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Abstract

In this paper, we test the bank lending channel of monetary policy transmission in Sweden. Using a panel of bank balance sheet data covering the period 1998:M1 to 2003:M6, we test for bank loan supply shifts by segregating banks by asset size, liquidity and capitalization. The main result is that small, illiquid and undercapitalized banks are significantly affected by monetary policy, which supports the hypothesis of the bank lending channel.

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Keywords: Monetary Transmission; Bank Lending Channel.

1 Introduction

In the aftermath of the banking and corporate debt crises of the early 1990s experienced by a number of industrialized countries, research interest has been redirected to the bank lending channel (BLC) of monetary transmission. This line of research focuses on the impact that changes in monetary policy may have on real aggregate spending by shifting the supply of bank loans.

The BLC hypothesis is that contractionary by the central bank, via the reserve requirement constraint on banks and the increased alternative cost of holding money, drains the volume of reservable deposits from the banking system. If banks cannot costlessly replace the fall in loanable funds through liquidating assets or through external forms of finance, then policy will decrease their loan supply and, in turn, the real spendings of their borrowers. Thus, there are two necessary conditions for a BLC to operate: (i) some spendings are dependent on bank lending, and (ii) monetary policy can affect the supply of bank loans, then

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the decrease in loan supply should depress real aggregate spending (Kashyap and Stein, 1995).[1]

Because condition (i) of the BLC is widely believed to hold true, empirical studies therefore focus on testing (ii), i.e., if monetary policy can shift the supply of bank loans. To this end, although early empirical studies used time series data to estimate bank loan models (e.g., Bernanke and Blinder, 1992), the more recent research tend to use panel data on the individual bank level (e.g., Kashyap and Stein, 1995; Kishan and Opiela, 2000). One reason for this is that regression estimates based on time series data cannot be used to determine whether the estimated lending responses to monetary policy emanates from loan demand or from the BLC through loan supply. Another reason is the extra time series observations that panel data brings to the table, which should result in more accurate response estimates.

With data on the individual bank level, testing the BLC begins with separating banks by some measure of balance sheet strength, which should be tied to banks ability to supply loans but unrelated to loan demand. By appropriate conditioning, a test may then be performed through simple regression analysis. The essential insight being that lending responses should, were they to emanate from loan supply, be disproportionately large for less creditworthy banks with weak balance sheets, which, due to adverse selection problems, are more likely to have difficulties substituting lost deposits with external forms of finance. To measure the balance sheet strength of banks, Kashyap and Stein (1995; 2000) suggest using asset size and liquidity, while Kishan and Opiela (2000) suggest capitalization. In this instance, the BLC predicts that relatively small, illiquid and poorly capitalized banks will reduce lending most as policy tightens.

Although the Swedish banking crisis and the recession that followed was particularly severe, we know of only one attempt to test the BLC in Sweden. Using quarterly data covering the period 1985:Q4 to 1995:Q4, Hallsten (1999) resorts to another promising avenue to identify loan supply responses to policy using aggregate data by examining the relative movements of bank loans and commercial papers (see, e.g., Kashyap *et. al.*, 1993). Hallsten finds that bank loans decline relative to commercial papers after a monetary contraction, which she interpret as evidence for a BLC.

In recent years, however, there has been a number of significant regulatory and structural changes in the Swedish financial system that may have reduced the scope of policy induced lending responses. Regulatory changes, such as the sharpened focus of the Riksbank, the Swedish central bank, on the interbank rate as operating objective, the strengthened market orientation of policy implementation and the abolishment of binding reserve requirements on banks, might have amended the incentives and the ability of banks to lend as policy changes. The deregulation of the financial system, the growth of nonbank capital markets and the increased competition among financial intermediaries might also have attenuated the role of banks in the transmission of monetary policy, whereby the scope of an operational BLC may have been reduced.

[1] In addition, there must be some form of rigidity to prices.

To this end, in this paper, we attempt to reexamine the BLC using a panel of monthly disaggregated bank balance sheet data covering the period 1998:M1 to 2003:M6. We model the bank loan behavior using a panel autoregressive distributed lag (ARDL) model. To identify the loan supply response to monetary policy, we separate banks by asset size, liquidity and capitalization. The results suggest that loan growth fall significantly following a monetary contraction by the Riksbank and that the fall is largest among small, illiquid and undercapitalized banks. Hence, we cannot reject the hypothesis that the Riksbank is able to affect the growth of loan supply. In conjunction with the finding that spendings are generally dependent on bank loans, this result suggest that there should be real spending effects that emanates from the supply of bank loans. Consequently, we cannot reject the hypothesis of the BLC. We also find evidence suggesting that deposit growth fall significantly when policy tightens and that banks with low creditworthiness are more constrained by such funds.

The paper proceeds as follows. In the subsequent section, we present the ARDL model and describe the test of the BLC. Sections 3 then presents the data material and the main empirical results, whereas Section 4 concludes our findings.

2 Testing the BLC

In this section, we first introduce the ARDL model of bank loan behavior and the test of the hypothesis that monetary policy can shift the supply of bank loans.[2] We then discuss the estimation of the resulting dynamic panel model.

