How does monetary policy affect the price and production of new loans? Some evidence from french bank panel data.

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Abstract: In this paper we use French bank panel data on balance sheets and income statements over the period 1993-2000, to evaluate the impact of monetary policy on bank loans. The model estimated is based on a profit maximization program. A particular emphasis is put on the distinction between outstanding amounts and flows of new loans. We find that the impact of monetary policy on new loans is consistent with the previous evaluations obtained from macroeconomics models.

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1 Introduction

"Though many macroeconomists would profess little uncertainty about it, the profession as a whole has no clear answer to the question of the size and nature of the effects of monetary policy on aggregate activity", Sims (1992). A first step towards an answer to this double question is then to determine the impact of monetary policy on bank lending and whether the credit channel has to play a role in it or not.

Using macroeconomic data, Bernanke and Blinder (1992) present evidence consistent with the view that monetary policy works at least in part through "credit" (i.e., bank loans) as well as through "money" (i.e., bank deposits). This empirical evidence is based on a model of monetary policy transmission sketched in Bernanke and Blinder (1988). This model is an extension of the simple IS-LM model in which loans are no longer viewed as perfect substitutes for bonds. It thus allows for a separate treatment of money and credit which leaves room for a credit channel mechanism to occur. In this model, the credit channel is not seen as "a distinct, free-standing alternative to the traditional monetary transmission mechanism, but rather a set of factors that amplify and propagate conventional interest rate effects". "The credit channel is *thus* an enhancement mechanism, not a truly independent or parallel channel (Bernanke and Gertler (1995))." In their 1992 paper, Bernanke and Blinder, using a VAR model on the United-States, show that "loans seem to respond *slowly* to monetary policy innovations-which makes economic sense because loans are contractual commitments".[1] The composition of the bank assets fall is noteworthy: "For the first six months or so after the policy shock, the fall in assets is concentrated almost entirely in securities; loans hardly move. However, shortly thereafter, security holdings begin gradually to rebuild, while loans start to fall. By the time two years have elapsed, security holdings have almost returned to their original value, and essentially the entire decline in deposits is reflected in loans. This pattern is just what we should expect. Loans are quasi-contractual commitments whose stock is difficult to change quickly. Banks therefore react to reduced deposits in the short run by selling off securities. In the long run, however, portfolios are rebalanced, with the primary effect falling on loans."

A growing literature using microeconomic data on banks (e.g. Kashyap and Stein (1995, 2000) and Kishan and Opiela (2000) for the United States, Ehrmann et alii (2001) for European countries and Loupias et alii (2001) for France) emphasizes the role of the credit channel: these papers show that there are important cross-sectional differences in the way that banks with varying characteristics (size, liquidity, capitalization) respond to policy shocks[2]. They

[1] They show that the responses to a one-standard deviation (31-basis-point) shock to the funds rate over an horizon of 24 months is a 1.4% decrease in the amount of outstanding loans. Deposits decrease faster (within 9 months instead of two years), but by only 0.8%. The effect on deposits appears to last at least for 48 months. The impact on security holdings is transitory. It reaches its peaks in about nine months (a decrease by 1.4%).

[2] All these characteristics seems to be relevant for the US, whereas only liquidity seems relevant for Europe.

all consider the impact of monetary policy to be its effect on either the level of the outstanding amounts of loans or its growth rate.

Despite the intuitive microeconomic justification of the so-called credit view[3] and the use of micro data, most of the estimated models, rest on a reduced form equation often based on a macroeconomic background (for an exception, see Kishan and Opiela (2000)).[4] Baltensperger (1980) surveys alternative approaches to the theory of the banking firm and emphasizes the fact that "a satisfactory theory of bank behavior appears as an indispensable prerequisite for a clear understanding of the workings of the financial sector of the economy in general, and of the money supply mechanism in particular."

The aim of this paper is a tentative to measure the impact of monetary policy on loans granted within a micro founded theoretical framework where the bank maximizes its profit subject to the balance-sheet constraint. This microfoundation involving both loans and deposits is supposed to allow to measure the global effect of both the direct impact of monetary policy (the impact of the textbook interest rate channel) and the "enhancement mechanism" as defined by Bernanke and Gertler (1995) (the impact of the so-called credit channel).

Contrary to previous papers, we take explicitly account of the fact that, while we are interested in the impact of monetary policy on *new loans* granted by banks, what we generally observe is the outstanding amount of loans as it appears in their balance sheet. Indeed, because in response to a monetary policy shock, banks can hardly renegotiate the loans they granted in the past, they can only adjust the amount of their new loans, not the total amount of their loans engagement (e.g. see C. Lown and S. Peristiani (1996)). We tackle this problem by making explicit the dynamic relationship that exists between the outstanding amount of loans granted by banks and their new loans. The aim of this paper is thus to explain the variations in loans granted to households and non financial companies from monetary financial institutions (MFIs) for the period 1993-2000, using the above mentioned distinction between new loans and outstanding amounts. This paper, contrary to the above mentioned literature, is not involved in studying the existence or the size of the credit channel as a distinct channel. Its aim is rather to evaluate the impact of monetary policy as a whole, including the enhancement mechanism due to the credit channel.

The structure of the paper is as follows: some features about duration of loans are given in section 2. The theoretical model is presented in section 3.

[3]For a reminder of this theory, see for example Bernanke and Gertler (1995). We focus our interest on the "bank lending channel". This channel involves the possible effect of monetary policy actions on the supply of loans by depository institutions. It may only work when deposits and bonds are imperfect substitutes in the balance sheets of banks. In that case, following a reduction in liquidity, banks cannot turn freely to the bond market, due to the external finance premium. Then, they must reduce the amount of loans they supply and/or further increase the interest rate they charge for loans, thus amplifying the initial effects of the monetary policy tightening.

[4]Kashyap and Stein (1995) describe a model involving bank asset and liability management, but the estimated equation is ad hoc.

Section 4 is devoted to the presentation of the banks dataset we use. Our econometric results are presented and discussed in section 5. Section 6 concludes.

2 New loans versus outstanding stocks.

As already mentioned, the question of the impact of monetary policy on bank lending can be formulated as follows: To which extent do banks modify their supply of *new loans* after a monetary policy change? In other words, how do these monetary policy changes affect the financing of the economy?

However, the problem one faces when looking for a quantitative evaluation of this impact is that the available data do not refer to new loans but to the outstanding amount of loans. Indeed, what we observe in bank balance sheets is, broadly speaking, the cumulative sum of all loans granted by banks in the past minus what has already been paid back by bank debtors. The question then arises of the way one should proceed to get a correct measure of the monetary policy impact on new loans when these are not directly observed. As stated by Lown and Peristiani (1996): "Still, a major criticism of the reduced form loan equations that we (and others) have estimated is that the dependent variable - the stock of outstanding loans - does not measure new loans issued." Indeed, as long as the duration of loans is longer than the periodicity of the data used in the econometric analysis, substituting the outstanding stocks for new loans induces a downward bias in the estimation of the impact of monetary policy. The shorter the period, the larger the bias is likely to be. Moreover, as shown by Baumel (1997), the dynamics of new loans is quite different from both that of the level of their outstanding stock and that of its first difference. Thus, the latter does not appear to be necessarily a good solution.

Indeed, the following table, based upon the Bank of France survey about the cost of new loans, presents some figures showing that the duration of loans is much longer than a quarter.

