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Christiano A. Coelho
João M. P. de Mello
Márcio G. P. Garcia

DEPARTAMENTO DE ECONOMIA
www.econ.puc-rio.br

Identifying the bank lending channel in Brazil through data frequency [§]

Christiano A Coelho[†], João M P De Mello[‡] and Márcio G. P. Garcia[¥]

Abstract

Using the different response timings of credit demand and supply, we isolate supply shifts after monetary policy shocks. We show that the bank lending channel exists in Brazil: after an increase (decrease) in the basic interest rate (Selic), banks reduce (increase) the quantity of new loans and raise (lower) interest rates. However, contrary to the empirical literature for the US, we find evidence that large banks react more than smaller ones to monetary policy shocks. Results may have important implications for monetary policy transmission in light of the recent wave of concentration in the Brazilian banking industry.

KEY WORDS: monetary policy transmission; credit markets; bank lending channel.

JEL CODES: E52; E58.

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[†] Central Bank of Brazil and Departamento de Economia, PUC-Rio: christiano.coelho@bcb.gov.br. .
[‡] Departamento de Economia, PUC-Rio: jmpm@econ.puc-rio.br.
[¥] Departamento de Economia, PUC-Rio: mgarcia@econ.puc-rio.br.

I. Introduction

Monetary policy affects economic activity through different channels. One mechanism is the credit channel, i.e., how monetary policy impacts the real sector through its effect on the functioning of credit markets (Bernanke and Blinder [1988], Bernanke and Gertler [1989], Bernanke, Gertler and Gilchrist [2000] and Kyiotaki and Moore [1997]). There are two types of credit channels: the broad credit channel and the bank lending channel. The former is the channel through which monetary policy affects the balance sheet of lenders and borrowers in the economy.

Banks fund a significant part of their operation issuing deposits, normally the cheapest way to get funding. Assuming that deposits and other source of funding are less-than-perfect substitutes, monetary policy, insofar as it affects the amount of deposits in the banking system, will shift the supply schedule of bank credit, a transmission mechanism known as the bank lending channel.

Bernanke and Blinder [1992] first tried to identify the bank lending channel by looking at the relationship between monetary policy shocks and future amounts of loans. Interpretation of their empirical results is blurred by the fact that, several months ahead of a monetary policy shock, aggregate lending changes because of both supply (bank lending channel) and demand reasons (changes in investment and consumption decisions). In other words, one cannot disentangle demand and supply reactions to monetary policy with low frequency data (quarterly in the case of Bernanke and Blinder [1992]). Kashyap, Stein and Cox [1993] also use quarterly data but look into the impact of monetary policy on commercial papers, a substitute for bank loans. Contractions in monetary policy are associated with *increases* in future quantities of commercial paper, supporting the idea of a supply shock. However, identification remains unsatisfactory. Focusing the empirical analysis on quantities does not exclude the possibility that demand for bank credit and commercial papers react differently to shocks in monetary policy.

Dissatisfaction with identification based on aggregate data led to the use of bank-level data. In a seminal work, Kashyap and Stein [1994] (KS hereafter) use bank characteristics to identify the bank lending channel. They assume that smaller banks,

relatively to larger ones, have more difficulty raising funds in money markets. In this case, differences in reactions of small and large banks to changes in monetary policy may be interpreted as evidence of the bank lending channel. Kashyap and Stein [2000] and Arena et al [2007] are additional examples of such strategy.

Kashyap and Stein [1994], Kashyap et al [2000] and Arena [2007] all rely on theoretical arguments that bank characteristics are informative about the bank's ability to substitute away from deposits. Thus, they always test a joint hypothesis of "bank lending channel plus larger-banks-can-better-substitute-deposits theory" is correct. Furthermore, even if the theory is correct, banks with different characteristics serve different clients (Berger et al [2005]). Large banks tend to serve large corporations and smaller banks tend to supply credit to Small and Medium Enterprises (SMEs). Large corporations have better access to capital markets than SMEs. Thus, large corporations have a more elastic credit demand than SMEs, and large banks would lose market share to bond markets if they tight credit concession in response to a shock in monetary policy.[1] In this case, differences in bank market structure for SMEs and corporations rationalize KS [1994, 2000] results without the bank lending channel being operative.

We contribute to the empirical understanding of the bank lending channel by employing a sharper identification strategy. Besides bank-level data, we use very high frequency data, loan-type information to isolate supply shocks driven by monetary policy. Our method bypasses both concerns with KS's identification strategy. We have daily bank-level data on interest rate and quantity. The high frequency of the data is used to isolate supply from demand shocks. The key identifying assumption is that supply reacts faster than demand to monetary shocks. Demand for credit depends on investment and consumption decisions that do not react immediately (our estimation window is very short, of just a few days) to changes in monetary policy. In contrast, banks' costs of funds increase immediately (on the following working day) to an increase in the basic interest rate, especially for short maturity loans such as working capital, or some types of consumer credit. Thus, by looking at a short window around the monetary policy committee meeting, we hold demand constant. This is our identification assumption.

[1] If shocks to monetary policy increase the cost raising capital in all funding markets (equity, bond and bank credit) commensurately, then corporations and SMEs would have equal bank credit demand elasticities.

Thus, reduced-form estimates of the impact of changes in the monetary policy on equilibrium amounts and interest rates can be interpreted as supply shifts.

Other features of our data help in identifying the bank lending channel. First, and differently from the literature, we use data on both new loans *and* interest rates. Shifts in credit demand and supply caused by monetary policy have, in theory, opposite effects on credit interest rate. Through the demand channel, a tightening of monetary policy reduces the equilibrium rate. Through the supply channel, interest rates increase. Hence, we corroborate our identification strategy by looking at the sign of the reduced form impact of monetary policy on lending rates. Second, we use data on several types of loans. The literature's goal (ours included) is to estimate a shift in supply by computing before and after quantities (and, in our case, interest rates). However, this object is conditional on demand elasticity. Therefore, the bank lending channel could be very different for different types of credit. In fact, when decomposing the response to monetary policy according to the size of the bank, quantity responses may differ because demand elasticities are different. Then, by looking at the same product across banks, we are able to estimate the decomposition according to bank characteristics without confounding different demand elasticities. Third, estimation by product type is also important for clean identification based on high frequency. Identification is cleanest for products with a short maturity because their relevant cost of funds is strongly linked to short-term rates.

We have two important findings. First, we document the bank lending channel directly. Credit volume and interest rate respond strongly to monetary policy changes in the direction one would expect if we were estimating a supply response: after basic rate increases, bank interest rate increases and credit volume contracts. Second, we investigate whether bank structure matters for the transmission of monetary policy. In sharp contrast with existing literature, we find that, in Brazil, larger banks react more strongly to monetary policy than smaller banks. Responses are similar among foreign and domestic owned, and privately versus government-owned banks.

Decomposing the impact of monetary policy according to bank size is interesting for two reasons. First and foremost, it is an important policy question per se, in light of recent changes in bank market structure. In particular, mergers in Brazil and other countries have produced larger banks. So the prediction is that monetary policy has more

power now. The second reason is identification. Part of the empirical literature (Kashyap and Stein [2000] and Arena et al [2007]) has typically assumed (but not having empirically shown) that large banks have better access to deposit substitutes because of informational and monitoring reasons. Papers then proceed to investigate whether large and small banks respond differently to shocks in monetary policy. They typically find that larger banks are less sensitive than small ones and interpret this as evidence in favor of the theory. We emphasize that, if it is assumed that supply reacts faster than demand to shocks in monetary policy, it's not necessary to resort to assumptions about how size determines ability to solve informational and monitoring problems. Epistemologically, all we need is our assumption to be more convincing than the one in Kashyap and Stein [2000] and Arena et al [2007], a bar we believe we pass.