2.1 The model

The variable ultimately to be explained is LN_{it}, the logarithm of real bank loans for bank $i = 1, 2, ..., N$ in time period $t = 1, 2, ..., T$. The core explanatory variable in bank loan models of this sort is Δi_t, an exogenous indicator variable of monetary policy shocks. To this end, the literature makes two leading suggestions; the change in a short term interest rate under the control of the central bank (Bernanke and Blinder, 1992) or the residuals from a vector autoregression (VAR) representing the reaction function of the central bank (Bernanke and Mihov, 1998). In this paper, we employ the change in the three month Stockholm interbank offered rate as policy indicator.[3]

Thus, Δi_t captures the effect of monetary policy on bank loans. Moreover, to be able to measure the extent to which policy responses depends on the balance sheet strength of banks, we may include a second explanatory variable that interacts Δi_t with a variable W_{it}, say, which represents one of the separating variables asset size (S_{it}), liquidity (L_{it}) or capitalization (C_{it}). Asset size is total assets, whereas liquidity and capitalization has been constructed as the

[2] For a detailed treatment of the theoretical BLC underpinnings, we make reference to Kashyap and Stein (1995), and Kishan and Opiela (2000).

[3] See Section 3.3 for a discussion.

ratio of bank liquid assets and capital to total assets, respectively. All three measures are in logarithms and they have been centered by their overall sample average, which makes W_{it} sum to zero across all banks. Therefore, the average interaction variable is also zero, which means that the lending effect of a change in $\Delta i_t W_{it}$ may be directly interpreted as a policy effect that depend on the balance sheet strength of banks (Ehrmann *et. al.*, 2001).

To account for loan demand movements, Δi_t and $\Delta i_t W_{it}$ are usually augmented by variables such as real GDP and CPI. However, because macroeconomic aggregates of this sort do not capture cross-sectional differences in lending opportunities, we instead include the logarithm of real certificates of deposits, CDs hereafter, and securities, denoted by CD_{it} and SEC_{it}, respectively (see, e.g., Kashyap and Stein, 1995; Kishan and Opiela, 2000).[4] Seasonal variation will be dealt with by a set of $K = 11$ monthly dummy variables DUM_{tk}, $k = 1, 2, ..., K$. In addition, we account for the effects of all possible time invariant loan determinants by an individual bank specific effect α_i, say. This term thus encompasses the effects of all explanatory variables such as geographical location that differs across banks but remains constant over time.

As for the dynamics of bank lending, many studies utilizes a static model, where the effects of past loans realizations on current loan realizations are ignored (see, e.g., Kashyap and Stein, 1995; Kishan and Opiela, 2000). There are, however, many economic arguments suggesting that lagged values of both the explanatory variables and loan itself may be relevant to current loan realizations. First, due to the close relationship that usually develops between banks and their customers, banks may be able to create so-called lock-in effects and thereby making it costly for the borrower to change bank. Thus, lagged loans affects current loans. Second, due to long term contractual commitments, policy will only impact lending behavior with a lag. Hence, lagged values of the explanatory variables should also be allowed to affect current loans.[5]

To allow for such dynamic effects, we model bank loans using the following ARDL model

$$\begin{aligned}\Delta LN_{it} &= \alpha_i + \sum_{j=1}^{J} \gamma_j \Delta LN_{it-j} + \sum_{j=0}^{J} \beta_j \Delta i_{t-j} + \sum_{j=0}^{J} \delta_j \Delta i_{t-j} W_{it-1} \\ &\quad + \sum_{j=0}^{J} \psi_j \Delta CD_{it-j} + \sum_{j=0}^{J} \phi_j \Delta SEC_{it-j} + \sum_{k=1}^{K} \theta_k DUM_{tk} + u_{it}.\end{aligned}$$

Because many of the included variables contains a unit root, the model is estimated in first differences, which means that we are now modelling the growth of

[4]For purpose of estimation, when included into the ARDL model, real GDP and CPI consistently turn up insignificant. To this end, real CDs and securities seem to provide a better fit. We therefore drop real GDP and CPI in favour of real CDs and securities (see, e.g., Kishan and Opiela, 2000; Kashyap and Stein, 1995).

[5]In addition, because the variables are based on balance sheet data, a specific endogeneity problem arises; if the balance sheet positions are strongly correlated, then it is not clear which position that causes the other. Therefore, the explanatory variables should enter the model with at least one lagged value (e.g., Ehrmann *et. al.*, 2001).

loans instead of its levels.[6] We assume a stable between ΔLN_{it} and the explanatory variables, which implies that the modulus of the roots of the autoregressive (AR) lag polynomial should be larger than unity in absolute value. To avoid having different values of the balance sheet strength measure in any given time period, W_{it} only enters the model with one lagged value (e.g., Ehrmann *et. al.*, 2001; Kashyap and Stein, 2000; Worms, 2001). We also restrict J, the ARDL orders, to six, which will be sufficient for the empirical part of this paper.[7] Moreover, because α_i is obviously correlated with lagged loan growth, and therefore also with u_{it}, we treat α_i as fixed rather than random.