Table 1: Average duration of credits[5] for banks[6]

date	credit to households	credit to non financial business	total
1993	9 years 6 months	1 year 4 months	2 years 3 months
1994	10 years 2 months	1 year 2 months	2 years 6 months
1995	10 years	1 year 2 months	2 years 4 months
1996	10 years	2 years	4 years 9 months
1997	10 years 5 months	1 year 9 months	2 years 11 months
1998	10 years 7 months	2 years	2 years 10 months
1999	11 years 8 months	3 years	4 years 8 months
2000	11 years 10 months	2 years 7 months	4 years 6 months

Source: Authors' computations from the survey data

Even though these figures probably exaggerate the variations of loan duration over time[7], they show that, on average, loans granted to the non financial private sector last from two to more than four years. Loans to households, which are mainly housing loans, last for about 10 years while those to non financial businesses are granted for a much shorter period, roughly between 12 and 24 months. Assuming a constant rate of reimbursement, this means that the ratio of stock to the new loans as it appears in bank quarterly balance sheet is about 40 for loans to households and between 4 and 8 for loans to businesses. Neither the outstanding amounts, nor their first differences, can be considered as a satisfactory measure of new loans.

3 The model

3.1 The theoretical model

The theoretical model is described first with a special emphasis on the demand elasticities. We then turn to the link between the loan interest rate and the policy interest rate.

3.1.1 The bank profit maximization program

Microeconomic models aimed at representing bank lending behavior generally stem from the maximization of their profit where the latter is defined using balance sheet items:

$$\Pi_{it} = \sum_l R_{it}^{l,t} \; EA_{it}^l \; - \sum_j S_{it}^{j,t} \; ED_{it}^j \; - CO_{it} \tag{1}$$

[5]To compute the average duration of the total amount of new loans, the durations of credit to households and to non financial businesses have been weighted by their respective share in the total of loans, taking account of the fact that the survey duration is not identical for these two types of loans.

[6]These figures do not include loans granted by "Etablissements spécialisés", "Sociétés financières" and "Banques spécialisées" as defined by the terminology of the survey.

[7]This is probably the consequence of sampling variations over time.

Then, EA^l_{it} represents the outstanding amount of type l asset of bank i at time t, ED^j_{it} that of liabilities of type j, $R^{l,t}_{it}$ and $S^{j,t}_{it}$ the corresponding creditor and debtor interest rates on the outstanding amount at time t and CO_{it} the operating costs.

For this definition of the profit to be correct, $R^{l,t}_{it}$ and $S^{j,t}_{it}$ have to be defined as "apparent" interest rates, i.e. respectively as the average rate of return on assets l and the cost of having a given amount of debt of type j. However, these variables do not merge with those used by banks as their decision variables. Depending on the type of asset or liability considered, the decision variable is either the instantaneous interest rate (e.g. for loans or for interest-bearing deposits) or the amount of assets/liabilities bought or sold (e.g. for bonds and shares). On the one hand, the apparent rates R^t_{it} depend both on the instantaneous rate (r_{it}) and on a mix of past ones (which we denote R^{t-1}_{it}), given that at least a part of the assets/liabilities are the result of bank past decisions. On the other hand, the outstanding amount of assets/liabilities also depends on the bank past decisions, as banks cannot necessarily sell or buy freely whatever they wish to. Then, one should take this into account when modelling bank behavior. Indeed, the dynamic relationship linking the amount of newly acquired and sold assets of type l to their outstanding amount can be written as:

$$EA^l_{it} \quad = \quad NA^l_{it} \; - \; NV^l_{it} \quad + \quad EA^l_{it-1}\,(1-\delta^l_{it}) \tag{2}$$

with :

EA^l_{it}: outstanding amount of assets l at the end of period t,
NA^l_{it}: newly acquired assets l during period t,
NV^l_{it}: assets l sold during period t,
thus ($NA^l_{it} \; - \; NV^l_{it}$): net acquisitions of asset l at time t
δ^l_{it} = "depreciation" rate of asset l for bank i during period t. For the sake of simplicity, it is assumed to be constant over time and across banks ($\delta^l_{it} = \delta^l$), which might be a quite strong assumption.

The same relationship as above applies to liabilities, except that we assume that banks cannot re-buy their own debts :

$$ED^j_{it} \quad = \quad ND^j_{it} \quad + \quad ED^j_{it-1}\,(1-\gamma^j) \tag{3}$$

In that case again, and in particular for deposits, γ^j is unknown, given that bank customers can decide to withdraw their deposits at any time.

Then, bank profit can be re-written as:

$$\begin{aligned} \Pi_{it} \quad = \quad & \sum_l r^l_{it}\,NA^l_{it} \; + \sum_l R^{l,t-1}_{it}\,[(1-\delta^l)\,EA^l_{it-1} - NV^l_{it}\,] \\ & - \sum_j s^j_{it}\,ND^j_{it} \; - \sum_j S^{j,t-1}_{it}\,(1-\gamma^j)\,ED^j_{it-1} - \; CO_{it} \end{aligned} \tag{4}$$

with r^l_{it} and s^j_{it} the instantaneous interest rates, i.e. respectively the rate of return on new assets l and the cost of having a given amount of new debt of type j. $R^{l,t-1}_{it}$ and $S^{j,t-1}_{it}$ are respectively the creditor and debtor interest rates during period t which apply to assets and debts owned during period t, *but* acquired before period t, i.e. already owned at time $t-1$.

The balance sheet constraint can then be written as:

$$\sum_l NA^l_{it} - \sum_l NV^l_{it} + \sum_l (1-\delta^l)\, EA^l_{it-1} = \sum_j ND^j_{it} + \sum_j (1-\gamma^j)\, ED^j_{it-1} \quad (5)$$

Banks' current profit clearly appears to depend not only on their current decisions but also on past ones. Indeed, commitments induced by past decisions must be fulfilled. Then, this re-writing of banks' profit allows us to make more explicit the banks' decision variables.

More precisely, we consider the following items:
A^1_{it}: cash and interbank transaction assets (with $\delta^1 = 1$, thus $NV^1_{it} = 0$),
A^2_{it}: customer loans for bank i during period t (with $NV^2_{it} = 0$),
A^3_{it}: security holdings,
D^1_{it}: interbank transaction liabilities (with $\gamma^1 = 1$),
D^2_{it}: deposits,
D^3_{it}: bonds and money market liabilities.

For the sake of simplicity A^4_{it}, permanent immobilizations, and D^4_{it}, capital and reserves, are ignored.

For loans, the depreciation rate δ^2 depends on repayments as contractually scheduled. However, there may exists payment defaults and anticipated repayments which make δ^2 not perfectly anticipated by banks. Since this is not under the bank control, we can consider this depreciation rate as exogenous. We assume that bank loans are not re-negotiable on a secondary market, so that past loans cannot be sold ($NV^2_{it} = 0$). Then, one can write down the dynamic relationship between the (unobserved) new loans NA^2_{it} and their stock EA^2_{it}, as they appear in bank balance sheets, as:

$$NA^2_{it} = EA^2_{it} - (1-\delta^2) \quad EA^2_{it-1} \quad (6)$$

One can easily assume that δ^1 and γ^1 equal one as cash and interbank transaction are very short term operations.

