THE IMPACT OF CAPITAL REQUIREMENTS IN BRAZILIAN BANKS LOAN SUPPLY

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1 INTRODUCTION

Crises in the financial system of a country implicate great damages to the society, given its role as credit provider to other segments of the economy and its ability to create money. In addition, the dispersion and low level of information of a major part of its creditors – the depositors – leave them practically unable to monitor their debtors. Such peculiarities would provide enough support to justify the existence of a specific framework for regulating and monitoring the financial sector. Nevertheless, it must be reminded that creating a stable financial system implies costs, which may be direct ones – the expenses of the regulatory authority, for instance – or indirect ones, as distortions that arise, for example, from the inefficiency induced by regulatory models that rely on assumptions other than banks profit maximization (COSTA, 1999).

Considering that kind of distortion, several papers have had as scope the effect of regulatory instruments in banking decisions. Among such instruments, capital requirements are highlighted, for being the most proliferated banking regulatory model on an international basis.

Studies that evaluate its impacts on banking behavior in a theoretical perspective may be classified into three main frameworks: one that views a bank as a portfolio manager (consolidated in Kim and Santomero, 1988), a second one that regards the incentive for risk taking under asymmetric information (such as in Giammarino *et al*., 1993), and a last one which deals with incomplete contracts among depositors, managers and stockholders of a bank (Dewatripont and Tirole, 1994, p. 133). Despite being their approaches very different, all those formulations converge on their conclusions: they all admit capital requirements efficiently elaborated in order to reduce agency problems and excessive investment in risky

assets. However, they are based upon too general hypothesis and propose optimal regulatory frameworks that many authors consider infeasible (FREIXAS; SANTOMERO, 2004).

Notwithstanding, the analysis of a bank as a portfolio manager has backed the elaboration, in 1988, of the Basel Accord (BASEL COMMITTEE ON BANKING SUPERVISION, 1988), international milestone in the definition of capital requirements, which establishes that banks must hold capital levels that should be compatible with the risk of their assets.[1] From then on, more specific studies were elaborated, foregrounding the search of empirical evidence of the impact of the new regulation on the allocation of banking assets.

Basel Committee on Banking Supervision (1999) compiles a series of papers that focus on G-10 countries, evaluating whether the Accord has reduced risk-taking in the financial system, as well as whether a shortfall in credit supply or a decrease in bank competitiveness relative to other forms of intermediation may be considered its side effects. The evidence they find indicates that the Accord implementation may have induced banks to raise their capital levels and, in some countries, constrained lending activities in periods of economic weakness.

A second group of articles approaches particularly the reduction in credit supply in the USA between 1989 and 1994 (the "credit crunch"). Furfine (2001) presents a brief review of the literature that pursued an explanation for such tendency, emphasizing higher capital requirements among other possible causes (lower loan demand, more regulatory scrutiny and secular trend).

Finally, there is empirical work that explicitly treats the relation between capital requirements and credit supply, which may be classified into two subsets. The first one, which includes Peek and Rosengreen (1995), Furfine (2001), Soares (2001) and Chiuri *et al*. (2002), analyzes the impact of the adoption of higher capital requirements, comparing credit supply before and after the implementation of Basel Accord[2]. The second one, best represented by Gambacorta and Mistrulli (2004), assumes capital regulation as given as it tries to infer its influence on bank lending, basing the empirical tests only in observations after the Accord implementation.

[1] Basel Accord has been firstly implemented by G-10, being afterwards adopted by other countries.
[2] There is also Saunders and Schumacher (2000), which analyzes the issue indirectly, considering capital requirements among the components of the spread in financial intermediation.

The papers are different as far as theoretical models, samples and proxies for capitalization are concerned. Nonetheless, a common finding in all of them is a positive relation between capital indexes and credit supply.

The interpretation of such result is, however, different in each of the groups. The papers that evaluate the impact of the implementation of capital requirements verify that negative shocks on bank capital may lead to reduction in credit supply. Yet, papers that regard capital regulation as one of the determinants of bank loans find that well capitalized banks are less constrained by capital requirements and have more opportunity to expand their lending activities.

In short, the reviewed literature shows that the difficulty in accurately measuring the variables that would be involved in the optimal capital requirement scheme, and also the necessity of standardizing that regulation on a worldly basis, induced the adoption a framework that may have had as a side effect the contraction of commercial loans. On the other hand, there is evidence that after the implementation of the Accord, the most stable institutions are those that offer credit the most.