Regarding the dynamics of the ARDL model, we will distinguish between a transitory one period external shock in u_{it}, which is assumed to be independent across banks, and a permanent policy shock in Δi_t. First, a shock in u_{it} not only affects current loan growths but also loan growths in subsequent periods; by a factor γ_1 in the following period, by $\gamma_1^2 + \gamma_2$ in the next, and so on. Although such shocks has no permanent effect on the growth rate of loans, the cumulated impact is $1/(1 - \sum_{j=1}^{J} \gamma_j)$. Hence, $\sum_{j=1}^{J} \gamma_j$, the sum of the AR parameters, captures the persistence of the loan shocks.

Second, and perhaps more important for our purposes, are the effects of permanent policy shocks in Δi_t. Such shocks has contemporaneous effects on the growth of loans by a factor $\beta_0 + \delta_0 W_{it-1}$; the effect on the average bank is β_0 and the effect that depends on the balance sheet strength of banks is δ_0. The compounded loan response in the subsequent period is $\beta_1 + \gamma_1(\beta_0 + \delta_0 W_{it-1})$; β_1 is the direct effect and $\gamma_1(\beta_0 + \delta_0 W_{it-1})$ is the effect emanating from the lagged loan terms. In the long run, the policy shock impacts loan growth by a common factor $\sum_{j=1}^{J} \beta_j / (1 - \sum_{j=1}^{J} \gamma_j)$ plus a factor $\sum_{j=1}^{J} \delta_j / (1 - \sum_{j=1}^{J} \gamma_j)$ that depend on the balance sheet strength of banks. These parameters are the so-called long run multipliers, which we henceforth will denote by suppressing the lag indices. That is, the long run multiplier on Δi_t is denoted by β, while that on $\Delta i_t W_{it-1}$ is denoted by δ, and so on.

2.2 The test

Given that the other explanatory variables captures any loan movements that is not caused by monetary policy, then β and δ measures the long run effect of policy on loan growth. Hence, the extent to which there are permanent lending effects of monetary policy can be directly assessed by estimating β and δ. An operational BLC imply that $\beta < 0$ and $\delta > 0$. Heuristically, contractionary policy reduces the growth rate of deposits, which forces banks to slow down loan supply. Due to problems of adverse selection on the external financial markets, banks with relatively low creditworthiness will find it more difficult to

[6] For the variables with a cross-section, we employ the Im *et. al.* (2003) test, whereas for i_t, we employ the augmented Dickey-Fuller test. The tests confirm the unit root hypothesis for all varibles in their levels but W_{it-1}.

[7] Because choosing J too large tend to result in very large standard errors as the number of insignificant variables becomes unwieldy, we estimate the model with insignificant dynamics omitted. To this end, the results indicate that $J = 6$ will suffice.

replace the lost funds with new debt. Hence, they will be more dependent on reducing their supply of loans. Moreover, given that condition (i) of the BLC is satisfied, then $\beta < 0$ and $\delta > 0$ should also be sufficient for an operational BLC.

Note, however, that because the test has only been constructed for the sole purpose of testing whether the Riksbank can shift loan supply or not, it cannot provide us with any information about how the Riksbank induces such shifts. To this end, the BLC hypothesis necessitates that the Riksbank is able to slow down the growth rate of deposits in the banking sector and that banks cannot costlessly replace the fall in deposits through liquidating assets or through external forms of finance. Only if these conditions are met can the Riksbank affect the supply of bank loans. Thus, to be able to provide a more detailed description of the BLC, then these conditions should also be tested. In fact, such tests may be readily constructed within the current framework by simply substituting the appropriate variables into the ARDL model.

First, the existence of a BLC necessitates that the Riksbank is able to induce a fall in the growth of deposits by banks. To test this hypothesis, we replace ΔLN_{it} in the ARDL model with ΔD_{it}, the growth of real deposits. Thus, if deposit growth falls following a monetary contraction, then this implies that $\beta > 0$. Second, to determine if the problems of adverse selection on the external financial markets also lead to deposit constraints on the growth of bank loans, we may test whether slower deposit growth is associated with slower loan growth. Within the current framework, if we replace Δi_t with ΔD_{it}, then this hypothesis imply that $\beta > 0$ and $\delta < 0$. Third, a formal test of the hypothesis that relatively creditworthy banks can more readily substitute away slower deposit growth by issuing new CDs may be constructed analogously by first replacing ΔLN_{it} with ΔCD_{it} and then infer whether $\beta > 0$ and $\delta > 0$. Finally, banks may be able to preemptive a fall in the growth rate of deposits by liquidating securities. If we substitute ΔSEC_{it} for ΔLN_{it}, then the appropriate hypothesis to test in this case is $\beta < 0$.

2.3 Estimation

Due to the fixed effects, the lagged values of the dependent variable on the right hand side of the ARDL model makes estimation difficult. The basic reason is that the first difference transformation needed to eliminate the fixed effects leads to a correlation between the transformed regressors and the transformed error term, which hampers estimation by least squares.[8] However, valid instruments for the lagged endogenous variables may be constructed from at least their twice lagged values. To this end, we follow the suggestion made by Anderson and Hsiao (1982) and use the twice lagged levels as instruments.[9] Because they

[8] In principal, the model could be estimated without first differentiating by instead including a complete set of N bank specific dummy variables. However, this not only reduces the degrees of freedom substantially but also aggravates the problem of multicollinearity among the regressors. Thus, we will transform the model by first differentiating prior to estimation.

