# Bank Loans and the Transmission Mechanism of Monetary Policy*

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**Abstract**

How monetary policy affects the economy is a central topic of debate in macroeconomics. The bank lending channel is one approach that emphasises the role of banks. Banks are important because of asymmetric information in the financial market. Banks are assumed to be better at handling information problems than other lenders. In this paper it is analysed how monetary policy works when there is a bank lending channel and then it is tested for the importance of this channel using Swedish data.

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## 1. Introduction

The connection between credit and the macro economic development has since long been a central topic of debate in macroeconomics.[2] Already in the 1930s, after the Great Depression, credits' macro economic role was emphasised. Fisher (1933) argued that it was the financial markets' bad performance that caused the deep recession at that time. During the 1960s the interest for this link fell. Instead the importance of money was emphasised. One reason for this was that empirical results pointed to a strong correlation between money and real variables (see e.g. Friedman and Schwartz (1963)). Further, theoretical research suggested that the financial system should not have any significant impact on the macro economic development. Franco Modigliani and Merton Miller showed for example in 1958 that under certain conditions a firm's capital structure is economically irrelevant.

The result of Modigliani and Miller builds in large on the assumption of complete markets, that is, perfect information. During the 1970s the assumption of perfect information came under increased criticism and a new literature of incomplete markets began to grow, starting with Akerlof´s paper from 1970 on the "lemons" problem. He illustrated how asymmetric information between buyers and sellers about product quality distorted the market equilibrium. Studies of the importance and implications of asymmetric information problems in the financial markets followed.[3] New development in micro economic theory together with growing difficulties in explaining the macro economic development with conventional monetary theory led to a renewed interest in credits.

When credit came in focus again it also influenced the research on how monetary policy affects the economy. Bernanke (1983) and Blinder and Stiglitz (1983) for example discussed the real effects of loanable funds. The new views of how the transmission of monetary policy works, under the assumption of incomplete capital markets, are usually called the "credit view" or "lending view" of monetary policy. The credit channels that are now analysed in the literature are most often referred to as the bank lending channel (Bernanke and Blinder (1988) and (1992), Miron, Romer and Weil (1994) and Stein (1995)) and the balance-sheet channel Brunner and Meltzer (1988), Bernanke and Gertler (1989), Gertler and Gilchrist (1994) and Gertler (1992)).

The starting point of these models is that there is asymmetric information in the financial market. Lenders can for example have an information disadvantage about the borrower's type, that is, his project opportunities, the expected ex post return on the project (adverse selection) and the effort made by the investor (moral hazard). This creates incentive problems that can make it very expensive for borrowers to obtain external financing, since lenders have to gather costly information about the borrower and/or try to write the contract in a way that reduces the information problems. The

[2]See Mark Gertler (1988) or Kashyap and Stein (1993) for surveys of the literature on the credit channel.
[3]See for example Rothschild and Stiglitz (1976), Jaffee and Russell (1976), Townsend (1979), Stiglitz and Weiss (1981) and Diamond (1984).

lender can for instance demand collateral or design contracts that can be re-negotiated. In a world with imperfect information borrowers then have imperfect access to credit markets.[4]

More precisely, the balance-sheet channel, that works through the total amount of credits in the economy, assumes that information asymmetries introduce a wedge between the price of uncollateralized external funds and the price of internal funds. This wedge depends inversely on the borrowers collateralizeable net worth. An exogenous disturbance, for example a change in the stance of monetary policy, that reduces the value of the collateral then widens the wedge and the cost of external finance increases. This might intensify the effect of the initial chock, since raised costs of finance result in lower investment spending, which means that the demand in the economy is depressed further. A lower demand in itself can reduce the value of the collateral even further, and investments fall more. Credit market frictions then amplify the impact of the initial disturbance on borrowers' spending decisions.

In the bank lending channel, which will be analysed in this paper, banks have a special role since they are assumed to be better at handling problems with asymmetric information than are direct lenders that operate in the bond market. Banks are more efficient than others at screening and monitoring borrowers if banks for example specialise in producing information, if banks have long-term relationships with their customers and/or because lending and other intermediary services are complementary activities. Banks therefore give loans to borrowers that, because they are subject to asymmetric information problems, find it costly or perhaps impossible to issue bonds in the private bond market. These borrowers are therefore in a sense bank "dependent". Bank loans are then a form of inside debt since banks have information about the borrower that is not available to other securities holders. Banks then reduces the wedge introduced by the information asymmetries, but not completely since banks are assumed to have rising marginal costs for their lending. Changing the relation between the possession of bonds and loans in its portfolio have economical consequences for the bank, if it at all is possible. If banks are assumed not to be able to issue CD's there is of course a limit for have much their lending can be extended. If bonds further are assumed to work as a buffer to unforeseen deposit withdrawal there are costs involved with rising the loan stock by selling out bonds. If they are allowed to issue CD's and the supply schedule for CD's is upward sloping the result is the same. Loans from an intermediary and bonds issued at the bond market can therefore not be seen as perfect substitutes, which is often assumed in the macro economic literature. The consequence of the assumption that both borrowers and lenders find loans and bonds as imperfect substitutes is that the central bank gets a separate channel to influence bank lending since it can control the amount of deposits and therefore the supply of loans in the economy.

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[4]That some borrowers have imperfect access to credit markets can also be a result of legal restrictions prohibiting contracts that completely reduce the principal-agent problem for example, restrictive covenants or collateral requirements.

This paper follows the literature on the bank lending channel. In section 2 the model is presented in detail. The behaviour of the different agents in the economy is analysed. In section 3 the effects of monetary policy are analysed under the assumption of perfect and imperfect capital markets. From the analysis it follows that monetary policy not necessarily has a larger impact on output when there is a bank lending channel at work.[5] The conditions for an amplifying effect of monetary policy are therefore specified. In section 4 the importance of a bank lending channel is examined on Swedish data. The results are in line with the existence of a bank lending channel in Sweden. Further the results indicate that this channel amplifies the effect monetary policy has on aggregate income. Section 5 concludes.

## 2. The model

The model that is used to analyse the effects of monetary policy under the assumption of credit market imperfections is partly a conventional IS/LM-model for a closed economy with markets for goods, bonds and money.[6] It is thus a static, short run model for aggregate demand, where prices are assumed to be given. The aggregate supply curve is horizontal, output is demand determined. Monetary policy is thus not neutral.

The ordinary IS/LM-model has then been extended with the assumption that there are information asymmetries in the financial markets. Specifically, lenders have imperfect information about some borrowers in the non-bank private sector, for example about medium sized firms with only little reputation, and small and new firms with no established reputation. These are borrowers whose problems of asymmetric information are especially pronounced. Introducing information asymmetries creates incentive problems that make it expensive or impossible for these borrowers to obtain financing by directly issuing securities, or bonds, on the open market. A market for bank loans is introduced. Borrowing from banks is usually the best or the only alternative for borrowers subject to information problems, because banks are assumed to be specialised in overcoming informational problems and therefore have lower costs of reducing these problems than other lenders.

Not all agents in the non-bank private sector are subject to information problems. Large, high quality firms with an established reputation for example, have perfect access to the credit markets. Since this group is not subject to capital market frictions they do not need to raise debt finance with monitoring and screening, that is, they do not benefit

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[5]This is something that is not emphasised in Bernanke and Blinder (1988). Miron, Romer and Weil (1994) on the other hand do analyse this aspect.

[6]The framework of the model follows Miron, Romer and Weil (MRW) (1994). Their model, in turn, builds largely on Bernanke and Blinder (1988). One difference in comparison with the present paper is that MRW do not analyse why banks regard loans and bonds as imperfect substitutes.

from bank lending. Assuming that there are costs involved with intermediation they will choose to issue bonds at the bond market rather than to borrow from banks.[7]

In this model borrowers hence find bank loans as imperfect substitutes to bonds, which is an important assumption for there to exist a bank lending channel. An implication of this is that the demand for bonds is separated from the demand for loans and that the demand for loans can be written as a function of the spread between the bank interest rate and the bond interest rate. Formally, the non-bank private sector's holdings of nominally denominated assets, $w$, consist in this model of bonds, $b^p$, deposits, $d$, and loans, $l$.[8] The stock of assets held by the non-bank private sector is fixed in the short run. The financial balance sheet constraint for the non-bank private sector is hence

$$w = b^p + d - l. \tag{1.}$$

As in the textbook IS/LM-model the demand for deposits or money (cash is ignored in this model) is written as a function of income, $y$, (the transaction motive) and the bond interest rate $i$,[9]

$$d^d = D^d(\underset{-}{i}, \underset{+}{y}). \tag{2.}$$

Income represents a transaction variable and when income increases so does the demand for money. Following Miron, Romer and Weil the opportunity cost of holding deposits is assumed to be the interest rate on bonds, which is a simplification.[10] The demand for deposits thus varies inversely with the bond interest rate, $i$. The return on deposits is assumed to be exogenously fixed and is normalised to zero.

The demand for loans is

$$l^d = L^{d,\rho}(\rho, i, y) \equiv L^{d,\rho}(i + \delta, i, y) \equiv L^d(\underset{-}{\delta}, \underset{-}{i}, \underset{+}{y}), \tag{3.}$$

where $\rho$ is the loan rate and $\delta$ denotes the spread between the bank interest rate and the bond interest rate, $\delta \equiv \rho - i$. The spread is then, like the interest rate $i$, solved for in

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[7]In Rajan (1992) it is argued that there are costs with bank financing since banks have bargaining power over the firm's profits, once projects have begun. Further, if for example there are transaction costs when a contract between a borrower and a lender is settled, borrowing in the bond market that works as direct borrowing between two parties is less costly than intermediation through a bank since the latter involves one more agent. Given that borrowers are charged for this extra cost, borrowers without information problems prefer the bond market.

[8]The notation is similar to that of Miron, Romer and Weil (1994), small letters signify quantities, capital letters signify functions, subscripts signify derivatives and superscripts signify subsets of quantities.

[9]It also depends on total wealth, but since wealth is assumed to be constant it is not included among the determinants.

[10]Alternatively one could assume that the opportunity cost of holding deposits is the non-bank private sector's borrowing costs, that is $i$ or $\rho$, the bank loan interest rate.

equilibrium. In what follows the model is solved for the spread instead of the loan rate. The demand for loans is then written as a function of the spread, the bond interest rate and the income level. The derivative with respect to the bond interest rate consequently includes both the direct effect that the bond interest rate has on the demand for loans and also its indirect effect through the bank interest rate, $L_i^d \equiv L_\rho^{d,\rho}\rho_i + L_i^{d,\rho}$. The derivative with respect to the spread is then the effect of a change in the loan rate given the bond interest rate, $L_\delta^d \equiv L_\rho^{d,\rho}\rho_\delta$.

Since bank loans and bonds are assumed to be imperfect substitutes a higher spread results in a finite fall in the demand for loans, $L_\delta^d > -\infty$. Some borrowers that leave the bank go without financing because their projects now have a negative net present value. Some turn to the bond market. This is the case if it is assumed that borrowers with asymmetric information problems after paying some fixed cost that depends on the borrowers degree of information problem can borrow at the bond market. This cost could for example be a cost of making the bond as liquid as a bond issued by a borrower without information problem. Borrowers that were just at the margin then turn to the bond market when the spread rises.

A rise in the bond interest rate and the corresponding change in the loan rate lowers the demand for loan because fewer projects have a positive net present value. The negative impact also follows from the effect that the interest rates have on the demand for deposits or money. A rise in the interest rates lowers money demand. This can here be accomplished both by holding more bonds or fewer loans or both. Higher interest rates then have a negative impact on the demand for loans. Formally, from the balance sheet constraint and the demand for deposits, given wealth, it follows that

$$(4.) \qquad L_i^d - B_i^p = D_{\underline{i}}^d ,$$

that is, the bond interest rate has a direct negative effect on the demand for loans, assuming that only some of the adjustment is accomplished through a rise in bond holdings. Finally, a higher income raises the demand for transaction money and consequently the demand for loans.

## 2.1 Banks

As mentioned above also banks have to find loans and bonds as imperfect substitutes for there to exist a bank lending channel. To understand why this is the case one can study a representative bank’s balance sheet.

Table 1. A bank's balance sheet

| Assets | Liabilities |
|---|---|
| $l^s$ = loans<br>$b^b$ = bonds<br>$r$ = reserves = $\tau d$ | $d$ = deposits |

On the asset side it is assumed that a bank holds loans, bonds and reserves. On the liability side it has deposits. The return on deposits is, as mentioned above, assumed to be exogenous. An individual bank can therefore not compete away deposits from other banks. This means that a single bank views its level of deposits as exogenously given.[11] As will be analysed below it is the central bank, through its control over the amount of reserves, that controls the aggregate amount of deposits.