In Brazil, the last great banking crisis resulted from the termination, in 1994, of a hyperinflation conjuncture that provided banks profits from short term and low risk investments in government indexed securities, in addition to the appropriation of part of the seigniorage gains (the so-called "float"). According to Goldfajn *et al*. (2003), rapid interventions in banks with solvency problems and adoption of improvements in prudential regulation right after macroeconomic stabilization enabled Brazilian economy to overcome the turbulent status. Since then, financial system has been stable and resilient to shocks. One indicator is the decrease in the number of bank institutions submitted to temporary special administration by Brazilian Central Bank's decrees: 49 between 1994 and 1998 *versus* 10 from 1999 to 2004.

From another standpoint, one can notice the system deficiency regarding credit activities, which should be the main operation of financial intermediates. Belaisch (2003) points out that, in spite of being Brazilian financial system large relative to other emergent countries in terms of total assets, the volume of loans is low. In the year 2000, while the percentage of credit operations relative to GDP was 70% in Chile, 45% in the USA and 104% in the Euro

area, the relation in Brazil was only 25%.[3] Besides, the author shows the high relation between operational costs and operational revenues: 89% in Brazil, superior than 69% verified in other Latin American countries[4] and 61% in the USA and Japan. Another important characteristic of Brazilian banking system is the large differential between costs of funding and loan interest rates (spreads): in august 2004, the average spread was 27,5%.[5] At last, the lowermost amount of long term loans supplied by non-governmental entities deserves special mention.

The presented situation of stability and low volume/high price of credit in Brazilian banking system motivates the inquiry of the relation between capital requirements and credit supply in that country. Furthermore, one should note the relevance of such subject in the current context, when implementation rules of the New Capital Accord ("Basel 2") are being defined.

Thus, the purpose of this paper is to analyze the impact that capital requirements currently have in the credit supply of banks operating in Brazil. Note that it does not intend to compare the credit supply before and after the implementation of capital requirements in Brasil. That is, we do not evaluate the impact of the implementation of that instrument in Brazil, but instead we analyze if, once implemented, such regulation affects banks portfolio decision.

To accomplish that purpose, we determined a model of credit supply in reduced form, considering capital requirements. The model suggests that the level of capital relative to risk-weighted assets has a positive effect on the amount of credit supplied, being that effect more pronounced in banks that fail to meet its capital requirements. In order to test the implications of the model, a sample of 133 financial conglomerates or banks possessing commercial or investment portfolios was used, in the period that begins in the first quarter of 2001 and ends in the second quarter of 2004. The estimates we obtained have shown the existence of a positive relation between credit supply and a capitalization index, being that relation stronger for less capitalized banks.

Besides this introduction, other five sections will be presented. In **Section 2**, we briefly expose the *modus operandi* of capital requirements in Brazil. In **Section 3**, bearing in mind

[3] Higher, although, than Argentina's (21%) or Mexico's (22%).
[4] Argentina, Chile, Colombia, Mexico and Peru.
[5] 13,1% in loans for legal entities and 45,7% for individuals. Source: Brazilian Central Bank.

the search for empirical evidence, we develop, based on the current literature, a model of credit supply. **Section 4** describes the variables and instruments used in the estimation. The results are presented in **Section 5** and **Section 6** concludes.

2 BASEL ACCORD IN BRAZIL

In Brazil, legislation concerning capital requirements follows essentially the guidelines established on an international basis by the Basel Committee, as instituted by Brazilian Monetary Council (Conselho Monetario Nacional – CMN) Resolution n. 2.099, from September 17th 1994 and its subsequent modifications.

That resolution also states that the observance to capital limits is an indispensable condition for a financial institution to operate, and determines penalties for irregular institutions, ranging from limitation in profits distribution to the liquidation of the institution.

The core of such legislation is the Basel index, which represents, *grosso modo*, the ratio between a bank's own capital and its risk weighted assets. Loans to private sector have the highest weight, whereas government securities have zero weight. Since 1997, minimum Basel index banks are required to have is 11%. In can be noticed that institutions have been massively following the regulation. Analyzing Figure 1A, one can see that most of Brazilian institutions have, from 2001 to 2004, indexes much superior to 11%, with the median standing around 20%.