[9] The Generalized Method of Moments (GMM) estimator proposed by Arellano and Bond (1991) is common in the literature. However, the GMM requires that N is large in relation to

are more efficient, we use instruments in levels rather than in first differences (Arellano, 1989).

The instruments are valid if the transformed residuals are not more than first order serially correlated, which we test using the robust second order serial correlation test proposed by Arellano and Bond (1991). Given that the instruments are valid and the model is stable, the resulting instrumental variables estimator is consistent as either T or N tends to infinity, or both. The long run parameters analyzed earlier can then be constructed by simply replacing the ARDL parameters by their estimated counterparts. To enable accurate inference, we estimate the standard errors using the Delta method. The estimation is carried out robustly using the Fejer kernel with bandwidth parameter 4. All necessary computations has been performed in GAUSS.

3 Empirical results

In this section, we first briefly describe the data and present some preliminary evidence on conditions (i) and (ii) of the BLC. Second, we examine the estimation results for the ARDL model and their implications for the hypothesis of the BLC. Finally, we do a robustness check on our results. Also, because Section 3.2 deals exclusively with condition (ii) and the test for policy induced loan supply shifts, Section 3.1 focuses on condition (i) and the issue of bank dependence.

3.1 The data

The monthly data used for this paper covers the period 1998:M1 to 2003:M6. Bank balance sheet data on 12 Swedish banks as well as all the relevant economic aggregates has been acquired through Statistics Sweden.[10] Hence, $N = 12$ and $T = 65$, which means that there are a total of 780 observations available. Bank total assets is defined as the sum of all bank assets, whereas liquid assets is cash plus balances with the Riksbank. Bank equity plus other reserves makes up bank capital. To enable more precise inference for different customer categories, bank loans and deposits are divided into three categories: (1) all customers, (2) firms, and (3) households.

As mentioned earlier, the two key banking sector features that determine the significance of the BLC are (i) the degree of bank dependence on behalf of borrowers and (ii) the ability of the Riksbank to shift loan supply. In this section, we infer the former by the size distribution of borrowers and the availability of external finance, while we gauge the loan supply response by the size distribution and health of the Swedish banking sector as well as by the influence of the Swedish government.

T, which is not satisfied in our case. In such cases, recent Monte Carlo evidence (e.g., Judson and Owen, 1999) suggest that the Anderson and Hsiao (1982) estimator has superior finite sample properties.

[10] All balance sheet items have been adjusted for mergers and acquisitions at the source.

Table 1: Bank mean balance sheet ratios.

Bank category		All	Strong	Weak
Number of banks		12	4	8
Assets	Total loans	0.711	0.674	0.730
	Household loans	0.208	0.064	0.280
	Firm loans	0.173	0.187	0.166
	Securities	0.155	0.104	0.180
	Reserves/liquid assets	0.005	0.008	0.004
Liabilities	Total deposits	0.777	0.659	0.835
	Household deposits	0.412	0.152	0.541
	Firm deposits	0.141	0.107	0.158
	Capital	0.145	0.185	0.125
	Commercial paper	0.043	0.111	0.009
	CDs	0.031	0.083	0.006
	Bonds	0.011	0.027	0.002
	Subordinated debt	0.020	0.035	0.013

Notes:

(*i*) Banks categories are by balance sheet strength.

(*ii*) The bank mean balance sheet ratios are in percent of total assets.

(*iii*) Banks are devided with respect to their balance sheet strength; all banks, the four strongest banks and the remaining weaker banks.

First, as for bank dependence, Ongena and Smith (2000) estimates that 23% of all Swedish firms has only one bank relationship and 56% has at most two such relationships.[11] Moreover, in the January 2003 issue of *Financial Stability Report*, the Riksbank stresses that low income households also have the highest debt to total asset ratios and that they therefore should be more sensitive to changing credit conditions. The report also show that about 25% of this household category uses more than one fifth of their disponible income on servicing their loan commitments. Furthermore, the large fraction of short term loans and loans made at adjustable rates, about 53%, also increases the sensitivity of aggregate spendings to changing credit conditions (*The Swedish Financial Market*, 2001). Together with the small Swedish equity and bond markets, and the high ratio of bank loans to total credit, this makes bank dependence high among Swedish firms and households in general.[12] Thus, condition (i) of the

[11] Taken a measure of the closeness between the banks and their customers, the high percentage of borrowers with a single bank relationship may also dampen any lending reaction to monetary policy as banks might find it profitable to, at least temporarily, absorb adverse policy shocks.

[12] The average share of total credit accounted for by bank loans was 45% over the sample period. Between 1999M12 and 2003M6, banks and firms accounted for an average of 8% respective 25% of the total issuance on the Swedish securities markets. Also, the share of firm liabilities accounted for by bank loans and securities was on average 58% respective 20% between 1999Q4 and 2003Q1.