Using these particularities, one can rewrite the profit as:

$$\begin{aligned}\Pi_{it} = {} & R^{1,t}_{it}\ EA^1_{it} + r^2_{it}\, NA^2_{it} + R^{2,t-1}_{it}(1-\delta^2)\, EA^2_{it-1} + R^{3,t}_{it}\ EA^3_{it} \\ & - \sum_j s^j_{it}\, ND^j_{it} - \sum_j S^{j,t-1}_{it}\,(1-\gamma^j)\, ED^j_{it-1} - CO_{it} \end{aligned} \quad (7)$$

Assuming the credit market to be non perfectly competitive, banks determine the interest rate on their new loans r^2_{it} so as to maximize their profit. They also decide the amount of securities they want to hold EA^3_{it} in their portfolio. It is assumed that the arbitrage condition is fulfilled[8] on the security market, that is $R^{3,t-1}_{it} = R^{3,t}_{it} = r^3_{it}$.[9]

Maximization of (7), with respect to r^2_{it} and EA^3_{it}, under constraint (5) leads to[10] the following first order condition[11]:

$$\frac{\partial EA^1_{it}}{\partial r^2_{it}}(R^{1,t}_{it} - R^{3,t}_{it}) \quad + \quad NA^2_{it} + \frac{\partial NA^2_{it}}{\partial r^2_{it}}(r^2_{it} - R^{3,t}_{it}) - \sum_j \frac{\partial ND^j_{it}}{\partial r^2_{it}}(s^j_{it} - R^{3,t}_{it}) = 0 \tag{8}$$

assuming that $\frac{\partial CO_{it}}{\partial r^2_{it}} = 0$, $\frac{\partial R^{1,t}_{it}}{\partial r^2_{it}} = 0$, $\frac{\partial R^{2,t-1}_{it}(1-\delta^2)EA^2_{it-1}}{\partial r^2_{it}} = 0$, $\frac{\partial R^{3,t}_{it}}{\partial r^2_{it}} = 0$, $\frac{\partial s^j_{it}}{\partial r^2_{it}} = 0$, $\frac{\partial R^{3,t}_{it}}{\partial EA^3_{it}} = 0$ and that $\frac{\partial CO_{it}}{\partial EA^3_{it}} = 0$.

$\frac{\partial R^{2,t-1}_{it}}{\partial r^2_{it}} = 0$ means that the interest payments on loans decided before date t, are not modified by a variation in the interest rate at date t. $\frac{\partial \delta^2 EA^2_{it-1}}{\partial r^2_{it}} = 0$ means that repayments on loans are not modified (e.g. loans are not repaid earlier) if the interest on loans is increasing or decreasing, which might be a strong assumption made for simplicity.

3.1.2 Assumptions about the demand elasticities for assets and liabilities

Now, in order to make our model fully estimable, we have to make further assumptions about $\partial EA^1/\partial r^2$, $\partial NA^2/\partial r^2$, $\partial ED^1/\partial r^2$ and $\partial ND^j/\partial r^2$ for $j = 2, 3$. We assume that:

$$\begin{aligned}
\partial EA^1_{it}/\partial r^2_{it} &= \varepsilon^{EA^1_{it}}_{r^2_{it}} \, EA^1_{it}; \\
\partial NA^2_{it}/\partial r^2_{it} &= \varepsilon^{NA^2_{it}}_{r^2_{it}} NA^2_{it}; \\
\partial ED^1_{it}/\partial r^2_{it} &= \varepsilon^{ED^1_{it}}_{r^2_{it}} \, ED^1_{it}; \\
\partial ND^j_{it}/\partial r^2_{it} &= \varepsilon^{ND^j_{it}}_{r^2_{it}} \, ND^j_{it} \text{ for } j = 2, 3;
\end{aligned}$$

[8]This is not perfectly true accountingly speaking, as only "transaction" securities are registered to their market price. The "investment" securities are registered at their purchase price. Thus in this latter case the apparent interest rate does not include gains and losses.

[9]Deciding EA^3_{it} is thus equivalent to decide $NA^3_{it} - NV^3_{it}$ the net acquisition of securities.

[10]See appendix 1 for more details.

[11]This is close to the specification considered by A. Worms (2001). See also E. Elyasiani et *alii* (1995).

where ε is the semi-elasticity of assets or liabilities with respect to r_{it}^2 (e.g. $\varepsilon_{r_{it}^2}^{NA_{it}^2} = (\partial NA_{it}^2/NA_{it}^2)/\partial r_{it}^2$). These semi-elasticities might be seen as demand elasticities for assets or liabilities with respect to the loan interest rate. The bank is thus not seen as a price taker, but as a monopolist optimizing along the loan demand curve of non-bank agents[12]. The same applies to interbank or other deposits and security liabilities. These semi-elasticities are assumed to be constant across banks and over time. This may be disputed as the bank clientele structure might vary with the characteristics of the bank.

Using equation (8) one can re-write the first order condition as:

$$\begin{aligned} NA_{it}^2 \quad &= \; -\varepsilon_{r^2}^{EA^1} EA_{it}^1 \; (R_{it}^{1,t} - R_{it}^{3,t}) \\ & \quad - \varepsilon_{r^2}^{NA^2} \; NA_{it}^2 (r_{it}^{2,t} - R_{it}^{3,t}) \\ & \quad + \varepsilon_{r^2}^{ED^1} \; ED_{it}^1 (S_{it}^{1,t} - R_{it}^{3,t}) \\ & \quad + \varepsilon_{r^2}^{ND^2} ND_{it}^2 (s_{it}^{2,t} - R_{it}^{3,t}) \\ & \quad + \varepsilon_{r^2}^{ND^3} ND_{it}^3 (s_{it}^{3,t} - R_{it}^{3,t}) \end{aligned} \tag{9}$$

3.1.3 The theoretical link between the loan interest rate and policy rate in our model

The loan interest rate is an endogenous variable in our model. The implicit link between this rate and the policy rate within our model may be computed using the following procedure. If one derives equation (9) with respect to the policy rate, one can express the derivative of the loan interest rate with respect to the policy rate as a function of the "other" interest rates, of their elasticity to the monetary policy rate and of the parameters of the model[13].

$$\begin{aligned} & \left[\begin{array}{c} (\varepsilon_{r^2}^{EA^1})^2 \; EA_{it}^1 \; (R_{it}^{1,t} - R_{it}^{3,t}) + 2 \; \varepsilon_{r^2}^{NA^2} \; NA_{it}^2 \\ +(\varepsilon_{r^2}^{NA^2})^2 \; NA_{it}^2 (r_{it}^{2,t} - R_{it}^{3,t}) - (\varepsilon_{r^2}^{ED^1})^2 \; ED_{it}^1 (S_{it}^{1,t} - R_{it}^{3,t}) \\ -(\varepsilon_{r^2}^{ND^2})^2 \; ND_{it}^2 (s_{it}^{2,t} - R_{it}^{3,t}) - (\varepsilon_{r^2}^{ND^3})^2 ND_{it}^3 (s_{it}^{3,t} - R_{it}^{3,t}) \end{array} \right] * \frac{\partial r_{it}^2}{\partial i} \\ = \; & -\varepsilon_{r^2}^{EA^1} EA_{it}^1 \; (\frac{\partial R_{it}^{1,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i}) + \varepsilon_{r^2}^{NA^2} \; NA_{it}^2 \frac{\partial R_{it}^{3,t}}{\partial i} \\ & + \varepsilon_{r^2}^{ED^1} \; ED_{it}^1 (\frac{\partial S_{it}^{1,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i}) + \varepsilon_{r^2}^{ND^2} ND_{it}^2 (\frac{\partial s_{it}^{2,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i}) \\ & + \varepsilon_{r^2}^{ND^3} ND_{it}^3 (\frac{\partial s_{it}^{3,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i}) \end{aligned} \tag{10}$$

[12]Chauveau and Saidane (1991) found, on macroeconomic data, a quite strong market power on French household loan market, although they don't find any evidence of any market power on the business loan market.