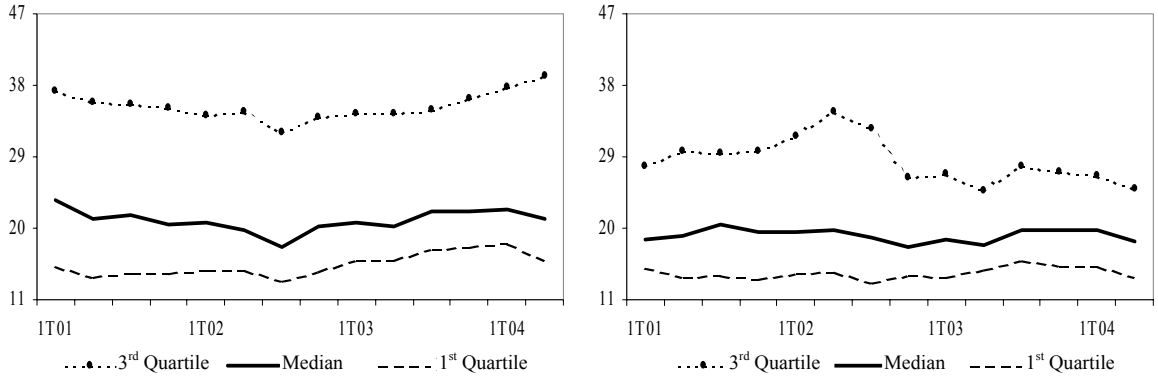

Figure 1

A) Basel index distribution per quarter in Brazilian banks

B) Basel index distribution per quarter (banks with high "loans/total assets" ratio)

One interpretation for such distribution could be the influence of banks that trade government securities as its predominant operation, consequently possessing low "loans/total assets" ratio

and thus high Basel index. Picture 1B, however, eliminates that possibility by showing that, even when only institutions with "loans/total assets" above the sample median are at stake, the incidence of Basel indexes much superior to the regulatory minimum is still dominant.

If one considers that holding a Basel index above the minimum required level implies holding more capital than necessary, and that usually capital is the most expensive funding source for a bank, there must be some kind of incentive for Brazilian banking system to consistently remain in such situation, fact that will be explored in the elaboration of a loan supply model in the next section.

3 A MODEL OF LOAN SUPPLY

The perspective of bank as a portfolio manager guides, throughout this section, the elaboration of a loan supply model, with the purpose of searching empirical evidence of how it can be affected by the imposition of capital requirements. The adopted formulation starts from a positive relation between the loans rate of return and its supplied volume. This relation is, nevertheless, shifted in a "*rate of return x quantity* plane" according to other costs stemming from the bank's decision of loan supply. More specifically, loan supply is a function of three factors:

Loan Supply = h(rates of return, capital requirements, adjustment costs)

Rates of return define the profitability of the operation, considering its opportunity cost. **Capital requirements**, core of the model, determines *costs* of regulation, whose motivation comes from Furfine (*Op. cit.*). At last, **adjustment costs** refers to the cost generated by a modification in loan supply not originated from a change of demand. h(**.**) is assumed to be a linear function.

The following items show how such issues are handled in the model.

3.1 Balance Sheet

The balance sheet consists of assets and liabilities. In the asset side, C_t is the loan supplied and T_t stands for the amount of government securities (which are assumed to be risk-free) held in instant t. In the liabilities side, D_t are the deposits and K_t is the bank own capital.

By hypothesis, the assets rates of return are associated to their credit risk. Thus, being R_t the loans rate of return, S_t the rate of return of government securities and d_t the deposits rate of payment, it is expected that $R_t > S_t > d_t$, with the rates allowed to vary in time.
Normalizing rates relative to d_t:

$$r_t = R_t - d_t \tag{1}$$

$$s_t = S_t - d_t \tag{2}$$

3.2 Rates of Return

A bank may allocate its resources either in loans or in government securities. Considering fixed the risk order of the operations, the rates of return are taken into account in the asset portfolio decision.
The loan supply C is expected to be positively related to its rate of return r, and negatively to s, as result to the incentive to the portfolio manager to increase return while controlling risk. It is assumed that those relations are linear, and being Γ_t the vector containing the other factors that determine loan supply and its relevant lags, what give us:

$$C_t = \sum_{j=0}^{m} \beta_{1j} r_{t-j} + \sum_{j=0}^{m} \beta_{2j} s_{t-j} + \Gamma_t \tag{3}$$

with: $\sum_{j=0}^{m} \beta_{1j} > 0$ e $\sum_{j=0}^{m} \beta_{2j} < 0$

The inclusion of lags of the explanatory variables is justified by the fact that the amount of loans supplied by a bank in t reflects not only the supply decision of the contemporary period, but also the decisions made in previous periods, which were determined by explanatory variables of previous periods, given the low liquidity and maturity greater than one period relative to that operation.

3.3 Capital Requirements

After Basel Accord, banks were expected to comply with risk based capital requirements:

$$IB_t = \frac{K_t}{w_1 C_t + w_2 T_t + O_t} \geq b \tag{4}$$

Formula (4) means that there is a minimum value b required for a bank Basel index (ratio between capital and risk weighted assets). w_1 is the weight for loans, defined in regulation and

known by the bank; $w_2 = 0$ is the weight for government securities and O_t corresponds to the other items that alter capital requirements (credit risk in *swaps* and market risk).