BLC seem to be satisfied by the data.

Second, as an indication of the size distribution of banks, Table 1 presents the mean value of selected balance sheet ratios when the banks has been divided according to their balance sheet strength. There are several regularities that are noteworthy. First, Swedish banks are generally illiquid. Second, there are clear differences between strong and weak banks with respect to capitalization suggesting that this variable may be useful in testing the BLC. Second, weak banks are better securitized, which is consistent with less creditworthy banks being unable to raise external finance on short notice. Third, weak banks are more dependent on households as both borrowers and depositors than strong banks. Fourth, only strong banks have access to external forms of finance and can issue commercial papers, CDs, bonds and subordinated debt. Fifth, weak banks finance their loan portfolio by deposits to a greater extent than strong banks. Thus, the overall implication from Table 1 is that less creditworthy banks should be more dependent on altering their loan supply in face of a monetary contraction.

Working in the opposite direction, however, is the high degree of government ownership and deposit insurance, which reduces the incentive of investors and depositors to monitor the risk exposure of banks. Any cross-sectional difference in the response of bank loans to policy that depend on the creditworthiness of banks therefore should be small.[13] The good health and the high concentration of the Swedish banking sector also works in that direction by increasing the scope of imperfect pricing in both loan and external markets.[14] Hence, although condition (i) of the BLC seem to be satisfied, we cannot make any strong conclusions regarding condition (ii) based on the descriptive evidence presented in this section. For this purpose, we will now continue to the estimation results and the formal test of whether monetary policy can shift the supply of bank loans.

3.2 Estimation results

In this section, we examine the empirical results on the hypotheses discussed in Section 2.2.[15] We begin by testing the prerequisite conditions for the Riksbank to be able to affect bank loan supply and then we continue with the actual test of whether monetary policy affects bank loan supply or not.

As explained earlier, for there to be an operational BLC, it is necessary that banks experience a fall in deposits following a monetary contraction and that they cannot costlessly replace the lost funds by liquidating securities or by issuing new CDs. To this end, Table 2 presents the estimates of the long run

[13]The Swedish government own 23% of all assets of the 10 largest Swedish banks (La Porta *et. al.*, 2000). These banks accounted for 94% of the total bank book value in 2001.

[14]The result before loan losses has increased by 20% for the consolidated bank sector over the sample period. Moreover, in 1999, the four largest Swedish banks accounted for 80% of the total bank lending and 86% of the total bank booked value (*The Swedish Financial Market*, 1999).

[15]Only the estimated long run loan responses to monetary policy are presented. The short run estimates are available from the author upon request.

Table 2: The effect of monetary policy on the availability of finance.

		CDs growth			Securities growth		
Variable	Para.	S_{it-1}	C_{it-1}	L_{it-1}	S_{it-1}	C_{it-1}	L_{it-1}
Δi_t	β	0.964	0.872	0.834	0.161	0.158	0.192
		(0.296)	(0.273)	(0.262)	(0.110)	(0.116)	(0.114)
$\Delta i_t W_{it-1}$	δ	0.507	2.301	0.385	-0.825	-0.603	-0.188
		(0.774)	(5.274)	(0.250)	(1.460)	(4.612)	(0.083)
ΔD_{it}	ψ	-0.359	-0.345	-0.409	2.701	2.785	2.747
		(0.165)	(0.175)	(0.191)	(1.482)	(1.523)	(1.530)
ΔX_{it}	ϕ	-0.209	-0.222	-0.219	0.084	0.063	0.075
		(0.061)	(0.065)	(0.065)	(0.025)	(0.020)	(0.023)
m_2		-0.010	-0.004	-0.009	-0.001	0.001	0.000
Generalized R^2		0.737	0.746	0.738	0.645	0.650	0.650
Sum of AR para.		-0.062	-0.038	-0.055	-0.090	-0.068	-0.071
Min. modulus		1.632	1.598	1.614	2.035	1.984	1.972

Notes:

(*i*) The table presents the estimated long run multipliers, where m_2 denotes the second order autocorrelation test. In both cases are the critical values given by the normal distribution.

(*ii*) The numbers within parantheses are the standard errors.

(*iii*) ΔX_{it} equals ΔSEC_{it} for CDs growth and ΔCD_{it} for securities growth.

multipliers for the growth rate of CDs and securities. The results are reported so that W_{it-1} equals S_{it-1} when asset size measures bank creditworthiness, C_{it-1} when the measure is capitalization, and L_{it-1} when the measure is liquidity. The table reveals that contractionary monetary policy significantly increases the growth rate of CDs but that it leaves the growth rate of securities unaffected.

Moreover, although not statistically significant, we see that the estimated long run multipliers on $\Delta i_t W_{it-1}$ for CDs are positive, which means that the increase in the growth of CDs following a monetary contraction is larger at more creditworthy banks. Hence, Table 2 suggest that the scope of banks to preemptive a fall in the growth rate of deposits through liquidating securities or through issuing CDs may be small. We have also performed analogous tests for the growth rate of bonds and commercial papers. The results show that the policy responses are insignificant, which supports the view that banks are unable to replace a slowdown in deposit growth through external forms of finance.

