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Bank Loan Supply and Monetary Policy Transmission in Germany: An Assessment Based on Matching Impulse Responses

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Bank Loan Supply and Monetary Policy Transmission in Germany: An Assessment Based on Matching Impulse Responses*

Abstract

This paper addresses the credit channel in Germany by using aggregate data. We present a stylized model of the banking firm in which banks decide on their loan supply in the light of expectations about the future course of monetary policy. Applying a VAR model, we estimate the response of bank loans to a monetary policy shock taking into account the reaction of the output level and the loan rate. We estimate our model to evaluate the response of bank loans by matching the theoretical impulse responses with the empirical impulse responses to a monetary policy shock. Evidence in support of the credit channel can be reported.

JEL Classification: E44, E52.

Keywords: Monetary policy transmission, credit channel, loan supply, minimum distance estimation.

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1 Introduction

The credit channel assigns banks a pivotal role in the transmission of monetary policy, which stems from the notion that financial markets are characterized by imperfections.[1] Banks are special in extending credit to borrowers – that cannot access other types of credit – because of their expertise in mitigating financial frictions. If banks adjust their loan supply following a change in the stance of monetary policy, this has a bearing on real activity, since some borrowers have to rearrange their expenditure decisions.[2]

As Bernanke and Gertler (1995) and Hubbard (1995) point out, the credit channel is working in addition to the interest rate channel, according to which monetary policy affects the level of investment and consumer spending by inducing changes in the cost of capital and yield on savings. Although, the credit channel and the interest rate channel diverge in assessing the relevance of financial considerations, they are deemed complementary, with the implication that monetary policy can be effective through these transmission channels simultaneously.

Following Bernanke and Blinder (1992), a number of studies based on vectorautoregression (VAR) analysis have examined whether the credit channel is operating alongside the interest rate channel by using aggregate data. Many studies have shown that bank loans decline after a monetary policy shock, but these findings are plagued by a severe identification problem, as it remains unclear whether the drop is driven by loan supply or loan demand effects. While the credit channel emphasizes a shift in loan supply, the interest rate channel stresses a shift in loan demand, which stems from a policy–induced decline in real activity. Distinguishing between these predictions is a difficult task, as *"it is not possible using reduced–form estimates based on aggregate data alone, to identify whether bank balance sheet contractions are caused by shifts in loan supply or loan demand"* (Cecchetti, 1995, p. 92).

In light of this ambiguity, several studies have explored heterogeneity across agents by moving from aggregate data to disaggregated data. For the U.S., Gertler and Gilchrist (1993), Gilchrist and Zakrajsek (1995) and Oliner and Rudebusch (1995) use panel data of a large number of business firms. From this research it appears that firms of different size encounter different financial constraints after a monetary tightening. Kashyap and Stein (2000) investigate panel data at the

[1] See Bernanke and Gertler (1995), Cecchetti (1995) or Hubbard (1995) for a survey of the credit channel of monetary policy transmission.

[2] This idea centers on the assumption that some borrowers – in particular small and medium–sized firms – cannot issue corporate bonds at reconcilable terms because of information problems or high costs associated with launching debt securities. Banks as financial intermediaries specialize in gathering and distilling information, which enables them to make loans to these borrowers at more favorable terms.

individual bank level. They observe that monetary policy particularly affects the lending behavior of small banks with less liquid balance sheets. Kishan and Opiela (2000) report a similar finding by approximating bank lending activities on the basis of bank size and bank capital.

So far, much work on the credit channel in Germany – implemented by Barran, Coudert, and Mojon (1997), De Bondt (2000), Ehrmann (2004), Ehrmann and Worms (2004), Holtemöller (2003), Hülsewig, Winker, and Worms (2004), Kakes and Sturm (2002), Von Kalckreuth (2003) and Worms (2003) – has employed aggregate and disaggregated data but reported contrary results. While some of these studies find evidence in support of the credit channel, others conclude that the credit channel is ineffective. The vagueness in the results reflects in part the difficulty in separating the loan supply effects from the loan demand effects that follow a monetary contraction.

This paper addresses the credit channel in Germany by using aggregate data.[3] We present a stylized model of the banking firm, which specifies the loan supply decision of banks in the light of expectations about the future course of monetary policy. Applying a VAR model, we estimate the response of bank loans to a monetary policy shock taking account of the reaction of the output level and the loan rate. We use our model as a guide to characterize the response of bank loans – i.e. to decompose the adjustment of bank loans into the parts that can be attributed to loan supply and loan demand – by matching the theoretical impulse responses with the empirical impulse responses to a monetary policy shock. In this vein, the identification problem inherent in approaches based on aggregate data is explicitly addressed.[4]

Our findings suggest that the credit channel is operating alongside the interest rate channel. Banks decrease their loan supply with an expected drop in their credit margin after a monetary policy shock, while loan demand declines with a drop in the output level and a rise in the loan rate. The decrease in loan supply occurs instantly and bottoms out gradually. The decrease in loan demand proceeds by degrees and continues more persistently.

The remainder of this paper is organized as follows. Section 2 presents our model of the banking firm, which establishes the basis for our testing. Section 3 sets out the empirical results, which are derived by adopting a two–step procedure. First, we estimate a VAR model to generate impulse responses to a mone-

[3]Notice that in our analysis of the credit channel in Germany we disregard any distinction between a bank lending channel and a balance sheet channel, which may coexist simultaneously. Since in Germany banks provide the majority of external finance to private households and firms, this suggests that the effects of monetary policy through these sub–channels coincide (Deutsche Bundesbank, 2000).

[4]To our knowledge separating loan supply effects from loan demand effects by matching impulse responses has not yet been proposed in the literature.

tary policy shock. Second, we estimate our model by using a minimum distance estimation, which matches the theoretical impulse responses with the empirical impulse responses. Section 4 provides concluding remarks.

2 A Model of the Banking Firm

Our analysis of the credit channel is based on a stylized model of the banking firm, in which banks decide on their loan supply when future monetary policy is uncertain. The model refers to Cosimano (1988) and Sargent (1979). Similar approaches have been developed by Bofinger (2001), Elyasiani, Kopecky, and Van Hoose (1995) and Mitusch and Nautz (2001).