[13]See appendix 2 for more details.

We assume that the impact of monetary policy (i_t being measured by the 3 months interbank interest rate) on the various bank interest rates (except the loan rate), may depend on bank specific variables, to account for its likely heterogeneity. The impact on each rate is thus determined by the following equations.

$$\begin{aligned} R^l_{it} &= a_0 + a_1\ i_t\ + a_2\ i_t \times size_i + a_3\ i_t \times rliq_{it} + a_4\ i_t \times rcap_{it} \\ &\quad + a_5\ size_i + a_6\ rliq_{it} + a_7\ rcap_{it} + \varepsilon_{it} \end{aligned} \tag{11}$$

with $l = 1, 3$.

$$\begin{aligned} S^j_{it} &= a_0 + a_1\ i_t\ + a_2\ i_t \times size_i + a_3\ i_t \times rliq_{it} + a_4\ i_t \times rcap_{it} \\ &\quad + a_5\ size_i + a_6\ rliq_{it} + a_7\ rcap_{it} + \varepsilon_{it} \end{aligned} \tag{12}$$

with $j = 1, 2, 3$.

The bank characteristics are defined in the following way. Size is defined as the log of total assets, liquidity as the ratio of cash and interbank assets over total assets, and capitalization as the ratio of capital and reserves over total assets. All the characteristics are normalized in order to be equal to zero for the average of the regression sample.

Assuming the above relationship (equations (11) and (12)) between the "other" interest rate and the policy rate and using equation (10), allows to compute the derivative of the loan interest rate with respect to the policy rate in a consistent framework.

3.2 The econometric model

The aim of our regressions is to estimate the value of all semi-elasticities (ε), from equation (9). Unfortunately, as stated above, flows are not observable; then, one has to use the dynamic relationship linking new assets or liabilities to their outstanding amounts. This means that if one wants to get estimations of semi-elasticities, one has also to estimate the depreciation rates (δ or γ).

Even after this substitution has been made, equation (9) still contains unobservable variables. Indeed, at the micro level, the interest rates on new assets r^l_{it} (respectively on new liabilities s^j_{it}) are not observable. A way to tackle this lack of data is to replace the rate of return of loans (r^2_{it}) by the ratio of revenues associated with these loans to their outstanding stock ($R^{2,t}_{it}$), as they appear in bank accounts and balance sheets. This solution presents three advantages. The first one is that it is quite simple to implement. The second one is that it allows to get bank specific interest rates. Indeed, although the nature of competition should lead to an homogeneity of the interest rates across banks, the data show this is not exactly the case, at least when one considers the total amount of loans. One possible explanation of this fact rests in the differences that exist across banks about the structure of the loans they grant. Indeed, interest rates differ depending on the type of loan. Then, "average" loans interest rates for banks specialized in short term business loans are likely to be different from those of banks specialized in say, housing loans. The third advantage is that this information can be collected for a large number of banks, once their balance sheet and accounts are available. Obviously, the drawback of this solution is that, during periods where interest rates strongly change over time, the discrepancy between the interest rate on newly granted loans (r_{it}^2) and this "apparent" interest rate ($R_{it}^{2,t}$) can be quite significant.[14]

Generalizing the previous statement, r_{it}^l (respectively s_{it}^j) will be approximated by $R_{it}^{l,t}$ (respectively $S_{it}^{j,t}$) in econometric computations. This was already the case for $R_{it}^{3,t}$, as one previously assumed that the arbitrage condition is fulfilled on the security market.

From equation (9) one can derive the following regression equation using the previous set of assumptions[15]:

$$\begin{aligned}
EA_{it}^2 \quad = \quad & -\,\varepsilon_{r^2}^{EA\,1}\, EA_{it}^1\,(R_{it}^{1,t} - R_{it}^{3,t}) \\
& +(1-\delta^2)\;\; EA_{i,t-1}^2 \\
& -\,\varepsilon_{r^2}^{NA\,2}\;\, EA_{it}^2 (R_{it}^{2,t} - R_{it}^{3,t}) \;+\; \varepsilon_{r^2}^{NA\,2}(1-\delta^2) EA_{i,t-1}^2\,(R_{it}^{2,t} - R_{it}^{3,t}) \\
& +\varepsilon_{r^2}^{ED\,1}\;\, ED_{it}^1 (S_{it}^{1,t} - R_{it}^{3,t}) \\
& +\,\varepsilon_{r^2}^{ND\,2} ED_{it}^2 (S_{it}^{2,t} - R_{it}^{3,t}) \;-\; \varepsilon_{r^2}^{ND\,2}(1-\gamma^2) ED_{i,t-1}^2 (S_{it}^{2,t} - R_{it}^{3,t}) \\
& +\,\varepsilon_{r^2}^{ND\,3} ED_{it}^3 (S_{it}^{3,t} - R_{it}^{3,t}) \;-\; \varepsilon_{r^2}^{ND\,3}(1-\gamma^3) ED_{i,t-1}^3 (S_{it}^{3,t} - R_{it}^{3,t})
\end{aligned} \tag{13}$$

The expected signs of the regression parameters are as follows:

$(1-\delta^2)$ is supposed to be positive and smaller than one. $(-\,\varepsilon_{r^2}^{NA\,2})$ should be positive, as new loans granted are decreasing with the level of the interest rate. $\varepsilon_{r^2}^{NA\,2}(1-\delta^2)$ should be consistent with the two previous coefficients.

$\varepsilon_{r^2}^{ED\,1}$, $\varepsilon_{r^2}^{ND\,2}$ and $\varepsilon_{r^2}^{ND\,3}$ signs should be negative as liabilities increase with loans and loans are decreasing with the interest rate. $(-\,\varepsilon_{r^2}^{ND\,1}(1-\gamma^1))$ and $(-\,\varepsilon_{r^2}^{ND\,3}(1-\gamma^3))$ should then be positive and consistent with the fact that $(1-\gamma^1)$ and $(1-\gamma^3)$ should be smaller than one.

[14] We did not use the data we have about the cost of new loans, as given in the "Cost of Credit" survey because the overlapping between the two samples is too small. However, we intend to study, in a separate paper, the link between the apparent interest rates computed on the outstanding stock of loans and the interest rate of new loans provided in this survey.

[15] where the regressors are

$$EA_{it}^1\,(R_{it}^{1,t} - R_{it}^{3,t}), EA_{i,t-1}^2,\; EA_{it}^2(R_{it}^{2,t} - R_{it}^{3,t}),\; EA_{i,t-1}^2\,(R_{it}^{2,t} - R_{it}^{3,t}),$$
$$ED_{it}^1(S_{it}^{1,t} - R_{it}^{3,t}), ED_{it}^2(S_{it}^{2,t} - R_{it}^{3,t}), ED_{i,t-1}^2(S_{it}^{2,t} - R_{it}^{3,t}),$$
$$ED_{it}^3(S_{it}^{3,t} - R_{it}^{3,t}),\; ED_{i,t-1}^3(S_{it}^{3,t} - R_{it}^{3,t})$$

The signs of $(-\varepsilon_{r^2}^{EA^1})$ is ambiguous. Indeed, even the sign of the substitution effect between EA^1 and NA^2 (for a given size of balance sheet) is unknown, because EA^3 may also be used as a substitute. Moreover, increases in r^2 may induce decreases in the balance sheet size, which may induce decreases in EA^2 everything else being equal.