One way of avoiding getting insolvent when having to repay its depositors on demand is for the bank to hold zero yielding reserves, $r = \tau d$, where $\tau$ is the reserve ratio. Reserves can consist of required reserves, and/or of excess reserves, reserves that the bank holds besides those that it can be restricted to hold.[12] Excess reserves are held if the bank finds the required reserve ratio too low.[13] The reserve ratio is assumed to be fixed and the demand for reserves is

$$(5.) \qquad r^d = \tau d.$$

The bank hence has a portfolio choice to allocate most of its deposits, $d(1-\tau)$, on loans and bonds. Bonds are hold primarily of liquidity motives and loans for their expected return, that is, since bonds are assumed to be more liquid than loans, bonds are, as reserves, held as a precaution against unanticipated deposit shortfalls. The bank's choice of how much of the non reserve assets it shall hold in the form of loans, i.e. the bank's willingness to supply loans, is defined as $\lambda = \frac{l^s}{l^s + b^b} = \frac{l^s}{d(1-\tau)}$. If banks are assumed not to issue certificates of deposits, $\lambda$ never exceeds one. As the supply of loans rises, given the stock of bonds, $\lambda$ rises.

From a representative bank's profit maximisation problem it is possible to derive what determines the bank's choice. A bank's expected profit can be expressed as

$$(6.) \qquad \Pi = d(1-\tau)\left[\rho\lambda - C(\lambda) + i(1-\lambda)\right]^{14} \qquad 0 < \lambda < 1.$$

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[11] It is assumed that depositors divide themselves equally among the existing number of banks.

[12] Reserves are the same as non borrowed reserves since banks are assumed to not borrow from the central bank.

[13] In Bernanke and Blinder's (1988) model excess reserves are a function of the bond interest rate, $i$. It is also possible to assume that the demand for excess reserves is a function of the loan rate. In Miron, Romer and Weils (1994) and in this paper it is assumed that excess reserves are not sensitive to any interest rate, given that a bank at all holds them, which is a simplification.

[14] This is similar to the formulation made by Keeton (1992).

Some of its deposits banks hold as reserves on which it receives no interest. The rest is used for borrowing and to buy bonds, with the shares $\lambda$ and $(1-\lambda)$ respectively. The profit on lending is the loan rate less the expected cost of intermediating each dollar of deposits, $C(\lambda)$, while the profit on the bond holding is the interest rate on bonds. The cost of intermediating includes for example the cost of monitoring and screening borrowers and the costs of liquidating loans and bonds to meet withdrawals of funds by depositors. A crucial assumption in what follows is that the cost of intermediating is a function of how much loans the bank holds, $C(\lambda)$, and that the bank's intermediating costs rise at an increasing rate as $\lambda$ goes up, $\partial C_{\lambda}/\partial\lambda > 0$. This is for example the case if the bank initially lends to borrowers with not so severe information problems and if an increased lending goes to borrowers with larger information problems. Keeton (1992) argued that the cost function is strictly convex if, when lending increases and $\lambda$ rises, not only the amount of loans the bank has to sell rises at a loss of deposits, but also the probability of such a withdrawal. Further if $\lambda$ rises as a result of banks cutting down their bond holdings, the expected liquidation costs rises at a deposit withdrawal since loans are less liquid than bonds and therefore more costly to sell of on a short notice.

Alternatively, it could be assumed that banks issue CDs ($\lambda$ may exceed one) and $C(\lambda)$ is the expected cost of CD financing. It then follows that $\partial C_{\lambda}/\partial\lambda > 0$ if there are increasing marginal costs of CD financing. The supply schedule for CDs is then upward sloping. Banks would have rising marginal costs for their borrowing if for example also banks were subject to asymmetric information problems.[15]

If the expression above is maximised with regard to $\lambda$[16], the first-order condition is

(7.) $$\rho - i = C_{\lambda} \qquad 0 < \lambda < 1.$$

A bank's willingness to supply loans, $\lambda$, then depends on the relative return on loans and can be written as a function of $\rho - i$, or $\delta$.

(8.) $$\frac{l^s}{l^s + b^b} = \lambda(\delta)$$

The bank then considers loans and bonds as imperfect substitutes. The total supply of bank credit is hence

(9.) $$l^s = \lambda(\underset{+}{\delta})d(1-\tau) \qquad \lambda(\delta) = 0 \text{ for } \delta < C_{\lambda}.$$

Since banks have to be compensated for the intermediating costs, the loan rate must in equilibrium always be higher then the bond interest rate for banks to be interested in giving out loans. As the spread increases the bank's demand for bonds fall and the

15 This is shown in Stein (1995) and in Kashyap and Stein (1993).

16 The bank is a price-taker with respect to the interest rates.

supply of loans rises. The derivative of $\lambda$ with respect to $\delta$ is finite since loans and bonds are imperfect substitutes.

### 2.2 The commodity market

Since the purpose of this paper is to analyse the effects of monetary policy, government debt is assumed to be unchanged throughout the analysis. Aggregate demand is therefore assumed to be positively related only to the amount of investment made in the economy. Investment is a function of the cost of financing. Aggregate demand is therefore a function of the interest rates

$$y = Y^{d,\rho}(\rho, i) \equiv Y^{d}(\underset{-}{\delta}, \underset{-}{i}). \tag{10.}$$

A higher cost of financing lowers investments and therefore income. The partial derivative of income with respect to the bond interest rate includes both the negative effect that a higher bond interest rate has on those borrowing from the bond market as well as the effect it has on those borrowing from banks, $Y_i^d \equiv Y_\rho^{d,\rho}\rho_i + Y_i^{d,\rho} < 0$. A higher spread at constant bond interest rate has only effect on those borrowing from banks and this effect is also negative, $Y_\rho^{d,\rho} \equiv Y_\delta^d < 0$.

### 2.3 Equilibrium conditions

The demand and supply functions for loans, deposits and reserves have now been derived. Equilibrium requires that demand equals supply on these asset markets and that there is equilibrium in the commodity market. The economy can be described by the following equilibrium conditions:

(11.) Reserve market: $d\tau = r^s$

(12.) Money market: $D^d(\underset{-}{i}, \underset{+}{y}) = d$

(13.) Loan market: $L^d(\underset{-}{\delta}, \underset{-}{i}, \underset{+}{y}) = \lambda(\underset{+}{\delta})d(1-\tau)$

(14.) Goods market: $y = Y^d(\underset{-}{\delta}, \underset{-}{i})$

The equilibrium in the bond market is ignored by Walras law, that is, if there is equilibrium in four markets in a five-market general equilibrium model, then it is also equilibrium in the fifth market. The exogenous variables in this system are the central bank's policy parameter, $r^s$, the amount of reserves, the reserve ratio, $\tau$ and the government deficit, $b^g$.

To be able to illustrate this system graphically the system is reduced as in Bernanke and Blinder (1988). The equilibrium condition for the reserve market can, as a start, be substituted into the equilibrium condition for the money market. Solving for deposits from the equilibrium in the reserve market gives

(15.) $d = \frac{1}{\tau} r$.

The supply of deposits can then be written as

(16.) $d^s = d = \frac{1}{\tau} r = \mu r$.

where $\mu$, is known as the money, bank or deposit multiplier since the deposit supply is some positive multiple of reserves. In this model the multiplier is assumed to be a constant since the demand for reserves is not affected by any interest rate. The total amount of deposits is therefore determined by the central bank's monetary policy, that is the total amount of reserves. Equilibrium in the money market can then be written as

(17.) $$D^d(\underset{-}{i}, \underset{+}{y}) = \mu r.$$

The equilibrium condition (17.) is substituted for deposits, $d$, in (13.), i.e. in the equilibrium condition for the loan market, deposits is replaced by the money supply, $\mu r$.

(18.) $$L^d(\delta, i, y) = \lambda(\delta)\mu r(1-\tau).$$

Then equation (18.) can be used to solve for the spread

(19.) $$\delta = \Delta(\underset{-}{i}, \underset{+}{y}; \underset{-}{r}).$$

The signs of the partial derivatives are discussed below. The equation for the spread is now substituted into the goods market equilibrium condition and the system is reduced to the following two equations:

(17.) $D(i, y) = \mu r$

(20.) $y = Y(i, \Delta(i, y; r))$[17].

The equilibrium in the model is illustrated in the figure below. Equation (17.) represents the usual LM curve. Equation (20.) is equal to what Bernanke and Blinder (1988) call the CC-curve, (for "commodities and credit"). In the figure below the ordinary IS-curve is also pictured. As is well known the IS-curve shows combinations of the interest rate and income that is consistent with goods market equilibrium. The lower the interest rate, the higher the level of investments and thus the higher the level of

[17] In what follows the functional expression $Y^d$ will for simplicity be written only as $Y$ and $D^d$ as $D$.

income, the IS-curve slopes downward. The CC-curve shows combinations of the general interest rate level and income consistent with goods market and also loan market equilibrium. As can be seen the CC-curve is steeper than the IS-curve.

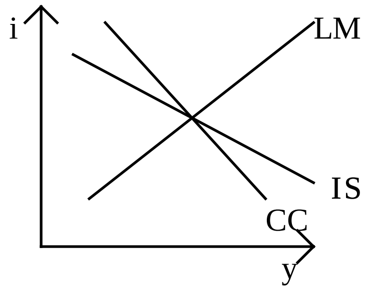


Figure 1. Equilibrium condition - graphically, for a negatively sloped CC-curve.

Formally the slopes of the two curves are given by

(21.) $$\left.\frac{dy}{di}\right|_{CC} = \frac{Y_i}{\left[1 - \underset{-}{Y_\delta}\Delta_y\right]} + \frac{Y_\delta \Delta_i}{\left[1 - \underset{+}{Y_\delta}\Delta_y\right]} > \left.\frac{dy}{di}\right|_{IS} = \underset{-}{Y_i} < 0.$$

As is seen in the equation above it is not even sure that the CC-curve has a negative slope.[18] This is discussed in more detail below.

## 3. The effects of monetary policy

The effects of monetary policy in case of a bank lending channel will now, as in Bernanke and Blinder's paper, be analysed in terms of the LM and CC curves. The results are compared with the effects from the ordinary money channel. Monetary policy is in this model the same as a change in the amount of reserves, which results in a change of the money supply. The method of changing the money supply is for the central bank to engage in open-market operations. If the system of the two equations above is totally differentiated it follows that the partial derivatives of income with respect to reserves is

[18] In Bernanke and Blinder's (1988) model the CC-curve is negatively sloped. They use the bank loan interest rate instead of the spread and they assume that the interest elasticity of the money multiplier is not too large. The derivative of the loan rate with respect to the bond interest rate is then positive, $\rho_i > 0$. If this is assumed also here, then the CC-curve here is also negatively sloped. The loan rate is given by $\rho = i + \delta$. The partial derivative with respect to $i$ is $\rho_i = 1 + \Delta_i$. It then follows that $\rho_i > 0$ if $\left|\Delta_i\right| < 1$ and $\left.\frac{dy}{di}\right|_{CC} = \frac{Y_i + Y_\delta \Delta_i}{\left[1 - Y_\delta \Delta_y\right]} = \frac{Y_\rho^\rho \rho_i + Y_i^\rho + Y_\rho^\rho \rho_\delta \Delta_i}{\left[1 - Y_\delta \Delta_y\right]} = \frac{Y_\rho^\rho \left(1 + \Delta_i\right) + Y_i^\rho}{\left[1 - Y_\delta \Delta_y\right]} < 0$

(22.)

$$\left.\frac{\partial y}{\partial r}\right|_{bc} = \frac{\frac{\mu}{D_y}\frac{\left[Y_i + Y_\delta \Delta_i\right]}{\left[1-Y_\delta\Delta_y\right]} + \frac{D_i}{D_y}\frac{Y_\delta\Delta_r}{\left[1-Y_\delta\Delta_y\right]}}{\frac{\left[Y_i+Y_\delta\Delta_i\right]}{\left[1-Y_\delta\Delta_y\right]}+\frac{D_i}{D_y}} = \frac{\underset{+}{\begin{bmatrix}\text{shift in}\\ \text{LM}\end{bmatrix}}\underset{\pm}{\begin{bmatrix}\text{slope of}\\ \text{CC}\end{bmatrix}} - \underset{+}{\begin{bmatrix}\text{slope of}\\ \text{LM}\end{bmatrix}}\underset{+}{\begin{bmatrix}\text{shift in}\\ \text{CC}\end{bmatrix}}}{\underset{\pm}{\begin{bmatrix}\text{slope of}\\ \text{CC}\end{bmatrix}}-\underset{+}{\begin{bmatrix}\text{slope}\\ \text{of LM}\end{bmatrix}}} \lessgtr 0$$ [19]

where $bc$ stands for the bank lending channel. In case of only a money channel, i.e. in the usual IS-LM model, the solution is

(23.)

$$\left.\frac{\partial y}{\partial r}\right|_{mc} = \frac{\mu\overline{Y}_i}{D_y\overline{Y}_i + D_i} = \frac{\frac{\mu}{D_y}\overline{Y}_i}{\overline{Y}_i + \frac{D_i}{D_y}} = \frac{\underset{+}{\begin{bmatrix}\text{shift in}\\ \text{LM}\end{bmatrix}}\underset{-}{\begin{bmatrix}\text{slope of}\\ \text{IS}\end{bmatrix}}}{\underset{-}{\begin{bmatrix}\text{slope}\\ \text{of IS}\end{bmatrix}}-\underset{+}{\begin{bmatrix}\text{slope of}\\ \text{LM}\end{bmatrix}}} > 0$$ [20],

where $mc$ stands for the money channel and $\overline{Y}_i$ is the derivative of output with respect to the interest rate, when aggregate demand is given by $y = \overline{Y}(i)$ .