2.1 Structure of the Model

Consider a banking system with many identical banks that act as price takers. Banks grant loans to nonbanks (L_t), which they finance with deposits (D_t) and central bank credits (B_t) after subtracting required reserves (R_t). Each bank takes the loan rate (r_t^L) and the deposit rate (r_t^D) as given. The central bank is assumed to administer the policy rate (r_t^M) that determines the interest rate on the interbank money market.[5]

For a single bank i, profit at time $t+j$ is given by:

$$\pi_{t+j}^i = r_{t+j}^L L_{t+j}^i - r_{t+j}^D D_{t+j}^i - r_{t+j}^M B_{t+j}^i - C_{t+j}, \tag{1}$$

where:

$$\begin{aligned}
\pi_{t+j}^i &= \text{profit at time } t+j, \\
L_{t+j}^i &= \text{loans at time } t+j \text{ at rate } r_{t+j}^L, \\
D_{t+j}^i &= \text{deposits at time } t+j \text{ at rate } r_{t+j}^D, \\
B_{t+j}^i &= \text{net position on the interbank money market} \\
&\quad\ \text{at time } t+j \text{ at rate } r_{t+j}^M, \\
C_{t+j} &= \text{costs of evaluating and adjusting the stock} \\
&\quad\ \text{of loans at time } t+j.
\end{aligned}$$

Note that equation (1) is defined for $j = 0, 1, 2, ...$

Bank profit matches the difference between the revenues and costs in the credit business. Besides interest costs, the bank faces costs associated with adjusting

[5]Throughout the paper we presume that the central bank implements monetary policy by means of an interest rate targeting procedure.

the loan portfolio (C_{t+j}), which are represented by (see e.g., Cosimano, 1988):

$$C_{t+j} = (a/2)(L^i_{t+j} - L^i_{t+j-1})^2, \tag{2}$$

where (a) is a positive constant. The costs of adjusting the loan portfolio can be thought of as reflecting the allocation of resources necessary to evaluate the creditworthiness of customers and to monitor loans during the duration. If the bank realizes a change in the size of its loan portfolio, this requires to reshuffle the amount of resources devoted to these activities.[6] Assume the banking sector comprises (n) banks with identical cost functions.

A single bank seeks to maximize the expected present value of its profit flow:

$$V_t = E_t \sum_{j=0}^{\infty} \beta^j \pi^i_{t+j}, \tag{3}$$

where (E_t) is the rational expectation operator conditioned on the information set (I_t) disposable at time t, and (β) is a discount factor ($0 < \beta < 1$). Let the information set (I_t) include the past values of all variables and the present values of all interest rates, i.e. $E_t(x_{t+j}) \equiv E(x_{t+j}|I_t)$.

The maximization is subject to the balance sheet constraint:

$$L^i_{t+j} + R^i_{t+j} = D^i_{t+j} + B^i_{t+j}, \tag{4}$$

where minimum reserves (R^i_{t+j}) are determined by: $R^i_{t+j} = dD^i_{t+j}$, with (d) denoting the minimum reserve ratio ($0 < d < 1$). For a single bank the level of deposits (D^i_{t+j}) is assumed to be exogenously given (see e.g., Baltensperger, 1980; Klein, 1971). Depending on stochastic flows, the bank adjusts its net position on the interbank money market (B^i_{t+j}) to meet the balance sheet constraint.[7] The deposit rate (r^D_{t+j}) is presumed to adjust to the interbank money market rate (r^M_{t+j}) in consideration of the minimum reserve ratio (d) due to arbitrage conditions (Freixas and Rochet, 1997, p. 57).

2.2 Deriving Optimal Loan Supply

A single bank maximizes the expected present value of its profit flow by choosing the optimal path of loans subject to the balance sheet constraint and conditional on the set of available information.

[6]Notice that the costs of adjusting the loan portfolio are symmetric and thus do not depend on whether the change in the loan volume is positive or negative.

[7]Hence, for a single bank (B^i_{t+j}) can either be positive or negative depending on whether the bank borrows or lends on net on the interbank money market at the prevailing interbank money market rate.

Bank i's optimal loan supply is given by:[8]

$$L^i_{t+j} = L^i_{t+j-1} + a^{-1} \sum_{s=0}^{\infty} \beta^s E_{t+j}(r^L_{t+j+s} - r^M_{t+j+s}), \quad j = 0, 1, 2, ..., \tag{5}$$

which raises with an expected increase in the loan rate and falls with an expected increase in the policy rate. If the cost of adjustment parameter for loans (a) increases, this requires a higher expected credit margin in order to maintain a specific level of lending.

Notice that optimal loan supply is derived from the first order–condition:

$$r^L_{t+j} - a(L^i_{t+j} - L^i_{t+j-1}) + a\beta E_{t+j}(L^i_{t+j+1} - L^i_{t+j}) - r^M_{t+j} = 0, \tag{6}$$

which shows that the optimal loan level is characterized by the equation of the spread between the loan rate and the policy rate and the marginal costs of evaluating and adjusting the loan portfolio. The first–order condition is valid for $j = 0, 1, 2, ...$; when $j = 0$, the variables refer to the presently observed and expected values.

2.3 Loan Market Repercussions

Our model incorporates the assumption of a single and homogeneous loan market. Aggregate loan supply of the banking sector satisfies (here, evaluated for $j = 0$):

$$L_t = L_{t-1} + na^{-1} \sum_{s=0}^{\infty} \beta^s E_t(r^L_{t+s} - r^M_{t+s}), \tag{7}$$

which is the sum of the supplies of the (n) identical banks that refer to the currently observed and expected values.

Aggregate loan demand is assumed to be given by:

$$L_t = b_1 y_t - b_2 r^L_t, \tag{8}$$

where (y_t) is the output level and (b_1) and (b_2) are positive parameters.[9] The demand for loans raises with an increase in the output level and falls with an increase in the loan rate. The parameters (b_1) and (b_2) denote the income elasticity and the interest elasticity of aggregate loan demand.

[8] The procedure used for deriving optimal loan supply is taken from Sargent (1979). See Appendix A for details.

[9] Modeling loan demand in dependency of the output level and the loan rate is meanwhile commonly accepted. See Calza, Gartner, and Sousa (2003), Hülsewig, Winker, and Worms (2004) or Kakes (2000) – among others – for empirical support.

The equilibrium in the loan market is characterized by the equilibrium loan level and the equilibrium loan rate.[10] The equilibrium loan volume that maximizes the banks' present value is (for $j = 0$):

$$L_t = \lambda_1 L_{t-1} + \lambda_1 n a^{-1} \sum_{s=0}^{\infty} \left(\frac{1}{\lambda_2}\right)^s E_t(B_1 y_{t+s} - r^M_{t+s}), \tag{9}$$

where λ_1 and λ_2 are positive characteristic roots, with $\lambda_1 < 1 < 1/\beta < \lambda_2$, and $B_1 = b_1/b_2$. The equilibrium loan volume increases with an expected increase in the output level and decreases with an expected increase in the policy rate. Substituting the equilibrium loan level (9) into the loan demand equation (8) yields the equilibrium loan rate:

$$r^L_t = B_1 y_t - B_2 \lambda_1 L_{t-1} - B_2 \lambda_1 n a^{-1} \sum_{s=0}^{\infty} \left(\frac{1}{\lambda_2}\right)^s E_t(B_1 y_{t+s} - r^M_{t+s}), \tag{10}$$

where $B_2 = 1/b_2$. The loan rate raises with an expected increase in the policy rate and falls with an expected increase in the output level.[11]

2.4 Implications for Monetary Policy Transmission

Our stylized model implies that banks decide on their loan supply in the light of expectations about the future course of monetary policy. Loan supply by the banks declines with an expected fall in the credit margin after a monetary tightening, but since the adjustment in the loan level is sluggish, the effects of monetary disturbances are only passed on gradually. Since this suggests that banks are not neutral conveyors of monetary policy – as predicted by the credit channel – this is equivalent to the notion that bank behavior can play a meaningful role in the propagation of monetary policy actions. We explore this prediction in the following section by assessing impulse responses to a monetary policy shock.