4 From the banks' dataset to the econometric sample

The Commission Bancaire, the French supervisor authority, collects quarterly balance sheet data and bi-annual income statement data for all MFIs having an activity in France. These individual data are available for the period 1993-2000 and for about 1000 MFIs and allow to work on a bi-annual periodicity. However, because we restrict to loans to consumers and non financial business firms, we need to know the bank clientele structure of each MFI. This information is available for only 92 % (respectively 81 %) of MFIs, for the first semester of 2000 (respectively for the first semester of 1993). Nevertheless, the corresponding share in total asset is 98 % (respectively 97 %). A more detailed description of the balance sheet data set is given in Loupias et alii (2001).

A potentially severe problem comes from the large number of bank mergers that took place during the observation period. We have reconstructed merged entities backward as the sum of the merging banks before the merger (as in Loupias et alii (2001)).

As is well known, a potential severe problem when using panel data to estimate a model is the presence of outliers. Outlying observations to be discarded from the original sample have been defined in the following way:

1) observations below the 2^{nd} and above the 98^{th} percentile of the growth rate of total assets;

2) observations below the 5^{th} and above the 95^{th} percentile for each "apparent" interest rates, i.e. respectively the rate of return on assets l and the cost of having a given amount of debt of type j;

3) observations below the first and above the last percentile of the first difference of loan, liquidity, and capitalization ratios.

Moreover, banks with no loans have also been discarded from the sample and, because of the computation of first differences and their lags, we have kept only banks for which we have at least five consecutive observations.

Finally, about 20% of banks, accounting for around 45% of total assets and for 55% of loans have been kept in the econometric sample.

5 The econometric results

5.1 Estimating the elasticity of bank lending to the interest rate.

Table 1 OLS, 2SLS and GMM estimates of the first order condition equation.

		OLS		2SLS		GMM	
estimated coeff	exp. sign	coeff.	std. dev.	coeff.	std. dev.	coeff.	std. dev.
$-\ \varepsilon_{r^2}^{EA^1}$	unknown	3.063	0.192	3.313	0.960	3.328	0.026
$(1-\delta^2)$	positive (<1)	0.875	0.007	0.858	0.058	0.858	0.000
$-\ \varepsilon_{r^2}^{NA^2}$	positive	3.101	0.681	19.476	3.120	19.585	0.094
$+\ \varepsilon_{r^2}^{NA^2}(1-\delta^2)$	negative	-0.304	0.703	-16.137	4.449	-16.233	0.101
$+\varepsilon_{r^2}^{ED^1}$	negative	-2.552	0.184	-2.933	1.024	-2.954	0.024
$+\ \varepsilon_{r^2}^{ND^2}$	negative	-6.287	0.357	-8.810	1.167	-8.828	0.035
$-\ \varepsilon_{r^2}^{ND^2}(1-\gamma^2)$	positive	4.580	0.393	7.095	1.289	7.124	0.037
$+\ \varepsilon_{r^2}^{ND^3}$	negative	-3.905	0.415	-4.117	1.516	-4.255	0.051
$-\ \varepsilon_{r^2}^{ND^3}(1-\gamma^3)$	positive	1.163	0.417	1.293	1.268	1.423	0.055
Constant		-0.000	0.000	0.000	0.000	0.000	0.000
Sargan stat.	(signif.)					41.984	(0.227)
m1	(signif.)	7.044	(0.000)	1.649	(0.099)	1.941	(0.052)
m2	(signif.)	0.647	(0.517)	-0.569	(0.569)	-0.440	(0.659)
number of obs.		1773		1773		1773	

Notes:

1) Time dummies are included in the regressions, but their coefficients (whose sum is restricted to be null) are not reported here;

2) Lags 2 of the first differences of the following variables have been used as instruments: loans, cash and interbank transaction assets, security holdings, interbank transaction liabilities, bonds and money market liabilities. Moreover, to increase efficiency, this instrument set has been expanded according to Arellano and Bond's procedure, i. e. all instruments have been multiplied by time dummies;

3) The T-statistics reported for the 2SLS estimates are robust ones, accounting for heteroscedasticity and serial correlation.

Each coefficient of the table has the expected sign. The product of the second and the third parameters is approximately equal to the opposite of the fourth one, which means that the implicit constraint is also fulfilled. The results obtained with OLS and GMM are quite different, specially as far as $\varepsilon_{r^2}^{NA^2}$ is concerned. The value of the Sargan statistics does not lead to reject the specification of our model.

A further interpretation of the coefficients and elasticities is given in section 5.3.

5.2 The estimated link between the "other" interest rate and policy rate.

The estimation results of equations (11) and (12) are provided in the following tables[16].

Interbank asset rate (R^1_{it}) estimation.

variable	coeff.	t-stat.
constant	0.02992	5.31
i	0.83779	5.50
i*size	-0.13681	-1.17
i*rliq	0.09127	0.11
i*rcap	-0.37531	-0.11
size	0.01497	3.44
rliq	-0.06727	-2.15
rcap	0.11631	0.89
R^2	0.18	

Security asset yield (R^3_{it}) estimation.

variable	coeff.	t-stat.
constant	0.03154	9.40
i	0.18634	2.05
i*size	0.13463	1.93
i*rliq	0.19502	0.39
i*rcap	4.09272	1.93
size	-0.00133	-0.51
rliq	0.02307	1.24
rcap	-0.15035	-1.94
R^2	0.14	

[16] For comparisons, we also compute the regression for $l = 2$. But this is inconsistent with our model, as far as the loan interest rate is supposed to be the solution of an optimization program. This regression is provided in appendix 3.

Interbank liability rate (S_{it}^1) estimation.

variable	coeff.	t-stat.
constant	0.02280	7.43
i	0.89499	10.79
i*size	-0.06100	-0.95
i*rliq	0.23403	0.51
i*rcap	1.71136	0.88
size	0.00342	1.44
rliq	-0.01884	-1.10
rcap	-0.01291	-0.18
R^2	0.08	

Deposit rate (S_{it}^2) estimation.

variable	coeff.	t-stat.
constant	0.01465	7.28
i	0.24569	4.52
i*size	0.01381	0.33
i*rliq	0.22786	0.75
i*rcap	3.20935	2.53
size	-0.00163	-1.05
rliq	0.03391	3.03
rcap	-0.10418	-2.24
R^2	0.27	

Security liability rate (S_{it}^3) estimation.

variable	coeff.	t-stat.
constant	0.02395	5.15
i	0.48144	3.83
i*size	0.04110	0.42
i*rliq	-1.81684	-2.60
i*rcap	0.62982	0.21
size	0.00069221	0.19
rliq	0.10329	3.99
rcap	0.00105	0.01
R^2	0.08	

5.3 Economic interpretation of the results

5.3.1 Depreciation rates and duration

The model gives estimations for the parameters δ^2 , γ^2 and γ^3 which are respectively the depreciation rates for half a year of loans, deposits and securities liabilities (without capital). The table below presents these figures[17] with the corresponding duration on an annual basis. The duration is computed, using the assumption of the constancy of the depreciation rates, as the inverse of the depreciation rate.

	depreciation rate	duration
loans	$2 * \delta^2 = 0.3$	3 years 6 months
deposits	$2 * \gamma^2 = 0.4$	2 years 6 months
security liabilities[18]	$2 * \gamma^3 = 1.3$	9 months

One may notice that the average duration obtained for loans (3 years and 1 month for total credits on average over the whole period) is consistent with the figures from the "credit cost survey" despite these figures are econometrically estimated using a completely different dataset.

