ISSN 1518-3548

BANCO CENTRAL DO BRASIL

Working Paper Series 187

The Influence of Collateral on Capital Requirements in the Brazilian Financial System: an approach through historical average and logistic regression on probability of default

Alan Cosme Rodrigues da Silva, Antônio Carlos Magalhães da Silva, Jaqueline Terra Moura Marins, Myrian Beatriz Eiras da Neves and Giovani Antonio Silva Brito

June, 2009

ISSN 1518-3548
CGC 00.038.166/0001-05

Working Paper Series	Brasília	n. 187	Jun.	2009	p. 1-47

Working Paper Series

Edited by Research Department (Depep) – E-mail: workingpaper@bcb.gov.br

Editor: Benjamin Miranda Tabak – E-mail: benjamin.tabak@bcb.gov.br
Editorial Assistent: Jane Sofia Moita – E-mail: jane.sofia@bcb.gov.br
Head of Research Department: Carlos Hamilton Vasconcelos Araújo – E-mail: carlos.araujo@bcb.gov.br

The Banco Central do Brasil Working Papers are all evaluated in double blind referee process.

Authorized by Mário Mesquita, Deputy Governor for Economic Policy.

General Control of Publications

Banco Central do Brasil

Secre/Surel/Dimep

SBS – Quadra 3 – Bloco B – Edifício-Sede – 1º andar

Caixa Postal 8.670

70074-900 Brasília – DF – Brazil

Phones: +55 (61) 3414-3710 and 3414-3567

Fax: +55 (61) 3414-3626

E-mail: editor@bcb.gov.br

Consumer Complaints and Public Enquiries Center

Banco Central do Brasil

Secre/Surel/Diate

SBS – Quadra 3 – Bloco B – Edifício-Sede – 2º subsolo

70074-900 Brasília – DF – Brazil

Fax: +55 (61) 3414-2553

Internet: http//www.bcb.gov.br/?english

The Influence of Collateral on Capital Requirements in the Brazilian Financial System: an approach through historical average and logistic regression on probability of default*

Alan Cosme Rodrigues da Silva**
Antônio Carlos Magalhães da Silva
Jaqueline Terra Moura Marins
Myrian Beatriz Eiras da Neves
Giovani Antonio Silva Brito***

Abstract

The Working Papers should not be reported as representing the views of the Banco Central do Brasil. The views expressed in the papers are those of the author(s) and do not necessarily reflect those of the Banco Central.

Using data drawn from the Brazilian Central Bank Credit Information System, this paper evaluates the impact of the use of collateral on the probability of default and, consequently, on capital requirement levels in the Brazilian financial system. Literature suggests that the existence of collateral in some credit operations increases the debtor's readiness to honor its commitment and, therefore, could result in a lower probability of default. The methodology used to calculate capital requirements is based on the Basel II IRB-Foundation Approach, although the probabilities of default have been estimated by historical averages following Basel II orientation, and corroborated by a logistic regression model. The test of hypothesis about difference between collateralized and uncollateralized probabilities of default for each risk class indicates that they are statistically different. This result was obtained both from historical average probability of default as from logistic regression model.

* Our gratitude to Marcelo Aragão and Priscilla Gardino for their collaboration in data treatment and for manipulating the SAS software. We would also express our thanks to Alcir Palharini, Plínio Romanini and Guilherme Yanaka, as well as to those who reviewed the article. The views expressed in this article are the exclusive responsibility of the authors and do not represent positions taken by the Central Bank of Brazil or its employees.

** Research Department, Central Bank of Brazil. E-mail: alan.cosme@bcb.gov.br; antonio.magalhaes@bcb.gov.br; jaqueline.terra@bcb.gov.br; myrian.neves@bcb.gov.br

*** Department of Off-site Supervision and Information Management, Central Bank of Brazil. E-mail: giovani.brito@bcb.gov.br

Under specific conditions, including the 11% capital requirement adopted in Brazil and Loss Given Default set at 45%, this paper also seeks to identify an equivalence factor of the ratio between capital requirements for credit risk in the Standardized Simplified Approach and that calculated through the IRB-Foundation Approach. For the sample utilized, the results indicate that collateralized nonretail operations have an average default probability of 2.46% and an equivalence factor of 60%. In contrast, uncollateralized nonretail operations have an average default probability of 6.66% and an equivalence factor of 93%, quite close to the 100% weighting factor of the Standardized Simplified Approach.

Keywords: Credit Risk, Probability of Default, Collateral, Basel II.
JEL Classification:G21

1. Introduction

Announced in June 2004, the New Capital Accord (Basel II)[1] introduces a series of principles and recommendations aimed at enhancing international financial system protection and solidity. Among other things, the Accord specifies parameters for calculating regulatory capital needed to cope with the market, credit and operational risks to which financial institutions are subject.

By expanding utilization of credit risk mitigating instruments in reducing capital requirements, Basel II innovates in the calculation of capital requirements. Viewed in terms of the borrower's probability of default, this paper seeks to assess the impact of utilization of collateral on capital charge (CC) levels of National Financial System institutions. The analysis restricts itself to the segment of nonretail operations[2], since a specific weighting factor has already been determined for the retail segment[3].