3 Empirical Results

Following Christiano, Eichenbaum, and Evans (2004) and Rotemberg and Woodford (1998), we estimate our model to evaluate the adjustment of bank loans to a monetary policy shock by using a two–step procedure. In the first step, we estimate a VAR model to derive empirical impulse responses. In the second step,

[10] Since the credit channel does not imply credit rationing (see e.g., Gertler and Gilchrist, 1993, p. 46), we assume – for the sake of simplicity – that the loan market clears by price.

[11] This implies that the loan rate may follow a current change in the policy rate, but – owing to adjustment costs – the adjustment is sticky if the change is perceived to be solely temporary.

we estimate our model by matching the theoretical impulse responses with the empirical impulse responses. The reaction of loan supply and loan demand to a monetary policy shock is then determined on the basis of the estimated model parameters.

3.1 Empirical Impulse Responses

As in Bernanke and Blinder (1992), we employ a VAR model of the form:

$$Z_t = A(L)Z_{t-1} + \mu + \varepsilon_t, \tag{11}$$

where Z_t is a vector of endogenous variables, μ is a vector of constant terms and ε_t is a vector of error terms that are assumed to be white noise. The variable vector Z_t comprises five variables:

$$Z_t = (\texttt{GDP}_t, \texttt{CPI}_t, r_t^M, \texttt{LOANS}_t, r_t^L)',$$

where GDP stands for real output, CPI for the price level, r^M for the short–term rate, which is controlled by the central bank, LOANS for real aggregate bank loans and r^L for the loan rate.[12] Loan supply by the banks should depend on the credit margin, i.e. the spread between r^L and r^M, while loan demand should depend on real output and the loan rate. As the central banks aims at guaranteeing price stability by setting the short–term rate, the price level is also included.

The VAR model is estimated in levels to allow for implicit cointegration relationships between the variables. The sample period starts in 1991Q1, after the German unification, and ends in 2003Q2.[13] All variables are expressed in logs, except the interest rates that are in decimals. The vector of constant terms comprises a constant and seasonal dummies. Choosing a lag length of three ensures that the error terms are free of autocorrelation and conditional heteroscedasticity.[14]

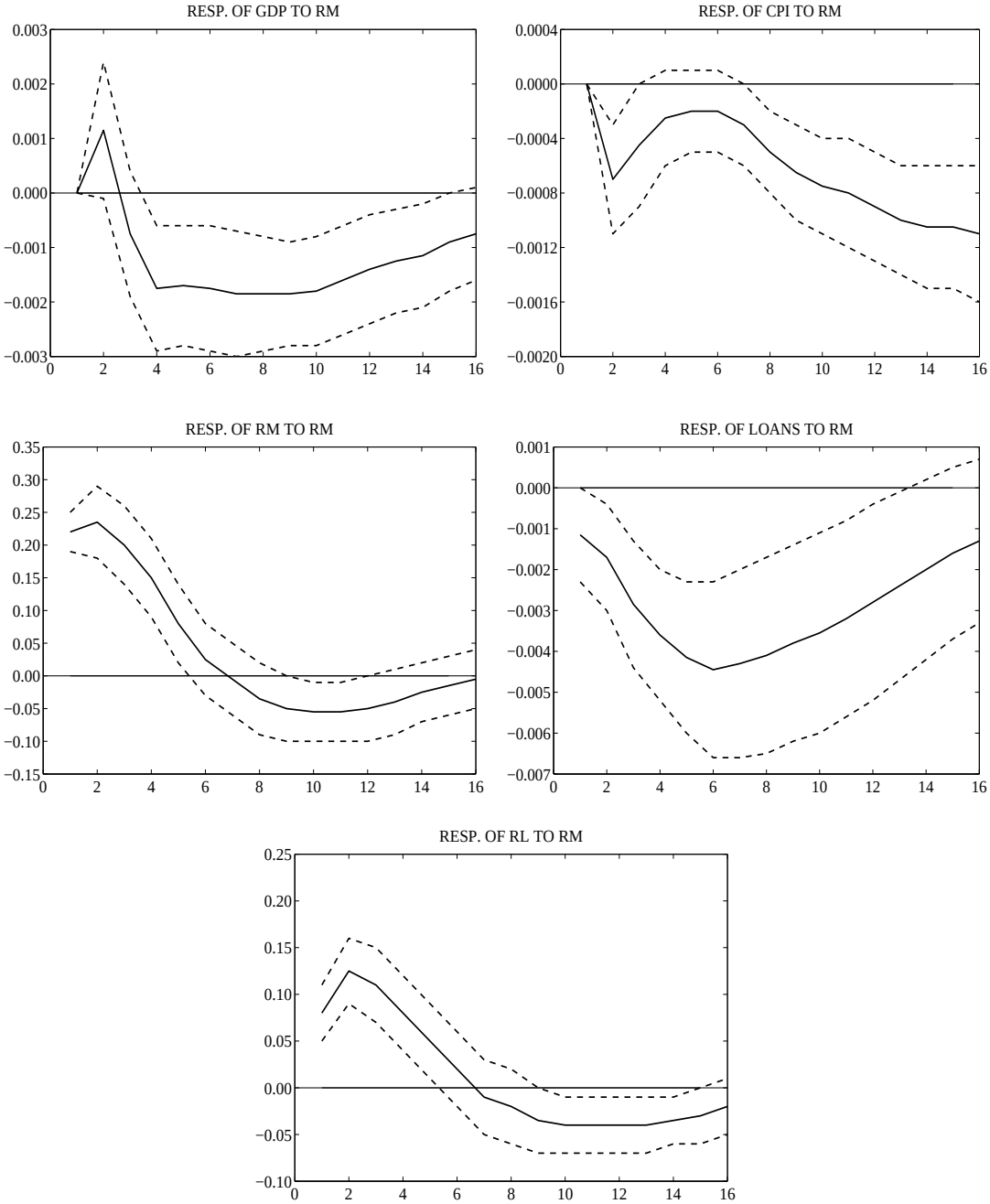
Based on the VAR model, we generate impulse responses of the variables in Z_t to a monetary policy shock, which is identified by imposing a triangular orthogonalization. The ordering of the variables implies that an innovation in the short–term rate affects the output level and the price level with a lag of one quarter, while the loan volume and the loan rate are affected within the same

[12] See Appendix B for a description of the variables used in the analysis.