Why are bank-size results different in Brazil and the US? We cannot answer this question definitely, but we may speculate. As we saw, the empirical literature has typically assumed as a valid hypothesis that large banks have better access to deposit substitutes because of informational reasons. In Brazil, it is not really obvious whether larger banks suffer less from opaqueness than smaller banks. Several small banks are publicly traded and receive wide coverage from sell-side analysts. In contrast, some of the largest banks are not publicly traded (or the Brazilian operation is not listed separately): CAIXA ECONÔMICA FEDERAL, HSBC, SAFRA and until very recently SANTANDER. Then, in contrast to the American banks, it is not clear whether smaller banks suffer more from informational problems. Numbers also make a difference. The Brazilian bank market has some 230 players (in contrast to more than 7,000 in the US). Large institutional depositors may be able to monitor a large proportion of small and mid-sized banks in Brazil. In addition, in Brazil, small banks have a more concentrated deposit base than large banks. Thus, it is unclear whether moral hazard problems plague smaller or larger banks. In summary, the informational content of the bank lending channel may still be operative but it may well work the other way around in Brazil.

Our results are important in terms of policy implications. With the *caveat* of external validity in mind, we find that large banks are more sensitive to monetary policy than smaller ones. With bank concentration increasing over time (a phenomenon not

particular to Brazil), our results suggest that monetary policy will have more power through the credit channel in the future.

The paper is organized as follows. In the section II we provide an overview of the recent evolution of the Brazilian credit market and the description of our dataset. Section III highlights our empirical strategy, with emphasis on the identification strategy. Results are presented in section IV. Section V concludes with a discussion about policy implications.

II. Background: the credit market in Brazil and monetary policy framework

The performance of Brazilian credit markets is still poor by international standards. Spreads are high and credit volume is low even when compared to other emerging markets. Gelos (2006) calculates that the average interest rate margin in Brazil was 8.9%, while the emerging economies average was 5% and Latin American countries average was 8%[2]. In the same paper the author shows that Brazilian credit to private sector-to-GDP ratio was the sixth smallest in a sample of sixteen countries, below those of Chile, Bolivia, Costa Rica and Honduras.[3]

Figure 1 depicts the distribution of the banks in our sample by total assets. A large number of small banks (187 banks with less than R$5 billion[4] in assets) represented, during the sample period, less than 14% of the industry's total assets. In contrast, the large banks[5] (average total asset during the sample of more than R$25 billion, US$ 9.25 billion) owned no less than two-thirds of the industry's assets. The twenty-four medium-

[2] In table 1 of Gelos (2006) the interest rate margins, measured as the bank total interest rate income minus total interest rate expense divided by the sum of total interest bearing assets, were 6.6% for Mexico, 5.5% for Chile and 4% for Colombia.

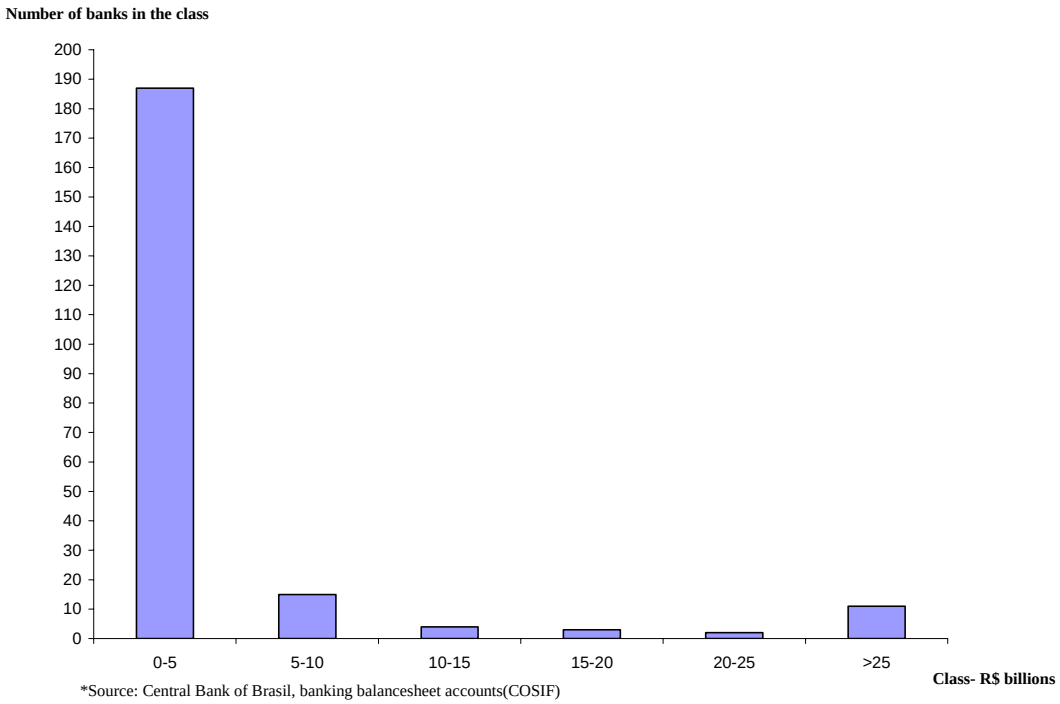
[3] For the difficulties in international comparisons of bank spreads see Costa e Nakane (2005). For the methodological decomposition of bank spread between costs, taxes and profit margin in Brazil see Costa and Nakane (2004).

[4] Using the average exchange rate during the sample period (Nov 01 to Dec 06), 2.7019 R$/US$, R$ 5 billion corresponds to US$ 1.85 billion. One should note, however, that volatility was very high during the sample period, which included a sudden stop episode in late 2002, when the exchange rate even touched 4 R$/US$.

[5] From these, three are government-owned banks (the first, the second and the eleventh largest banks) and represented 29.6% of system total asset. Three are foreign banks and represented 12.4% of the system total assets. The remaining are domestic private banks and represented 58% of the system total asset. One of the banks in this group is not a retail bank, but instead its main market niche is wealth management, catering to rich clients and large companies.

sized banks amounted to 20.6% of the system total assets. A couple of important features for our empirical strategy emerge from graph 2. First, variation in bank size is abundant, so we are able to test if large and small banks react differently to monetary policy shocks. Second, the pass-through of marginal cost to prices depends on market power (Panzar and Rosse (1987)), and the industry is rather concentrated.

Figure 1 - Distribution of banks by total asset*



*Source: Central Bank of Brasil, banking balancesheet accounts(COSIF)

Table 1 shows the balance sheet of the banking sector. Panel A is the liability side. Time deposits are the largest category and represent some 20.2% of the industry's liability.

Table 1 - Decomposition of the liability side of the Brazilian banks balance sheet*	
Equity	11.7%
Demand Deposits	7.6%
Time Deposits	20.2%
Saving Deposits	13.0%
Repurchase Agreements	17.7%
Foreign Loans	4.8%
Earmarked funds from domestic oficial institutions	5.0%
Others	20.0%
Source: Central Bank of Brazil. * Average over the November of 2001 - December of 2006 period	

The Brazilian banking industry has some peculiarities worth noting.[6] The first is the prominent presence of the public sector in financial intermediation. Government participation in the banking sector is high. Two out of the three largest commercial banks in Brazil are state-owned (*Banco do Brasil* and *Caixa Econômica Federal*).[7] In 2006 they represented roughly 23% of all outstanding credit in the banking system. In addition, the federal government owns a very large development bank (BNDES) that alone was responsible for another 11% of all credit outstanding in 2006. In general, state-owned banks have preferential or exclusive access to sources of funds that are more stable and cheaper.[8] Some of this funding is earmarked to targeted sectors, such agricultural working capital loans, housing and trade finance for exports and imports. The remaining was market-based credit. Potentially important to our purposes, BNDES, the large development bank, funds working capital loans to SMEs through private banks using the low-cost funding from payroll deductions (see earmarked funds from domestic official institutions in table 1). In 2006, earmarked lending represented 15.1% of total lending. Finally, the Brazilian banking system relies little on time, demand and savings deposits for international standards (41% of bank's liabilities). In terms of external validity, our results are contingent on intermediation with low reliance on deposits.