In addition, Table 3 reports the effect of deposit growth on loan growth for the firm and household customer categories.[16] Consistent with the BLC hypothesis that frictions in the external financial markets cause banks to depend on deposits funding, we see that the estimates of β are significantly positive.

[16] The results for the all customer category are very similar to those presented for firms and they are therefore excluded. The results are available from the author on request.

Table 3: The effect of deposit growth on loan growth.

Variable	Para.	Firm loan growth			Household loan growth		
		S_{it-1}	C_{it-1}	L_{it-1}	S_{it-1}	C_{it-1}	L_{it-1}
ΔD_{it}	β	0.455	0.435	0.272	0.121	0.064	0.087
		(0.100)	(0.084)	(0.106)	(0.044)	(0.023)	(0.030)
$\Delta D_{it} W_{it-1}$	δ	0.596	3.590	0.071	-0.429	0.987	-0.203
		(1.341)	(5.059)	(0.124)	(0.240)	(0.827)	(0.082)
ΔCD_{it}	ψ	0.023	0.017	0.029	0.001	0.002	0.001
		(0.005)	(0.003)	(0.006)	(0.000)	(0.001)	(0.000)
ΔSEC_{it}	ϕ	-0.011	-0.002	-0.006	-0.014	-0.012	-0.014
		(0.002)	(0.001)	(0.001)	(0.006)	(0.005)	(0.005)
m_2		-0.003	-0.026	-0.012	-0.031	-0.033	-0.036
Generalized R^2		0.509	0.439	0.494	0.834	0.836	0.835
Sum of AR para.		-0.815	-0.960	-0.917	-0.005	0.005	-0.014
Min. modulus		1.242	1.151	1.189	1.317	1.320	1.318

Notes:

(*i*) The table presents the estimated long run multipliers, where m_2 denotes the second order autocorrelation test. In both cases are the critical values given by the normal distribution.

(*ii*) The numbers within parantheses are the standard errors.

The table also show that these frictions are significantly smaller for larger and more liquid banks in the household category.

The policy response of the growth rate of deposits and loans are reported for the three different customer categories in tables 4 through 6. Beginning with the results on deposit growth, we see that the estimates of β are significantly negative in all cases, which imply that the key necessary condition for the Riksbank to affect the growth of loan supply is satisfied. Save for the liquidity interacted regressions, we also see that $\Delta i_t W_{it-1}$ tend to enter the model insignificant, which implies that the growth of deposits falls uniformly regardless of balance sheet strength.

The intuition behind this finding is the following. If we assume that a monetary contraction causes a fall in aggregate deposits and that the competition for deposits among Swedish banks are low, then, banks will experience an exogenous funding shock when the Riksbank shifts to contractionary policy. Thus, given that banks are unwilling to take action to offset an erosion of their deposits, then deposit growth will fall uniformly across banks. Moreover, if banks face a homogenous loan demand, then this result suggest that cross-sectional loan growth differences must reflect differential loan supply responses.

Next, we continue to the results on loan growth, where we first note that the estimates of β, the long run effect of monetary policy on the average bank, are significantly negative. Consistent with the BLC, this implies that loan growth

Table 4: The effect of monetary policy on the all customer category.

		Deposit growth			Loan growth		
Variable	Para.	S_{it-1}	C_{it-1}	L_{it-1}	S_{it-1}	C_{it-1}	L_{it-1}
Δi_t	β	-0.015	-0.017	-0.013	-0.021	-0.030	-0.025
		(0.006)	(0.007)	(0.006)	(0.008)	(0.011)	(0.009)
$\Delta i_t W_{it-1}$	δ	-0.009	-0.332	0.021	0.113	-0.485	0.030
		(0.017)	(0.172)	(0.008)	(0.039)	(0.422)	(0.013)
ΔCD_{it}	ψ	-0.012	-0.012	-0.014	-0.007	-0.004	-0.010
		(0.004)	(0.004)	(0.005)	(0.002)	(0.001)	(0.003)
ΔSEC_{it}	ϕ	0.013	0.016	0.015	-0.031	-0.026	-0.028
		(0.004)	(0.005)	(0.005)	(0.010)	(0.009)	(0.009)
m_2		0.002	-0.002	-0.001	-0.002	-0.004	-0.003
Generalized R^2		0.765	0.763	0.766	0.825	0.825	0.828
Sum of AR para.		-0.323	-0.334	-0.313	-0.278	-0.280	-0.272
Min. modulus		1.404	1.405	1.410	1.778	1.783	1.761

Notes:

(*i*) The table presents the estimated long run multipliers, where m_2 denotes the second order autocorrelation test. In both cases are the critical values given by the normal distribution.