Assume for example that the central bank intends to lower the amount of reserves and therefore money in the economy. To reduce the amount of reserves and money the central bank can sell bonds to the non-bank private sector. In order to persuade them to hold more bonds and less money, the interest rate on bonds must rise. That is, the opportunity cost of holding deposits must rise. The LM-curve shifts to the left by $-\frac{\mu}{D_y}$. In figure 2 this is shown graphically. Borrowing becomes more expensive which lowers the amount of investment made and therefore aggregate demand, $Y_i < 0$. This is similar to what happens according to the money view. A fall in reserves in the conventional IS/LM-model has a negative effect on the income level and a positive impact on the bond interest rate.

[19] Derived in appendix A.

[20] Derived in appendix A.

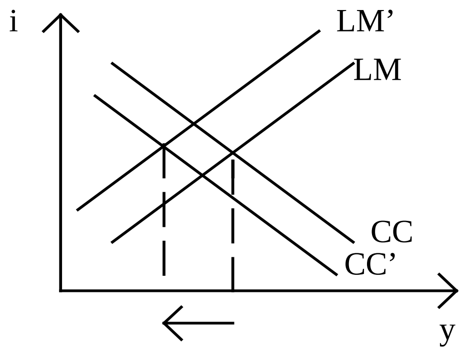


Figure 2. Monetary policy, when the CC-curve has a negative slope.

When there is a bank lending channel it is necessary to also consider what happens to the spread, that is, what happens in the loan market. According to the lending view a change in reserves has an effect on the supply of loans and therefore the spread, $\Delta_r$:

(24.) $$\Delta_r = \frac{\partial \delta}{\partial r} = \frac{\left[\lambda(\delta)\mu(1-\tau)\right]}{\left[L^d_\delta - \lambda_\delta \mu r(1-\tau)\right]} < 0.$$

A lower amount of reserves and therefore deposits reduces the amount of funds banks have to invest with $\lambda(\delta)\mu(1-\tau)$. An excess demand of loans appears which puts an upward pressure on the spread. Since banks find loans and bonds as imperfect substitutes, $\lambda_\delta < \infty$, they can not fully insulate their loan supply simply by rearranging their portfolio of other assets and liabilities. Banks are assumed not to be able to fully offset the decline in deposits by selling securities since this is associated with rising costs. If banks are assumed to be able to issue CDs and the marginal cost of external financing is a rising function of the amount borrowed, the result is the same. Since also borrowers find bonds and loans as imperfect substitutes, $L^d_\delta > -\infty$, there is a finite fall in the demand for loans in respond to the increasing spread. There can not be a flight over to the bond market that equalises the interest rates again. There is hence a finite rise in the supply of loans and a finite fall in the demand for loans in response to the increased spread. This continues until a new equilibrium is reached.

The fall in reserves has in the end caused a fall in bank lending and a rise in the spread, $\Delta_r < 0$. This makes the income fall further. At the initial bond interest rate, $i$ the bank interest rate is now higher and income lower, the CC-curve has shifted to the left. The direct effect on the spread, and thereby the income level, from a change in reserves is in the diagram above then captured by a shift in the CC-curve. This shift in the CC-curve, besides the shift in the LM-curve, that follows from a monetary action amplifies the effect of monetary policy.[21]

[21] Assuming that the slope of the CC curve is less than the slope of the LM curve.

Beside the direct effect on the supply of loans, monetary policy also has an indirect effects on the demand for loans, since the demand for loans is affected by the general interest rate level and income. As analysed above the ordinary money channel made the interest rate rise. This affects the demand for loans and hence the spread according to

(25.) $$\Delta_i = \frac{\partial \delta}{\partial i} = \frac{-L_i^d}{\left[L_\delta^d - \lambda_\delta \mu r(1-\tau)\right]} < 0 .$$

As analysed above a rise in the bond interest rate and in the loan rate $\rho$ (given $\delta$) makes the demand for loans falls, $L_i^d < 0$, since the non-bank private sector wants to hold less money and since fewer projects have a positive net present value. This results in an excess supply of loans. When the new equilibrium is reached bank borrowing is decreased and so is the spread. A rise in the bond interest rate then makes the spread fall. As analysed above the spread can be changed since bonds and loans are imperfect substitutes. The fall in the spread makes aggregate demand rise. A higher interest rate then has an indirect positive effect on income, $Y_\delta \Delta_i > 0$. Further, the decline in income due to the direct effect of the interest rate lowers the demand for transaction money, $L_y^d > 0$. This also results in an excess supply of loans and consequently the spread falls:

(26.) $$\Delta_y = \frac{\partial \delta}{\partial y} = \frac{-L_y^d}{\left[L_\delta^d - \lambda_\delta \mu r(1-\tau)\right]} > 0.$$

The decrease in the spread increases income further.

The fall in the demand for loans hence makes the spread fall. The smaller spread has a positive impact on investments and thus income that decreases the impact monetary policy has on income, this is captured by the steeper slope of the CC-curve compared to the slope of the IS-curve.[22]

In short one can conclude that a contraction of monetary policy, as in the ordinary IS-LM-model increases the general interest rate level, which in turn makes aggregate demand fall, (the LM-curve shifts to the left). According to the lending view the fall in reserves decreases bank lending and the spread is increased. This is possible since perfect substitutes for bank loans are not available. A higher spread depresses income, (the CC-curve also shifts to the left). The effect of monetary policy is hence amplified. An offsetting element though is that the demand of loans falls in respond to the increase in the interest rate and the decrease in income. The spread falls which increases income, (the slope of the CC-curve is steeper than the IS-curve). It is therefore ambiguous what effect monetary policy has on the spread and consequently on the interest rate and the

[22]The result here, that the CC-curve and the IS-curve can have different slopes, also follows from Bernanke and Blinders (1988) model, but this is something that they do not comment upon.

income level. It is hence not only the outcome of the interest rate that is ambiguous, as is concluded in Bernanke and Blinder (1988).[23]

The implications of the assumption of bonds and loans being imperfect substitutes are seen in the equations above. If borrowers regard bank loans and bonds as perfect substitutes the derivative of the loan demand with respect to the spread goes to minus infinity, $L_\delta^d \to -\infty$. If banks consider them as perfect substitutes then $\lambda_\delta \to \infty$. It then follows that $\Delta_r = \Delta_i = \Delta_y = 0$, i.e. the spread would be a constant. Assuming that $Y_i = \overline{Y_i}$ equation (22.) hence collapses into equation (23.). A separate channel of monetary policy through the loan rate then does not exist under these circumstances.

### 3.1 A condition for an enhancement mechanism

To get a deeper understanding of what the bank lending channel is, that is, to understand how monetary policy affects income in case of a bank lending channel and how large this effect is compared with the effect when there is only a money channel, a few simplifying assumptions are now made. This corresponds to what is done in Miron, Romer and Weil (1994). First the partial derivatives of income with respect to reserves are rewritten and related to each other

$$(27.)\qquad \left.\frac{\partial y}{\partial r}\right|_{bc} = \frac{Y_i\mu + Y_\delta\left[\Delta_r D_i + \Delta_i \mu\right]}{D_i\left[1 - Y_\delta \Delta_y\right] + D_y\left[Y_i + Y_\delta \Delta_i\right]} \quad \lessgtr \quad \left.\frac{\partial y}{\partial r}\right|_{mc} = \frac{\overline{Y_i}\mu}{D_i + D_y \overline{Y_i}},$$

or[24]

$$(28.)\qquad \left.\frac{\partial y}{\partial r}\right|_{bc} = \left.\underset{-}{\frac{\partial y}{\partial i}}\underset{\pm}{\frac{\partial i}{\partial r}}\right|_{bc} + \underset{-}{\frac{\partial y}{\partial \delta}}\underset{\pm}{\frac{\partial \delta}{\partial r}} \quad \lessgtr \quad \left.\frac{\partial y}{\partial r}\right|_{mc} = \left.\underset{-}{\frac{\partial y}{\partial i}}\underset{-}{\frac{\partial i}{\partial r}}\right|_{mc} > 0.$$

The effect on income of a change in reserves is ambiguous since the effects on the bond interest rate and the spread are ambiguous. Further as follows from equation (28.) the difference between the two models is not only that reserves affect the spread which has implications for output, it is also so that the effect reserves have on the interest rate

[23] In Bernanke and Blinder (1988) the result is that when there is a bank lending channel the relation between reserves and income is positive. If it is assumed that the direct effect the bond interest rate has on income is larger than the indirect effect through the spread, that is, the CC-curve has a negative slope, then this is the result even here. Bernanke and Blinder (1988) also conclude that monetary policy gets more expansionary compared with a situation where there is only a money channel, but this is something that does not follow directly from their model in their paper from 1988. A negatively sloped CC-curve is not a sufficient assumption to determine whether the bank lending channel makes monetary policy more or less effective compared with a situation where bonds and loans are perfect substitutes, since the effect on the spread still is ambiguous. In a note Bernanke and Blinder stated that they had to invoke certain elasticity assumptions to get some of their comparative statistics results.

[24] In appendix C the expression for the bank lending channel is derived.

differ in the two models. Finally it is not obvious that the interest rate elasticity of aggregate demand is the same in the two models.

The expression above is now rewritten using simplifying assumptions considering the elasticities of the non-bank private sector's demand for different assets. The adding up constraint for the interest elasticities, given total wealth for the whole non-bank private sector is used. It is given by equation (4.) and repeated here for convenience:

(4.) $$B_i^p + D_i - L_i^d = 0.$$

Dividing by the total amount of deposits gives

(29.) $$\frac{D_i}{\mu r} = \frac{L_i^d}{l^d}\frac{l^d}{\mu r} - \frac{B_i^p}{b^p}\frac{b^p}{\mu r}.$$

The first simplifying assumption is that in response to an increase in the interest rates the percentage changes in the holdings of loans and bonds are the same:

(30.) $$\frac{L_i^d}{l^d} = -\frac{B_i^p}{b^p}.$$

One can then write

(31.) $$\frac{L_i^d}{l^d} = \frac{D_i}{\mu r}\left[\frac{\mu r}{l^d + b^p}\right].$$

The same thing is now done with the income elasticities. The adding up constraint for the income elasticities is given by

(32.) $$B_y^p + D_y - L_y^d = 0$$

The second simplifying assumption is that the percentage changes in the holdings of loans and bonds in response to income changes are the same:

(33.) $$\frac{L_y^d}{l^d} = -\frac{B_y^p}{b^p}.$$

One can then write

(34.) $$\frac{L_y^d}{l^d} = \frac{D_y}{\mu r}\left[\frac{\mu r}{l^d + b^p}\right].$$

Combining equations (31) and (34) gives that:

(35.) $$D_y L_i^d = D_i L_y^d.$$

The implication of the assumptions stated in equations (30) and (33) above is that the relation between the non-bank private sector's possession of loans and bonds, $l^d / b^p$, is not affected by a change in the bond interest rate and the corresponding change in the loan rate, or of a change in income, but only of a change in the spread. The loan demand and the total bond demand then have the same functional form.

Using these assumptions, equation (27) can be rewritten as:[25] [26]

(36.) $$\frac{Y_i \mu}{D_i + D_y Y_i} + \frac{Y_\delta [\Delta_r D_i + \Delta_i \mu]}{D_i + D_y Y_i} \lessgtr \frac{Y_i \mu}{D_i + D_y Y_i},$$

that is:

(37.) $$\left.\frac{\partial y}{\partial r}\right|_{bc} = \underset{+}{\frac{\partial y}{\partial i}} \left.\frac{\partial i}{\partial r}\right|_{mc} + \underset{\pm}{\frac{Y_\delta [\Delta_r D_i + \Delta_i \mu]}{D_i + D_y Y_i}} \lessgtr \left.\frac{\partial y}{\partial r}\right|_{mc} = \underset{+}{\frac{\partial y}{\partial i}} \left.\frac{\partial i}{\partial r}\right|_{mc}.$$

From this it follows that the bank lending channel includes the ordinary money channel. A monetary action first has real effects in line with the ordinary IS/LM-model. Monetary policy then also influences the economy through its effect on the spread. The difference between the two models is then summarised by the following expression

(38.) $$\frac{Y_\delta [\Delta_r D_i + \Delta_i \mu]}{D_i + D_y Y_i} \lessgtr 0.$$

It should be noted that the bank lending channel could be defined as only consisting of equation (38.). In this paper the bank lending channel is represented by equation (22.). The result that the bank lending channel includes the ordinary monetary channel is hence only an implication of how the bank lending channel is defined in this paper.