[6] We are grateful to Arturo Galindo for calling our attention to this point.
[7] Banco do Brasil is the largest commercial bank and Caixa Econômica Federal is the third, when we measure bank's size by total assets. Both are owned by the federal government.
[8] One example is the "judicial litigation deposits", which are deposits for civil suits settlements that are not final. By law they have to be deposited in public banks, with regulated low rates, 6% real p.a., a low figure for Brazil (see below). Another important source are workers' unemployment insurance funds

A short description of the Brazilian monetary policy framework is in place. After floating its currency, the real (BRL), in January, 1999, Brazil adopted inflation targeting (IT). The two-year-ahead inflation target is set every year (in early July) by the Monetary Policy Council, a committee composed by the Finance Minister, the Planning Minister, and the Central Bank Governor. This is supposed to reflect society's preferences towards inflation. The Brazilian Central Bank has, so far, been *de facto* independent in carrying out the implementation of monetary policy to achieve the inflation target. Currently, the Monetary Policy Committee (COPOM) meets every six weeks (initially, every four weeks) to decide upon the basic interest rate (the Selic rate).

III. Data and Descriptive Statistics

Our main data source is an original and unique call-report database from the Central Bank of Brazil.[9] Call reports have daily information, at the bank-type of loan level, on interest rates and volume of new loans, our two dependent variables. On a monthly basis, banks have to report data on maturity and default rates. The dataset contains only non-earmarked credit. Data run from June-2000 through December-2006.

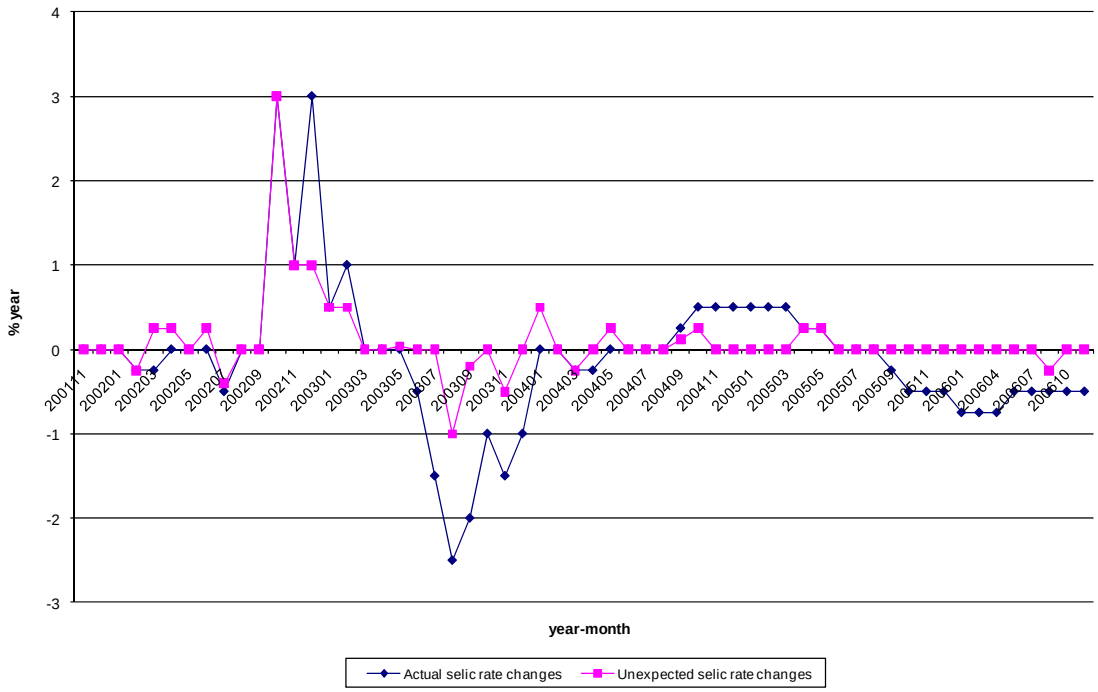
Loans are classified into six categories of consumer lending, and eleven types of credit to firms. Categories differ in several dimensions such as the presence of collateral, type of borrower, maturity of the credit, and whether rates are fixed or adjustable.

The main explanatory variable is the unexpected change in the basic interest rate, which is defined as the difference between the target set for the basic interest rate (hereafter SELIC) and the median of the market players' expectations the day before the meeting (the so-called FOCUS survey, which is the equivalent of the market consensus), both publicly available. Expected changes in monetary policy should also have an impact on credit market. However, our identification strategy relies crucially on high frequency responses to changes in monetary policy. Since it is hard to determine when expected component was priced in, we work with the unexpected component only for identification reasons. The Focus survey began in November of 2001. Thus, our final sample period is November 2001 through December 2006.

[9] Data are not publicly available for bank privacy reasons.

Figure 2 depicts the actual and unexpected SELIC changes. It shows large unexpected changes by the end of 2002, a period of macroeconomic instability that preceded the inauguration of President Lula. In the first meetings during the new administration, the market consensus (median) underestimated the increases in the SELIC, reflecting the central bank's attempt to gain reputation. In the second semester of 2003, the market underestimated the cuts in the SELIC. In 60% of the Monetary Policy Committee (COPOM) meetings, the consensus forecasts were right. Thus, variation is available to estimate the impact of surprises on the equilibrium quantity of loans and interest rates.

Figure 2: Actual x Unexpected changes in selic rate



Tables 2 and 3 have pairwise correlations between changes in lending interest rate and Selic (unexpected and actual), and changes in new loans and Selic (unexpected and actual). Correlations suggest that it takes two days for changes in the basic rate to affect lending rates and quantities: three and four days after the meeting the correlation between

unexpected changes in SELIC and lending rates (quantities) has the expected positive (negative) sign.

Table 2 - Correlations between selic and lending interest rate*

	Large banks	
	Unexpected selic variation	**Actual selic variation**
$interest_{t+1}$	-0.04	-0.01
$interest_{t+2}$	-0.06	-0.05
$interest_{t+3}$	**0.10**	**0.09**
$interest_{t+4}$	**0.13**	**0.26**
$interest_{t+5}$	0.12	0.13
	Medium banks	
	Unexpected selic variation	**Actual selic variation**
$interest_{t+1}$	-0.04	-0.09
$interest_{t+2}$	-0.03	-0.12
$interest_{t+3}$	**-0.12**	**-0.18**
$interest_{t+4}$	**-0.06**	**-0.17**
$interest_{t+5}$	0.14	0.04
	Small banks	
	Unexpected selic variation	**Actual selic variation**
$interest_{t+1}$	0.03	-0.03
$interest_{t+2}$	-0.002	-0.07
$interest_{t+3}$	**-0.06**	**-0.10**
$interest_{t+4}$	**0.07**	**0.09**
$interest_{t+5}$	0.08	0.01

*Source: Own elaboration from the Central Bank of Brazil data. The definitions of the variables are the following: $interest_{t+1}$ is the difference between the average credit annual interest rate one day after the monetary policy committee meeting and the average interest rate one day before the meeting; $interest_{t+2}$ is the difference between the average credit annual interest rate two days after the monetary policy committee meeting and the average interest rate one day before the meeting; the same logic applies to higher order differences.