(*ii*) The numbers within parantheses are the standard errors.

falls as policy tightens. Moreover, comparing the estimated long run multipliers between the three different customer categories, we see that the magnitude of the estimates of β are smallest for total loans and largest for household loans. In particular, for total loans, the estimates imply that a 1% increase in the interbank rate eventually leads to a decline in loan growth at the average bank by about 0.03%. For firm loans, the corresponding estimates imply a decline in loan growth by about 0.10%, whereas, for households, the implied decline in loan growth is about 0.18%.[17]

The part of the long run lending response to policy that impacts bank loans differently depending on the balance sheet strength of banks is captured by δ. In this case, regardless of customer category, we see that the estimated long run multipliers have their expected positive sign when significant. Consequently, we cannot reject the hypothesis that the Riksbank is able to affect the growth of loan supply for any of the categories. Hence, condition (ii) of the BLC seem to be satisfied by the data.

Additionally, as for the persistence of the temporary loan shocks, we see that the sums of the estimated AR parameters differ substantially between the

[17] These estimates are very small in comparison to those obtained in earlier studies. For instance, Ehrmann *et. al.* (2001) reports analogous long run estimates for France, Germany, Italy and Spain, which all lies in the neighborhood of one. For the US, recent research (e.g., Kishan and Opiela, 2000) suggest that the policy effect on loan growth is even larger.

Table 5: The effect of monetary policy on the firm category.

		Deposit growth			Loan growth		
Variable	Para.	S_{it-1}	C_{it-1}	L_{it-1}	S_{it-1}	C_{it-1}	L_{it-1}
Δi_t	β	-0.050	-0.054	-0.054	-0.101	-0.095	-0.092
		(0.009)	(0.009)	(0.009)	(0.023)	(0.022)	(0.021)
$\Delta i_t W_{it-1}$	δ	-0.029	-0.091	0.027	0.050	-0.151	0.020
		(0.009)	(0.088)	(0.005)	(0.014)	(0.234)	(0.008)
ΔCD_{it}	ψ	-0.015	-0.014	-0.015	0.029	0.030	0.028
		(0.003)	(0.002)	(0.003)	(0.006)	(0.006)	(0.006)
ΔSEC_{it}	ϕ	0.015	-0.008	-0.006	0.005	0.007	0.003
		(0.005)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
m_2		-0.020	-0.023	-0.020	-0.017	-0.018	-0.017
Generalized R^2		0.744	0.737	0.741	0.627	0.629	0.628
Sum of AR para.		-0.657	-0.677	-0.668	-0.978	-0.970	-0.967
Min. modulus		1.433	1.416	1.432	1.451	1.449	1.445

Notes:

(*i*) The table presents the estimated long run multipliers, where m_2 denotes the second order autocorrelation test. In both cases are the critical values given by the normal distribution.

(*ii*) The numbers within parantheses are the standard errors.

different customer categories. At on extreme are firm loans, where the sum of the estimated AR parameters hovers around -0.97, which implies a half-life of an exogenous shock in the growth of firm loans of about 23 months. At the other extreme are household loans, where the half-life of an exogenous shock to the growth of household loans is only about one week. Thus, although shocks are not very persistent in the growth rate of household loans, they are very persistent in the growth rate of firm loans.

As for the diagnostics, the second order autocorrelation test indicate that the serial correlation pattern of the residuals is consistent with the maintained assumption that the first differentiated disturbance term do not exhibit autocorrelation of any order larger than two. Neither do the modulus of the smallest AR root indicate a misspecification for any of the regressions presented in the tables. Additionally, the generalized R^2, which is a valid criterion in the instrumental variables regression, show that the ARDL model provides a good fit for all specifications.

3.3 Robustness checks

The results of Section 3.2 suggest that the Riksbank is able to bring about significant changes in the growth of loans and that the policy response depends on the balance sheet strength of banks. Although this result is consistent with

Table 6: The effect of monetary policy on the household category.

		Deposit growth			Loan growth		
Variable	Para.	S_{it-1}	C_{it-1}	L_{it-1}	S_{it-1}	C_{it-1}	L_{it-1}
Δi_t	β	-0.096	-0.091	-0.089	-0.185	-0.175	-0.184
		(0.033)	(0.031)	(0.031)	(0.064)	(0.061)	(0.066)
$\Delta i_t W_{it-1}$	δ	0.061	-0.016	0.017	-0.018	0.300	0.036
		(0.021)	(0.073)	(0.005)	(0.020)	(0.130)	(0.013)
ΔCD_{it}	ψ	-0.019	-0.017	-0.017	0.009	0.005	0.006
		(0.006)	(0.006)	(0.006)	(0.003)	(0.002)	(0.002)
ΔSEC_{it}	ϕ	-0.019	-0.018	-0.017	-0.012	-0.013	-0.009
		(0.006)	(0.006)	(0.006)	(0.004)	(0.005)	(0.003)
m_2		-0.023	-0.028	-0.025	-0.033	-0.035	-0.034
Generalized R^2		0.741	0.835	0.832	0.812	0.811	0.820
Sum of AR para.		-0.019	-0.030	-0.021	-0.090	-0.079	-0.051
Min. modulus		1.351	1.348	1.344	1.306	1.309	1.300

Notes:

(*i*) The table presents the estimated long run multipliers, where m_2 denotes the second order autocorrelation test. In both cases are the critical values given by the normal distribution.