Equation (38.) can then be simplified further[27] and it turns out that monetary policy in case of a bank lending channel has a larger impact on income than in case of only a money channel, if the following condition is fulfilled

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[25] In appendix B expression is derived.

[26] It is assumed that $Y_i = \overline{Y_i}$, since $Y_i$ includes both the effect that the higher bond interest rate has on those borrowing from the bond market and also the direct effect it has on those borrowing from banks and $\overline{Y_i}$ also gives the direct effect that a rise in the interest rate has on all borrowers.

[27] This is done in appendix B.

(39.) $$1 > \left[\frac{\mu r}{l^d + b^p}\right],$$

where $\left[\frac{\mu r}{l^d + b^p}\right]$ defines the relationship between the interest and income elasticities of money and loan demand. From equation (31) and (34) it is then clear that condition (39) is fulfilled if the elasticity of loan demand is lower than the elasticity of money demand. If for example the interest rate rises from a reduction in reserves, the percentage change in the holdings of loans due to the fall in the demand for loans must be less than the percentage change in deposits and therefore the fall in the supply of loans. The loan rate will then rise more than the bond interest rate, the spread widens. Reserves have a negative impact on the spread.[28] The bank lending channel then works in line with the money channel and a fall in reserves leads to a fall in income, as in the ordinary IS/LM-model. The difference is that monetary policy has a larger impact on output compared with a situation with only a money channel. Formally,

(40.) $$\left.\frac{\partial y}{\partial r}\right|_{bc} = \frac{\partial y}{\partial i}\left.\frac{\partial i}{\partial r}\right|_{mc} + \frac{Y_\delta\left[\Delta_r D_i + \Delta_i \mu\right]}{\underset{+}{D_i + D_y Y_i}} > \left.\frac{\partial y}{\partial r}\right|_{mc} = \frac{\partial y}{\partial i}\left.\frac{\partial i}{\partial r}\right|_{mc} > 0$$

and

(41.) $$\left.\frac{\partial y}{\partial r}\right|_{bc} = \underset{-}{\frac{\partial y}{\partial i}}\left.\underset{\pm}{\frac{\partial i}{\partial r}}\right|_{bc} + \underset{-}{\frac{\partial y}{\partial \delta}}\underset{-}{\frac{\partial \delta}{\partial r}} > 0.$$

The two models of course differ also with respect to the effect on the bond interest rate of a change in monetary policy. In case of only a money channel the bond interest rate rises when monetary policy is tightened. When there is a bank lending channel a monetary tightening leads to a smaller increase of the bond interest rate**,** given condition (39), if it at all rises.[29] It is hence possible to get a larger effect on the income level with a smaller increase in the bond interest rate.

## 4. Empirical tests of the bank lending channel

When testing for the existence of a bank lending channel one approach in the literature has been to look at the development of interest rate spreads. It follows from the theoretical analysis above that the spread between the bond interest rate and the bank

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[28] That the total effect on the spread of a change in reserves is negative, given condition (39.), can be shown mathematically. This is done in appendix C.

[29] In appendix B the solution is derived.

interest rate may be affected by the stance of the monetary policy. Kashyap, Stein and Wilcox (1993) test whether the spread between the bank loan and commercial paper interest rate is affected by a change in monetary policy. The result is that there is a significant rise in the spread after a monetary contraction.

Yet another test of the importance of the bank lending channel is to look at how companies' (or households') debt composition is changed after a monetary contraction. If borrowers have different sources of financing, and it turns out that bank borrowing falls by more than other forms of financing, it could indicate that there has not been a general fall in the demand for credits but rather a fall in the supply of bank loans. This would then indicate that banks treat loans and bonds as imperfect substitutes, which is one of the conditions for the existence of a bank lending channel. If loans and bonds instead are perfect substitutes the mix would not be altered when the stance of monetary policy changed. This is tested on aggregate data by Kashyap, Stein and Wilcox (1993). They look at how the ratio of bank loans to the sum of bank loans and commercial paper, called the mix, responds to a change in the stance of monetary policy. They use several different measures of the stance of monetary policy, one is the federal funds rate. They conclude that a change in monetary policy alters the mix of loans and commercial paper. To exclude the possibility that bonds only work as a buffer to bank loans, that is that borrowers do not find loans and bonds as imperfect substitutes, they further examine the relation between the mix and various measures of investment. If the mix has no real effects, this indicates that monetary policy does not affect the total amount of credits (which is necessary for there to be any real effects). Kashyap, Stein and Wilcox however find that the mix affects investment, even after controlling for other factors such as interest rates and output.

Oliner and Rudebusch (1993) extend Kashyap, Stein and Wilcox' research by incorporating all types of short-term debt and by allowing for differential responses of small and large firms. They use data for manufacturing companies. The results of the broader measures of the mix vary. If other short term credits than bonds are included in the denominator and if the Romers' dates[30] are used as a measure of the stance of monetary policy the results are consistent with the earlier results, that is, the mix is altered by a change in monetary policy. When the sample is divided into large and small firms most of the relations found in the total sample turn out to be insignificant. Monetary policy only had a significant impact on small firms mix variable, including only commercial paper. But it turned out that the mix raised when monetary policy was tightened. This suggests that small firms shift towards bank lending at a monetary contraction. Their conclusion is that the overall evidence from the debt mix provides little or no support for a bank credit channel.

Bernanke and Blinder (1992) have studied how banks adjust their portfolios after a change in the stance of monetary policy. According to the model the direct effect is that

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[30]In Romer and Romer (1990) six dates since World War II are identified as episodes when the Fed appeared to have tightened monetary policy. The technique they use for identification is to read the minutes of the FOMC, the Federal Open Market Committee.

banks adjust the supply of loans. If it turns out that banks fully insulate the change in deposits by adjusting their net holdings of bonds it seems that there is not a direct connection between lending and monetary policy. Monetary policy is in their study interpreted as a change in the Federal funds rate. The finding is that banks adjust both their assets and their debts to a change in the stance of monetary policy. During the first six months after a monetary tightening bond holdings fall. After that they rise while at the same time lending falls. Two years later banks' bond holdings are back on their trend levels while their lending has fallen. The result, Bernanke and Blinder claim, supports the bank lending channel. A problem with this approach is that it is unclear what caused the change in the stock of loans. It could have been caused by a change in the supply of loans, but it could also have been caused by a change in the demand for loans. It might be that it is only the ordinary money channel that is at work, that is the demand for loans falls.

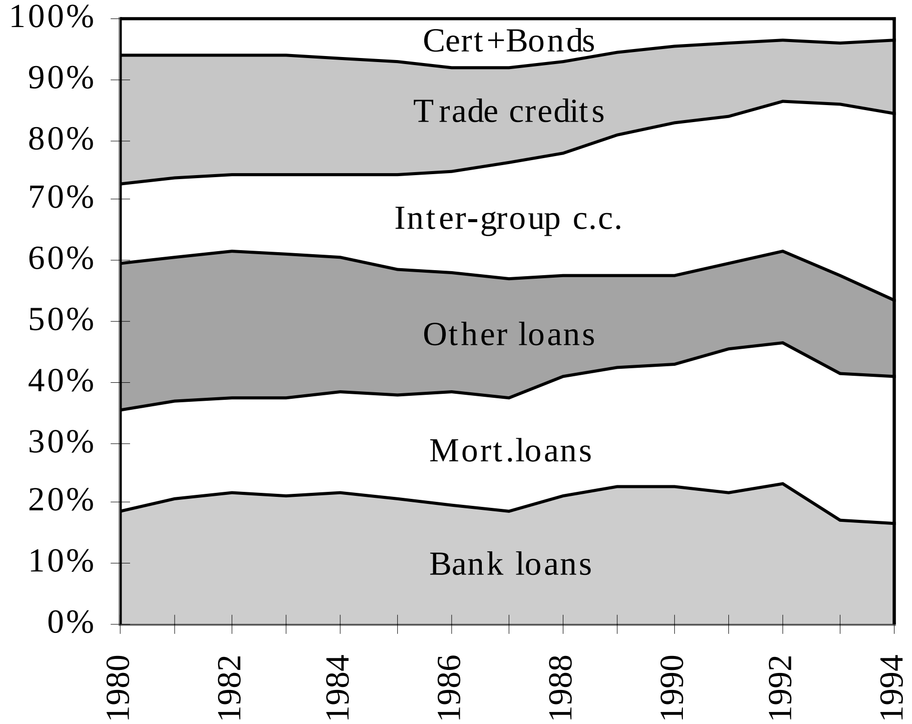
### 4.1 Non-financial enterprises' debt structure

When looking at the existence of a bank lending channel in Sweden it can as a start be informative to look at companies' debt structure. The analysis will be restricted to only include non-financial enterprises, defined as state businesses and other companies (corporations, trade companies, limited partnership, incorporated association, foundations and interest groups).[31] In the model above the non-bank private sector could only choose between borrowing from banks or issuing bonds at the private bond market. In the figure below non-financial enterprises' debt structure is shown.[32] It can be seen that many other sources of financing are used.

[31] Data come from Statistics Sweden, Finansräkenskaperna.

[32] Non financial companies' debt also consists of stocks, leasing and a discrepancy post.

Figure 1. Non-financial companies debt structure.



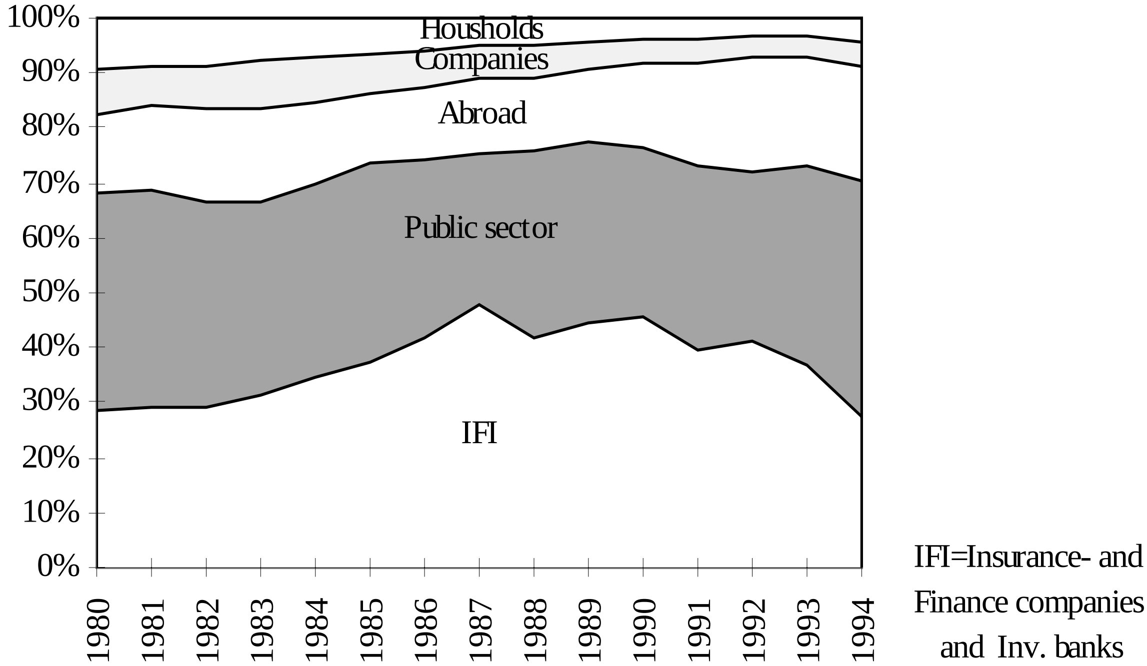

Not incl. stocks, leasing, and a disc. post.

Bonds and certificates are not a very important source of financing and they are falling rather then rising in importance. One explanation is that since the beginning of 1990 only companies with the highest rating (K1) are able to issue bonds. Today around 30 companies has access to the private bond market. This is a result of the crisis in the financial sector in the late 1980's. Many investors then made losses on the commercial paper market. Before the crisis it seemed as if the risks involved with buying commercial papers were not recognised. The interest rate on commercial papers where only slightly higher than the interest rate on treasury bills. When it became clear that the risks were larger than expected, investors choose not to price the risk but rather lend only to borrowers with a top rating. This is an example of how asymmetric information problems distort the market equilibrium.

Bank borrowing stands for barely 20 percent of the outstanding debt (defined here as total debt less stocks, leasing and discrepancies). In 1994 only 17% of the debt was in the form of bank loans. Mortgage loans have grown in importance. In 1980 it amounted to 14 percent of total debt, in 1994 the figure was 20 percent. Loans from mortgage institutes consist to more than 90 percent of loans from housing credit institutes. One special feature of these loans is, as the name indicates, that borrowers have to have a collateral to get the loan. When borrowing from a bank it can also be necessary to provide some security for the loan but the form is not as restricted as when borrowing from a mortgage institute. Another feature of mortgage loans is that they usually have fixed terms, compared to bank loans that usually have flexible terms. In the econometric analysis loans from mortgage institutes will therefore not be included since they are not a very close substitute to bank loans.