5.3.2 The impact of monetary policy on loan rates

At the sample average, all bank characteristics are nil. So, it is very easy to compute the relationship between each interest rate and the policy rate. Given the average values for the outstanding amounts, the "apparent" rates and the value of the estimated coefficients, one can use our equation (10) to compute the impact of monetary policy on the loan interest rate for a representative bank, i.e. for a bank having the average of all bank characteristics as its own characteristics. The average impact of monetary policy on the loans rate we get is of 0.409 point for an increase of 1% point of the policy rate. This is close to the impact after 3 months obtained by Mojon (2001) for France on a macroeconomic basis over the period 1992-98. This estimation is roughly half of the estimation reported in Baumel and Sevestre (2000). This difference may be explained in two different ways. The first one is that Baumel and Sevestre computations are made assuming the constancy of the balance sheet structure of banks. The explanation of the smaller impact of monetary policy could then come from the modification of the balance sheet structure. Other possible explanations might be that the samples in this study does not cover the same period nor exactly the same population of banks.

This impact computed for a representative bank (i.e. a bank having as its characteristics the average across all banks) is only one of the possible measures of the impact of monetary policy. One can also compute the average of all impacts for each individual bank at each point in time. Weighting those individual impacts by the share of each observation in the total of loans leads to the following estimate: the impact of a one point change of the monetary policy indicator on the loan interest rate (ρ) is of 0.485 point. This value is the one used in the remaining of the paper.

[17] These figures come almost directly from the estimated coefficients. For example, δ^2 is equal to (1 - 0.858), with 0.858 the estimated coefficient for $(1 - \delta^2)$ on a semi-annual basis. It has to be multiplied by two in order to know the depreciation rate on an annual basis.

[18] Security liabilities include CDs, MTN, and various other liabilities.

5.3.3 Impact of monetary policy on new and outstanding loan amounts

The model provides estimates of the demand semi-elasticities of new loans and other items to the loan interest rates ($\varepsilon_{r^2}^{EA^1}$, $\varepsilon_{r^2}^{NA^2}$, $\varepsilon_{r^2}^{ND^1}$, $\varepsilon_{r^2}^{ED^2}$ and $\varepsilon_{r^2}^{ND^3}$). As these semi-elasticities measure the impact of an increase (or a decrease) in the loan interest rates, one has to multiply them by the coefficient of impact of monetary policy on the loans interest rate, i.e. by ρ=0.485 to know the total impact of monetary policy.[19]

Moreover, the semi-elasticity of outstanding stocks to the loans interest rate may be computed in the following way. One knows that :

$$EA_{it}^2 = NA_{it}^2 + EA_{it-1}^2(1-\delta^2)$$

Then, $\partial EA_{it}^2/\partial r_{it}^2 = \partial NA_{it}^2/\partial r_{it}^2 + 0$, and $\frac{\partial EA_{it}^2/EA_{it}^2}{\partial r_{it}^2} = \frac{\varepsilon_{r^2}^{NA^2} NA_{it}^2}{NA_{it}^2+EA_{it-1}^2(1-\delta^2)}$. As long as EA_{it}^2 is not too far from EA_{it-1}^2, one may approximately write that $EA_{it}^2 = \frac{NA_{it}^2}{\delta^1}$. Thus, one may write that $\frac{\partial EA_{it}^2/EA_{it}^2}{\partial r_{it}^2} = \delta^2\varepsilon_{r^2}^{NA^2}$.

Then, it is possible to compute the impact of monetary policy on new loans and on outstanding amounts after one semester. This is also true for deposits, bonds and security liabilities.

IMPACT OF MONETARY POLICY (assets)

	cash and interbank	loans	security holdings
on new...	$\rho\varepsilon_{r^2}^{EA^1}$ =-1.6	$\rho\varepsilon_{r^2}^{NA^2}$ =-9.5	n.a.
on outstanding ...	$\rho\varepsilon_{r^2}^{EA^1}$ =-1.6	$\rho\varepsilon_{r^2}^{NA^2}\delta^2$ =-1.3	n.a.

IMPACT OF MONETARY POLICY (liabilities)

	cash and interbank	deposits	security liabilities
on new...	$\rho\varepsilon_{r^2}^{ED^1}$ =-1.4	$\rho\varepsilon_{r^2}^{ND^2}$ =-4.3	$\rho\varepsilon_{r^2}^{ND^3}$ =-2.1
on outstanding...	$\rho\varepsilon_{r^2}^{ED^1}$ =-1.4	$\rho\varepsilon_{r^2}^{ND^2}\gamma^2$ =-0.8	$\rho\varepsilon_{r^2}^{ND^3}\gamma^3$ =-1.4

So the increase of one percentage point of the monetary policy rate induces a decrease of new loans by 9.5 % and a decrease in the outstanding amount of loans by 1.3% after half a year. The impact on deposits is lower than the impact on loans. This is consistent with the fact that monetary policy works partly through the bank lending channel and with results by Bernanke and Gertler (1992)[20].

If we study the dynamics for loans starting from a steady state, using both the fact that the dynamic relationship is

[19]Remember that flows and outstandings are the same for cash and interbank transactions.
[20]Their results are provided for the United States for the period 1959-1978.

$$EA^2_{it} = NA^2_{it} + (1 - \delta^2)EA^2_{it-1} \quad (14)$$

and the fact that new loans have decreased of 9.5 %, the cumulative impact of a permanent increase of 100 basis points in the interest rate on outstanding amounts of loans may be computed[21]. The same story applies to deposits and security liabilities. These dynamics are computed every thing else being equal:

cumulative impact after a 100 basis pts increase of monetary policy rate on the outstanding amount of... (%)	loans	deposits	security liabilities
a semester	-1.3	-0.8	-1.4
a year	-2.5	-1.5	-1.8
two years	-4.4	-2.5	-2.0
five years	-7.4	-3.8	-2.1
ten years	-9.1	-4.2	-2.1
∞	-9.5	-4.3	-2.1

Our measure of the impact on bank lending of a change in the policy rate is, after one year has elapsed, quite similar to that obtained by Kashyap and Stein (1995) using US bank panel data over the period 1976-1992. Indeed, according to their regression results, the impact of a 100 basis point increase in the federal funds rate leads to a decrease by - 1.2 to - 3.5 % depending on banks' size[22].

Moreover, we can compare our results with previous ones obtained by Barran, Coudert and Mojon (1996) from a VAR model estimated with French macroeconomic data. For that purpose, we have computed the consequence of a shock of only 33 basis points on the monetary policy rate lasting for only a year and a half.

cumulative impact after a 33 basis points temporary increase of the monetary policy rate (%)	loans	deposits	security liabilities
one semester	-0.4	-0.3	-0.5
one year	-0.8	-0.5	-0.6
one year and a half	-1.2	-0.7	-0.7
two years	-1.0	-0.5	-0.2
five years	-0.4	-0.1	0.0
ten years	-0.1	-0.0	0.0

[21] We start from a steady state $EA^2_{it} = EA^2_{it-1}$ normalized to 100. Knowing the dynamic relation $EA^2_{it} = NA^2_{it} + (1 - \delta^2)EA^2_{it-1}$ and the value of $\delta^2 = 0.14$, this implies $NA^2_{it} = 14$. As we know that NA^2_{it} decreases by 8.0% after a monetary policy increase of one point, one can easily compute the dynamics of EA^2_{it}.