As in Furfine (*Op. cit.*), here we assume that a bank whose capital approximates the minimum level stated by the requirement faces increasing costs. That is, when a bank is close to stop complying with the regulation, supervisors may, for instance, impose restrictions in the activities of the bank or demand an increase in the credit provisioning. In addition, when a bank has already fallen below the requirement ($IB < b$), further measures may be imposed, on top of the increased intensity of those previously mentioned. Supervisors may require the institution to follow a recapitalization plan, restrict payment of dividends, or, in extreme situations, declare the liquidation of the bank.

Costs of regulation CR_t are assumed to be linear functions exclusively of the Basel index, and are defined in two continuous sections, as shown in Figure 2.[6]

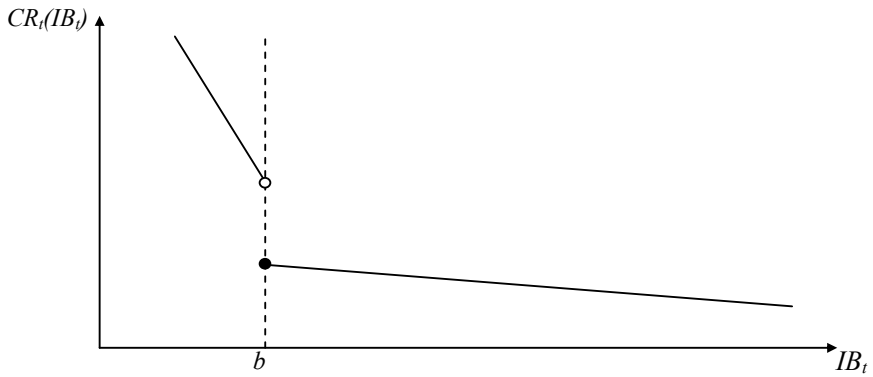

Figure 2 – Costs of regulation

In the first part, where $0 < IB < b$, the cost function has a higher intercept and is steeper. The second part, where $IB \geq b$, indicates that a bank complying with capital requirements are also subject to such costs, but with lighter intensity.[7] The discontinuity point corresponds to the minimum required level. Thus:

$$CR_t = \alpha_1 + \alpha_2 d1_t - (\pi_1 + \pi_2 d1) IB_t \qquad (5)$$

with $\alpha_1, \alpha_2, \pi_1, \pi_2 > 0$, $\pi_2 < \dfrac{\alpha_2 - \alpha_1}{b}$ and $d1 = 0$ if $IB_t \geq b$; $d1 = 1$ otherwise.

[6] In the model in Furfine (2001), those costs are continuous.

[7] Furfine's (2001) model also allows costs to have different intensities in different periods, what corresponds to increased supervision enforcement, but this issue will not be considered here.

From (4), one can check that $\frac{\partial IB_t}{\partial C_t} < 0$. From (5), one can conclude that an increase in loan supply, *ceteris paribus*, causes a reduction in IB_t, implying an increase in CR_t. That increase corresponds to a downward shift of the loan supply in the "*rate of return x quantity* plane". Thus, an increase in the rate of return of loans (or a decrease in *s*, which would produce the same qualitative effect), which would result in an increase in the quantity supplied, is attenuated by the increase in the costs of regulation, and the net effect is a diminished increase in the loan supply. That is, a bank with higher *IB* in *t-n* incurs lower costs of regulation and has higher incentive to increase its loan supply in *t* relative to a situation where its capitalization is lower. Assuming loan supply is shifted on a proportional basis relative to the increase in costs of regulation:

$$C_t = -\sum_{j=0}^{m} \gamma_j CR_{t-j} + \Gamma_t, \quad \sum_{j=0}^{m} \gamma_j > 0 \tag{6}$$

And, consequently:

$$C_t = \sum_{j=0}^{m} \left[-\eta_{1j} - \eta_{2j} d1 + \left(\phi_{1j} + \phi_{2j} d1_{t-j} \right) IB_{t-j} \right] + \Gamma_t \tag{7}$$

Equation (7) presents a positive relation between loan supply and the capitalization index (ϕ_1), being such effect more pronounced in banks that fail to comply with the regulation (ϕ_2). The presented formulation differentiates the case where a possible positive relation between *IB* and the loan supply is observed simply because of the existence of extremely sub-capitalized banks (low *IB*), which are explicitly forced to reduce their loan operations or to increase its capital, from the case where such cost is less intense, although incurring even in more capitalized banks.