So called other loans consist to a large part of loans from insurance companies, finance companies, investment banks and loans from the public sector. Further this category contains loans from companies, households and also loans from abroad, this is shown below. Other loans have fallen in importance over time, see again figure 3. In the beginning of 1980 they amounted to around 25 percent of the outstanding debt and in 1994 the share was 13 percent.

Figure 2. Other loans to non-financial companies.




Trade credits have also fallen in importance, from around 20 % in the beginning of 1980 to a little more than 10% in 1994. Inter-group company claims, which is a form of inside debt, has on the other hand been growing during the last years and in 1994 it amounted to 30% of the total outstanding debt. Both trade credits and inter-group company claims can be divided into credits from within the country and credits from abroad. In both cases credits from abroad amount to barely 15 percent of the total amounts of credits. In the analysis that follows quarterly data will be used. Unfortunately quarterly data is only available for credits from abroad, for inter-group company claims and trade credits. But since the correlation between credits from abroad and credits from companies in Sweden are high this is hopefully not a big problem, the correlation between the *annual* data on credits from abroad and credits from within the country is for inter-group company claims 0.99 and for trade credits 0.77. The results for credits from abroad in what follows, will hence probably be true for the total amount of inter-group company claims and trade credits.

The conclusion so far is then that very few companies in Sweden today have access to the commercial paper market, and that bank loans are not as dominant source of finance as one might think. Other financial sources are instead being used. Inter-group company claims are for example used to a large extent.

### 4.2 The bank lending channel in Sweden

When analysing the impact of a bank lending channel in Sweden one modification of the theoretical model first has to be done to be able to use it as a reference model. In the theoretical discussions above monetary policy was assumed to be the same as a change in the amount of reserves. In practice however, the instrument of central banks is usually the short term interest rate. This is true also for Sweden since 1986. Before that Swedish banks and the financial market in general were highly regulated and monetary policy was conducted by changes in the regulation. In the econometric study that follows data are therefore used only from 1986 and the stance of monetary policy is measured by the over night interest rate.[33] The bond interest rate, not reserves, should hence be treated as the exogenous variable in the model. The model should therefore be reduced in a slightly different way. When the central bank pegs the interest rate $D^d(\underset{-}{i},\underset{+}{y})$ is substituted into the loan market equilibrium instead of $\mu r$ since the money demand determines the amount of money in the economy. Starting from the theoretical model in section 2, summarised by the following equilibrium equations

(13.) Loan market: $L^d(\underset{-}{\delta},\underset{-}{i},\underset{+}{y}) = \lambda(\underset{+}{\delta})d(1-\tau)$

(14.) Goods market: $y = Y^d(\underset{-}{\delta},\underset{-}{i})$

(17.) Money market: $D^d(\underset{-}{i},\underset{+}{y}) = \mu r$.

the model is reduced by substituting the money market equilibrium into the loan market:

(42.) Loan market: $L^d(\underset{-}{\delta},\underset{-}{i},\underset{+}{y}) = \lambda(\underset{+}{\delta})D^d(\underset{-}{i},\underset{+}{y})(1-\tau)$.

Solving for the spread now gives

(14.) Goods market: $y = Y^d(\underset{-}{\delta},\underset{-}{i})$

[33] The over night interest rate was used instead of the repo rate (or the marginal interest rate) to be able to run the regressions from 1986.

(43.) Loan market: $\delta = \Delta(\underset{\pm}{i}, \underset{\pm}{y})$.

Without further assumptions the impact of a change in the interest rate or the income level on the spread is unclear, once the effect on the demand for money is taken into account. Again it follows that the bank lending channel will amplify the effect of monetary policy if the total effect on the spread of a monetary tightening is positive.

One way of testing for the existence of a bank lending channel in Sweden could then be to estimate the above system. But before moving from the theoretical model to the real world one have to take into consideration the results from section (4.1), which were that non-financial companies in Sweden also use other sources of financing besides bank loans and bonds. The bank lending channel analysed in the theoretical part of this paper does of course not give an exact answer to how the bank interest rate should move in relation to the interest rates of these other sources of financing. Can for example a loan from a finance company be seen as a perfect substitute to bonds? But what we do know is that according to the money view all financial assets are perfect substitutes. This implies that they should all behave in the same way when monetary policy is changed. According to the bank lending channel the interest rate on bank loans moves differently from the bond rate. If the other sources of financing are not perfect substitutes to bank loans their interest rates should also move differently from bank loans. This distinguishes the bank lending channel from the broader credit channel, in which the interest rates on all external financing behave similarly. To distinguish between the two credit channels it is hence necessary to have data on how the spread between the loan rate and the interest rate on the other sources of financing move after a change in the stance of monetary policy. Unfortunately it is not possible to construct time series of the spread between the loan rate and the other sources of financing used above because of lack of data. The only spread that can be constructed is the spread between the loan rate and a bond rate. What one can do is then to estimate the above two equations and from these results draw conclusions about the possibility of an existence of a credit channel. This is done below.

To be able to analyse the existence of a bank lending channel quantities is also looked at, as is done in Kashyap, Stein and Wilcox (1993) and Oliner and Rudebusch (1993). According to the bank lending channel monetary policy has a direct effect on bank loans, through its effect on the supply of loans, which makes bank loans move differently from bonds. If the other sources of financing are not perfect substitutes to bank loans they should also move differently from bank loans when the stance of monetary policy changes. As in the two studies mentioned above different measures of the mix, which relates bank loans to other credits, are therefore constructed.[34] In case of only a money channel one would expect the mix not to be altered by a change in the

[34]Since the purpose of this paper is not to analyse the exact feature of all these other sources of financing it will therefore not be analysed how they move in relation to loans or bonds. Instead the analysis focuses on how bank loans move in relation other finance sources seen as a group in response to a change in the stance of monetary policy, where the group is successively extended.

stance of monetary policy. If on the other hand the mix falls when the central bank raises the short term interest rate, it could indicate that the supply of loans has decreased and that there is a separate bank lending channel.[35]

The first mix that was constructed is the same as in Kashyap, Stein and Wilcox (1993). It is defined as

$$MIX_{KSW} = \frac{l}{l+b}, \qquad (44.)$$

where $b$ is bonds and certificates. The other, broader measures of the mix are

$$MIX_{O} = \frac{l}{l+b+o}, \qquad (45.)$$

where $o$ is defined as other loans,

$$MIX_{TC} = \frac{l}{l+b+o+tc}, \qquad (46.)$$

where $tc$ stands for trade credits (from abroad, see above), and

$$MIX_{CC} = \frac{l}{l+b+o+tc+cc}, \qquad (47.)$$

where $cc$ stands for inter-group company claims (from abroad, see above). In figure 5 and 6 the development of the different measures of the mix are shown.[36]

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[35]This of course rests on the assumption that the demand for loans and the demand for other sources of financing move similarly.

[36]Since stock statistics of financial assets and liabilities do not exist on a quarterly basis in the Financial accounts it was necessary to construct data. Data were calculated using the stock statistic for 1985 and then adding the transaction values that are available on a quarterly basis in the quarterly Financial accounts. What is not included compared to the usual annual stock statistic are revaluation's resulting from for example changes in the exchange rate. Further the quarterly data for non financial companies is for foreign liabilities based on something called the "FUTS", which in English is "companies' foreign assets and liabilities". Data from this investigation covers all companies that have foreign assets or liabilities of more than 86 million Swedish kronor. Companies that have assets and liabilities of 40 000 Swedish kronor up to 86 million Swedish kronor have been chosen from a probability sample and then enumerated to be on the proper level.

Figure 3. The development of the different measures of the mix.

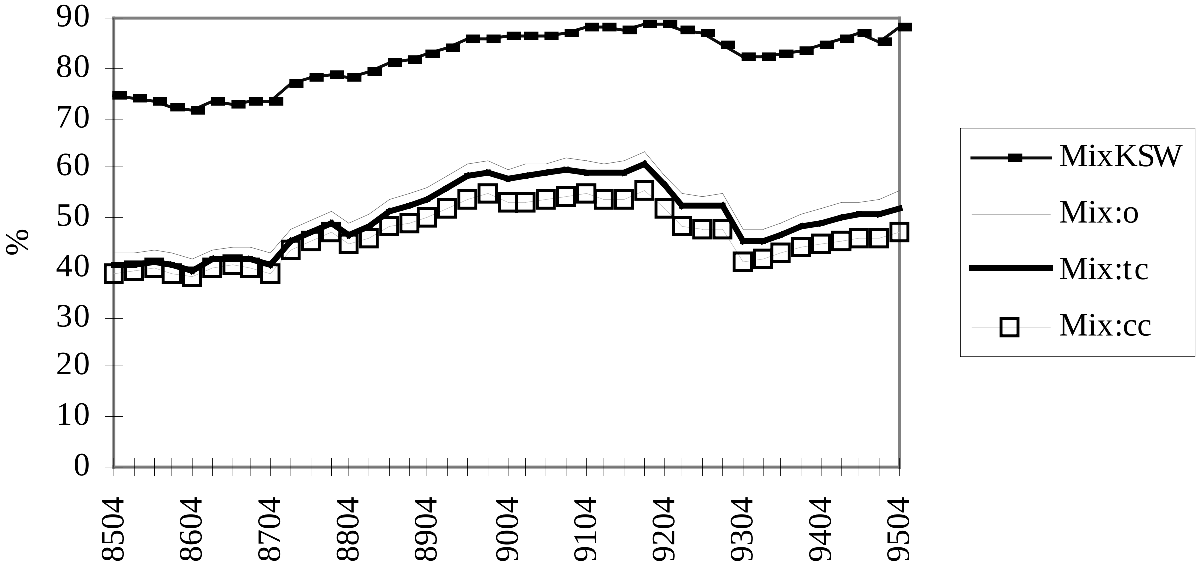
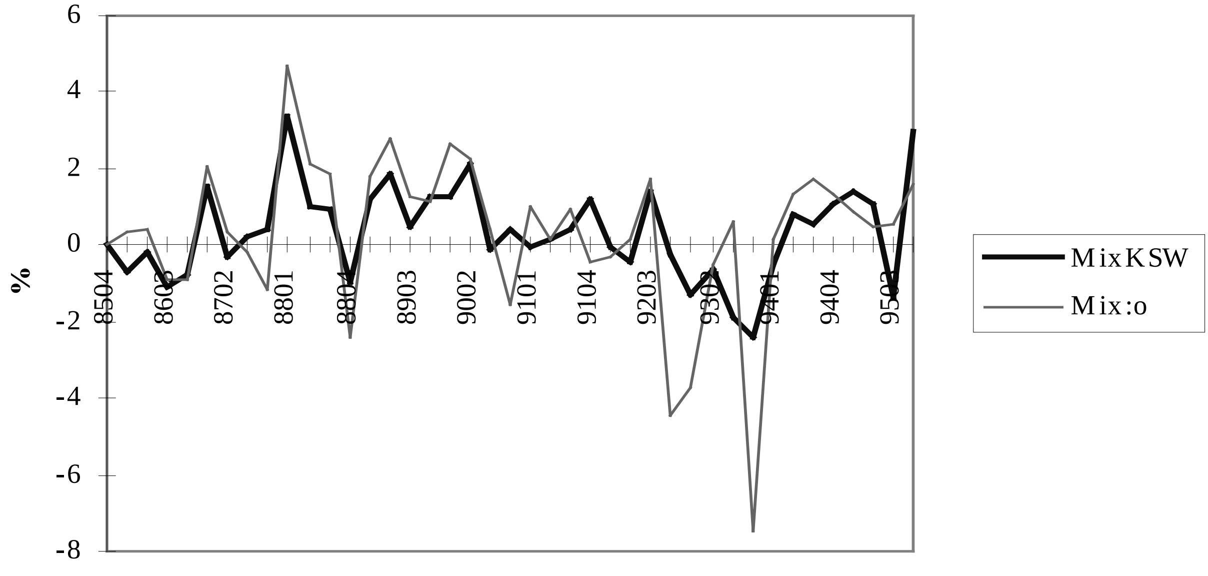



Figure 4. Quarterly changes.