[22] Unfortunately, Kashyap and Stein (1995) do not compute any lon run coefficients and the figures provided in the paper do not allow to compute them.

The dynamics of loans we get is consistent with the results obtained for France by Barran, Coudert, and Mojon (1996) over the period 1976-1994. The dynamics of loans and deposits is also quite similar to the one obtained for the first three semesters by Bernanke and Blinder (1992) for the United States over the period 1959-1978. One has of course to be very cautious about the fact that the studied periods are not at all the same, but this seems to indicate that the significant impact of monetary policy on new loans (a decrease of 9.5 percents for an increase of 1% point) is consistent with previous measurements of the impact of monetary policy on outstanding loans.

This impact is also consistent with previous results by Chauveau and Saidane (1991) who show that the loan demand elasticity with respect to the interest rate lies between 0.2 for business loans to 2.8 for short term household loans. Indeed, given that the average loan interest rate was about 6 percent over the regression period, our semi-elasticity of 9.5 is equivalent to an elasticity of 0.57. Given that new loans to businesses account for about 70 %[23] of all new loans, it is not surprising that our estimated elasticity is closer to the lower bound given by Chauveau and Saidane.

6 Conclusion

In this paper we explicitly model the impact of monetary policy on new loans. We find that an increase by 1 % point in the monetary policy rate leads in average to an increase by about 0.5 % point in the loan rates. Moreover, the impact of monetary policy on new loans is consistent with the previous evaluations obtained from macroeconomics models.

But the robustness of this result has to be checked. Our intention for further research is then first to pay a particular attention to the banks' clientele structure. Indeed, we assume that all banks face the same demand. This is a rather strong assumption which can be easily softened by taking account of banks' size and/or other characteristics. Moreover, it is also likely that the reaction of bank lending to changes in monetary policy differs across different types of loans: either because of banks' ability to shrink more easily their supply for certain types of loans or because their customers can, for some of them, substitute other sources of finance to bank loans when the latter are reduced.

[23]This figure is obtained from the cost of credit survey conducted by the bank of France.

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8 Appendix 1

Banks' maximization problem may be written as reported below (from equation (7) and (5) of the body text):

Maximization of

$$\begin{aligned}\Pi_{it} &= R_{it}^{1,t}\ EA_{it}^{1}\ + r_{it}^{2}\, NA_{it}^{2}\ + R_{it}^{2,t-1}(1-\delta^{2})\, EA_{it-1}^{2} + R_{it}^{3,t}\ EA_{it}^{3} \\ &\quad - \sum_{j} s_{it}^{j}\, ND_{it}^{j}\ - \sum_{j} S_{it}^{j,t-1}\ (1-\gamma^{j})\, ED_{it-1}^{j} -\ CO_{it} \end{aligned} \tag{15}$$

with respect to r_{it}^2 and EA_{it}^3,
under the constraint

$$EA_{it}^{1}\ + NA_{it}^{2}\ + (1-\delta^{2})\, EA_{it-1}^{2} + EA_{it}^{3} = \sum_{j} ND_{it}^{j} + \sum_{j}\ (1-\gamma^{j})\, ED_{it-1}^{j} \tag{16}$$

Maximisation of (15), with respect to r_{it}^2 and EA_{it}^3, under constraint (16) leads to the following Lagrangean:

$$\begin{aligned} L &= R_{it}^{1,t}\ EA_{it}^{1}\ +\ r_{it}^{2}\, NA_{it}^{2}\ + R_{it}^{2,t-1}(1-\delta^{2})\, EA_{it-1}^{2} + R_{it}^{3,t}\ EA_{it}^{3} \\ &\quad - \sum_{j} s_{it}^{j}\, ND_{it}^{j}\ - \sum_{j} S_{it}^{j,t-1}\ (1-\gamma^{j})\, ED_{it-1}^{j} -\ CO_{it} \\ &\quad -\lambda \left[\begin{array}{c} EA_{it}^{1}\ + NA_{it}^{2}\ + (1-\delta^{2})\, EA_{it-1}^{2} + EA_{it}^{3} \\ - \sum_{j} ND_{it}^{j} - \sum_{j}\ (1-\gamma^{j})\, ED_{it-1}^{j} \end{array} \right] \end{aligned} \tag{17}$$

First order conditions assuming that $\frac{\partial CO_{it}}{\partial r_{it}^2} = 0$, $\frac{\partial R_{it}^1}{\partial r_{it}^2} = 0$, $\frac{\partial R_{it}^{2,t-1}(1-\delta^2)\, EA_{it-1}^2}{\partial r_{it}^2} = 0$, $\frac{\partial R_{it}^3}{\partial r_{it}^2} = 0$, $\frac{\partial s_{it}^j}{\partial r_{it}^2} = 0$, $\frac{\partial R_{it}^3}{\partial EA_{it}^3} = 0$ and that $\frac{\partial CO_{it}}{\partial EA_{it}^3} = 0$, may be written as:

$$\begin{aligned} \frac{\partial L}{\partial r_{it}^{2}} &= 0 \\ &\Leftrightarrow\ R_{it}^{1,t} \frac{\partial EA_{it}^{1}}{\partial r_{it}^{2}} + NA_{it}^{2}\ + r_{it}^{2}\ \frac{\partial NA_{it}^{2}}{\partial r_{it}^{2}} + 0 + R_{it}^{3,t} \frac{\partial EA_{it}^{3}}{\partial r_{it}^{2}} - \sum_{j} s_{it}^{j} \frac{\partial ND_{it}^{j}}{\partial r_{it}^{2}} - 0 \\ &\quad -\lambda \left[\frac{\partial EA_{it}^{1}}{\partial r_{it}^{2}} + \frac{\partial NA_{it}^{2}}{\partial r_{it}^{2}} + 0 + \frac{\partial EA_{it}^{3}}{\partial r_{it}^{2}} - \sum_{j} \frac{\partial ND_{it}^{j}}{\partial r_{it}^{2}} - 0 \right] \\ &= 0 \end{aligned} \tag{18}$$

$$\frac{\partial L}{\partial EA_{it}^{3}} = 0 \Leftrightarrow R_{it}^{3,t} - \lambda \ = 0 \tag{19}$$

and the balance sheet constraint.
Thus one can writte:

$$\begin{aligned} & \frac{\partial EA_{it}^{1}}{\partial r_{it}^{2}}(R_{it}^{1} - R_{it}^{3,t}) + NA_{it}^{2} + \frac{\partial NA_{it}^{2}}{\partial r_{it}^{2}}(r_{it}^{2} - R_{it}^{3,t}) \\ & - \sum_{j} \frac{\partial ND_{it}^{j}}{\partial r_{it}^{2}}(s_{it}^{j} - R_{it}^{3,t}) \\ = \quad & 0 \end{aligned} \tag{20}$$