The Basel Committee developed two approaches to calculating CC on credit risk portfolio: the Standardized Approach and the Internal Rating-Based Approach or IRB Approach. In both cases, CC on credit risk is a percentage of the value of the institution's exposure, weighted by risk factors. However, the difference between the two approaches is found in the way the risk weighting factors are obtained: in the first approach, ratings specified by external agencies or parameters determined by regulatory entities are used, while internal rating systems developed by the financial institutions themselves are used in the second approach.

This study uses the IRB Approach as the CC calculation model since, with implementation of the Standardized Simplified Approach (SSA), the next CC model to be adopted by financial institutions in Brazil will most likely be the IRB Approach.[4]

There are two CC calculation methods in the IRB Approach: the IRB-Foundation Approach, in which PD is estimated by the banks and the other risk components – LGD (Loss Given Default), EAD (Exposure at Default) and M (Maturity)

---

[1] *International Convergence of Capital Measurement and Capital Standards – A Revised Framework, Basel Committee on Banking Supervision*, BIS, 2004.

[2] In this segment, only operations classified as "specific nature" and based on nonearmarked resources were considered.

[3] According to the Brazilian Central Bank Circular 3.360/2007, the weighting factor is 75%.

[4] Following the schedule presented in Brazilian Central Bank Communiqué n. 12,746/2004.

- are given by the supervisory entity, and the IRB Advanced Approach, in which all risk components are estimated by the institutions.

The basic version of the IRB Approach is used in this study in order to verify the impact that the use of collateral provokes on PD and, consequently, on CC in the IRB Foundation Approach.

It should be mentioned that literature recognizes the direct impact of collateral on LGD, since it raises the rate of credit recovery. Nonetheless, some studies evaluate the relation between collateral and borrower risk. Stiglitz and Weiss (1981) observe a different context to study collateral and borrower risk relationship. According to them, in the credit market, the information asymmetry between borrower and lender can lead to problems such as adverse selection and moral hazard[5]. In this case, the price forming mechanism is not efficient. The interest rates are greater and only riskier projects are selected, which leads to a worsening of the portfolio credit quality. In this context, the collateral is used as a discipline mechanism, acting as an incentive to less risky behaviors. In other words, the presence of collateral would be associated to a smaller PD. Wette (1983) describes that Stiglitz and Weiss' (1981) reasoning related to adverse selection also occurs on environments where the clients are risk neutral.

According to Bester (1985), financial institutions decide to grant credit based on a simultaneous choice of interest rates and collateral according to the operation/borrower risk level. Besides, Bester (1995) shows that low default probability clients are more inclined to accept greater collateral volume request from financial institutions than greater interest rates. Among riskier loans, the reasoning is the inverse.

Besanko and Thakor (1987) also study the loan grant in an asymmetric information context (a priori, lenders do not know borrowers´ PD) under a multidimensional pricing model which considers credit value, interest rate and collateral required, as well as possibility of rationing. The authors found a negative relationship between collateral and borrower risk.

Boot, Thakor and Udell (1991) try to answer theoretical and empirically the following question: under which conditions there is a positive relationship between

[5] Santos (2005) argues that information asymmetry and adverse selection are more relevant for micro and small companies credit market compared to corporate credit market, because banks invest more on better knowledge about their potential clients.

borrower risk and collateral? In this case, the authors develop a competitive equilibrium analysis, also considering moral hazard and private information issues. The first issue would come from lenders incapacity to observe, after the loan is granted, the borrower´s actions that would affect the projects payoff from which the loan would be paid. The second issue would come from the fact that lender does not know borrower risk profile before loan granting; such would be a borrower private information (asymmetric information). The authors show that collateral is a powerful instrument to mitigate moral hazard, although this imposes deadweight repossession cost to lender. Thus, the authors obtain a positive relationship between collateral requirements and borrower risk. Though, when it is considered the private information in analysis, this positive relationship may be accented or diminished, being possible to observe greater collateral requirement from riskier or less risky borrower.

In this way, according to Jimenez and Saurina (2004), there are two alternative interpretations of the relationship between collateral and the borrower's PD. On the one hand, assuming that the possibility of execution is very small, low risk borrowers prefer to offer high-quality collateral. Consequently, collateral functions as a signal, making it possible for the institution to reduce the problem of adverse selection caused by informational asymmetry between the institution and the borrower at the moment in which the loan is granted. Therefore, a negative relationship between collateral and PD would be expected, based on the hypothesis that collateral is a sign of a high-quality borrower.

On the other hand, there is a general perception among lenders that the need for collateral is associated to the low quality of the credit, thus resulting in a positive relationship between collateral and PD. Using the first interpretation, this paper investigates a possible indirect impact of collateral on PD that, following the IRB Approach, influences capital charge levels of the institutions involved.

Various studies have dealt with the question of estimating PD. In Brazil, Schechtman et al. (2004) utilize a credit scoring model based on logistic regression to calculate the PD of a credit portfolio through the use of data drawn from the Central Bank's former Credit Risk Center (CRC). The purpose of that study is to identify the significant variables that influence PD.