Table 3 - Correlations between selic and new loans*

	Large banks	
	Unexpected selic variation	**Actual selic variation**
new_loans_{t+1}	0.07	-0.15
new_loans_{t+2}	0.061	-0.09
new_loans_{t+3}	**-0.13**	**-0.19**
new_loans_{t+4}	**-0.11**	**-0.31**
new_loans_{t+5}	0.14	-0.02
	Medium banks	
	Unexpected selic variation	**Actual selic variation**
new_loans_{t+1}	0.04	-0.11
new_loans_{t+2}	0.07	-0.11
new_loans_{t+3}	**-0.02**	**-0.11**
new_loans_{t+4}	**-0.11**	**-0.31**
new_loans_{t+5}	0.17	0.02
	Small banks	
	Unexpected selic variation	**Actual selic variation**
new_loans_{t+1}	-0.05	-0.17
new_loans_{t+2}	0.01	-0.15
new_loans_{t+3}	**-0.07**	**-0.10**
new_loans_{t+4}	**-0.07**	**-0.24**
new_loans_{t+5}	0.17	0.01

*Source: Own elaboration from the Central Bank of Brazil data. The definitions of the variables are the following: new_loans_{t+1} is the difference between the average volume of new loans one day after the monetary policy committee meeting and the average volume of new loans one day before the meeting; new_loans_{t+2} is the difference between the average volume of new loans two days after the monetary policy committee meeting and the average volume of new loans one day before the meeting; the same logic applies to higher order differences.

Following the literature, we decompose the impact of monetary according to bank size, and different categories have distinct funding profiles. Consider the size taxonomy of figure 1. Table 4 shows deposits as a proportion of total liabilities for the three bank size categories (large, medium and small).

Table 4: Deposit funding by bank's size - % of total liability*

	Large banks			
	Total deposits/liability	Demand deposits/liability	Time deposits/liability	Saving deposits/liability
average	45.7	8.1	23.4	14.2
median	45.6	8.9	22.0	12.4
minimum	25.8	2.9	3.2	1.2
maximum	74.7	13.0	43.6	31.3
	Medium banks			
	Total deposits/liability	Demand deposits/liability	Time deposits/liability	Saving deposits/liability
average	20.7	2.5	14	4.6
median	18.1	0.7	11	0
minimum	0	0	0	0
maximum	65.2	9	38	29.1
	Small banks			
	Total deposits/liability	Demand deposits/liability	Time deposits/liability	Saving deposits/liability
average	33.8	3.5	29	1.2
median	25.5	0.5	20	0
minimum	0	0	0	0
maximum	98.1	67	98	37.3

*Source: Own elaboration from banks' balance sheet accounts (Cosif, Central Bank of Brazil)

Clear differences in funding strategies operation emerge. Large banks have the highest percentage of their liability as deposits. Nevertheless, smaller banks have more deposits than medium-sized banks. This is true for both sub-categories of deposits (time and demand), but demand deposits are only relevant for large banks. Savings deposits monotonically decrease with size.

Some of the facts in table 4 are unsurprising. Banks must have branches all over the country in order to be able to compete for the demand and saving deposits. The time deposits market is segmented between large denomination CDs and the “retail” market for individuals. Small and medium size banks are able to get funding in the wholesale CDs market.

III. Empirical Strategy

Identifying the banks’ lending reactions is akin to the standard problem of estimating demand and supply relations in microeconometrics. The bank lending channel refers to the supply side of the credit market, but we typically observe only equilibrium values. Following a monetary policy shock, it is conceivable that not only the supply of

credit shifts, but also demand for credit, a problem first recognized by Kashyap and Stein (1994).

Existing empirical literature has used bank characteristics to isolate demand factors (Kashyap and Stein (2000), Arena et al (2007)). The key identifying assumption is that banks differ in their abilities to substitute away from deposits. Furthermore, observable characteristics determine the ability to move to and from deposits. In this case, one may interpret different reactions to monetary policy as evidence of the bank lending channel. Typically, one assumes that larger, more liquid and foreign owned (in emerging countries) banks are better equipped to move to and from deposits. The theoretical motivation behind these assumptions is as follows. The presence of deposit insurance makes deposits free of informational asymmetries, thereby becoming the cheapest and more stable way to fund bank credit operations. When forced to raise equity, long-term debt and short-term wholesale debt, banks have to pay dearly for informational asymmetries and non-contractibilities. In this context, larger banks, perhaps because of *too-big-to--fail* effect or because they are easier to monitor, pay less when substituting away from deposits to these more expensive instruments (see Kashyap and Stein (2000) and Stein (1998)). The same would apply for foreign banks in emerging countries. Liquidity also matters because, if banks have very liquid instruments in the asset part of the balance sheet, they may sell position when facing funding shortage. Finally, banks follow distinct strategies for funding. In Brazil, as Table 4 shows, larger banks have a stronger reliance on deposits than smaller banks, although the industry's as a whole relies little on deposits in an international comparison.[10]

Regardless of the empirical validity of such theoretical arguments, banks with characteristics serve different clientele. In this case, *equilibrium* reaction to monetary policy may differ for demand reasons: different borrowers may react differently to monetary policy shocks. For example, middle-market banks specialize in receivables' discounting for Small and Medium Enterprises (SMEs). Large universal banks, in addition to discounting, do short and medium term working capital loans for larger firms. It is quite conceivable that large firms will reduce their working capital demand in

[10] Among Latin American countries, the Brazilian banking system has the lowest Deposits-to-Liabilities ratio, 41%. The average is 65%. We kindly thank Arturo Galindo for pointing this out and sending out the data on different Latin American countries.

response to monetary tightening, but SMEs will not cut so fast their demand for discounting. Furthermore, consumer credit is highly concentrated in larger banks, and consumption and investment may react very differently to monetary policy.

In contrast with the literature, our main identification strategy is data-driven. A well established fact in monetary economics is that output and inflation are only slowly affected by the traditional monetary policy mechanism (see Christiano et al (1999), among many others[11]). In the short run, consumption and investment decisions have some inertia. Since monetary policy affects banks' marginal cost immediately for several products, credit supply should react faster to monetary policy than credit demand. Using daily data and focusing on few days before and after the monetary policy committee meeting, we are confident we are recovering only systematic supply shifts. In addition to high frequency, we have information about flows, i.e., new loans. This is crucial for our strategy to be successful because stocks hardly move much in the very short-run. Another advantage *vis-à-vis* the literature, we have data on interest rate, which is useful to corroborate that we capture supply shocks: supply and demand shocks to monetary policy have similar implications for quantities, but opposite implications for interest rates. Finally, we also follow the literature and decompose the response to monetary policy according to bank characteristics, i.e., size, ownership and liquidity.

In the event study, we compare the amount of new loans issued and interest rates charged on a few days before and after the monetary policy committee meeting to set a new target for the basic interest rate. We use only the surprise of the announcement, i.e., the difference between the median expected change in the basic interest rate (day before the meeting) and the actual change.[12] In doing so, we mitigate the possibility that most effects of policy announcement may have occurred way before the meeting.

We estimate the following equations:

[11] The famous expression coined by Friedman [1972] is that monetary policy works with "long and variable lags."
[12] As a robustness test we used the actual interest rate changes too. Results are available upon request.

$$New\_loans_{ijt+N} - New\_loans_{ijt-1} = c_{ij} + \beta_1 characteristic_{it} + \beta_2 unexpected\_selic_t + Controls_{ijt} + \varepsilon_{ijt} \quad (1)A$$

$$New\_loans_{ijt+N} - New\_loans_{ijt-1} = c_{ij} + \beta_1 characteristic_{it} + \beta_2 unexpected\_selic_t + \beta_3 characteristic_{it} unexpected\_selic_t + Controls_{ijt} + \omega_{ijt} \quad (1)B$$

$$Interest_{ijt+N} - Interest_{ijt-1} = c_{ij} + \gamma_1 characteristic_{it} + \gamma_2 unexpected\_selic_t + Controls_{ijt} + \mu_{ijt} \quad (2)A$$

$$Interest_{ijt+N} - Interest_{ijt-1} = c_{ij} + \gamma_1 characteristic_{it} + \gamma_2 unexpected\_selic_t + \gamma_3 characteristic_{it} unexpected\_selic_t + Controls_{ijt} + \eta_{ijt} \quad (2)B$$