As can be seen $MIX_O$, $MIX_{TC}$ and $MIX_{CC}$ are at about the same level and they move very similar. The KSW-mix on the other hand is moving slightly differently to the others. Because of the similarity between the different series only the $MIX_O$ is used in the regressions that follow.[37]

A test for the existence of a bank lending channel in Sweden was hence conducted by estimating the following systems using Full-Information Maximum Likelihood (FIML):[38]

(48.)
$$y_t = c + \sum_{j=1}^{3} \alpha_j y_{t-j} + \beta_\delta \delta_{t-1} + \beta_r r_{t-1} + \beta_{y^*,t-1} y^*_{t-1} + \beta_{y^*,t-2} y^*_{t-2} + \varepsilon_t^{y,\delta}$$
$$\delta_t = c + \sum_{j=1}^{3} \alpha_j \delta_{t-j} + \sum_{j=0}^{3} \phi_{i,t-j} i_{t-j} + \phi_y y_{t-1} + \varepsilon_t^{\delta}$$

(49.)
$$y_t = c + \sum_{j=1}^{2} \alpha_j y_{t-j} + \sum_{j=1}^{3} \beta_{\Delta MIX,t-j} \Delta MIX_{O,t-j} + \beta_r r_{t-1} + \beta_{y^*} y^*_{t-1} + \beta_{e,t-1} e_{t-1} + \beta_{e,t-2} e_{t-2} + \varepsilon_t^{y,\Delta MIX}$$
$$\Delta MIX_{O,t} = c + \sum_{j=1}^{4} \alpha_j \Delta MIX_{O,t-j} + \sum_{j=1}^{8} \phi_{\Delta i,t-j} \Delta i_{t-j} + \beta_y y_{t-1} + \varepsilon_t^{\Delta MIX}$$

where $y_t$ is the output gap, $y_t^*$ is the foreign output gap[39], $r$ is the short term real interest rate measured as the overnight interest rate less the current inflation rate, $e$ is the real exchange rate, $\delta$ is the spread defined as $\delta = \rho - i*$, $\rho$ is the bank interest rate (the end of quarter figures for banks average lending rate to non-financial enterprises)[40],

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[37]Initially the different measures of the mix were regressed in a single equation set up, as in Kashyap, Stein and Wilcox (1993) and Oliner and Rudebusch (1993), using only the interest rate as regressor. The results were very similar for $MIX$ , $MIX$ and $MIX$ and in large the same also for the KSW-mix. When estimating the system therefore only one of the measures was used, the $MIX$ . Further it can be noted that the results of the system regression are in line with the results from the single equation estimation.

[38]Before estimating the regression models, the series were analysed in terms of a unit root test, the Augmented Dicky-Fuller test. On a 5% significance level the hypotheses that the output gap, the real interest rate and the spread contain unit roots were rejected. On a 1% significance level the hypotheses that the nominal interest rate and the foreign output gap contained unit roots were rejected. On a 10% significance level the hypothesis that the mix contained a unit root was not rejected. The first differences of the mix-variable are therefore used instead of the level. These results should of course not be taken too seriously since the values of the mix only can be in the interval 0 to 100. Finally, it turned out that the real exchange rate was not stationary during the sample period, but despite this it was included in the regressions in levels.

[39]The Swedish output gap is measured by a HP-filter setting $\lambda = 1600$. The regression was also run using $\lambda = 50000$. The effects that the bank lending proxy and the monetary policy proxy had on output were not affected very much by this. The foreign output gap is measured by a HP-filter setting $\lambda = 1600$.

[40]Data on the bank interest rate is from Sveriges Riksbank, Statistical Yearbook, 1987, 1988, 1989, 1990, 1991, tables 60 and 61 "Bank interest rates for sector wise lending", the business sector, and from the report "Average lending and deposit rates of banks and housing intermediates", December 1996.

$i^*$ is the interest rate on six-month treasury bills[41] (the last week average figure of the quarter) and $i$ is the over night interest rate (quarterly average).

The lag distributions were chosen using the Schwarz criterion, the Akaike criterion and the result from the F-tests that indicates the progress of the system reduction. Besides using these criteria the behaviour of the residuals was also taken into account.

Output is hence regressed on its own lags, one of the proxies for the bank lending channel, the spread or the mix, a proxy for the money channel, the over night interest rate, and some other exogenous variables. The different proxies of the bank lending channel are simultaneously regressed on the instrument of monetary policy and output. The regression results are summarised in the tables below.

Table 2. Regression results when the spread is used as a proxy for the bank lending channel.

| | Spread | | Output |
|---|---|---|---|
| $\alpha_1$ | 0,86 (4,85)* | $\alpha_1$ | 0,25 (1,86)** |
| $\alpha_2$ | -0,03 (-0,15) | $\alpha_2$ | 0,29 (2,00)** |
| $\alpha_3$ | -0,37 (-2,58)* | $\alpha_3$ | 0,11 (0,97) |
| $\phi_{i,t}$ | 0,07 (2,28)* | $\beta_\delta$ | -0,82 (-4,91)* |
| $\phi_{i,t-1}$ | 0,10 (3,28)* | $\beta_r$ | -0,10 (-3,81)* |
| $\phi_{i,t-2}$ | -0,18 (-4,55)* | $\beta_{y^*,t-1}$ | 0,45 (2,21)* |
| $\phi_{i,t-3}$ | 0,07 (2,16)* | $\beta_{y^*,t-2}$ | -0,61 (-3,01)* |
| $\phi_y$ | -0,16 (-1,87)* | | |
| LM-test, AR, F-st[42] | 1,01 [0,42] | | 1,79 [0,17] |
| Vector LM-test, AR, F-st | 1,26 [0,27] | | |
| LM-test, ARCH, F-st[43] | 0,99 [0,44] | | 0,49 [0,75] |
| Normality $\chi^2$ | 3,70 [0,16] | | 1,81 [0,40] |
| Vector Normality $\chi^2$ | 5,88 [0,21] | | |

Figures within the parentheses are t-statistics, figures within brackets are p-values.
* Significantly different from zero at the 5 percent level.
** Significantly different from zero at the 10 percent level.

[41] The maturity on bank loans is less than one year, this is restricted by law. Since the actual maturity on loans is not known, it is here assumed that it on average is around half a year. The six month treasury bill is therefore used when calculating the spread instead of the over night interest rate, to match the assumed maturity of bank loans better. An average of the last week's treasury bill interest rate is used instead of the end of quarter observation. This is to smooth the interest rate slightly and thereby avoiding catching daily changes not connected to the stance of monetary policy. The quarterly average of the over night interest rate is used to get a measure of the stance of monetary policy for the whole quarter. The tests were also rerun with the quarterly average of the repo rate and the average of the last weeks repo rate in the quarter, and the results remain about the same.

[42]The figures reported are for the test that the disturbances in the single equation follow an AR(4) process. Other processes and lags were also tested and unless anything else is reported the tests showed no sign of autocorrelation. The same is true for the test of the disturbances of the system.

[43] This is an LM test for autocorrelated squared residuals. The figures reported are for three lags.

Table 3. Regression results when the mix is used as a proxy for the bank lending channel.

| *MIX* | | | Output |
|---|---|---|---|
| $\alpha_1$ | 0,08 (0,478) | $\alpha_1$ | 0,17 (1,09) |
| $\alpha_2$ | -0,09 (-0,53) | $\alpha_2$ | 0,06 (0,43) |
| $\alpha_3$ | -0,32 (-2,02)** | | |
| $\alpha_4$ | 0,50 (2,85)* | | |
| $\phi_{\Delta\ ,\ -1}$ | -0,23 (-3,21)* | $\beta_{\Delta MIX,t-1}$ | 0,05 (0,74) |
| $\phi_{\Delta i,t-2}$ | -0,21 (-2,35)* | $\beta_{\Delta MIX,t-2}$ | 0,04 (0,53) |
| $\phi_{\Delta i,t-3}$ | -0,11 (-1,13) | $\beta_{\Delta MIX,t-3}$ | 0,21 (3,15)* |
| $\phi_{\Delta i,t-4}$ | -0,18 (-1,86)** | $\beta_r$ | -0,11 (-3,85)* |
| $\phi_{\Delta i,t-5}$ | -0,48 (-5,82)* | $\beta_{y^*,t-1}$ | 0,61 (3,31)* |
| $\phi_{\Delta i,t-6}$ | -0,23 (-2,70)* | $\beta_{e,t-1}$ | -0,12 (-2,68)* |
| $\phi_{\Delta i,t-7}$ | -0,14 (-1,79)** | $\beta_{e,t-2}$ | 0,16 (3,60)* |
| $\phi_{\Delta i,t-8}$ | -0,28 (-3,71)* | | |
| $\phi$ | 0,64 (2,46)* | | |
| LM-test, AR, F-st[44] | 1,15 [0,37] | | 2,50 [0,09] |
| Vector LM-test, AR, F-st[45] | 0,67 [0,80] | | |
| LM-test, ARCH, F-st[46] | 0,07 [0,99] | | 0,22 [0,92] |
| Normality $\chi^2$ | 4,61 [0,10] | | 0,54 [0,76] |
| Vector Normality $\chi^2$ | 4,68 [0,32] | | |

Figures within the parentheses are t-statistics, figures within brackets are p-values.
*Significantly different from zero at the 5 percent level.
** Significantly different from zero at the 10 percent level.

As can be seen above both the spread and the $MIX$ have a significant impact on output. The signs are also as predicted, output falls when the spread increases and when the mix variable decreases. This is in line with what follows from the bank lending theory. Further, the interest rate has a significant impact on the spread, as the bank lending theory states. The p-value for the test of whether the total effect of the interest rate on the spread is zero[47] is 0.03, the effect is then highly significant. It also follows that a monetary contraction widens the spread between the bank interest rate and the

[44]The figures reported are for the test that the disturbances in the single equation follow an AR(4) process. Other processes and lags were also tested and unless anything else is reported the tests showed no sign of autocorrelation.
[45]The figures reported are for the test that the disturbances of the system follow an AR(4) process. Other processes and lags were also tested and unless anything else is reported the tests showed no sign of autocorrelation.
[46] This is an LM test for autocorrelated squared residuals. The figures reported are for three lags.
[47]The restriction tested is; $\beta_1 + \beta_2 + \beta_3 + \beta_4 = 0$.

bond rate, indicating that the effect of monetary policy is amplified. Also the result for the mix is in line with the theory. There is a significant fall in the mix after a monetary contraction. The t-statistics for the individual beta estimates indicate further that the mix is affected by monetary policy two years back and up to the last quarter.

Further, the output gap is only marginally significant in the spread equation, and as noted above its significance is sensitive to how the equation is specified. The output gap, on the other hand, is highly significant in the mix-equation. The impact of the output gap on the spread is negative while it is positive on the mix. This implies that no counteracting effect on the spread through income appears.

Finally the different diagnostic tests reveal no evidence of poor specification. The LM-tests, testing for the existence of autocorrelation, show no evidence of serial correlation. Further there are no signs of non-normality of the residuals.

It should also be noted that the results considering the effect of the bank lending proxies and the effects of the real interest rate on output were not sensitive to the choice of lag length. Other specifications using other lag lengths of the independent variables gave similar results. The same was true for a specification with the real exchange rate in the output equation with the spread.[48] Further, using the level or the first difference of the interest rate as regressor in the mix-equation did not affect the overall results, the only difference was the choice of lag length.[49] The significance of the income level in the spread equation and its impact was on the other hand was very sensitive to the choice of lag length.

As mentioned above the results when using the spread between the bank interest rate and the bond interest rate does not make it possible to distinguish between the two different credit channels. These results only show that the ordinary monetary channel is an insufficient description of the transmission mechanism of monetary policy. From the regressions using the mix-variable on the other hand it follows that bank loans behave differently from other sources of financing, bank loans seem to fall more than other credits after a monetary contraction. These results are then in favour of the existence of a bank lending channel in Sweden. Further the results using the spread indicate that the credit channel works in line with the ordinary money channel and hence enhances the effect of monetary policy.

[48] The reason for not including the real exchange rate is that it turned out not to be significant.

[49]In the single equation set up the spread equation was, as a comparison, also regressed using the first differences instead of the levels. This did not affect the results. When estimating the single equations the real over night interest rate, defined as the over night interest rate less the current inflation rate was also used as a regressor instead of the nominal interest rate. This did not affect the results either.

## 5. Conclusions

The theoretical conclusions were that for there to exist a bank lending channel borrowers and banks must find loans and bonds as imperfect substitutes and prices have to be temporarily sticky. It then follows that in case of a monetary tightening borrowers with asymmetric information problems can not costlessly offset a decline in bank loans simply by issuing bonds at the private bond market, if that is at all possible. The same is true for the banks, they can not costlessly adjust their balance sheets to insulate their lending after a monetary tightening. By changing the amount of deposits in the economy and thereby the availability of loanable funds in the bank sector the central bank influences aggregate demand in the economy through a credit channel, assuming prices are temporarily sticky and monetary policy therefore is not neutral.

Without making any further assumptions the effect of monetary policy on income in case of a bank lending channel is ambiguous and it is unclear whether monetary policy has a larger or smaller impact on income compared with a situation where there is only a money channel. If it is assumed that the demand for loans and bonds have the same functional form the analysis can be simplified and the bank lending channel can be defined as including both the ordinary money channel and a separate channel through the effect on the spread.