Parente and Costa (2003) use CRC data to verify the importance of information drawn from public centers in evaluating the credit risk of Brazilian companies. Utilizing a default forecasting model, the authors identified the variable related to the credit volume in arrears as the most important in explaining borrower behavior. Parallel to this, the variable related to co-obligations indicates that a company's PD drops as the level of collateral increases.

Based on a one year migration matrix, Carneiro et al. (2005) defines the proxy for PD. This matrix is calculated according to the client quantity criterion from 2002 to 2004 for each banking entity included in the study. The concept of delinquent credits identified in the study is that used for clients with risk classifications from E to H. This criterion is based on Resolution n. 2,682, dated December 21, 1999, which determines that credits overdue for more than 90 days are to be rated no higher than E[6].

Using the IRB Foundation Approach and based on credit operations registered in the Central Bank Credit Information System (CIS) between June/2004 and June/2006, the objective of this paper is to assess the indirect impact through PD of utilization of collateral on the CC of financial institutions. The CIS is the credit operation databank that succeeded the CRC. The original system was implemented in 1997 by CMN Resolution n. 2,390, dated May 22, 1997, which determined that financial institutions were obligated to send information on their clients' debts and liabilities for guarantees to the Central Bank of Brazil. In 2002, Circular n. 3,098, dated March 20, 2002, broadened the scope of the information included in the database, thus giving rise to the CIS.

As one result, the paper identifies the risk weighting factors that equalize total CC[7] between the SSA and the IRB Foundation Approach. It should be mentioned that in Brazil, the regulation indicates lower weighting factors for specific exposures, which were not included in this study. From the exposures that SSA deals in the same way, with no discrimination between collateralized and uncollaterized operations, the calculation of the equivalence factor aims to verify the existence of a possible differentiation of the risk weighting factor for collateralized operations.

[6] Except in those cases in which maturity of the operation is greater than 36 months. In this case, calculation of twice the period of arrears is permitted according to the terms of the cited Resolution.
[7] Defined here as capital requirements (CC) plus provisions.

The study is divided into four sections. The following section describes the methodology employed. The results are found in the third section, followed by conclusions in the fourth and final section.

2. Methodology

In Brazil, the regulation defining SSA was issued on September/2007 through the Resolution 3.490 and Circular 3.360, which determined that CC on credit risk, known as the Portion referring to Risk Weighted Assets – P_{RWA}, must be at least equal to:

$$P_{RWA} = 0{,}11 \times \sum_j RWA_j = 0{,}11 \times \sum_j \left[RWF_j \times \left(EAD_j - \Pr ov_j \right) \right], \quad (1)$$

in which:

RWA_l= Risk Weighted Asset of the j-th operation, net of provisions;

RWF_j= Risk Weighting Factor of the j-th operation;

EAD_j= Exposure at Default, equal to the debt balance of the operation on the date of calculation; and

$Prov_j$= Provisions of the j-th operation, calculated according to the terms of Resolution n. 2,682/99.

According to the regulation, the Brazilian Central Bank defined standardized RWFs for the credit operations of all financial institutions. Recognizing the effect of credit risk mitigators, as stated in the Basel II Accord, Circular 3.360/2007 indicated lower weighting factors for specific exposures. For example, depending on the relationship between the debt balance of the operation and the assessment value of the collateral, the weighting factor can be as low as 35% in real estate financing guaranteed by chattel mortgages and 50% in mortgage-guaranteed home loans. The standard factor was set at 100% for exposures for which no specific FPR was defined.

In the IRB Approach, exposures are divided into classes and each class has its own specific risk weighting function. The exposure classes are as follows: corporate

exposure (five subclasses), sovereign exposure, bank exposure, retail exposure (three subclasses) and equity exposure.

According to the IRB Approach, CC for corporate, sovereign and bank exposure is calculated as follows:

$$CC = 8\% \times \sum_j RWA_j \ , \tag{2}$$

in which:

$$RWA = K \times \left(1 \diagup 8\%\right) \times EAD \ , \tag{3}$$

K (Capital Requirement), for exposures not in *default*[8]:

$$K = \left[LGD \times N\left(\frac{N^{-1}(PD)}{\sqrt{(1-R)}} + \sqrt{\left(\frac{R}{1-R}\right)} \times N^{-1}(0{,}999) \right) - PD \times LGD \right] \times \frac{(1+(M-2{,}5)\times b)}{(1-1{,}5\times b)} \tag{4}$$

K (Capital Requirement), for exposures in *default*:

$$K = \max\left[0; \left(LGD\ - LGD_{Estimated}\right)\right], \tag{5}$$

$$b\left(maturity\ \ adjustment\right) = \left(0{,}11852 - 0{,}05478 \times \ln(PD)\right)^2 , \tag{6}$$

$$R(Correlation) = 0{,}12 \times \frac{\left(1-e^{(-50\times PD)}\right)}{\left(1-e^{(-50)}\right)} + 0{,}24 * \left[1 - \frac{\left(1-e^{(-50\times PD)}\right)}{\left(1-e^{(-50)}\right)}\right], \tag{7}$$

The parameters above must be calculated separately for each credit exposure. In the IRB-Foundation, LGD is set at 45% and M at 2.5 years.