The subscript *i* refers to the bank, *j* refers to the type of credit, and the dimension *t* to the period, an event, i.e., a meeting of the monetary policy committee. In other words, *t* + *N* means *N* days after the day the committee announced the new rate. Correspondingly, *t* – 1 is the day before the meeting. Thus, New_Loans_{ijt+N} is the amount at N^{th} day after the committee's meeting. In some specifications we include fixed-effect dummies for the pair bank-type of credit. The coefficients of interest are β_2, β_3 , γ_2 and γ_3. β_2 and γ_2 are expected to be negative and positive, respectively, if are to capture a supply effect. The signs of β_3 and γ_3 are less clear-cut. For example, the standard assumption in the literature is that larger banks are less restricted in funding options. In this case, we would expect β_3 and γ_3 to be negative and positive, respectively. We also estimated the models with two different dependent variables: log(New Loans$_{t+N}$/ New Loans$_{t-1+N}$) and the percentage change in new loans. Results are similar and are available upon request.[13]

One legitimate concern with the specification is whether changes in SELIC (expected or unexpected) truly reflect the changes in cost of funds. SELIC is a short-term rate, and some loans have longer maturity and, in theory, we should look at the whole yield curve. We deal with this problem empirically. Table A.V in the appendix shows

[13] We use several observations of different types of credit for the same pair bank-event. Thus, errors might be correlated and we cluster errors at bank-event level for the baseline model and results are slightly *more* precise than when we use only robust standard errors. Results are shown in the appendix.

two things. First, the average maturity of loans in Brazil is short: 7 months. Then, short-term rates seem appropriate. Second, there is heterogeneity in maturity among different types of loans. So, if estimates are not sensitive to the type of loan considered, SELIC is not a bad measure of cost of funds.

IV. Results

IV.A. General effects of monetary policy

IV.A.1 Main estimates

Tables 5 and 6 show the results for (1)A and (2)A, i.e., the models without any decomposition:

Table 5: Effect on new loans without decomposition

Dependent variable: $New\ Loans_{t+N}$ - $New\ Loans_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
Δ unexpected_selic	.17***	.015	-.29***	-.11***
	(.048)	(.032)	(.048)	(.025)
N obs	45532	45480	45255	45030
N groups	1090	1087	1085	1083

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

Table 6: Effect on interest rates without decomposition

Dependent variable: $Interest\ rate_{t+N}$ - $Interest\ rate_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
Δ unexpected_selic	-.64***	-.69***	.63***	1.4***
	(.2)	(.19)	(.18)	(.18)
N obs	27060	27097	27022	26633
N groups	810	812	811	803

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

The results show that unexpected changes in the SELIC rate have a negative and statistical significant effect on new loans, and a positive and statistical significant effect on lending interest rate on the third and fourth days after the committee's meeting. In days 1 and 2, results are reversed. We prefer results for days 3 and 4 for four reasons. First, they are more consistent than results for days 1 and 2. In fact, day 2's the impact on quantity is zero. Second, banks may hesitate to move on the very first days, to avoid moving alone. This is yet more important for small banks, which may act as followers. In fact, when we decompose observations by size, we see that results for days 1 and 2 for larger banks are inconsistent for prices and quantities (see tables 9 and 10 below). Third, there is a delay between the contract date and the fund release date. For example, the contract date could be one day after the meeting, but the actual release of the fund could be two or three days after. The same kind of effect could affect the new loans one and two days after the meeting: in this case at least part of the loans actually refers to the day of the meeting (or even prior), which is not affected by the new information about basic interest rate. Last, but not least, results for days 3 and 4 have theoretical support: they represent a supply shift. Even if they were consistent, it would be hard to interpret results for days 1 and 2 because they are compatible with demand, not supply, and demand should not respond this quickly. Thus, throughout the discussion, we focus on days 3 and 4.

In quantitative terms, an unexpected increase of the Selic rate of 1% per year implies a drop[14] of average daily new loans of R$290 thousand (US$ 107 thousand, about 11% of the average value of the new loans in the sample). Industry wide this means an impact of R$57.7 million (US$ 21.3 million, approximately 2.7% of the average value of the industry new loans in the sample). [15]

The effect of SELIC on credit interest rate is positive and statistically significant in windows 3 and 4. The estimated pass-through in the 3-days window is less than one, which means that not all Selic's variation is passed on credit interest rate. This stickiness is compatible with market power (Panzar and Rosse (1987)) or with adverse selection in

[14] These calculations use the 3-days window results.

[15] We use several observations of several different types of credit for the same pair bank-event. Thus, errors might be correlated and we cluster errors at bank-event level for the baseline model and results are slightly more precise than when we use only robust standard errors. Results are shown in the appendix.

credit markets as in Stiglitz and Weiss (1981). The signs and magnitudes of our estimated responses to SELIC for the 3 and 4-days windows are compatible with supply but not demand shifts, corroborating our identification strategy.

IV.A.2 Robustness checks

Figure 1 shows that our sample contains only a few large banks. By equally weighting, the documented differences come mostly from differences between medium and small ones. To prove our results, we weight observations by bank size. Results, which are similar, are in tables A.I and A.II of the appendix.

Figure 2 shows that our sample contains several events in 2002, a year of economic turmoil in Brazil. Therefore, our results may be driven by crisis periods. We re-estimate the model excluding all events from 2002. Results, which are similar, are in tables A.III and A.IV of the appendix.

Another important issue concerns the possibility of hoarding. If announcements are made at pre-announced dates, lenders (or banks) may hoard loan applications until the uncertainty is uncovered. Two comments are in place. First, hoarding applies only to quantities, not interest rates. Second, we take steps to address the possibility that hoarding mechanically produces the results for quantities. If hoarding is in fact relevant empirically, we should observe that new loan concessions should be lower in the days immediately preceding the COPOM meetings than, say, 7 to 10 days before the meeting. This is irrespective of whether SELIC rates surprise up or down. Table A.VI in the appendix shows that this is not the case.

IV.B Size Decomposition

In this subsection we follow the literature and estimate models (1)B and (2)B decomposing the impact of monetary policy according to bank size. The intuition is that as larger banks have more collateral to offer, they probably will find easier to trade deposits for other kind of debts. Furthermore, investors could be more willing to buy shares of larger banks if they thought government saw them as too big to fail. We use the

log of assets as a measure of size. Tables 7 and 8 show the results for new loans and interest rate, respectively[16].

Table 7: Effect on new loans by size

Dependent variable: *New Loans* $_{t+N}$ - *New Loans* $_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
size	0.23***	0.34***	0.51***	0.26***
	(0.07)	(0.06)	(0.07)	(0.05)
Δunexpected_selic	-2***	-0.004	3.6***	1.3***
	(0.6)	(0.4)	(0.7)	(0.3)
Δunexpected_selic x size	0.1***	0.002	-0.18***	-0.06***
	(0.03)	(0.2)	(0.03)	(0.02)
N obs	45442	45404	45181	44956
N groups	1090	1087	1085	1083

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

Table 8: Effect on interest rates by size

Dependent variable: *Interest rate* $_{t+N}$ - *Interest rate* $_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
size	-0.09	-0.22	0.78*	0.41
	(0.31)	(0.3)	(0.34)	(0.3)
Δunexpected_selic	-3.7*	-5.5***	-6.3***	-3.5**
	(2.2)	(1.9)	(2.1)	(1.7)
Δunexpected_selic x size	0.14	0.22**	0.32***	0.23***
	(0.1)	(0.08)	(0.09)	(0.07)
N obs	27006	27048	26976	26584
N groups	810	811	811	803

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

[16] The results using size could be generated by the larger amount of medium and small banks in our sample. In order to deal with this possible problem we estimated the same model of this section including weights based on the sample average size of each bank. Results are showed in the tables A.I and A.II of the appendix. We can see that results are not qualitatively different from those of tables 6 and 7.