9 Appendix 2: Theoritical link between the loan interest rate an policy rate

We derive equation (9) reported below,

$$\begin{aligned} NA_{it}^{2} &= -\,\varepsilon_{r^2}^{EA^{\,1}} EA_{it}^{1}\ (R_{it}^{1,t} - R_{it}^{3,t}) \\ &\quad -\,\varepsilon_{r^2}^{NA^{\,2}}\ NA_{it}^{2}(r_{it}^{2,t} - R_{it}^{3,t}) \\ &\quad +\varepsilon_{r^2}^{ED^{\,1}}\ ED_{it}^{1}(S_{it}^{1,t} - R_{it}^{3,t}) \\ &\quad +\,\varepsilon_{r^2}^{ND^{\,2}} ND_{it}^{2}(s_{it}^{2,t} - R_{it}^{3,t}) \\ &\quad +\,\varepsilon_{r^2}^{ND^{\,3}} ND_{it}^{3}(s_{it}^{3,t} - R_{it}^{3,t}) \end{aligned}$$

with respect to the policy rate, using the decomposition with respect to the loan interest rate.

$$\begin{aligned} &\left[\frac{\partial NA_{it}^{2}}{\partial r_{it}^{2}}\right] * \frac{\partial r_{it}^{2}}{\partial i} \\ = &\ -\,\varepsilon_{r^2}^{EA^{\,1}} \frac{\partial EA_{it}^{1}}{\partial r_{it}^{2}} * \frac{\partial r_{it}^{2}}{\partial i}(R_{it}^{1,t} - R_{it}^{3,t}) - \varepsilon_{r^2}^{EA^{\,1}}\ EA_{it}^{1}(\frac{\partial R_{it}^{1,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i}) \\ &\ -\,\varepsilon_{r^2}^{NA^{\,2}} \frac{\partial NA_{it}^{2}}{\partial r_{it}^{2}} * \frac{\partial r_{it}^{2}}{\partial i}(r_{it}^{2,t} - R_{it}^{3,t}) - \varepsilon_{r^2}^{NA^{\,2}}\ NA_{it}^{2}(\frac{\partial r_{it}^{2,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i}) \\ &\ +\,\varepsilon_{r^2}^{ED^{\,1}} \frac{\partial ED_{it}^{1}}{\partial r_{it}^{2}} * \frac{\partial r_{it}^{2}}{\partial i}(S_{it}^{1,t} - R_{it}^{3,t}) + \varepsilon_{r^2}^{ED^{\,1}}\ ED_{it}^{1}(\frac{\partial S_{it}^{1,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i}) \\ &\ +\varepsilon_{r^2}^{ND^{\,2}} \frac{\partial ND_{it}^{2}}{\partial r_{it}^{2}} * \frac{\partial r_{it}^{2}}{\partial i}(s_{it}^{2,t} - R_{it}^{3,t}) + \varepsilon_{r^2}^{ND^{\,2}} ND_{it}^{2}(\frac{\partial s_{it}^{2,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i}) \\ &\ +\varepsilon_{r^2}^{ND^{\,3}} \frac{\partial ND_{it}^{3}}{\partial r_{it}^{2}} * \frac{\partial r_{it}^{2}}{\partial i}(s_{it}^{3,t} - R_{it}^{3,t}) + \varepsilon_{r^2}^{ND^{\,3}} ND_{it}^{3}(\frac{\partial s_{it}^{3,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i}) \end{aligned} \quad (21)$$

Using the assumptions on the semi-elasticities, one has

$$\begin{aligned} &\varepsilon_{r^2}^{NA^{\,2}} NA_{it}^{2} \frac{\partial r_{it}^{2}}{\partial i} \\ = &\ -\,(\varepsilon_{r^2}^{EA^{\,1}})^2 EA_{it}^{1} \frac{\partial r_{it}^{2}}{\partial i}(R_{it}^{1,t} - R_{it}^{3,t}) - \varepsilon_{r^2}^{EA^{\,1}}\ EA_{it}^{1}(\frac{\partial R_{it}^{1,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i}) \\ &\ -\,(\varepsilon_{r^2}^{NA^{\,2}})^2 NA_{it}^{2} \frac{\partial r_{it}^{2}}{\partial i}(r_{it}^{2,t} - R_{it}^{3,t}) - \varepsilon_{r^2}^{NA^{\,2}}\ NA_{it}^{2}(\frac{\partial r_{it}^{2,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i}) \\ &\ +\,(\varepsilon_{r^2}^{ED^{\,1}})^2 ED_{it}^{1} \frac{\partial r_{it}^{2}}{\partial i}(S_{it}^{1,t} - R_{it}^{3,t}) + \varepsilon_{r^2}^{ED^{\,1}}\ ED_{it}^{1}(\frac{\partial S_{it}^{1,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i}) \end{aligned}$$

$$+(\varepsilon_{r^2}^{ND\ 2})^2 ND_{it}^2 \frac{\partial r_{it}^2}{\partial i}(s_{it}^{2,t} - R_{it}^{3,t}) + \varepsilon_{r^2}^{ND\ 2} ND_{it}^2 (\frac{\partial s_{it}^{2,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i})$$

$$+(\varepsilon_{r^2}^{ND\ 3})^2 ND_{it}^3 \frac{\partial r_{it}^2}{\partial i}(s_{it}^{3,t} - R_{it}^{3,t}) + \varepsilon_{r^2}^{ND\ 3} ND_{it}^3 (\frac{\partial s_{it}^{3,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i}) \quad (22)$$

Finally, one has

$$\begin{bmatrix} (\ \varepsilon_{r^2}^{EA\ 1})^2\ EA_{it}^1\ (R_{it}^{1,t} - R_{it}^{3,t}) + 2\ \varepsilon_{r^2}^{NA\ 2}\ NA_{it}^2 \\ +(\ \varepsilon_{r^2}^{NA\ 2})^2\ NA_{it}^2 (r_{it}^{2,t} - R_{it}^{3,t}) - (\varepsilon_{r^2}^{ED\ 1})^2\ ED_{it}^1 (S_{it}^{1,t} - R_{it}^{3,t}) \\ -(\ \varepsilon_{r^2}^{ND\ 2})^2\ ND_{it}^2 (s_{it}^{2,t} - R_{it}^{3,t}) - (\ \varepsilon_{r^2}^{ND\ 3})^2 ND_{it}^3 (s_{it}^{3,t} - R_{it}^{3,t}) \end{bmatrix} * \frac{\partial r_{it}^2}{\partial i}$$

$$= \ -\ \varepsilon_{r^2}^{EA\ 1} EA_{it}^1\ (\frac{\partial R_{it}^{1,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i}) + \varepsilon_{r^2}^{NA\ 2}\ NA_{it}^2 \frac{\partial R_{it}^{3,t}}{\partial i}$$

$$+\varepsilon_{r^2}^{ED\ 1}\ ED_{it}^1 (\frac{\partial S_{it}^{1,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i}) + \varepsilon_{r^2}^{ND\ 2} ND_{it}^2 (\frac{\partial s_{it}^{2,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i})$$

$$+\varepsilon_{r^2}^{ND\ 3} ND_{it}^3 (\frac{\partial s_{it}^{3,t}}{\partial i} - \frac{\partial R_{it}^{3,t}}{\partial i}) \quad (23)$$

10 Appendix 3: Direct impact of the policy rate on the loan interest rate

Loan interest rate (R_{it}^2) estimation (only for comparison).

variable	coeff.	t-stat.
constant	0.04709	19.47
i	0.85275	13.05
i*size	-0.04927	-0.98
i*rliq	-0.58737	-1.62
i*rcap	-0.46298	-0.30
size	-0.00214	-1.15
rliq	0.00301	0.22
rcap	-0.00655	-0.12
R^2	0.22	

At the sample average, the impact of a one point change in the monetary policy indicator on the loan interest rate can be evaluated to 0.840 (which is close to the estimation obtained by Baumel and Sevestre (2000)).