[13] The end of our sample period is determined by the switch to the new MFI interest rate statistics of the European Central Bank (ECB), which entails a structural break in the data. See Deutsche Bundesbank (2004) for details.

[14] The VAR is estimated with JMulti by Lütkepohl and Krätzig (2004) as a SUBSET–VAR, after running a restriction search routine on the basis of the Akaike information criterion in order to achieve a parsimonious specification. See Brüggemann and Lütkepohl (2001) – among others – for a discussion about the advantages of SUBSET–VAR models.

Figure 1: Empirical Impulse Responses



Notes: Orthogonalized impulse responses to a monetary policy shock. The solid lines display impulse responses. The dashed lines are 90% error bands computed from a bootstrap procedure with 2000 replications. The horizontal axis is in quarters.

quarter. Figure 1 displays the impulse responses of the variables to a monetary policy shock, which is reflected by a one–standard–deviation shock to the short–term rate. The simulation horizon covers 16 quarters. The solid lines denote impulse responses. The dotted lines are approximate 90% error bands that are derived from a bootstrap routine with 2000 replications.[15]

Following a monetary policy shock, bank loans decline immediately. This corroborates the results of De Bondt (2000), Holtemöller (2003) and Hülsewig, Winker, and Worms (2004), who investigate the response of aggregate bank lending in Germany in a similar framework using monthly and quarterly data. The drop in bank loans continues for around twelve quarters until it breaks off. The output level falls after three quarters, reaching a peak after around seven quarters, and returns to baseline subsequently. The price level drops by degrees and declines persistently. The loan rate and the short–term rate increase for about four quarters and decrease afterwards. The loan rate follows a similar pattern as the short-term rate, but generally remains on a lower level.

As Bernanke and Gertler (1995) and Cecchetti (1995) point out, the decline in bank loans after a monetary tightening is consistent with the credit channel, but since the adjustment can be interpreted as being induced by loan supply and loan demand, clear predictions are difficult to establish. For an insight, we estimate our model in an attempt to reveal the reaction of loan supply and loan demand by adopting a minimum distance estimation, which matches the theoretical impulse responses with the empirical impulse responses to a monetary policy shock. Before we present the results, we briefly discuss the methodology applied.

3.2 Methodology

The estimation of our model is based on the following state space representation:

$$A_0 X_{t+1} = A_1 X_t + \upsilon_{t+1}, \tag{12}$$

where X_t is the state vector, which is composed of a vector $X_{1,t}$ of backward–looking variables and a vector $X_{2,t}$ of forward–looking variables, A_0 and A_1 are coefficient matrices and υ_{t+1} is a vector of shocks:

$$A_0 \begin{bmatrix} X_{1,t+1} \\ E_t X_{2,t+1} \end{bmatrix} = A_1 \begin{bmatrix} X_{1,t} \\ X_{2,t} \end{bmatrix} + \begin{bmatrix} \upsilon_{1,t+1} \\ 0 \end{bmatrix}.$$

The state space representation comprises the following equations:

$$L_t = \psi^{-1}\beta E_t L_{t+1} + \psi^{-1} L_{t-1} + B_1 na^{-1}\psi^{-1} y_t - na^{-1}\psi^{-1} r_t^M \tag{13}$$

[15] For each variable the horizontal axis shows the number of quarters after the monetary policy shock has been initialized. The vertical axis measures the response of the relevant variables. In case of `LOANS CPI` and `GDP` a value of 0.001 corresponds to a 0.1 percent change of the baseline value, while in case of the interest rates a value of 0.1 corresponds to a change of 10 basis points.

$$r_t^L = B_1 y_t - B_2 L_t \tag{14}$$

$$y_{t+1} = \gamma_1 y_t + \gamma_2 (r_t^L - 400(p_t - p_{t-1})) \tag{15}$$

$$p_{t+1} = \alpha_1 p_t + \alpha_2 y_t \tag{16}$$

$$r_{t+1}^M = \delta_1 r_t^M + (1 - \delta_1) 400 \delta_2 (p_{t+1} - p_t) + \eta_{t+1}, \tag{17}$$

where $\psi \equiv (\beta + na^{-1} B_2 + 1)$, $B_1 = b_1/b_2$ and $B_2 = 1/b_2$.

The first two equations specify the loan volume and the loan rate, which are derived from our model.[16] The output level is described by equation (15) as a dynamic IS relation according to which real output is determined by the previous level of real output and the real loan rate. Relating the output level to the real loan rate attributes to the importance of credit conditions in the propagation of monetary policy shocks. The price level is depicted by equation (16) as a backward–looking Phillips curve that relates the price level to the output level. Equation (17) illustrates the reaction function of the central bank that is described by a simple Taylor–type policy rule in which the short–term rate is adjusted to movements in the inflation rate and the previous short–term rate.[17] The monetary policy shock is reflected by the shock term η_{t+1}.

Summarizing these equations in matrix form yields:

$$X_{1,t} = \begin{bmatrix} y_t \\ p_t \\ p_{t-1} \\ r_t^M \\ r_{t-1}^L \\ L_{t-1} \end{bmatrix}, X_{2,t} = \begin{bmatrix} L_t \end{bmatrix}, A_0 = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \beta \end{bmatrix}, \upsilon_{1,t+1} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ \eta_{t+1} \\ 0 \\ 0 \end{bmatrix},$$

$$A_1 = \begin{bmatrix} \gamma_1 + \gamma_2 B_1 & -400\gamma_2 & 400\gamma_2 & 0 & 0 & 0 & -\gamma_2 B_2 \\ \alpha_2 & \alpha_1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ A_1^{4,1} & A_1^{4,2} & 0 & \delta_1 & 0 & 0 & 0 \\ B_1 & 0 & 0 & 0 & 0 & 0 & -B_2 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ -B_1 na^{-1} & 0 & 0 & na^{-1} & 0 & -1 & \psi \end{bmatrix},$$

[16] The identity of equation (9) and equation (13) is shown in Appendix A.2 (see equation (A.8)).

[17] Notice that we have investigated different types of policy rules in which the output level was additionally included; though, preliminary estimations have shown that the level of output turned out to be insignificant.

where $A_1^{4,1} = 400(1-\delta_1)\alpha_2\delta_2$ and $A_1^{4,2} = 400(\alpha_1 - 1)(1-\delta_1)\delta_2$.

The closed loop dynamics of the model, which serves as a starting point to generate impulse responses, are given by:

$$\begin{aligned} X_{1,t+1} &= (A_{11} + A_{12}C)\, X_{1,t} + \upsilon_{1,t+1} \\ X_{2,t} &= CX_{1,t}, \end{aligned} \tag{18}$$

where A_{11} and A_{12} are sub–matrices of $A = A_0^{-1}A_1$, which have been partitioned conformably with $X_{1,t}$ and $X_{2,t}$.[18] Using the algorithms as described in Söderlind (1999), the matrix C is determined numerically.