(*ii*) The numbers within parantheses are the standard errors.

the BLC, there are, at least, three impediments that may invalidate such an interpretation.

First, if the change in the interbank rate is not exogenously determined by the Riksbank as assumed, then the estimated long run multipliers may not reflect policy responses. However, it is by now well established (see, e.g., Bernanke and Blinder, 1992; Bernanke and Mihov, 1998) that monetary policy is most accurately identified by concentrating on the market for bank reserves since this is the market where central banks operates. Indeed, since the Riksbank targets the interbank rate, demand shocks should be sterilized and fluctuations in the interbank rate should therefore only reflect exogenous monetary policy shocks. Thus, the change in the interbank rate should provide an accurate policy measure.

Fore sake of conservatism, however, we assess the robustness of the results to this end by employing an alternative policy indicator. In particular, we use the the residuals from a small VAR, which includes the interbank rate, a constant term, and two lagged values of the logarithm of real GDP and inflation.[18]

[18] This specification is consistent with the views expressed by the Riksbank in the September 1997 and the October 1999 issues of *Inflation Report*. Bernanke and Mihov (1998) also include nonborrowed and total bank reserves in the VAR. Since the interbank rate is the target variable of the Riksbank, however, adding reserves typically has little impact on the dynamics of the VAR. Also, because the Riksbank stresses the output gap measure of economic variability, we

All variables are in first differences and fluctuations in the interbank rate are assumed to represent policy shocks (see, e.g., Bernanke and Blinder, 1992; Kishan and Opiela, 2000). To be able to measure GDP on monthly basis, we use the seasonally adjusted activity index produced by Statistics Sweden, which is constructed so as to closely follow the corresponding quarterly published GDP series. Inflation is measured as CPI less transitory components.[19] For the purpose of this paper, reproducing the estimation results employing this alternative policy indicator do not alter the main findings.

Second, if the included demand variables are insufficient for their intended purpose, then there is also a loan demand interpretation to our results. That is, the decline in bank lending associated with a monetary tightening could be induced by a fall in loan demand brought on by the weaker economy operating through the dampening effect of higher interest rates. This explanation is, of cause, highly unlikely since one would then have to argue that the borrowers of weak banks differ significantly from those of strong banks and that demand drops more for borrowers at weak banks in a fashion that is not captured by our demand variables.

Nevertheless, to investigate the loan demand hypothesis a little bit further, we reestimate the ARDL model for the growth of loans to the public sector. The essential insight here is that banks might be willing to shield loans to certain customers that are considered particularly valuable. Thus, a fall in loan demand should decrease loans uniformly, whereas a fall in loan supply should leave loans to such valuable customers unaltered. To this end, banks may assign special value to their relationship with the public sector since there are no informational problems and therefore no increasing marginal cost to intermediation. Because the estimated loan response to policy is not significantly different from zero, this narrows the scope of a loan demand interpretation and strengthens the evidence in favour of the BLC.

Third, the results may be contaminated by measurement errors generated from the bipolar heterogeneity of the Swedish banking sector. For instance, the small number of large banks may result in a disproportionately large weight being attached to random factors in that part of the banking sector. Another possibility is that the estimated long run policy responses may be generated by the relatively large number of small banks even though the actual loan response is determined by the small number of large banks. Thus, the estimated long run policy responses may not be informative with respect to the effect of monetary policy on loan growth. To this end, we divide the sample according to loan market share and then reestimate the model for the two subsamples. Since the results do not differ markedly between the subsamples, the results presented herein should not depend on the effects of bipolar heterogeneity.

have also estimated the VAR using the filtered cyclical component of real GDP instead of real GDP itself. The filtering was carried out using the Hodrick-Prescott filter with smoothing parameter 1600. The results was not much altered by this modification.

[19] Both the GDP and the CPI are in 1995 year's prices. Inflation is the CPI adjusted for interest expenditures, indirect taxes and subsidies, and prices on imports.

4 Conclusion

The existence of a BLC has been shown to have important implications for the effect and conduct of monetary policy, especially in light of the banking and corporate debt crises of the early 1990s. The major concern raised is that monetary policy may cause asymmetric lending responses that not only could affect real activity but also threaten the stability of the entire financial system. Tests for such lending responses have recently focused on separating banks by cross-sectional differences in their balance sheet strength. In this paper, we separate banks by asset size, liquidity and capitalization. Our study adds to the existing empirical literature by considering a panel of Swedish data covering the better part of the Swedish banking sector over the last five years.

Overall, the results reported in this paper support the BLC hypothesis on at least four accounts. First, we find that households and firms are generally constrained to bank lending, which imply that any policy induced shifts in the supply of bank loans should also cause real spending effects. Second, we find that banks are significantly deposit constrained and that they have only limited access to external forms of finance, which suggest that banks may be unable to dampen the effect of slower deposit growth on loan growth. Third, the result that deposit growth falls significantly following a monetary contraction imply that the Riksbank is able to shift the portfolio composition of banks towards more costlier forms of finance. Finally, our main finding is that the Riksbank is able to significantly affect the growth rate of loans and that the estimated policy responses depend on the balance sheet strength of banks.

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