These relations harmonize with the specifications evaluated by Peek and Rosengreen (*Op. cit.*) and Chiuri *et al.* (*Op. cit.*), and are also compatible with other theoretical reasons that would explain a positive relation between a capitalization index and loan supply. In Saunders and Schumacher (*Op. cit.*) and Gambacorta and Mistrulli (*Op. cit.*), for instance, banks often endogenously chose to maintain capital levels above the requirements as a preventive measure against shocks on their patrimony due to uncertainties like default risk. Thus, under a maximizing behavior, they could avoid lending pursuing to reduce the risk of capital inadequacy in the future.

In summary, when other factors that affect loan supply are controlled, banks with higher Basel indexes will have supply more loans. Furthermore, this effect is expected to be exacerbated in banks whose capitalization falls below the requirement.

3.4 Adjustment Costs

If a bank intends to modify its loan volume in a way different from that dictated by the demand, it will incur costs. Reasons for such adjustment costs could be the brake of implicit contracts *a la* Sharpe (1990), loss of scale (Diamond, 1984) or loss of income (Berger *et al.*, 1993) in the case of supply reduction when demand is increasing, or the decrease in the quality of the operations the bank may face when it wishes to increase supply when demand is low.

Therefore, adjustment costs are minimum when loan supply increases at a rate identical to that of the demand, which implies that, for each bank, a modification in loans concession stemming from a modification in demand will not have costs, whereas as modification originated by a change in supply will result in costs.

With C_t^* being the demand faced by a bank, adjustment costs CA_t are given by:

$$CA_t = \delta\left(C_t - C_t^*\right)^2 \tag{8}$$

However, demand is not directly observable. One can assume, nevertheless, that banks will not consistently supply loans in a quantity different from the quantity demanded, objecting to reduce CA_t. Consequently, given the other variables that affect credit supply, it will be, in t, proportional to credit supply in t-1 and to other variables that shift demand. Such variables may be either macroeconomic ones or bank's own characteristics that indicate a shift of its demand.[8] Hence:

$$C_t = \lambda C_{t-1} + \sum_{j=0}^{m} \theta_j Y_{t-j} + \phi_j \psi_t + \Gamma_t \tag{9}$$

with Y_t a vector containing macroeconomic variables that shift demand and ψ_t a vector of bank characteristics.

[8] One can notice that some macroeconomic variables, besides indicating demand shifts, also shift loan supply. The latter effect is captured by changes in r and s. See Section 5.3.

3.5 Loan Supply

From (3), (7) and (9), the following reduced form of loan supply is obtained:

$$C_t = \alpha' + \lambda C_{t-1} + \sum_{j=0}^{m} \beta_{1j} r_{t-j} + \sum_{j=0}^{m} \beta_{2j} s_{t-j} + \sum_{j=0}^{m} \left[-\alpha_{2j} d1 + \left(\pi_{1j} + \pi_{2j} d1_{t-j} \right) IB_{t-j} \right] + \sum_{j=0}^{m} \theta_j Y_{t-j} + \phi_j \psi_t + c + u_t \quad (10)$$

where c is a vector containing bank non-observable characteristics, constant in time, that affect loan supply, and u_t corresponds to the other factors that explain loan supply not included in the model.

4 ESTIMATION

In this section we present a brief discussion on the variables used in the estimation of the reduced form of the loan supply and also on the sample. Data source is *Plano Contábil das Instituições do Sistema Financeiro* – COSIF, which contains the accounting data of all the banks that operate in Brazil.

4.1 Loan Supply

As dependent variable we used $\log(C_{it})$, the natural logarithm of the total non directioned loans supplied by bank i at period t. This variable is compatible with the hypothesis from the theoretical model that banks supply loans considering profit opportunities, and not because of legally oriented credit concession programs.

4.2 Rates of Return of Assets

Variables r_{it} and s_{it} correspond, respectively, to the rates of return of loans and government securities, both net of deposit costs. The proxies that we used consist of the quarterly income of each operation divided by the average balance of the operation in the same quarter, netting out deposit payment rate (calculated the same way). We assume that the proxies are redundant in the structural equation, and that the correlation between real rates of return (not observable) in t and the other explanatory variables in s is zero, for $s \geq t$ when the proxies are included.
An alternative measure for the rates of return could be the interest rates effectively charged by banks (*ex-ante* prices), but it was not used because of the unavailability of the daily supplied

loan volumes that would be necessary for the calculus of a monthly weighted average. Furthermore, for the calculation of the rate of return of government securities, only *ex-post* prices were available.

