.60

Notes for Table 4: Standard deviations relative to results obtained for perfect immediate pass-through. Pass-through to lending and deposit rates is incomplete in the long run.

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