In this study, the basic version of the IRB Approach was employed. Consequently, estimation of the debtors' PDs became a *sine qua non* condition for calculating CC on the credit risk of the exposures and evaluating the impact of the utilization of mitigators on this charge.

The mitigating instrument considered in this study was collateral. This study is not based on the personal collateral mitigator, since this type of collateral would result in estimation of PDs associated to the guarantor and not to the borrower. Identification of personal guarantors would demand cross-referencing of data that would be extremely costly in operational terms and, therefore, would go well beyond the scope of this study. The major types of collateral in the CIS are mortgages, chattel mortgages, liens and

[8] In equation (4), N(.) and N^{-1}(.) are the cumulative distribution functions of the Standardized Normal and its inverse, respectively.

credit assigns. It is important to underscore that this study considered only the question of whether the operation did or did not have collateral registered in the CIS, without reference to the value of such collateral. The reason for this is that this information is obligatory only for relevant operations or, in other words, those with values of more than R$ 5 million.

It should be mentioned that although, in Brazil, only the biggest banks should apply for the IRB Foundation model, in this study all the banks were included since the operations in the CIS are not identified.

The starting point of this paper is a set of credit operations used to calculate the PDs of the borrowers/operation in each risk category, according to the terms of Resolution n. 2,682/99. The set of credit operations in question was the stock of nonretail operations or, more specifically, all operations with clients with overall liability[9] of more than R$ 100,000.00 registered in the CIS on June 30, 2004. Aside from this, only operations granted by the institution and still in its active portfolio and operations based on nonearmarked resources were utilized. Consequently, such operations as those based on BNDES[10] resources were excluded.

One of the reasons underlying exclusion of retail operations is the fact that they are dealt with in a differentiated manner in Circular 3.360/2007. According to that document, retail operations that, among other characteristics, are defined as those in which debtors have total liability of less than R$400,000.00 will have a risk weighting factor of 75%, according to Basel II. In this paper, the operations were selected before the Circular had been issued and the definition was based on the draft where the limit was lower.

Some credit modalities are no longer considered in the survey, since they have special characteristics that could influence PDs and make it difficult to analyze the impact of collateral: rural and agribusiness financing, real estate financing, earmarked credits, co-obligations, working capital operations with maturities of less than 30 days, compror and vendor credits and stock and bond financing.

[9] In calculating total liability, credit operations in active portfolios with matured and maturing balances, co-obligations and balances registered as losses are all taken into consideration.
[10] Brazilian Development Bank.

The rural and agribusiness financing modality is a highly specific market segment, with its own peculiarities as regards interest rates, funding, application of credits, and so forth. Real estate financing already has a specific weighting factor in Basel II, as indicated in Circular 3.360/2007. Earmarked credits are compulsory by nature since there is an absolute link between funding and utilization of these resources.

Though credit risk does exist, there is no predefined flow of payments in the co-obligations modality. According to the methodology adopted in this study, this flow would be required to calculate PD. The modality of working capital credits with maturities of less than 30 days was excluded, since financial institutions normally roll over these credits repeatedly. Evidently, this would require a differentiated methodology to calculate PD. Compror, vendor and stock and bond financing credits normally involve self-liquidity mechanisms that differentiate them from other modalities.

Finally, operations in the Consumer Credit – Automobile Loan modality were not included in the study. During treatment of the database, signs of inconsistencies in the information supplied by financial institutions were detected, specifically with respect to the collateral offered in these operations. Since this is a credit modality in which the collateral of the financed item normally has a significant impact on the risk level of the operation, inconsistencies in the data could jeopardize the result of the study as a whole. For this reason, it was decided that this modality would be excluded from the study and would be dealt with in a specific paper in the future.

Operations were separated into groups according to type of collateral: no collateral whatsoever, only real collateral, real and personal collateral and only personal collateral. Only the first two groups were considered in this paper, since analysis of personal collateral would imply estimation of the PD of the guarantor and not of the borrower/operation.

After filtering the relevant credit modalities, a final filter was seen to be necessary in order to make the study operationally feasible and relevant to the credit market under analysis: 1) select modalities in which, individually, each of the total value of collateralized operations and the total value of uncollateralized operations represent at least 10% of the sum total of collateralized and uncollateralized operations; and 2) among the modalities selected above, choose those in which both of the quantity

of collateralized and uncollateralized operations represent at least 10% of the total sum of collateralized and uncollateralized operations.

In this way, eight modalities were considered after the final filter. These are as follows: 1) special overdraft checks and accounts; 2) personal credit - excluding payroll-deducted loans; 3) working capital credits with maturities of more than 30 days; 4) other loans; 5) consumer loans - other goods; 6) other financing; 7) import financing; 8) other credits/debtors for purchases of securities and goods.

Following identification of the eight modalities studied in this paper, the operations were grouped according to risk category[11] and monitored over a 12-month period starting on June 30, 2004. The objective here was to identify those registering defaults during that period. The default criterion chosen was that referring to credit operations in arrears for more than 90 days or with risk ratings of E, F, G or H or already written-off as losses.[12] [13] [14]

Monitoring of these operations over time made it possible to calculate the proportion of operations in default at any moment in the 12-month period after June 30, 2004, compared to the total number of operations existent on that date for each risk category[15]. In this way, PD estimates by risk category were obtained for both collateralized and uncollateralized operations, implicitly assuming that observed frequency of default is a good proxy for PD. In order to verify if the differences between the frequencies of default of each group (collateralized and uncollateralized operations) were statistically significant, a test of hypothesis about this difference was conducted.