In line with our previous estimates, banks' reactions to changes in monetary policy are again compatible with a supply response: they increase lending interest rates and contract new loans after a monetary policy contraction.

Results on the interaction term are in sharp contrast with existing literature. If large banks were better equipped in substituting away from deposits, they should respond less strongly to changes in monetary policy. In fact, they respond more strongly. Using estimates in tables 7 and 8, tables 9 and 10 show the average response for the three groups of banks: small, medium and large sized. In general, small banks do not respond to shocks in monetary policy. On the other hand, among large banks a one percentage-point unexpected increase in the SELIC rate causes an average daily reduction of R$1.24 million (US$ 459 thousand), which means an average aggregate daily reduction of R$13.6 million (US$ 5.03 million, approximated 8.8% of the average value of the large banks new loans in the sample). Accordingly, interest rates charged by small banks is insensitive to unexpected changes in monetary policy and a one percentage-point unexpected increase in the SELIC rate causes a increase of 2.13 percentage points in the interest rate charged by large banks[17].

Table 9: Estimates by size - New Loans

	N=1	*N=2*	*N=3*	*N=4*
Smallest size	-0.39	0.02	0.76	0.27
	P-value F-test<0.01	*P-value F-test=0.79*	*P-value F-test<0.01*	*P-value F-test<0.01*
Average size	0.16	0.03	-0.23	-0.08
	P-value F-test<0.01	*P-value F-test=0.22*	*P-value F-test<0.01*	*P-value F-test<0.01*
Largest size	0.73	0.04	-1.24	-0.43
	P-value F-test<0.01	*P-value F-test=0.76*	*P-value F-test<0.01*	*P-value F-test<0.01*

[17] Figure 2 shows that five events of unexpected changes in Selic occurred in 2002, a year of economic crisis in Brazil. To ensure that results are not confined to crisis period, we re-estimated the model of this section excluding 2002. Tables A.III and A.IV of the appendix have the results, which are qualitatively similar to those in tables 6 and 7.

Table 10: Estimates by size - Interest Rate				
	N=1	*N=2*	*N=3*	*N=4*
Smallest size	-1.53	-2.09	-1.34	0.07
	P-value F-test=0.03	*P-value F-test<0.01*	*P-value F-test=0.06*	*P-value F-test=0.98*
Average size	-0.85	-0.91	0.38	1.30
	P-value F-test<0.01	*P-value F-test<0.01*	*P-value F-test=0.06*	*P-value F-test<0.01*
Largest size	-0.01	0.30	2.13	2.56
	P-value F-test=0.93	*P-value F-test=0.36*	*P-value F-test<0.01*	*P-value F-test<0.01*

IV.C Decomposition according to different types of loans

Banks of different sizes serve different clienteles. Our identification strategy is tailored to isolate supply shocks. Nevertheless, identification is cleanest if one could restrict attention to a homogeneous class of borrowers. Furthermore, focusing on a homogeneous class of borrowers, we would estimate the supply shock for the same demand elasticity. We have no data on the borrower side but we do have information on the type of credit, which is a good proxy for type of borrower. Tables 11, 12, 13 and 14 are analogous to tables 9 and 10, but the sample is restricted to working capital (tables 11 and 12) and consumer credit (tables 13 and 14). Results are similar to those in tables 9 and 10, which use all types of credit.[18]

Table 11: Estimates by size - New Loans (Working capital)				
	N=1	*N=2*	*N=3*	*N=4*
Smallest size	-0.03	-0.05	0.45	0.13
	P-value F-test=0.79	*P-value F-test*=0.70	*P-value F-test*<0.01	*P-value F-test*=0.28
Average size	0.04	0.03	-0.15	-0.03
	P-value F-test=0.13	*P-value F-test*=0.40	*P-value F-test*<0.01	*P-value F-test*=0.4
Largest size	0.13	0.12	-0.81	-0.21
	P-value F-test=0.44	*P-value F-test*=0.57	*P-value F-test*<0.01	*P-value F-test*=0.3

[18] We omit the analogous of tables 7 and 8 (all types of credit) for working capital and consumer credit. Results, which are very similar to those in tables 7 and 8, are available upon request.

Table 12: Estimates by size - Interest Rates on working capital loans

	N=1	*N=2*	*N=3*	*N=4*
Smallest size	-0.88	-0.18	0.98	1.17
	P-value F-test=0.22	*P-value F-test=0.82*	*P-value F-test=0.18*	*P-value F-test=0.12*
Average size	-0.22	0.12	1.50	1.16
	P-value F-test=0.56	*P-value F-test=0.55*	*P-value F-test<0.01*	*P-value F-test<0.01*
Largest size	0.53	0.45	2.07	1.14
	P-value F-test=0.24	*P-value F-test=0.3*	*P-value F-test<0.01*	*P-value F-test=0.06*

Table 13: Estimates by size - New Loans (Consumer credit)

	N=1	*N=2*	*N=3*	*N=4*
Smallest size	-0.25	-0.13	0.91	0.44
	P-value F-test<0.01	*P-value F-test=0.30*	*P-value F-test<0.01*	*P-value F-test<0.01*
Average size	1.31	0.08	-0.23	-0.13
	P-value F-test<0.01	*P-value F-test=0.05*	*P-value F-test<0.01*	*P-value F-test<0.01*
Largest size	3.01	0.30	-1.48	-0.75
	P-value F-test<0.01	*P-value F-test=0.15*	*P-value F-test<0.01*	*P-value F-test<0.01*

Table 14: Estimates by size - Interest Rates on consumer credit

	N=1	*N=2*	*N=3*	*N=4*
Smallest size	-2.27	-3.21	-2.34	-0.10
	P-value F-test=0.09	*P-value F-test<0.01*	*P-value F-test=0.06*	*P-value F-test=0.96*
Average size	-1.50	-1.81	-0.22	1.40
	P-value F-test<0.01	*P-value F-test<0.01*	*P-value F-test=0.54*	*P-value F-test<0.01*
Largest size	-0.65	-0.28	2.11	3.04
	P-value F-test=0.39	*P-value F-test=0.8*	*P-value F-test<0.01*	*P-value F-test<0.01*

IV.D Liquidity

The second decomposition is done according to asset liquidity. Banks with more liquidity assets (say, government bonds) have better collateral to post, allowing them to substitute away from deposits if they become too expensive. In addition, banks may sell liquid assets if conditions get too tight.

We use the following measure of liquidity:

Tables 15 and 16 present the results.

Table 15: Effect on new loans by liquidity

Dependent variable: *New Loans* $_{t+N}$ - *New Loans* $_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
liquidity	0.01	0.26**	0.37***	0.18
	(0.2)	(0.13)	(0.13)	(0.12)
Δunexpected_selic	0.22***	0.05	-0.31***	-0.09***
	(0.06)	(0.04)	(0.06)	(0.03)
Δunexpected_selic x liquidity	-0.37***	-0.2	0.14	-0.12
	(0.14)	(0.13)	(0.19)	(0.11)
N obs	45442	45404	45181	44956
N groups	1090	1087	1085	1083

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

Table 16: Effect on interest rates by liquidity

Dependent variable: *Interest rate* $_{t+N}$ - *Interest rate* $_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
liquidity	-0.12	-0.39	-1.8	-0.12
	(1.2)	(1.3)	(1.3)	(1.4)
Δ unexpected_selic	-0.19	0.19	1.1***	1.2***
	(0.35)	(0.3)	(0.35)	(0.25)
Δ unexpected_selic x liquidity	-3.3	-6.8***	-3.7	1.5
	(2.5)	(2.1)	(2.9)	(1.2)
N obs	27006	27048	26976	26584
N groups	810	811	811	803

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

Contrary to theoretical arguments, estimates show that liquidity does not appear to influence the transmission of monetary policy through the bank lending channel.