4.3 Regulatory Variables

Costs referring to regulatory capital levels – whose existence constitutes the hypothesis to be tested in this paper – are evaluated by the inclusion of the variables $\log(IB_{it})$ (logarithm of the Basel index IB for bank i at period t), $d1_{it}$ (dummy variable indicating if bank i's IB falls below regulatory minimum at t), the interaction of both variables and their lags.

It is plausible to admit that those variables might be correlated to non-observable factors that also affect loan supply. For instance: the expansion of the loan supply may be related to any evaluation of the bank based on the market, which would be reluctant to finance less capitalized institutions. In this case, the coefficient of $\log(IB_{it})$ would measure not only the effect of bank supervision but also the effect of market discipline on the loan supply, and the variable would be considered endogenous. Another source of endogeny would the negative relation between loan supply and Basel index, as shown in (4). To cope with this issue, an instrumental variable *insp* will be used, corresponding to the total *in-loco* supervisory exams, measured in *days x men*, that each institution was submitted to per quarter. We assume that *insp* is statistically significant in the linear projection of $\log(IB_{it})$, $d1_{it}$ and $d1_{it}\log(IB_{it})$ on the exogenous variables and not correlated to the error in equation (10).

4.4 Macroeconomic Variables

Vector Y_{it} includes an indicator of aggregate level of production $\log(PIB_t)$, an indicator of the interest rate paid by government securities $Selic_t$, the nominal exchange rate $Cambio_t$ and the variation of a price index $IPCA_t$. One can notice that those variables control also the effect of temporal macroeconomic variations.

The hypothesis that growing economic activity implies increased loan demand justify the inclusion of an indicator of aggregate level of production. The nominal exchange rate Real/Dollar and the average interest rate paid by government bonds have a double effect. On the one hand, they shift the loan supply by affecting its opportunity cost (changing rates of return of securities whose price is totally or partially determined in foreign currency or by the interest rate of government bonds). On the other hand, they shift the loan demand because their volatility indicates uncertainty and alters expectations related to the macroeconomic

conjuncture, given the actions of private agents and the monetary authority [see, for instance, Koyama and Nakane (2002)]. The rate of inflation is also considered for that effect.

4.5 Characteristics of Banks

Vector ψ_{it} contains a dummy variable indicating if the bank is owned by the government ($Publico_i$), the ratio of bank i's total assets relative to the system total assets in t ($AtivoAT_{it}$) and a liquidity indicator [$\log(Liquidez_{it})$].

4.6 Sample

Our sample is composed by all financial conglomerates that contain at least one commercial or one investment bank and that made the option of calculating Basel index on a consolidated basis, and by commercial or investment banks that calculate their Basel index on an individual basis ("banks" from now on).[9] We included only banks that had loan operations. The sample starts with 133 banks and finishes with 118. Data were adjusted for mergers and acquisitions that occurred in the sampling period[10], as well as for banks that calculated Basel index individually and changed for a consolidated calculation and *vice-versa*.[11] Data are quarterly, ranging from January 2001 to june 2004 (14 quarters).
Table 3 presents the main descriptive statistics of the mentioned variables.

Table 3 – Descriptive Statistics

Variable	Observations	Average	St. Deviation	Minimum	Maximum
log(*C*)	1732	5,35	2,28	-6,21	10,76
r	1717	4,49 % p.q.	50,93 % p.q.	-2075,86 % p.q.	170,60 % p.q.
s	1653	1,37 % p.q.	13,24 % p.q.	-196,51 % p.q.	399,66 % p.q.
log(*IB*)	1755	3,24	0,79	1,06	11,00
*d*1	1755	0,02	0,13	0	1
*d*1 log(*IB*)	1755	0,04	0,29	0	2,40
log(*PIB*)	14	4,90	0,03	4,86	4,95
Selic	14	4,52 % p.q.	0,72 % p.q.	3,64 % p.q.	6,00 % p.q.
Cambio	14	2,82 R$/US$	0,47 R$/US$	2,06 R$/US$	3,60 R$/US$
IPCA	14	2,28 % p.q.	1,52 % p.q.	1,15 % p.q.	6,56 % p.q.
Público	1755	0,12	0,32	0	1
AtivoAT	1755	0,80 %	2,44 %	0,00 %	20,02 %
log(*Liquidez*)	1754	1,759	3,617	-5,924	16,172

[9] Development banks were not considered due to their specificities regarding asset allocation and funding.
[10] When a bank is acquired by a conglomerate, it is removed from the sample, and data from the acquiring bank include also data from that bank.
[11] That was done by considering as one same sectional unity a bank that used to calculate its Basel index on an individual basis and begun to do it on a consolidated basis.