Furthermore, a logistic regression model was developed in order to investigate the relevance of collateral as an independent variable on the behavior of the probability of default. The other independent variables used in the model were suggested by

[11] Though Basel II (paragraph 404) recommends utilization of at least seven risk brackets for operations that are not in default, this study utilized the first five risk classes (AA, A, B, C and D) of Resolution n. 2,682/99, as stated in the CIS.

[12] In Resolution 2,682/99, risk classification is based primarily on the question of arrears. Operations with arrears of 90 days are classified no higher than level E.

[13] In those cases in which the period to maturity was greater than 36 months on June 30, 2004, the criterion of arrears was calculated at twice its value, according to Resolution 2,682/99.

[14] In order to prevent inconsistency among ratings of financial institutions, we chose the worst case between the classification based on credit in arrears and the rating given by the financial institution.

Schechtman et al. (2004). Many of these variables were categorical and they were transformed into dummy variables. The variable for collateral was one of these cases and based on its coefficient signal, it was possible to critique the test of hypothesis findings. The variables data were collected based on information from June 30, 2004 to June 30, 2005. The sample was split into two parts, one to estimate the model and the other to evaluate and adjust the model. Section 3 shows how the model was constructed, as well as its main findings.

Even though Basel II suggests utilization of data for a period of at least five years, only two dates were considered for calculating the annual rate of default: June 30, 2004 and June 30, 2005. The reason for this was the simple fact that the CIS has not been in existence for five years. The same eight modalities of the stock used in the previous year were also applied to operations on June 30, 2005. From that point forward, all procedures used to estimate PD as described above were repeated. At the end, the simple average between the annual rate of default in 2004 and in 2005 was calculated for each risk category and used as proxy for estimating the PD of each category.

After estimating PD for each risk rating, the next step was to calculate the CC of operations existent on June 30, 2006. In this case, only operations belonging to the eight modalities previously chosen and to the two groups of operations considered (collateralized and uncollateralized) were selected.

The risk classification for the operations in each group was given on the basis of the classification obtained in June 2006. Consequently, based on the estimates obtained, PD was associated to this classification. In this study, the LGD level utilized was 45%, as defined in the IRB Foundation Approach of Basel II. The capital requirement (K) for each group was determined according to the already cited IRB-Foundation Approach formulas. In the same way, the K was calculated using the maturity (M) of 2.5 years. However, an analysis of K sensitivity to various other M levels was also carried out, with M varying at six months intervals.

Starting with the individual values of K in each one of the two groups of operations, the value of Risk Weighted Asset (RWA) was calculated per operation with

[15] This methodology is consistent with the document "An Explanatory Note on the Basel II IRB Risk Weight Functions", BIS, July 2005.

the percentage of 11% and not 8% as specified in Basel II. Consequently, the formulas of RWA of the *j-th* operation and of CC for operations existent on June 30, 2006 had to be redefined, as follows:

$$RWA_j = K_j \times \frac{1}{11\%} \times EAD_j , \tag{8}$$

$$CC = 11\% \times \sum_j RWA_j = 11\% \times \sum_j \left(K_j \times \frac{1}{11\%} \times EAD_j \right) = \sum_j \left(K_j \times EAD_j \right) , \tag{9}$$

A decision was made to utilize total CC (CC plus provisions) in order to evaluate the indirect impact of the collateral mitigator on the CC of National Financial System institutions, in light of the differentiated levels of provisioning between the SSA, for which the percentages used in this study are defined in Resolution 2,682/99, and the IRB Foundation Approach, in which the percentages are given by the levels of expected loss (PD times LGD).

Aside from this, it was also possible to compare the determinant risk weighting factor of CC in the IRB Foundation Approach with that of SSA. To do this, a factor had to be found for which total CC would be identical for the two approaches (equation 10). In this paper, this factor was denominated the equivalence factor and was obtained as shown below:

$$\left[\sum_j \left(K_j \times EAD_j \right) + \sum_j \left(PD_j \times LGD_j \times EAD_j \right) \right] = F_{Equiv} \left[0{,}11 \times \sum_j \left(EAD_j - \text{Prov}_j \right) \right] + \sum_j \text{Prov}_j \therefore$$

$$F_{Equiv} = \frac{\left[\sum_j \left(K_j \times EAD_j \right) + \sum_j \left(PD_j \times LGD_j \times EAD_j \right) \right] - \sum_j \text{Prov}_j}{\left[0{,}11 \times \sum_j \left(EAD_j - \text{Prov}_j \right) \right]} \tag{10}$$

Calculated for both the collateralized and uncollateralized groups of operations, the equivalence factor makes it possible to measure the impact that collateral would have through PD on the SSA weighting factor. Though SSA deals equally with all operations, with no discrimination between collateralized and uncollateralized credits, one should recall that the objective sought in calculating the equivalence factor is to verify the existence of a possible differentiation of the risk-weighting factor for collateralized operations.