For the matching of impulse responses, we estimate the set of parameters:

$$\xi \equiv (b_1, b_2, na^{-1}, \delta_1, \delta_2, \gamma_1, \gamma_2, \alpha_1, \alpha_2),$$

by minimizing a measure of distance between the theoretical impulse responses and the empirical impulse responses. The discount factor is calibrated to: $\beta = 0.99$. The optimal estimator of ξ minimizes the corresponding distance measure $J^{opt}(\xi)$ (see Christiano, Eichenbaum and Evans, 2004):

$$J = \min_{\xi} \left(\hat{\Psi} - \Psi(\xi)\right)' V^{-1} \left(\hat{\Psi} - \Psi(\xi)\right), \tag{19}$$

where $\hat{\Psi}$ denote the empirical impulse responses, $\Psi(\xi)$ describe the mapping from ξ to the theoretical impulse responses and V is the weighting matrix with the variances of $\hat{\Psi}$ on the diagonal.[19] The minimization of the distance implies that those point estimates with a smaller standard deviation are given a higher priority.

3.3 Minimum Distance Estimation

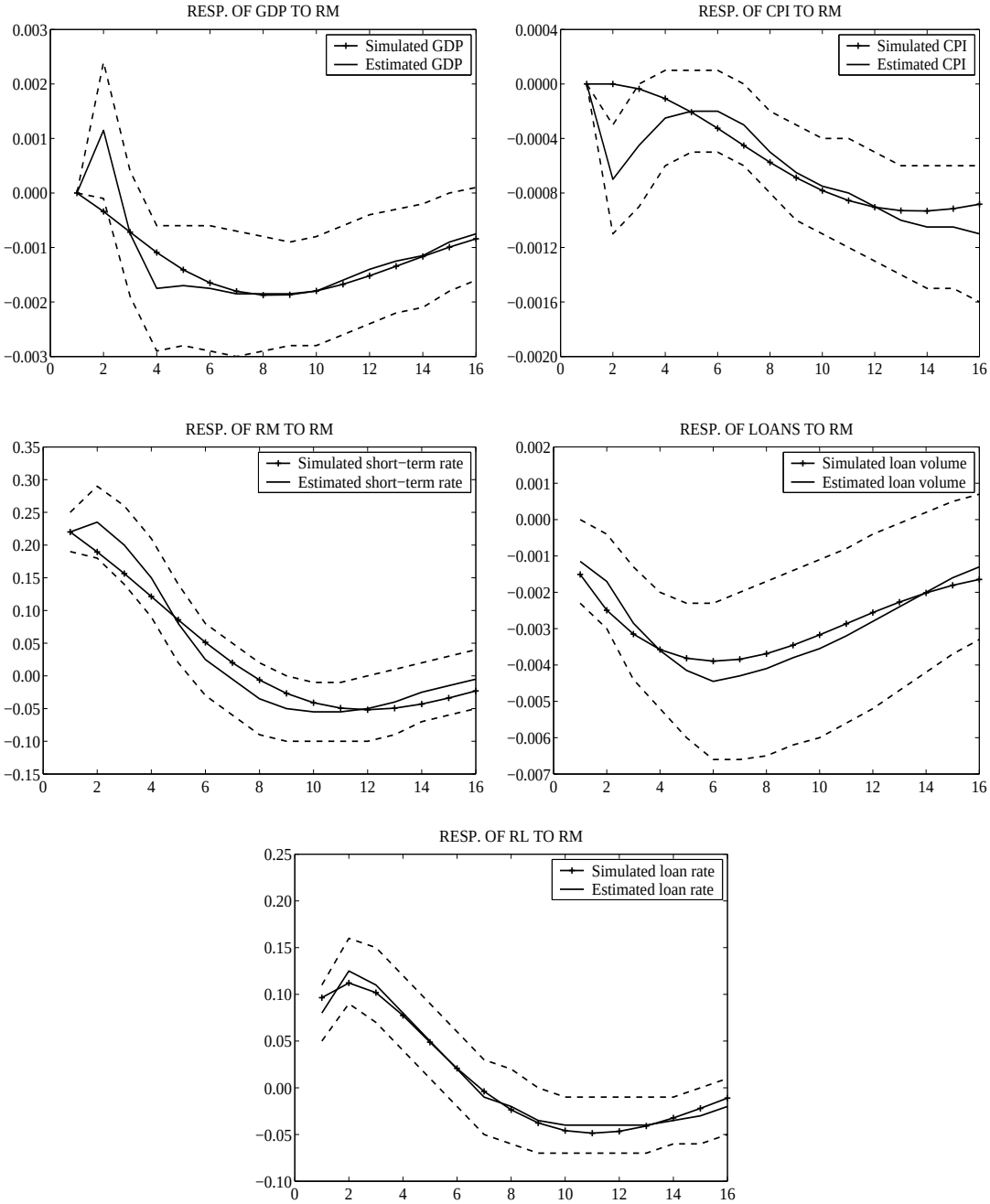
In estimating our model we aim at evaluating the adjustment of bank loans to a monetary policy shock. The impulse responses are shown in Figure 2 together with the error bounds. The theoretical responses conform quite closely with the empirical responses and fall generally – except for the primary reaction of the output level and the price level – within the confidence interval.

Following a monetary policy shock, bank loans decline promptly and return to baseline subsequently. The output level drops temporally. The price level initially reacts sluggish, but declines persistently afterwards. The loan rate and short–term rate increase immediately and decrease subsequently.

[18] Notice that $A_0^{-1}\begin{bmatrix}\upsilon_{1,t+1}\\ 0\end{bmatrix} = \begin{bmatrix}\upsilon_{1,t+1}\\ 0\end{bmatrix}$ since A_0 is block diagonal with an identity matrix as its upper left block and the lower block of the shock vector is zero.

[19] If ξ is normally distributed, then J has a χ^2–distribution with $N - m$ degrees of freedom, where N is the number of observations on the impulse responses and m is the number of coefficients (see e.g., Smets and Wouters, 2002).

Figure 2: Theoretical Impulse Responses



Notes: The solid lines are empirical impulse responses and the solid lines with symbols are theoretical impulse responses. The dashed lines are 90% error bounds. The horizontal axis is in quarters.