Further it follows that monetary policy has a larger impact on output in case of a bank lending channel if the interest and income elasticities of the loan demand is lower than the elasticities of money, that is the shift in the supply of loans due to the change in reserves is larger than the shift in the demand for loans due to the change in the demand for money. The spread is then negatively related to reserves. A rise in reserves lowers the loan rate more than the bond interest rate, a fall raises the bank interest rate more than the bond interest rate. The bank lending channel then works in line with the ordinary money channel and the effect of monetary policy on aggregate income is enhanced.

In the empirical section it was initially concluded that only a few companies have access to the bond market. According to the theoretical analysis in this paper this could imply that monetary policy has a larger effect than suggested by the ordinary IS-LM-model. In practice however companies use other substitutes to bank loans besides bonds. When testing for a bank lending channel in Sweden these other sources of financing therefore also have to be included in the analysis. In this paper it is therefore analysed how bank loans move in relation to bonds and also other sources of financing after a change in the stance of monetary policy. The result is that the mix between bank loans and bonds and other sources of financing ($MIX$) are significantly altered by a change in monetary policy as predicted by the bank lending channel. Banks then seem to find bank loans and bonds as imperfect substitutes.

It is simultaneously tested if the mix ($MIX$) has any real impacts on the economy. This would indicate that also borrowers find loans and other sources of finance as imperfect substitutes, i.e. they can not fully offset a decline in bank loans by increasing other forms of loans. The result is that the mix significantly affects output. A bank lending channel hence seems to exist in Sweden and it works in the same direction as the ordinary money channel.

Tests of whether the spread between the loan rate and the bond rate move in response to a change in the stance of monetary policy are also conducted. The result is that the spread is significantly altered after a monetary contraction. Further the result is that the spread increases when the interest rate rises, which indicates that the effect of monetary policy is enhanced. No counteracting effect trough aggregate demand appears in this case. It is simultaneously tested whether the spread has any real effects. It turns out that the spread has a significant negative impact on output. The results are hence in line with what is predicted by the bank lending channel. But a problem with the results for the spread is that they are also consistent with the broader view of the credit channel. The results for the spread can then only be used as an indication of the existence of a credit channel, it can not sort out which credit channel that is at work.

**APPENDIX**

## A. The effect of monetary policy

### Imperfect substitutes

Equilibrium conditions;

(50.) $D(i,y) = \mu r$
(51.) $y = Y(i, \Delta(i, y, r))$.

Write these as implicite functions.

(52.) $D(i,y) - \mu r = 0$
(53.) $y - Y(i, \Delta(i, y, r)) = 0$

The Jacobian is;

(54.) $$|J| = \begin{vmatrix} \partial F^1 / \partial i & \partial F^1 / \partial y \\ \partial F^2 / \partial i & \partial F^2 / \partial y \end{vmatrix} = \begin{vmatrix} D_i & D_y \\ -Y_i - Y_\delta \Delta_i & 1 - Y_\delta \Delta_y \end{vmatrix} = D_i \left[1 - Y_\delta \Delta_y\right] + D_y \left[Y_i + Y_\delta \Delta_i\right] \gtrless 0$$

This system satisfies the conditions of the implicit-function theorem if
1) the functions have continuous derivatives, which is true since all component functions have continuous derivatives by assumption and
2) the Jacobian is non zero. This is not necessary the case here, it is therefore necessary to assume that $D_i\left[1 - Y_\delta \Delta_y\right] + D_y Y_i \neq D_y Y_\delta \Delta_i$.

It is then possible to write the implicit functions;
(55.) $i^* = i^*(r)$
(56.) $y^* = y^*(r)$

and also write;

(57.) $D(i^*, y^*) - \mu r = 0$
(58.) $y^* - Y(i^*, \Delta(i^*, y^*, r)) = 0$.

Then take the partial derivative with respect to $r$.

(59.) $$D_i \frac{\partial i^*}{\partial r} + D_y \frac{\partial y^*}{\partial r} - \mu = 0$$

(60.) $$(1-Y_\delta\Delta_y)\frac{\partial y^*}{\partial r}-(Y_i+Y_\delta\Delta_i)\frac{\partial i^*}{\partial r}-Y_\delta\Delta_r=0.$$

This gives the matrix equation;

(61.) $$\begin{bmatrix} D_i & D_y \\ -Y_i-Y_\delta\Delta_i & 1-Y_\delta\Delta_y \end{bmatrix}\begin{bmatrix} \dfrac{\partial i^*}{\partial r} \\ \dfrac{\partial y^*}{\partial r} \end{bmatrix}=\begin{bmatrix} \mu \\ Y_\delta\Delta_r \end{bmatrix}.$$

The solution is, by Cramer´s rule;

(62.) $$\frac{\partial i^*}{\partial r}=\frac{\begin{vmatrix} \mu & D_y \\ Y_\delta\Delta_r & 1-Y_\delta\Delta_y \end{vmatrix}}{|J|}=\frac{\mu\left[1-Y_\delta\Delta_y\right]-D_yY_\delta\Delta_r}{|J|}\lessgtr 0$$

(63.) $$\frac{\partial y^*}{\partial r}=\frac{\begin{vmatrix} D_i & \mu \\ -Y_i-Y_\delta\Delta_i & Y_\delta\Delta_r \end{vmatrix}}{|J|}=\frac{D_iY_\delta\Delta_r+\mu\left[Y_i+Y_\delta\Delta_i\right]}{|J|}=$$

$$=\frac{\dfrac{\mu}{D_y}\dfrac{\left[Y_i+Y_\delta\Delta_i\right]}{\left[1-Y_\delta\Delta_y\right]}+\dfrac{D_i}{D_y}\dfrac{Y_\delta\Delta_r}{\left[1-Y_\delta\Delta_y\right]}}{\dfrac{\left[Y_i+Y_\delta\Delta_i\right]}{\left[1-Y_\delta\Delta_y\right]}+\dfrac{D_i}{D_y}}=$$

$$=\frac{\underset{+}{\begin{bmatrix}\text{shift in}\\ \text{LM}\end{bmatrix}}\underset{\pm}{\begin{bmatrix}\text{slope of}\\ \text{CC}\end{bmatrix}}-\underset{+}{\begin{bmatrix}\text{slope of}\\ \text{LM}\end{bmatrix}}\underset{+}{\begin{bmatrix}\text{shift in}\\ \text{CC}\end{bmatrix}}}{\underset{\pm}{\begin{bmatrix}\text{slope of}\\ \text{CC}\end{bmatrix}}-\underset{+}{\begin{bmatrix}\text{slope}\\ \text{of LM}\end{bmatrix}}}\lessgtr 0$$

Slope of the CC-curve

(64.) $$\left.\frac{dy}{di}\right|_{CC}=\frac{Y_i}{\underset{-}{\left[1-Y_\delta\Delta_y\right]}}+\frac{Y_\delta\Delta_i}{\underset{+}{\left[1-Y_\delta\Delta_y\right]}}.$$

Shift in the CC-curve

(65.) $$\left.\frac{dy}{dr}\right|_{CC}=\frac{Y_\delta\Delta_r}{\left[1-Y_\delta\Delta_y\right]}.$$

Slope of the LM-curve

(66.) $\frac{dy}{di} = \frac{-D_i}{D_y}$.

Shift in the LM-curve

(67.) $\left.\frac{dy}{dr}\right|_{LM} = \frac{\mu}{D_y}$.

Slope of IS-curve

(68.) $\left.\frac{dy}{di}\right|_{IS} = Y_i$.

**Perfect substitutes**

If banks consider bonds and bank loans as perfect substitutes then $\lambda_\delta \to \infty$. If borrowers think that they are perfect substitutes then $L_\delta \to -\infty$ . The spread is then zero and independent of the bond interest rate, the income level and reserves. The partial derivatives of the spread go towards zero.

The Jacobian is then;

(69.) $|J| = \begin{vmatrix} \partial F^1 / \partial i & \partial F^1 / \partial y \\ \partial F^2 / \partial i & \partial F^2 / \partial y \end{vmatrix} = \begin{vmatrix} D_i & D_y \\ -\overline{Y}_i & 1 \end{vmatrix} = D_i + D_y \overline{Y}_i < 0$

given the equilibrium conditions;

(70.) $D(i, y) = \mu r$
(71.) $y = \overline{Y}(i)$.

The partial derivatives are now;

(72.) $\frac{\partial i^*}{\partial r} = \frac{\mu}{|J|} < 0$

(73.) $\dfrac{\partial y^*}{\partial r} = \dfrac{\mu \overline{Y}_i}{|J|} = \dfrac{\mu \overline{Y}_i}{D_y \overline{Y}_i + D_i} = \dfrac{\dfrac{\mu}{D_y}\overline{Y}_i}{\overline{Y}_i + \dfrac{D_i}{D_y}} = \dfrac{\underset{+}{\begin{bmatrix}\text{shift in}\\ \text{LM}\end{bmatrix}}\underset{-}{\begin{bmatrix}\text{slope of}\\ \text{IS}\end{bmatrix}}}{\underset{-}{\begin{bmatrix}\text{slope of}\\ \text{IS}\end{bmatrix}} - \underset{+}{\begin{bmatrix}\text{slope of}\\ \text{LM}\end{bmatrix}}} > 0$

**B. Comparison of the two models**

**The income level**

We have that

(74.) $\dfrac{Y_i \mu + Y_\delta \left[\Delta_r D_i + \Delta_i \mu\right]}{D_i\left[1 - Y_\delta \Delta_y\right] + D_y\left[Y_i + Y_\delta \Delta_i\right]} > \dfrac{\mu \overline{Y}_i}{D_i + D_y \overline{Y}_i}.$

Rewrite the first part

(75.)
$$\frac{Y_i \mu + Y_\delta\left[\Delta_r D_i + \Delta_i \mu\right]}{D_i - D_i Y_\delta \Delta_y + D_y Y_i + D_y Y_\delta \Delta_i} = \frac{Y_i \mu + Y_\delta\left[\Delta_r D_i + \Delta_i \mu\right]}{D_i + D_y Y_i - \dfrac{Y_\delta}{\left[L_\delta - \lambda_\delta \mu r(1-\tau)\right]}\left[D_y L_i - D_i L_y\right]} > \frac{\mu \overline{Y}_i}{D_i + D_y \overline{Y}_i}.$$

Use that

(76.) $D_y L_i^d = D_i L_y^d.$

it then follows that

(77.) $\dfrac{Y_i \mu}{D_i + D_y Y_i} + \dfrac{Y_\delta\left[\Delta_r D_i + \Delta_i \mu\right]}{D_i + D_y Y_i} \lessgtr \dfrac{\overline{Y}_i \mu}{D_i + D_y \overline{Y}_i}.$

Assuming that $\overline{Y}_i = Y_i$ the expression can be rewritten as

(78.) $\Delta_r D_i + \Delta_i \mu \lessgtr 0.$

This expression can be simplified further. First substitute for $\Delta_r, \Delta_i$

(79.) $\lambda(\delta)\mu(1-\tau) D_i - L_i^d \mu \lessgtr 0.$

Use that $l^d = l^s = \lambda(\delta)\mu r(1-\tau)$. It then turns out that the condition for the expression to be positive is that

(80.) $\frac{D_i}{\mu r} - \frac{L_i^d}{L^d} > 0.$

Substituting for $\frac{L_i^d}{l^d}$, using equation (31.) the condition can also be written as

(81.) $1 > \left[\frac{\mu r}{l^d + b^p}\right].$

Following MRW

(82.) $\frac{D_i Y_\delta \Delta_r + \mu Y_\delta \Delta_i}{D_i + D_y Y_i} > 0.$

Substitute for $\Delta_r$ and $\Delta_i$;

(83.) $\frac{Y_\delta}{D_i + D_y Y_i}\left[\frac{D_i \lambda(\delta)\mu(1-\tau) - \mu L_i^d}{\left[L_\delta^d - \lambda_\delta \mu r(1-\tau)\right]}\right] > 0$

Multiply with $r/r$;

(84.) $\frac{Y_\delta / r}{D_i + D_y Y_i}\left[\frac{D_i \lambda(\delta)\mu r(1-\tau) - \mu r L_i^d}{\left[L_\delta^d - \lambda_\delta \mu r(1-\tau)\right]}\right] > 0.$

Use that $l^d = l^s = \lambda(\delta)\mu r(1-\tau)$ and divide by $l^d$;

(85.) $\frac{Y_\delta / r}{D_i + D_y Y_i}\left[\frac{D_i - \mu r \frac{L_i}{l^d}}{\left[\frac{l_\delta^d}{l^d} - \frac{\lambda_\delta}{\lambda}\right]}\right] > 0.$