3. Results

3.1. Probability of Default Estimation

The initial quantities of operations in the nonretail group reached 872,000 and 911,000 on June 30, 2004 and June 30, 2005, respectively, the two dates used as bases for estimating PDs. After filtering the operations, the final stock dropped to 184,000 in June 2004 and 185,000 in June 2005.

Even after application of the filters, the profile of the final stock of operations in terms of types of collateral was quite similar to the profile of the initial stock, on both June 30, 2004 and June 30, 2005. This suggests that the data selected are adequate for analysis of the impact of the collateral mitigator.

Tables 1 and 2 below present estimates of PD broken down by risk classification in the period from June 30, 2004 to June 30, 2005 and from June 30, 2005 to June 30, 2006, for the groupings of uncollateralized and collateralized operations, respectively. The quantity of operations and the weighted arithmetic average of PDs by risk classification are also presented. This average was used as the final estimate for calculating CC on June 30, 2006. PDs were also estimated stratified according to modalities and risk classification in the same periods and the results can be found in Table A at the Appendix.

Table 1 – Estimated default probabilities for uncollateralized operations stratified according to risk classification

Class	*Total June 30, 2004*	*PD June 30, 2004 to June 30, 2005*	*Total June 30, 2005*	*PD June 30, 2005 to June 30, 2006*	*Average PD*
AA	21,402	1.19%	15,400	1.05%	1.12%
A	37,110	3.77%	24,419	3.68%	3.72%
B	27,186	5.89%	29,200	6.34%	6.11%
C	24,389	8.58%	18,894	10.38%	9.48%
D	5,674	33.63%	4,493	38.59%	36.11%
E	1,860	100.00%	1,796	100.00%	100.00%
F	1,506	100.00%	1,346	100.00%	100.00%
G	1,117	100.00%	1,026	100.00%	100.00%
H	6,528	100.00%	5,581	100.00%	100.00%
TOTAL	**126,772**		**102,155**		

Table 2 – Estimated default probabilities for collateralized operations stratified according to risk classification

Class	*Total June 30, 2004*	*PD June 30, 2004 to June 30, 2005*	*Total June 30, 2005*	*PD June 30, 2005 to June 30, 2006*	*Average PD*
AA	13,459	0.72%	12,818	0.60%	0.66%
A	19,916	0.75%	32,955	1.30%	1.02%
B	11,106	1.42%	14,463	2.25%	1.83%
C	8,918	2.77%	15,559	5.36%	4.06%
D	2,100	13.57%	3,468	20.47%	17.02%
E	237	100.00%	699	100.00%	100.00%
F	279	100.00%	557	100.00%	100.00%
G	74	100.00%	362	100.00%	100.00%
H	768	100.00%	2,408	100.00%	100.00%
TOTAL	**56,857**		**83,289**		

In the two periods considered, PDs increased as the risk classification of the operation worsened. Aside from this, the default rates found in classes AA to D in the group of collateralized operations were smaller than in the other group. The weighted averages of PDs for the portfolio of collateralized operations not in default was 1.69% and 3.00% for 2005 and 2006, respectively, while PDs were 6.27% and 7.15% for the portfolio of uncollateralized operations not in default, respectively. Taken by themselves, these amounts suggest that uncollateralized operations have a greater chance of default. A test of hypothesis about difference in proportion was carried out in order to test whether the lesser difference between PDs obtained for the collateralized group of operations and those obtained for the uncollateralized group in each risk classification is statistically significant. Specification of the test and its results are found on Table 3. One can conclude that, for all of the risk categories considered, the samples supplied sufficient evidence to detect a negative difference between collateralized PD and uncollateralized PD, at a significance level of 5%.

Table 3 – Test of Hypothesis about difference between collateralized and uncollateralized PDs obtained for each risk class.

H_0: Collateralized PD - Uncollateralized PD = 0
H1: Collateralized PD - Uncollateralized PD PD < 0
Significance level of 5%

June 30, 2004 to June 30, 2005					
Class	***Collateralized PD***	***Uncollateralized PD***	***Difference between PDs***	***Test Statistic***	***Result***
AA	0.72%	1.19%	-0.47%	-4,2795	Rejects H0
A	0.75%	3.77%	-3.02%	-21,1564	Rejects H0
B	1.42%	5.89%	-4.46%	-18,9342	Rejects H0
C	2.77%	8.58%	-5.81%	-18,3675	Rejects H0
D	13.57%	33.63%	-20.06%	-17,4477	Rejects H0
Average PD	**1.69%**	**6.27%**	**-4.58%**	**-41,5633**	**Rejects H0**
June 30, 2004 to June 30, 2005					
Class	***Collateralized PD***	***Uncollateralized PD***	***Difference between PDs***	***Test Statistic***	***Result***
AA	0.60%	1.05%	-0.45%	-4,1173	Rejects H0
A	1.30%	3.68%	-2.38%	-18,7434	Rejects H0
B	2.25%	6.34%	-4.09%	-18,4935	Rejects H0
C	5.35%	10.38%	-5.03%	-17,0041	Rejects H0
D	20.47%	38.59%	-18.12%	-17,3804	Rejects H0
Average PD	**3.00%**	**7.15%**	**-4.15%**	**-38,5423**	**Rejects H0**

3.2. Logistic Regression

Consider a set of *p* independent variables denoted by $x' = (x_1, x_2, ..., x_p)$, the vector of the i^{th} row of matrix (X) of explicative variables. Each element of matrix (X) correspond to (x_{ij}), where *i* = 1, 2,..., *n* and *j* = 0, 1,..., *p*, with x_{i0} = 1. Given Y the outcome variable from a multiple regression model, where Y has a Bernoulli probability distribution with success parameter π_i. Suppose the conditional success probability is given by $P(Y=1|x)=\pi(x)$ and the conditional failure probability is denoted by $P(Y=0|x)=1-\pi(x)$.