Table 1 summarizes the estimated set of parameters $\hat{\xi}$ that minimize the distance measure. The parameter for the degree of stickiness na^{-1} is 0.004. The income elasticity b_1 and the interest elasticity b_2 are 2.16 and 0.016, which is in line with other reported elasticities that range between 1.1–2.5 and 0.01–0.60 (see e.g., Calza, Gartner and Sousa, 2003; Calza, Manrique and Sousa, 2003; Hülsewig, Winker and Worms, 2004; Kakes, 2000).[20]

Table 1: Parameter Estimates

Parameter	Estimate	Standard Error
b_1	2.1644	0.2519
b_2	0.0157	0.0024
na^{-1}	0.0043	0.0009
δ_1	0.8617	0.0215
δ_2	3.4393	0.8755
γ_1	0.9478	0.0180
γ_2	-0.0035	0.0005
α_1	0.8492	0.0383
α_2	0.1062	0.0183

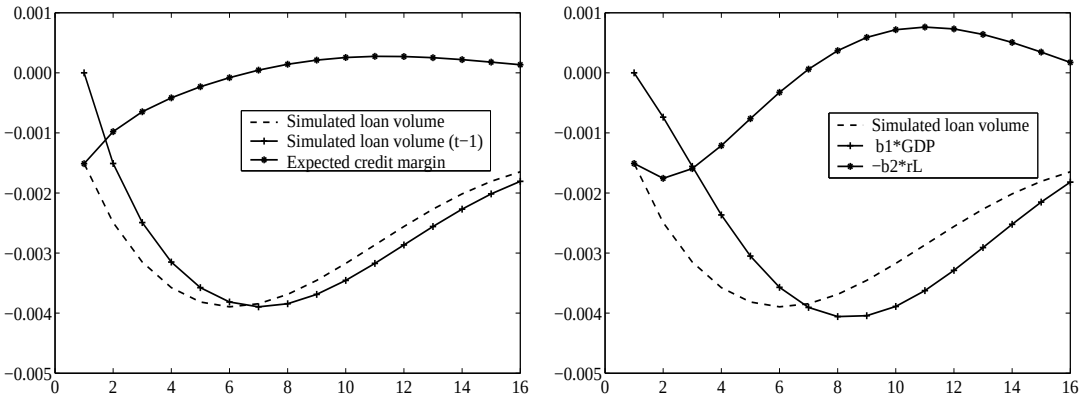
Notes: The value function is 31.02 with a probability of 0.99. The probability is calculated by using a χ^2–distribution with 71 degrees of freedom. The standard errors are calculated as the square root of the diagonal elements of the inverted Hessian matrix resulting from the optimization of the value function.

In the reaction function of the central bank, the short–term rate reacts positively to movements in the inflation rate. The output level is negatively related to the real loan rate with an interest elasticity γ_2 of around -0.004. Finally, the price level is positively attached to the output level, implying a slope of the Phillips curve α_2 of roughly 0.11.

Our model implies that the adjustment of bank loans is determined jointly by the response of loan supply and loan demand to a monetary policy shock. Recall that loan supply depends on the previous loan level and the expected

[20]The divergence in the estimated elasticities of loan demand might result from using different types of loan aggregates, in particular different categories and different maturities, which implies that it might be difficult to find a robust benchmark within these ranges. According to Calza, Gartner, and Sousa (2003), a possible explanation for an income elasticity above unity is that GDP might capture the effect of omitted variables, such as wealth, which are also relevant to explain loan demand.

Figure 3: Decomposed Response of the Loan Volume



(a) Loan supply components (b) Loan demand components

Notes: The dashed lines display the simulated adjustment of bank loans after a monetary policy shock. The solid lines display the simulated adjustment of the loan supply components and the loan demand components that are calculated from the estimated and calibrated model parameters. The horizontal axis is in quarters.

credit margin (see equation (7)):

$$L_t = L_{t-1} + na^{-1} \sum_{s=0}^{T} \beta^s E_t(r^L_{t+s} - r^M_{t+s}),$$

while loan demand depends on the output level and the loan rate (see equation (8)):

$$L_t = b_1 y_t - b_2 r^L_t.$$

Figure 3 displays the response of bank loans after a monetary contraction decomposed into the components that drive loan supply and loan demand, which are calculated on the basis of the estimated and calibrated model parameters.[21] The reaction of bank loans corresponds to the cumulative response of the respective loan supply and loan demand components.

The findings show that loan supply by the banks declines with an expected fall in the credit margin after a monetary policy shock. The drop in the credit margin occurs instantly and bottoms out gradually (see Figure 3, panel a). Loan demand declines with the decrease in the output level and the increase in the loan rate. The fall proceeds promptly despite the primary sluggish response of

[21] Since the simulation horizon only covers 16 quarters, we re–ran our simulation with $T = 100$ for the calculation of the expected credit margin in order to approximate the infinite time horizon.

the output level that is surpassed by the primary response of the loan rate (see Figure 3, panel b).

Our results imply that the adjustment of bank loans is characterized by the mutual drop in loan supply and loan demand following a monetary contraction. The decrease in loan supply emerges instantly and fades gradually, while the decrease in loan demand proceeds by degrees and continues more persistently.

In conclusion, our findings suggest that loan supply by the banks plays a meaningful part in the transmission of monetary policy. This result may be seen complementary to the approaches of Atanasova (2003) and Balke (2000), which explore the asymmetric effects of monetary policy shocks for the U.S. in a threshold VAR by using aggregate data. Their findings conform with the notion that credit conditions are a major factor in shaping the consequences of monetary policy.

4 Concluding Remarks

This paper has addressed the credit channel in Germany by using aggregate data. We have developed a stylized model of the banking firm in which banks decide on their loan supply in the light of expectations about the future course of monetary policy. We have estimated the response of bank loans to a monetary policy shock taking account of the reaction of the output level and the loan rate. Using our model as a guide, we have evaluated the response of bank loans – i.e. disclosing the parts that can be attributed to loan supply and loan demand – by matching the theoretical impulse responses with the empirical impulse responses to a monetary policy shock.

Our findings suggest that the credit channel in Germany is working alongside the interest rate channel, which is consistent with De Bondt (2000), Holtemöller (2003), Hülsewig, Winker, and Worms (2004), Kakes and Sturm (2002) and Worms (2003), who draw similar conclusions. Our results imply that loan supply by the banks declines with an expected fall in the credit margin after a monetary policy shock, while loan demand drops with a fall in the output level and a raise in the loan rate. The decrease in loan supply occurs immediately and bottoms out gradually. The decrease in loan demand proceeds by degrees and continues more persistently.

Appendix

A A Stylized Model of the Banking Firm

This appendix provides the steps used to derive a single bank's optimal loan supply and the loan market equilibrium. Define the lag operator by H such that $HX_t = X_{t-1}$.