IV.E Deposits and Earmarked Funds

The credit channel of monetary policy operates mainly through its impact on the cost of funds to banks. Deposits, a form of short-term debt, are immediately affected by changes in the basic rate. Thus, one should conjecture that the impact of monetary policy depends on the proportion of deposits different banks hold in their liabilities. In fact, as Table 4 shows, larger banks rely more on demand deposits than smaller ones. Because of that, results in subsection IV.B may be due to different liability composition (see subsection IV.F for further evidence). Tables 17 and 18 test this conjecture.

Table 17: Effect on new loans by demand deposits

Dependent variable: *New Loans* $_{t+N}$ *- New Loans* $_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
%demand deposits	-.016	.31	.065	-.28
	(.35)	(.3)	(.32)	(.28)
Δ unexpected_selic	.1***	.00072	-.21***	-.088***
	(.035)	(.024)	(.035)	(.02)
Δ unexpected_selic x %demand deposits	1.3***	.28	-1.5***	-.39**
	(.43)	(.26)	(.44)	(.2)
N obs	45442	45404	45181	44956
N groups	1090	1087	1085	1083

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

Table 18: Effect on interest rates by demand deposits

Dependent variable: *Interest rate* $_{t+N}$ - *Interest rate* $_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
%demand deposits	-.66	2.1	1.4	-6.2*
	(3.2)	(3.8)	(3.2)	(3.3)
Δ unexpected_selic	-.69**	-.61***	.55**	1***
	(.27)	(.24)	(.24)	(.22)
Δ unexpected_selic x %demand deposits	1.1	-1.4	1.3	5.4***
	(2.1)	(1.6)	(1.7)	(1.8)
N obs	27006	27048	26976	26584
N groups	810	811	811	803

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

In line with the conjecture, Tables 17 and 18 show that banks rely more on deposits for their funding respond more to changes in monetary policy. This is true for both on interest rates and loan concessions at the same three and four day window. Small and large banks differ in their funding strategy. Then, it is important to check whether results in tables 8 and 9 are robust to controlling for difference in funding strategy (see tables 23 and 24 below).

Also on the liability side, banks receive funding from the government through some programs. BNDES earmarked for working capital to small and medium-sized firms is the largest component of this kind of fund. These loans have variable but regulated rates and, by construction, should respond less to shocks on monetary policy. Tables 19 and 20 have the estimates of the models (1)B and (2)B decomposed by BNDES funding as a percentage liabilities.

Table 19: Effect on new loans by earmarked funds

Dependent variable: *New Loans* $_{t+N}$ - *New Loans* $_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
%earmarked funds	-.018	-.075	-.24	-.21
	(.22)	(.22)	(.22)	(.2)
Δ unexpected_selic	.18***	.015	-.31***	-.12***
	(.052)	(.034)	(.051)	(.026)
Δ unexpected_selic x %earmarked funds	-.16*	.0059	.31***	.14***
	(.091)	(.063)	(.094)	(.05)
N obs	45442	45404	45181	44956
N groups	1090	1087	1085	1083

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

Table 20: Effect on interest rates by earmarked funds

Dependent variable: *Interest rate* $_{t+N}$ - *Interest rate* $_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
%earmarked funds	.38	2.4	2.8	3.6
	(2.5)	(2.3)	(2.4)	(2.3)
Δ unexpected_selic	-.65***	-.84***	.55***	1.4***
	(.21)	(.21)	(.21)	(.19)
Δ unexpected_selic x %earmarked funds	.4	2.8***	1.4	.36
	(1.2)	(1)	(1.1)	(1)
N obs	27006	27048	26976	26584
N groups	810	811	811	803

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

In line with expectations, banks with a large share of earmarked BNDES funding are less sensitive to changes in monetary policy. Again, banks differ in their reliance on earmarked funds. Thus, as previously emphasized, it is important to check whether results in tables 8 and 9 are robust to controlling for difference in earmarked funding (see tables 23 and 24 below).

IV.E Ownership

Previous literature has found that ownership matters for the credit channel. Arena et al (2007) argue that foreign banks may have smaller sensitivity to changes in the basic interest rate because of access to a larger deposit base outside the country. So, foreign banks would be less likely to be financially restricted in the debt market. State-owned banks may also respond differently from privately owned banks for two reasons. First, their deposits base is more stable and less costly (savings accounts, whose interest rates are regulated), giving them an advantage in responding to deposit shocks. Second, state-owned banks are likely to have a different objective function. Tables 21 and 22 have the estimates of the models (1)B and (2)B decomposed by ownership.

Table 21: Effect on new loans by ownership

Dependent variable: *New Loans* $_{t+N}$ - *New Loans* $_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
Δunexpected_selic x Foreign	0.15**	0.03	-0.20***	-0.17***
	(0.07)	(0.06)	(0.06)	(0.05)
Δunexpected_selic x Private	0.11**	0.03	-0.22***	-0.04*
	(0.05)	(0.03)	(0.05)	(0.02)
Δunexpected_selic x State-owned	0.5**	-0.10	-0.88***	-0.28**
	(0.25)	(0.14)	(0.28)	(0.13)
N obs	45442	45404	45181	44956
N groups	1090	1087	1085	1083

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

Table 22: Effect on interest rates by ownership

Dependent variable: *Interest rate* $_{t+N}$ - *Interest rate* $_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
Δunexpected_selic x Foreign	-0.62**	-0.63**	0.86***	1.1***
	(0.31)	(0.31)	(0.31)	(0.3)
Δunexpected_selic x Private	-0.61*	-0.73***	0.37	1.3***
	(0.31)	(0.27)	(0.27)	(0.26)
Δunexpected_selic x State-owned	-0.76***	-0.64	1.1***	2.3***
	(0.29)	(0.42)	(0.31)	(0.36)
N obs	27006	27048	26976	26584
N groups	810	811	811	803

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

As suggested by previous results, banks respond (at day 3 and 4) to an increase in SELIC by reducing new loans and increasing interest rates. Interestingly, government-owned banks' responses are somewhat stronger than private ones (both domestic and foreign), although the difference is not statistically significant. Government-owned banks are larger than average, making it crucial to check whether the size effect is not an ownership effect.

IV.F Horse-racing all decompositions

So far, results suggest that only size matters. Here we estimate one big model with all decomposition to have a clearer picture of which ones are more important. Tables 22 and 23 show the results.

Table 23: Effect on new loans: horse racing

Dependent variable: *New Loans* $_{t+N}$ - *New Loans* $_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
size	0.23***	0.35***	0.5***	0.26***
	(0.07)	(0.06)	(0.07)	(0.05)
liquidity	0.05	0.24*	0.3**	0.16
	(0.2)	(0.13)	(0.14)	(0.12)
%demand deposits	0.16	0.59**	0.57*	-0.07
	(0.35)	(0.3)	(0.31)	(0.28)
%earmarked funds	0.12	0.2	0.18	-0.01
	(0.22)	(0.22)	(0.23)	(0.2)
Δ unexpected_selic x size	0.11***	0.009	-0.19***	-0.06***
	(0.03)	(0.02)	(0.03)	(0.02)
Δ unexpected_selic x liquidity	-0.56**	-0.12	0.39	-0.06
	(0.25)	(0.13)	(0.28)	(0.11)
Δ unexpected_selic x %demand deposits	0.99**	0.48	-1**	-0.18
	(0.43)	(0.34)	(0.42)	(0.23)
Δ unexpected_selic x %earmarked funds	-0.1	0.03	0.21*	0.12**
	(0.11)	(0.07)	(0.11)	(0.06)
Δunexpected_selic x Foreign	-2.1***	-0.18	4***	1.2***
	(0.74)	(0.52)	(0.73)	(0.38)
Δunexpected_selic x Private	-2***	-0.14	3.7***	1.2***
	(0.65)	(0.46)	(0.65)	(0.34)
Δunexpected_selic x State-owned	-1.9**	-0.32	3.5***	1.1***
	(0.72)	(0.54)	(0.69)	(0.37)
N obs	45442	45404	45181	44956
N groups	1090	1087	1085	1083