Replace $L_i^d / l^d$ according to equation (31.) in the text;

$$(86.)\quad \frac{Y_\delta / r}{D_i + D_y Y_i}\left[\frac{D_i - \mu r \dfrac{D_i}{\mu r}\left[\dfrac{\mu r}{l^d + b^p}\right]}{\left[\dfrac{L_\delta^d}{l^d} - \dfrac{\lambda_\delta}{\lambda}\right]}\right] = \frac{D_i Y_\delta / r}{D_i + D_y Y_i}\left[\frac{1 - \left[\dfrac{\mu r}{l^d + b^p}\right]}{\left[\dfrac{L_\delta^d}{l^d} - \dfrac{\lambda_\delta}{\lambda}\right]}\right] =$$

$$\frac{D_i Y_\delta}{r\left[D_i + D_y Y\right]_i \left[\dfrac{L_\delta^d}{l^d} - \dfrac{\lambda_\delta}{\lambda}\right]}\left[\frac{l^d + b^p - \mu r}{l^d + b^p}\right] > 0\,.$$

A condition for the credit channel to be more effective than the money channel is then that ;

$$(87.)\quad l^s + b^p - \mu r > 0.$$

**The bond interest rate**

Doing the same exercise with the partial derivative of the bond interest rate the result is that the effect on the bond interest rate is smaller under the assumption of imperfect substitutes.

$$(88.)\quad \frac{\mu\left[1 - Y_\delta \Delta_y\right] - D_y Y_\delta \Delta}{D_i + D_y Y_i} \lessgtr \frac{\mu}{D_i + D_y \overline{Y_i}} < 0.$$

The difference is hence;

$$\frac{Y_\delta\left[-\mu\Delta_y - D_y \Delta_r\right]}{D_i + D_y Y_i}$$

which is positive, using the simplifying assumptions

$$(89.)\quad -\mu\Delta_y - D_y\Delta_r = -\mu L_y + D_y \frac{l}{r} = -\frac{L_y}{l} + \frac{D_y}{\mu r} = 1 - \frac{\mu r}{l + b} \lessgtr 0\,.$$

It is hence unclear whether the derivative of the interest rate with respect to reserves is negative. The derivative is

(90.) $$\frac{\partial i^*}{\partial r} = \frac{\mu + Y_\delta\left[-\Delta_y \mu - \Delta_r D_y\right]}{D_i + D_y Y_i} = \frac{\mu + \frac{Y_\delta}{\left[L_\delta^d - \lambda_\delta \mu r(1-\tau)\right]}\left[L_y^d \mu - \lambda(\delta)\mu(1-\tau)D_y\right]}{D_i + D_y Y_i} \lesseqgtr 0.$$

For a negative effect it is necessary that

(91.) $$\frac{\mu + \frac{Y_\delta}{\left[L_\delta^d - \lambda_\delta \mu r(1-\tau)\right]}\left[L_y^d \mu - \lambda(\delta)\mu(1-\tau)D_y\right]}{D_i + D_y Y_i} < 0$$

or

(92.) $$\frac{\mu + \frac{Y_\delta \mu l^d}{\left[L_\delta^d - \lambda_\delta \mu r(1-\tau)\right]}\left[\frac{L_y^d}{l^d} - \frac{D_y}{\mu r}\right]}{D_i + D_y Y_i} < 0$$

$$\frac{\mu + \frac{Y_\delta \mu l^d}{\left[L_\delta - \lambda_\delta \mu r(1-\tau)\right]}\left[\frac{D_y}{\mu r}\left[\frac{\mu r}{l^d + b^p}\right] - \frac{D_y}{\mu r}\right]}{D_i + D_y Y} < 0$$

$$\frac{\mu - \frac{Y_\delta \mu l^d D_y}{\left[L_\delta^d - \lambda_\delta \mu r(1-\tau)\right]\mu r}\left[\frac{l^d + b^p - \mu r}{l^d + b^p}\right]}{D_i + D_y Y_i} < 0$$

$$\frac{\mu\left[1 - \frac{Y_\delta l^d D_y}{\left[L_\delta^d - \lambda_\delta \mu r(1-\tau)\right]\mu r}\left[\frac{l^d + b^p - \mu r}{l^d + b^p}\right]\right]}{D_i + D_y Y_i} < 0$$

for this to hold its necessary that

(93.) $$1 - \frac{Y_\delta l^d D_y}{\left[L_\delta^d - \lambda_\delta \mu r(1-\tau)\right]\mu r}\left[\frac{l^d + b^p - \mu r}{l^d + b^p}\right] > 0$$

as is seen it is not sure that the effect on the interest rate is negative.

**C. A system of three equations**

Use the equilibrium conditions

(94.) $D(i, y) = \mu r$

(95.) $L^d(\underset{-}{\delta}, \underset{-}{i}, \underset{+}{y}) = \lambda(\underset{+}{\delta})d(1-\tau)$

(96.) $y = Y^d(\underset{-}{\delta}, \underset{-}{i})$.

Replace $d$ by $\mu r$. Solve the system. The Jacobian is;

(97.) $|J| = \left[L^d_\delta - \lambda_\delta \mu r(1-\tau)\right]D_i - L^d_i D_y Y_\delta + \left[L^d_\delta - \lambda_\delta \mu r(1-\tau)\right]D_y Y_i + D_i L^d_y Y_\delta \lesseqgtr 0$

or

$$\left[L^d_\delta - \lambda_\delta \mu r(1-\tau)\right]\left[D_i + D_y Y_i\right] + Y_\delta\left[D_i L^d_y - L^d_i D_y\right] \lesseqgtr 0.$$

The solution for the income level and the bond interest rate is the same as above, that is;

(98.) $$\frac{\partial y^*}{\partial r} = \frac{Y_i \mu\left[L^d_\delta - \lambda_\delta \mu r(1-\tau)\right] + Y_\delta\left[D_i \lambda(\delta)\mu(1-\tau) - L^d_i \mu\right]}{|J|} \lesseqgtr 0$$

(99.) $$\frac{\partial i^*}{\partial r} = \frac{\left[L^d_\delta - \lambda_\delta \mu r(1-\tau)\right]\mu - Y_\delta D_y \lambda(\delta)\mu(1-\tau) + Y_\delta L^d_y \mu}{|J|} \lesseqgtr 0.$$

The solution for the income level can be rewritten as:

(100.) $$\frac{\partial y^*}{\partial r} = \frac{Y_i \mu\left[L^d_\delta - \lambda_\delta \mu r(1-\tau)\right] + Y_\delta D_i \lambda(\delta)\mu(1-\tau) - Y_\delta L^d_i \mu}{|J|} + \quad \text{/add some terms/}$$

$$\frac{Y_i Y_\delta \lambda(\delta)\mu(1-\tau)D_y - Y_i Y_\delta \lambda(\delta)\mu(1-\tau)D_y + Y_i Y_\delta L^d_y \mu - Y_i Y_\delta L^d_y \mu}{|J|} =$$

$$\frac{Y_i \mu\left[L^d_\delta - \lambda_\delta \mu r(1-\tau)\right] - Y_i Y_\delta \lambda(\delta)\mu(1-\tau)D_y + Y_i Y_\delta L^d_y \mu}{|J|} +$$

$$\frac{Y_\delta \lambda(\delta)\mu(1-\tau)D_i + Y_\delta \lambda(\delta)\mu(1-\tau)Y_i D_y - Y_\delta Y_i L^d_y \mu - Y_\delta L^d_i \mu}{|J|}$$

$$= Y_i \frac{\partial i}{\partial r} + Y_\delta \frac{\partial \delta}{\partial r}.$$

**The effect of monetary policy on the spread**

Given the condition that $D_y L_i^d = D_i L_y^d$ the Jacobian can be rewritten as;

(101.) $|J| = \left[L_\delta^d - \lambda_\delta \mu r(1-\tau)\right]\left[D_i + D_y Y_i\right] > 0.$

The solution for the income level and the bond interest rate is the same as above. The solution for the spread is, by Cramer´s rule;

(102.) $$\frac{\partial \delta^*}{\partial r} = \frac{\lambda\mu(1-\tau)\left[D_i + Y_i D_y\right] - \mu\left[L_y^d Y_i + L_i^d\right]}{|J|} \lessgtr 0.$$

Using the simplifying conditions in section 3.1 it can rewritten as;

(103.) $$\frac{1}{r\left[\frac{L_\delta^d}{l^d} - \frac{\lambda_\delta}{\lambda}\right]}\left[\frac{l^d + b^p - \mu r}{l^d + b^p}\right] < 0.$$

If the condition specified $l^d + b^p - \mu r > 0$ is satisfied then a rise in reserves has a negative impact on the spread.

## References


[1] Akerlof, George (1970), "The Market for Lemons: Quality Uncertainty and the Market Mechanism," *Quarterly Journal of Economica*.

[2] Bernanke, Ben S. (1983), "Nonmonetary Effects of the Financial Crisis in the Propagation of the Great Depression," *American Economic Review* 73, 257-276.

[3] Bernanke, Ben S. (1992-93), "Credit in the Macroeconomy," *Quarterly Review, Federal Reserve Bank of New York*, Spring, 50-70.

[4] Bernanke, Ben S. and Blinder, Alan S. (1988), "Credit, Money, and Aggregate Demand," *American Economic Review, Papers and Proceedings* 78, 435-39.

[5] Bernanke, Ben S. and Blinder, Alan S. (1992), "The Federal Funds Rate and the Channel of Monetary Transmission," *American Economic Review* 82, 901-921.

[6] Bernanke, Ben S. and Gertler, Mark (1989), "Agency Costs, Net Worth, and Business Fluctuations," *The American Economic Review* 79, No. 1.

[7] Blinder, Alan S. and Stiglitz, Joseph E. (1983), "Money, Credit Constraints and Economic Activity," *American Economic Review, Papers and Proceedings* 73, 297-302.

[8] Brunner, K. and Meltzer A.H. (1988), "Money and Credit in the Transmission Process," *American Economic Review Papers and Proceedings* 78, 446-51.

[9] Diamond, Douglas W. (1984), "Financial Intermediation and Delegated Monitoring," *Review of Economic Studies*, 393-414.

[10] Fisher, Irving (1933), "The Debt-Deflation Theory of Great Depressions," *Econometrica*, I, October.

[11] Friedman, Milton and Schwartz, Anna J. (1963), "A Monetary History of the United States, 1867-1960," Princeton, N.J.: Princeton University Press.

[12] Gertler, Mark (1988), "Financial Structure and Aggregate Economic Activity: An Overview," *Journal of Money Credit and Banking* 20 part 2, 559-88.

[13] Gertler, Mark (1992), "Financial Capacity and Output Fluctuations in an Economy with Multi-Period Financial Relationships," *Review of Economic Studies* 59, 455-472.

[14] Gertler, Mark and Gilchrist, Simon (1994), "Monetary policy, business cycles, and the Behaviour of Small Manufacturing Firms," *The Quarterly Journal of Economics* CIX, May.

[15] Jaffe, Dwight and Thomas, *Russell (1976), "*Imperfect Information and Credit Rationing," *Quarterly Journal of Economics* 90, 651-666.

[16] Kashyap, Anil K. and Stein, Jeremy C. (1993), "Monetary Policy and Bank Lending," NBER, Working Paper No. 4317.

[17] Kashyap, Anil K. Stein, Jeremy C. and Wilcox, David W. (1993), "Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance," *American Economic Review* 83, No. 1, 78-98.

[18] Keeton, William R. (1992), "Monetary Policy Implications of Bank Security Holdings and Large CDs," Research Working Paper, Federal Reserve Bank of Kansas City, December 1992.

[19] Miron, Jeffrey A., Romer, Christina D. and Weil, David N. (1994), "Historical Perspectives on the Monetary Transmission Mechanism," NBER Working Paper No. 4326.

[20] Modigliani, Franco and Merton, Miller (1958), "The Cost of Capital, Corporation Finance and The Theory of Investment," *American Economic Review* 48, 261-97.

[21] Oliner, Stephen and Rudebusch, Glenn (1992), "The Transmission of Monetary Policy: Evidence from the Mix of External Debt and the Importance of Internal Finance," mimeo, Federal Reserve Board.

[22] Oliner, Stephen and Rudebusch, Glenn (1993), "Is There a Bank Credit Channel for Monetary Policy?" Working paper, Federal Reserve Board, Washington, D.C.

[23] Rajan, Raghuram G. (1992), "Insiders and Outsiders: The Choice between Informed and Arm's-Length Debt," *The Journal of Finance* XLVII, No. 4, 1367-1400.

[24] Romer, Christina D. and David H. Romer (1990), "New Evidence on the Monetary Transmission Mechanism," Brookings Papers on Economic Activity: 1990:1, Washington, DC: The Brookings Institution, 149-213.

[25] Rothschild, Michael and Stiglitz, Joseph (1976), "Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information," *Quarterly Journal of Economics* 90, 630-49.

[26] Stein, Jeremy C. (1995), "An Adverse Selection Model of Bank Assets and Liability Management with Implications for the Transmission of Monetary Policy," NBER Working Paper No. 5217.

[27] Stiglitz, J.E. and Weiss, A.M. (1981), "Credit Rationing in Markets with Imperfect Information," *American Economic Review* 71.

[28] Townsend, Robert (1979), "Optimal Contracts and Competitive Markets with Costly State Verification," *Journal of Economic Theory* XXI.