The logit of the logistic regression model is given by the equation $g(x)=\beta_0+\beta_1 x_1+\beta_2 x_2+...+\beta_p x_p$, where $\pi(x)=\frac{e^{g(x)}}{1+e^{g(x)}}$. The vector of unknown parameters is given by $\beta=(\beta_0+\beta_1+\beta_2+...+\beta_p)'$ and β_j is the j^{th} parameter associated to the independent variable x_j.

Thus, the logarithm of the likelihood function to be maximized in β for the logistic regression parameters estimation can be written as $\ell(\beta) = \sum_{i=0}^{n} \left[y_i x_i' \beta - \ln\left(1 + e^{x_i' \beta}\right) \right]$, where $\ell(\beta)$ is the likelihood function.

3.2.1 Parameters Estimation and Model Evaluation

The sample used to estimate the parameters of the logistic regression model is limited to collateralized and uncollateralized credits, filtered as described, from CIS database on June 30, 2005. The choice of this date is related to the fact that the independent variables were constructed based on borrowers information from twelve months before the selected date and our database had been filled with information since June 30 2004. The description of selected variables is found on appendix.

The sample was divided into two parts: 70% to model estimation (93.284 operations) and 30% to evaluate and adjust the model (40.071 operations). This separation was controlled by dummy of collateral, dummy of default and credit's modality, aiming to ensure similarity between samples. The estimations were calculated using Stata 9.2.

At the beginning, 25 independent variables have been selected and they were all used in model (1). The categorical variables have been substituted by dummies, and in the presence of multicollinearity, variables were eliminated.

On model (2), it was used stepwise method to select variables, where 23 variables were identified as statistically significant.

On models (3) and (4), interations were introduced to evaluate the effects between collateral x credit modality (model 3) and collateral x worst borrower classification at the financial system (model 4). The idea of introducing interations of collateral with other variables is to evaluate if the effect of collateral on outcome variable is uniform for any value of the other variables. For these models, the estimation was realized using stepwise method.

Table 4 – Logistic Regression Models to Default Probability, June 30, 2005.

Model (1) includes all selected independent variables; model (2) includes independent variables selected by stepwise method; model (3) includes interaction effect between collateral and credit modality and model (4) includes interaction effect between collateral and worst borrower class on financial system. Significance level: 5%.

Model	***Observations***	***Log likelihood***	***Hosmer-Lemeshow chi^2(8)***	***Prob > chi^2***	***Area under ROC curve***
1	93284	-15517.9	15.33	0.0531	0.8578
2	93284	-15529.1	14.68	0.0657	0.8577
3	93284	-15461.1	15.56	0.0490	0.8595
4	93284	-15535.6	12.31	0.1380	0.8572

Table 4 shows the tests results of the models estimation. Using Hosmer-Lemeshow statistics as selection criteria, we chose model 4 as the best fitted model. Table 5 shows model 4 estimation results. We can observe that, for this model, only 21 variables were statistically significant.

Table 5 – Logistic Regression Models for Probability of Default, including interaction effect between collateral and worst borrower class on financial system, June 30, 2005.

Parameter	***Coeficient***	***Standard Error***	***Wald Chi-Square***	***Pr > ChiSq***	***Odds Ratio***
Intercept	-1.3173	0.2062	-6.39	0.0000	
Classification in Jun/2005 A	-0.5610	0.0888	-6.32	0.0000	0.5706
Classification in Jun/2005 B	0.4621	0.0487	9.48	0.0000	1.5873
Classification in Jun/2005 C	0.7299	0.0493	14.80	0.0000	2.0749
Classification in Jun/2005 D	1.7560	0.0610	28.77	0.0000	**5.7895**
Dummy of Delay in Financial Institution	0.7849	0.0486	16.15	0.0000	2.1922
Dummy of Delay in Brazilian Financial System	0.8998	0.0508	17.72	0.0000	2.4591
Dummy of Increase in Financial Institution	0.1415	0.0358	3.95	0.0000	1.1520
Dummy of Collateral	**-0.3575**	**0.0390**	**-9.16**	**0.0000**	**0.6994**
Dummy of Default 12 Months in Financial Institution	0.8826	0.0956	9.23	0.0000	2.4173
Dummy of Write Off in Financial Institution	0.2044	0.0723	2.83	0.0050	1.2267
Dummy of Write Off in Brazilian Financial System	0.4760	0.0495	9.62	0.0000	1.6096
Exposure in Brazilian Financial System	-0.3819	0.0182	-20.96	0.0000	0.6826
Proportion of Debt in Financial Institution	-1.0225	0.0976	-10.48	0.0000	0.3597
Interaction Dummy of Collateral x Worst Borrower Classification in Limited Brazilian Financial System H	**0.4314**	**0.1310**	**3.29**	**0.0010**	**1.5393**
Modality Consumer Loans	0.4210	0.0897	4.69	0.0000	1.5235
Modality Working Capital Credits	0.5529	0.0441	12.53	0.0000	1.7383
Modality Other Credits	-0.5609	0.1655	-3.39	0.0010	**0.5707**
Modality Other Loans	0.3547	0.0621	5.71	0.0000	1.4257
Modality Other Financing	0.3446	0.1085	3.18	0.0010	1.4115
Worst Classification in Financial Institution E	-0.3943	0.1586	-2.49	0.0130	0.6741
Worst Classification in Financial Institution HH	2.6303	1.2929	2.03	0.0420	**13.8777**
Worst Classification in Financial Institution in	0.1871	0.0439	4.27	0.0000	1.2057