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

Table 24: Effect on interest rates: horse racing

Dependent variable: *Interest rate* $_{t+N}$ - *Interest rate* $_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
size	-0.08	-0.17	0.87**	0.43
	(0.32)	(0.3)	(0.35)	(0.3)
liquidity	.006	-0.18	-1.70	0.37
	(1.2)	(1.3)	(1.3)	(1.4)
%demand deposits	-1.00	1.8	2.8	-6.00*
	(3.2)	(3.9)	(3.3)	(3.3)
%earmarked funds	0.35	2.3	3.9	4.3*
	(2.5)	(2.3)	(2.5)	(2.4)
Δ unexpected_selic x size	0.16*	0.23***	0.31***	0.24***
	(0.09)	(0.08)	(0.09)	(0.07)
Δ unexpected_selic x liquidity	-3.6	-8.2***	-5.40	0.42
	(3.1)	(2.7)	(3.6)	(1.4)
Δ unexpected_selic x %demand deposits	1.4	-1.9	-0.35	4.40***
	(2.2)	(1.5)	(1.5)	(1.6)
Δ unexpected_selic x %earmarked funds	0.08	1.6	0.71	0.99
	(1.1)	(0.99)	(1)	(1)
Δunexpected_selic x Foreign	-3.9*	-4.9***	5.50***	4.80***
	(2)	(1.8)	(1.8)	(1.7)
Δunexpected_selic x Private	-3.6*	-4.7***	5.50***	4.00**
	(1.9)	(1.8)	(1.8)	(1.7)
Δunexpected_selic x State-owned	-3.6*	-3.7*	4.50**	3.90**
	(1.9)	(2)	(1.8)	(1.9)
N obs	27006	27048	26976	26584
N groups	810	811	811	803

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

When we horse-race all explanations, results are somewhat similar to those we get when estimating the models separately. We find that a stronger response by larger banks (reduce more new loans and increase more the interest rate). Banks whose funding rely more on deposits increase their interest rates more, as expected, but we find no results on quantities. Thus, we do not find these results conclusive. A higher proportion of earmarked funds is associated with a damped response in quantities, but no response in

interest rate. This is precisely as expected: earmarked funds are passed on with regulated rates. Then, prices should not respond much.

V. Conclusion

We studied the monetary policy transmission mechanism that works through bank credit in Brazil: the bank lending channel. We had access to a unique data set that include all bank credit concessions (above a threshold) in Brazil, both to firms and people. The data include the loan amount and the interest rate charged. We use the daily frequency of the new loans and interest rate information to identify bank credit supply responses to monetary policy shocks (unexpected basic interest rate changes) in a cleaner way than in the previous literature.

In contrast to the existing empirical literature for other countries, in Brazil, larger banks respond more to shocks in monetary policy than smaller ones. We do not interpret this result as evidence contrary to the theoretical mechanism behind the bank lending channel. The empirical literature typically uses US data (Kashyap, Stein and Wilcox (1993), Kashyap, Stein (2000)). The assumption – reasonable for the US - is that informational asymmetries and moral hazard problems plague smaller banks more than large ones. In Brazil the assumption is much less obviously true.

Our results have potentially important implications for the conduct of monetary policy in Brazil. The impact of changes in the basic interest rate (SELIC) is transmitted more strongly by larger banks, which hold the largest share of loans in the economy, increasing the power of monetary policy. Furthermore, market structure has been changing. In particular, consolidation has increased the size of a typical bank. Our results suggest that the power of the monetary policy through the credit channel will increase overtime.

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Appendix

Table A.I: Effect on new loans by size with weights††

Dependent variable: *New Loans* $_{t+N}$ - *New Loans* $_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
size	0.26***	0.4***	0.58***	0.3***
	(0.08)	(0.07)	(0.09)	(0.06)
Δ unexpected_selic	-2.3***	0.01	4.2***	1.4***
	(0.74)	(0.49)	(0.79)	(0.38)
Δ unexpected_selic x size	0.12***	0.001	-0.21***	-0.07***
	(0.04)	(0.02)	(0.04)	(0.02)
N obs	45442	45404	45181	44956
N groups	1090	1087	1085	1083

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

†† Weigths were defined as the sample average of the logarithim of total assets

Table A.II: Effect on interest rates by size with weigths††

Dependent variable: *Interest rate* $_{t+N}$ - *Interest rate* $_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
Size	-0.08	-0.23	0.78**	0.4
	(0.29)	(0.28)	(0.32)	(0.28)
Δunexpected_selic	-3.7*	-5.3***	-5.9***	-3.4**
	(2.1)	(1.8)	(2)	(1.6)
Δunexpected_selic xsize	0.14	0.21***	0.31***	0.22***
	(0.09)	(0.08)	(0.09)	(0.07)
N obs	27006	27048	26976	26584
N groups	810	811	811	803

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

†† Weigths were defined as the sample average of the logarithim of the total assets

Table A.III: Effect on new loans by size, excluding 2002

Dependent variable: *New Loans* $_{t+N}$ - *New Loans* $_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
size	0.38***	0.48***	0.66***	0.37***
	(0.1)	(0.08)	(0.1)	(0.07)
Δ unexpected_selic	2.3**	0.34	6.3***	2.9***
	(1)	(1)	(1.3)	(0.97)
Δ unexpected_selic x size	-0.12**	-0.02	-0.32***	-0.15***
	(0.05)	(0.05)	(0.07)	(0.05)
N obs	34599	34586	34352	34132
N groups	1080	1077	1076	1073

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

Table A.IV: Effect on interest rates by size, excluding 2002

Dependent variable: *Interest rate* $_{t+N}$ - *Interest rate* $_{t-1}$ †

	N=1	*N=2*	*N=3*	*N=4*
Size	0.17	0.05	0.93**	0.58
	(0.36)	(0.35)	(0.44)	(0.37)
Δunexpected_selic	1.4	-6.8*	-8.7**	-7.8*
	(5.1)	(3.8)	(4.1)	(4.3)
Δunexpected_selic xsize	-0.04	0.31*	0.44**	0.4**
	(0.22)	(0.17)	(0.18)	(0.19)
N obs	20691	20783	20592	20346
N groups	786	788	787	774

Robust standard deviation in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

† Source: Central Bank of Brazil

Table A.V: Credit Average maturity*

	Total			Working Loans			Consumer Credit		
	Jan 2002	Jan 2004	Jan 2006	Jan 2002	Jan 2004	Jan 2006	Jan 2002	Jan 2004	Jan 2006
Large banks	180	200	239	104	91	120	260	306	353
Medium banks	176	208	219	122	126	126	282	282	336
Small banks	317	282	311	150	269	140	407	373	407

*Maturity measured in days

Table A.VI: New Loans around monetary policy committee meetings*

	No of observations	Mean	Standard Deviation	Minimum	Maximum
Day of the meeting	45991	2.7	11.2	0	254.6
One day before	46051	3.0	12.9	0	345.9
Two days before	45547	4.1	18.0	0	362.1
Three days before	45475	3.1	13.1	0	298.6
Four days before	45479	2.8	11.9	0	307.9
Five days before	45457	3.0	13.2	0	379.9
Six days before	45441	3.4	16.3	0	1049.9
Seven days before	45381	3.8	16.9	0	360.3
Eight days before	45348	3.0	13.0	0	329.2
Nine days before	45321	2.9	12.7	0	293.2
Ten days before	45283	3.1	13.8	0	357.3

* New loans are measured in R$ million

Departamento de Economia PUC-Rio
Pontifícia Universidade Católica do Rio de Janeiro
Rua Marques de Sâo Vicente 225 - Rio de Janeiro 22453-900, RJ
Tel.(21) 35271078 Fax (21) 35271084
www.econ.puc-rio.br
flavia@econ.puc-rio.br