A.1 Optimal Loan Supply of a Single Bank

Optimal loan supply of a single bank is found by rewriting the first–order condition (6) as:

$$\beta E_{t+j} L^i_{t+j+1} - (1+\beta) L^i_{t+j} + L^i_{t+j-1} = -a^{-1}(r^L_{t+j} - r^M_{t+j}), \tag{A.1}$$

for $(j = 0, 1, 2, ...)$, or:

$$\beta \left[1 - \frac{1+\beta}{\beta} H + \frac{1}{\beta} H^2 \right] E_{t+j} L^i_{t+j+1} = -a^{-1}(r^L_{t+j} - r^M_{t+j}), \tag{A.2}$$

for $(j = 0, 1, 2, ...)$. Using the procedure established by Sargent (1979, pp. 197–199), the left–hand side of equation (A.2) may be factored to obtain:

$$\beta(1 - \frac{1}{\beta} H)(1 - H) E_{t+j} L^i_{t+j+1} = -a^{-1}(r^L_{t+j} - r^M_{t+j}), \tag{A.3}$$

for $(j = 0, 1, 2, ...)$.

The forward solution to equation (A.3) may be found by recognizing that $(1 - \xi H)^{-1} E_{t+j} x_{t+j} = -\sum_{i=1}^{\infty} \left(\frac{1}{\xi}\right)^i E_{t+j} X_{t+j+i}$, if $\xi > 1$ and $\{x_t\}$ is bounded (Sargent, 1979, p. 173). Here, $\xi = 1/\beta > 1$ and $x_{t+j} = (r^L_{t+j} - r^M_{t+j})$ is bounded, if the transversality condition is satisfied.

The transversality condition is given by $\lim_{T\to\infty} E_t \beta^T \{r^L_T - a(L^i_T - L^i_{T-1}) - r^M_T\} = 0$, where T denotes the terminal period. According to Sargent (1979, pp. 197–200 and 335–336), the transversality condition holds if it is assumed that the stochastic processes for the interest rates, $\{r^L_{t+j}\}_{j=0}^{\infty}$, and $\{r^M_{t+j}\}_{j=0}^{\infty}$ are of exponential order less than $1/\beta$., i.e. for some $K > 0$ and $1 < X < 1/\beta$,

$$|E_t r^L_{t+j}| < K(X)^{t+j} \text{ and } |E_t r^M_{t+j}| < K(X)^{t+j}.$$

The forward solution to the bank's problem is (Sargent, 1979, p. 336):

$$E_{t+j} L^i_{t+j+1} = L^i_{t+j} + (a\beta)^{-1} \sum_{s=1}^{\infty} \beta^s E_{t+j}(r^L_{t+j+s} - r^M_{t+j+s}), \tag{A.4}$$

for $(j = 0, 1, 2...)$. Next, expand the information set from I_{t+j} to I_{t+j+1} in (A.4), which is the information the bank has when taking the decision on L_{t+j+1}, and redefine the index from $t + j + 1$ to $t + j$:

$$L^i_{t+j} = L^i_{t+j-1} + a^{-1} \sum_{s=0}^{\infty} \beta^s E_{t+j}(r^L_{t+j+s} - r^M_{t+j+s}), \tag{A.5}$$

for $(j = 0, 1, 2...)$.

A.2 Loan Market Equilibrium

The loan market equilibrium is characterized by the equilibrium values of the loan level and the loan rate.

The equilibrium loan level (9) can be derived by means of the following steps. Multiplying equation (A.1) with n and setting $j = 0$ yields:

$$\beta E_t L_{t+1} - (1 + \beta)L_t + L_{t-1} = -na^{-1}(r^L_t - r^M_t). \tag{A.6}$$

Next solve the demand for loans equation (8) for the loan rate:

$$r^L_t = B_1 y_t - B_2 L_t, \tag{A.7}$$

where $B_1 = b_1/b_2$ and $B_2 = 1/b_2$, and substitute r^L_t into equation (A.6), to obtain:

$$\beta E_t L_{t+1} - (\beta + na^{-1}B_2 + 1)L_t + L_{t-1} = -na^{-1}(B_1 y_t - r^M_t). \tag{A.8}$$

Applying the expectation lag operator yields:

$$\beta \left[1 - \frac{\psi}{\beta}H + \frac{1}{\beta}H^2\right] E_t L_{t+1} = -na^{-1}(B_1 y_t - r^M_t), \tag{A.9}$$

where $\psi \equiv (\beta + na^{-1}B_2 + 1)$. Now factor the left side of equation (A.9) using the procedure suggested by Sargent (1979, pp. 339–342):

$$\left[1 - \frac{\psi}{\beta}H + \frac{1}{\beta}H^2\right] = (1 - \lambda_1 H)(1 - \lambda_2 H), \tag{A.10}$$

where λ_1 and λ_2 are positive characteristic roots, with $\lambda_1 < 1 < 1/\beta < \lambda_2$.

Substituting expression (A.10) into (A.9) and applying the forward solution as in (A.4) yields:

$$E_t L_{t+1} = \lambda_1 L_t + n(a\beta)^{-1} \sum_{s=1}^{\infty} \left(\frac{1}{\lambda_2}\right)^s E_t(B_1 y_{t+s} - r^M_{t+s}). \tag{A.11}$$

Equation (A.11) can be rewritten by expanding the information set from I_t to I_{t+1}, which gives:

$$L_t = \lambda_1 L_{t-1} + \lambda_1 n a^{-1} \sum_{s=0}^{\infty} \left(\frac{1}{\lambda_2}\right)^s E_t(B_1 y_{t+s} - r^M_{t+s}), \tag{A.12}$$

after changing the index from $t+1$ to t and recognizing that $\lambda_1 = 1/(\beta\lambda_2)$.

The equilibrium loan rate (10) is found by inserting equation (A.12) into equation (A.7) and rearranging terms.

B Data Base

The data is taken from the German Bundesbank (www.bundesbank.de) and the German Federal Statistical Office (www.destatis.de).

1. `GDP`: Real German GDP in prices from 1995, seasonally unadjusted. German Federal Statistical Office.

2. `CPI`: Consumer price index, seasonally unadjusted. German Bundesbank: UUFA01.

3. `LOANS`: Loans to domestic firms and private households (all banks), seasonally unadjusted. German Bundesbank: PQA350; deflated with the consumer price index.

4. Loan rate r^L: Average of the rate on mortgage loans and the rates of current account loans. German Bundesbank: SU0001, SU0004 and SU0049. Converted into quarterly data.

5. Short–term interest rate r^M: Three–month money market rate, Frankfurt/Main, monthly averages, German Bundesbank: SU0107. Converted into quarterly data.

References

Atanasova, C. (2003): "Credit Market Imperfections and Business Cycle Dynamics: A Nonlinear Approach," *Studies in Nonlinear Dynamics and Econometrics*, 7, 516–536.

Balke, N. S. (2000): "Credit and Economic Activity: Credit Regimes and Nonlinear Propagation of Shocks," *Review of Economics and Statistics*, 82, 344–349.

Baltensperger, E. (1980): "Alternative Approaches to the Theory of the Banking Firm," *Journal of Monetary Economics*, 6, 1–37.