5 RESULTS

The model was estimated folloing Arellano and Bond's (1991) proposed procedure for the generalized method of moments (GMM). The estimated specification corresponds to equation (10) and includes one lag of the dependent variable, lags of the variables related to costs of regulation and contemporary correlation and one lag of the other explanatory variables.

Such specification, on the one hand, is compatible with the average maturity of Brazilian banking loans (213 days in August 2004). On the other hand, it reflects the fact that the actions of the banking supervision are lagged relatively to banking operations. For these reasons, contemporary correlation of variables related to costs of regulation were not included (Basel index and indicator of capital inadequacy).[12]

Table 4 presents the results in three parts. **Panel a** displays the sum of coefficients of statistically significant variables (at 5% level) of each variable. **Panel b** displays the sum of coefficients that were not statistically significant at the 5% level.

Panel c displays the test statistics for the specification tests proposed by Arellano and Bond (*Op. cit.*).

[12] In addition, the exclusion of contemporary lags of such variables allows us to better control their endogeny.

Table 4 – Results of Estimation

Theoretical model of estimation is the version proposed by Arellano and Bond (1991) of GMM. Besides *insp*, variables *PIB*, *IPCA*, *Câmbio*, *Selic* and *Público* are included in the instrumental variables matrix. *r*, *s*, *AtivoAT* and *log(Liquidez)* are used as instruments only for future periods. *Público* is included in the equation only after data have been differentiated. Usual hypotheses concerning relation between instruments and regressors are assumed. Coefficients were obtained at the first stage of the estimation, with heteroskedasticity robust standard errors. Test statistics for 1st and 2nd order errors correlation (m_1 and m_2) were calculated at both stages, and the test statistic for validity of instruments (s), at the second stage.

a. GMM Estimator – Sum of Statistically Significant Coefficients at 5%

Dependent Variable: $\Delta\log(C_{it})$

Explanatory Variable	Coeficient	Standard Error	p-value
$\Delta\log(C_{t-1})$	0,794	0,086	0,000
Δr	0,202	0,053	0,000
Δs	0,365	0,119	0,002
$\Delta d1$	-1,707	0,652	0,009
$\Delta\log(IB)$	0,256	0,113	0,024
$\Delta d1\log(IB)$	0,813	0,278	0,003
ΔPIB	2,272	0,798	0,004
$\Delta Selic$	-10,521	5,430	0,053
$\Delta Cambio$	-0,182	0,053	0,001

b. GMM Estimator – Sum of not Statistically Significant Coefficients at 5%

Explanatory Variable	Coeficient	Standard Error	p-value
$\Delta IPCA$	4,676	3,254	0,151
Público	0,007	0,010	0,518
$\Delta AtivoAT$	6,754	4,915	0,169
$\Delta\log(Liquidez)$	0,001	0,008	0,898

c. Specification Tests

Test Statistic	1st Stage		2nd Stage	
	Calculated Value	p-value	Calculated Value	p-value
m_1	-2,95	0,003	-2,63	0,009
m_2	-0,75	0,455	-0,75	0,451
s	-		116,82	1,000

5.1 Specification Tests

2nd order non-autocorrelation of first-difference errors, evaluated by test statistic m_2, cannot be rejected, which indicates non-autocorrelation of errors in level. The test for the validity of instruments, performed at the second stage regression and evaluated by the *s* statistic fails to reject the null hypothesis.

Therefore, one cannot reject the assumed hypotheses for consistency of the estimation.

5.2 Analysis of Results

5.2.1 Capital Requirements

Analyzing the estimated coefficients, it is possible to see that holding a Basel index below the minimum required, as expected from a theoretical point of view, reduces significantly the supply of loans of a bank. Besides, both the Basel index as the interaction with the capital inadequacy indicator have positive signs and are statistically significant.

Hence, *ceteris paribus*, banks with lower levels of capitalization will be those with the lowest supply of loans in future periods. Considering also the exogeny hypothesis for that variable, such result corroborates the acceptation of the main hypothesis of this paper: capital requirements do affect loan supply of banks operating in Brazil, even when legal undercapitalization is controlled. Its worth highlighting that this result – a positive relation between a capital index and loan supply – is aligned with results found by Peek and Rosengreen (*Op. cit.*), Chiuri *et al.* (*Op. cit.*) and Gambacorta and Mistrulli (*Op. cit.*)