Barran, F., V. Coudert, and B. Mojon (1997): "The Transmission of Monetary Policy in the European Countries," in *European Monetary Policy*, ed. by S. C. Collignon, pp. 81–111, London.

Bernanke, B. S., and A. S. Blinder (1992): "The Federal Fund Rate and the Channels of Monetary Transmission," *American Economic Review*, 82, 901–921.

Bernanke, B. S., and M. Gertler (1995): "Inside the Black Box: The Credit Channel of Monetary Policy Transmission," *Journal of Economic Perspectives*, 9(4), 27–48.

Bofinger, P. (2001): *Monetary Policy: Goals, Institutions, Strategies, and Instruments*. Oxford University Press, New York.

Brüggemann, R., and H. Lütkepohl (2001): "Lag Selection in Subset VAR Models with an Application to a U.S. Monetary System," in *Econometric Studies: A Festschrift in Honor of Joachim Frohn*, ed. by R. Friedmann, L. Knüppel, and H. Lütkepohl, pp. 107–128, Münster. LIT Verlag.

Calza, A., C. Gartner, and J. Sousa (2003): "Modelling the Demand for Loans to the Private Sector in the Euro Area," *Applied Economics*, 35(1), 107–117.

Calza, A., M. Manrique, and J. Sousa (2003): "Aggregate Loans to the Euro Area Private Sector," Working Paper Series 202, European Central Bank.

Cecchetti, S. G. (1995): "Distinguishing Theories of the Monetary Transmission Mechanism," *Federal Reserve Bank of St. Louis Review*, 77(3), 83–97.

Christiano, L. J., M. Eichenbaum, and C. Evans (2004): "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," *Journal of Political Economy*, forthcomming.

Cosimano, T. F. (1988): "The Banking Industry und Uncertain Monetary Policy," *Journal of Banking and Finance*, 12, 117–139.

De Bondt, G. J. (2000): *Financial Structure and Monetary Transmission in Europe*. Edward Elgar, Cheltenham, UK.

Deutsche Bundesbank (2000): "The Relationship between Bank Lending and the Bond Market in Germany," *Monthly Report*, January, 33–47.

——— (2004): "The new MFI Interest Rate Statistics – Methodology for Collecting the German Data," *Monthly Report*, 1, 47–62.

Ehrmann, M. (2004): "Firm Size and Monetary Policy Transmission: Evidence from German Business Survey Data," in *Ifo Survey Data in Business Cycle and Monetary Policy Analysis*, ed. by J. E. Sturm, and T. Wollmershäuser, pp. 145–172, Heidelberg. Physica Verlag.

Ehrmann, M., and A. Worms (2004): "Bank Networks and Monetary Policy Transmission," *Journal of the European Economic Association*, forthcomming.

Elyasiani, E., K. J. Kopecky, and D. Van Hoose (1995): "Costs of Adjustment, Portfolio Seperation, and the Dynamic Behavior of Bank Loans and Deposits," *Journal of Money, Credit and Banking*, 27(4), 955–974.

Freixas, X., and J.-C. Rochet (1997): *Microeconomics of Banking*. MIT Press Cambridge, Massachusetts, Massachusetts.

Gertler, M., and S. Gilchrist (1993): "The Role of Credit Market Imperfections in the Monetary Transmission Mechanism: Arguments and Evidence," *Scandinavian Journal of Economics*, 95(1), 43–64.

Gilchrist, S. G., and E. Zakrajsek (1995): "The Importance of Credit for Macroeconomic Activity: Identification through Heterogenity," in *Is Bank Lending important for the Transmission of Monetary Policy?*, ed. by J. Peek, and E. S. Rosengreen, vol. 39 of *Federal Reserve Bank of Boston Conference Series,*, pp. 129–158, Boston.

Holtemöller, O. (2003): "Further VAR Evidence for the Effectiveness of a Credit Channel in Germany," *Applied Economics Quarterly*, 49(4), 359–381.

Hubbard, R. G. (1995): "Is There a Credit Channel for Monetary Policy?," *Federal Reserve Bank of St. Louis Review*, 77(3), 63–77.

Hülsewig, O., P. Winker, and A. Worms (2004): "Bank Lending in the Transmission of Monetary Policy: A VECM Analysis for Germany," *Jahrbücher für Nationalökonomie und Statistik*, 224(5), 511–529.

Kakes, J. I. (2000): *Monetary Transmission in Europe*. Edward Elgar, Celtenham.

Kakes, J. I., and J.-E. Sturm (2002): "Monetary Policy and Bank Lending: Evidence from German Banking Groups," *Journal of Banking and Finance*, 26, 2077–2092.

Kashyap, A. K., and J. C. Stein (2000): "What do a Million Observations on Banks Say About the Transmission of Monetary Policy?," *American Economic Review*, 90(3), 407–428.

Kishan, R. P., and T. P. Opiela (2000): "Bank Size, Bank Capital, and the Bank Lending Channel," *Journal of Money, Credit, and Banking*, 32(1), 121–141.

Klein, M. A. (1971): "A Theory of the Banking Firm," *Journal of Money, Credit and Banking*, 3, 205–218.

Lütkepohl, H., and M. Krätzig (eds.) (2004): *Applied Time Series Econometrics*. Cambridge University Press, Cambridge.

Mitusch, K., and D. Nautz (2001): "Interest Rate and Liquidity Risk Management and the European Money Supply Process," *Journal of Banking and Finance*, 25(11), 2089–2101.

Oliner, S. D., and G. D. Rudebusch (1995): "Is there a Bank Lending Channel for Monetary Policy?," *Federal Reserve Bank of San Francisco Economic Review*, 2, 3–20.

Rotemberg, J. J., and M. Woodford (1998): "An Optimization–Based Econometric Framework for the Evaluation of Monetary Policy: Expanded Version," Technical Working Paper 233, National Bureau of Economic Research.

Sargent, T. J. (1979): *Macroeconomic Theory*. Academic Press, New York.

Smets, F., and R. Wouters (2002): "Openness, Imperfect Exchange Rate Pass–Through and Monetary Policy," *Journal of Monetary Economics*, 49, 947–981.

Söderlind, P. (1999): "Solution and Estimation of RE Macromodels with Optimal Policy," *European Economic Review*, 43, 813–823.

Von Kalckreuth, U. (2003): "Monetary Transmission in Germany: New Perspectives on Financial Constraints and Investment Spending," in *Monetary Policy Transmission in the Euro Area*, ed. by I. Angeloni, A. Kashyap, and B. Mojon, pp. 173–186, Cambridge. Cambridge University Press.

Worms, A. (2003): "The Reaction of Bank Lending to Monetary Policy Measures in Germany," in *Monetary Policy Transmission in the Euro Area*, ed. by I. Angeloni, A. Kashyap, and B. Mojon, pp. 179–198, Cambridge. Cambridge University Press.

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