The results from the estimation allows us also to check the expected effect of a change on the minimum required level for the Basel index (*b*) on the loan supply of bank on a limit situation ("marginal bank"). *Ceteris paribus*, before the alteration of *b*, the expected loan supply for the marginal bank is:

$$\sum_{j=0}^{m} \phi_{1j} \Delta \log\left(IB_{it-j}\right) + other\ \ factors \qquad (11)$$

After an increase in *b*, the marginal bank has a capital inadequacy, and its expected loan supply is then:

$$\sum_{j=0}^{m} \eta_{2j} \Delta d1_{it-j} + \sum_{j=0}^{m} \phi_{1j} \Delta log\left(IB_{it-j}\right) + \sum_{j=0}^{m} \phi_{2j} \Delta d1_{it-j} \; log\left(IB_{it-j}\right) + other \; factors \tag{12}$$

The expected effect in the loan supply of the marginal bank is given, therefore, by (12) – (11):

$$Expected \; effect = \sum_{j=0}^{m} \eta_{2j} \Delta d1_{it-j} + \sum_{j=0}^{m} \phi_{2j} \Delta d1_{it-j} \log\left(IB_{it-j}\right) \tag{13}$$

Substituting the coefficients with the estimated values (with $IB = 11$ in Brazil):

$$Expected \; effect = -1{,}707 + 0{,}813 \cdot \left(2{,}398\right) = 0{,}242$$

Therefore that the elevation of the minimum required level of Basel index is insufficient to reduce the supply of loans of a marginal bank, meaning that, for this kind of bank, there is no trade-off between solvency and loan supply.

The results obtained here have also an implication in terms of formulation of banking regulation. As exposed, the fact that brazilian banks have high levels of capital does not mean that, on average, capital requirements do not affect them. Given the established causal relation, when its capital level is reduced, even without touching the minimum requirement, the average bank would reduce its loan supply, and consequently, its exposure to risk. Thus, the formulator of the policy should consider that the existence of costs of regulation and incentives for banks to maintain capital levels above the minimum requirement indicates that the legal minimum level could be somewhere below the ideal minimum level to be held by banks in order to assure systemic stability.

It is worth highlighting that, in spite of the existence of high loan interest rates and low loan volume in Brazil, and also highly capitalized banks, the results we found does not allows one to establish a conflictive relation between financial system stability and efficiency in credit concession.

5.2.2 Other Explanatory Variables

The coefficient for the lagged dependent variable was estimated at significance level below 1%, and the value was below 1, what indicates the model is stationary.

The rate of return of loans, as expected, is positively related to loan supply. However, the rate of return of government securities is also significantly positive. Nevertheless, the effect of that indicator may have been captured by the variable *Selic*, which is significantly negative. A negative relation between loan supply and *Selic* aligns to other results already found, such as Takeda (2003) and Graminho and Bonomo (2002).[13]

The relation between loan supply and the economic activity is also significantly positive, corroborating the hypothesis that higher economic activity generates more demand for loans. The exchange rate is negatively related to the dependent variable. A possible explanation is the fact that increases in Real on the price of dollar elevate the profitability of government securities. Another feasible explanation is that devaluations of the exchange rate may reflect conjunctures of higher risk, when supply of credit is reduced. Variations in the inflation index *IPCA* may not be considered significant in this model. One justification is that its effect may have been captured either by *Selic* or by the exchange rate, which it is strongly correlated with.

5.2.3 Other Specifications

Other specifications were evaluated, considering different lags included, other indicators of rate of return of assets, capital inadequacy, bank characteristics and macroeconomic variables, which did not alter the qualitative results.

6 CONCLUDING REMARKS

This paper presented theoretical reasons why capital requirements may affect banks loan supply. That would be mainly because this kind of regulation would impose an additional cost to the concession of loans and would alter banks profit maximizing portfolio decision. Besides, we verified that most of Brazilian banks consistently hold capital levels above the requirements.

These factor motivated the elaboration of a model whose main hypothesis is the incidence, on loan operations, of "costs of regulation", that would be negatively related to a bank's capital level. Under that hypothesis, one expects to find, *ceteris paribus*, banks with higher capital levels (Basel index) with higher loan supply.

[13] Although the latter found a non significant relation when analyzing only large banks or medium-sized banks.

The hypothesis was tested by means of the estimation of the model using a GMM approach. The results indicate a positive relation between the Basel index and loan supply, accentuated in banks not in compliance with capital requirements, highlighting the importance of capital regulamentation on bank's portfolio decision, as was predicted by the model, and previously verified in other papers. One implication is the possibility of establishing as the legal minimum requirement a lower level than the ideal one form the perspective of stability of the banking system. We highlight the importance of such result in the current context of definitions for the new Basel accord.

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