Parameter	*Coeficient*	*Standard Error*	*Wald Chi-Square*	*Pr > ChiSq*	*Odds Ratio*
Limited Brazilian Financial System C					
Worst Classification in Financial Institution in Limited Brazilian Financial System D	0.4499	0.0504	8.92	0.0000	1.5682
Worst Classification in Financial Institution in Limited Brazilian Financial System E	0.4784	0.0919	5.21	0.0000	1.6135
Worst Classification in Financial Institution in Limited Brazilian Financial System F	0.6650	0.1075	6.19	0.0000	1.9445
Worst Classification in Financial Institution in Limited Brazilian Financial System G	0.4594	0.1069	4.30	0.0000	1.5831
Expiration Period	0.0009	0.0000	21.06	0.0000	1.0009
Relationship Period	-0.0001	0.0000	-10.98	0.0000	0.9999
Proportion of Delay in Financial Institution	-0.5157	0.1052	-4.90	0.0000	0.5971
Proportion of Delay in Brazilian Financial System	2.2348	0.1438	15.54	0.0000	**9.3442**
Number of Lenders	0.0428	0.0059	7.25	0.0000	1.0438
Total Debt	0.1440	0.0166	8.70	0.0000	1.1549
Effective Interest Rate of Operation	0.0047	0.0004	12.13	0.0000	1.0047

In general, the independent variables presented coefficient signal as expected. The variable credit classification in Jun/2005 showed[16] the expected behavior: as credit classification gets worst, its probability of default is higher. This can be verified through increasing odds ratio, in the way that, credits classified as D have six more chances to default than credits classified in the range AA to C. The variable worst classification in limited Brazilian financial[17] system had similar behavior.

According to the model, it should be observed that a borrower who, in any of the twelve months before Jun/2005, had any loan write-off (classification HH) in a financial institution has fourteen more chances to default in the same institution than a borrower out of this situation.

In respect to credits modalities, the model shows uniform behavior, with odds ratio greater than unit, except to the modality denominated other credits, which has odds ratio of 0.57, meaning that the chance of a credit default in this modality is reduced in 43% compared to a credit in a different modality.

About the variable of interest, dummy of collateral, it is noticed a negative coefficient, with an odds ratio lower than one (0,70), meaning that the chance of default is smaller in the presence of collateral, which corroborates the results found in earlier

[16] In the logistic regression, the categorical variable was transformed into a dummy variable, where the AA classification was considered as the basal level.

[17] This variable shows the information about the worst classification of the borrower in the system considering the last twelve months before Jun 30, 2006, limited to the sample used in this article.

section. In a general sense, collateralized operations have their chance of default lowered by 30% when compared to uncollateralized operations.

The model with the crossed effect introduced by the interaction between collateral and borrower's worst classification in Brazilian financial system suggests that, to classification H, the interaction's coefficient is significant; which means that collateral is relevant in the situation immediately before the write-off. In that case, the association between risk factor and outcome variable depends, in some way, on the co-variable level. This interaction has an odds ratio of 1.54 and to its interpretation, according to Hosmer and Lemeshow (2000), it is necessary to decompose the cross effect – the impact grade of collateral on probability of default depends if the borrower was classified as H among any financial institution along the year before. The odds ratio of collateral, considering that the borrower had a different classification in financial system along the last 12 months, is 0.47. On the other side, the odds ratio of collateral, considering that the borrower was classified as H along the last 12 months, is 0.72. This means that the collateral has a mitigation effect over the chance of default of operations whose borrowers have not been classified as H in the system in a greater grade (it reduces the chance of default by 53% if compared to uncollateralized operations) than borrowers classified as H in the system (reduction of chance of default by 27%).

The elected logistic model (model 4) was applied over the second part of the sample (test sample), which corresponded to 30% of total observations (40.071 operations). In this case, the area under the ROC curve was 0.8577, which represents an excellent discrimination power of the model.

Table 6 shows the average of the estimated PDs for each risk classification, as well as the results of the test about difference between collateralized and uncollateralized PDs. The test results corroborate the hypothesis that PDs behave differently in the presence of collateral.

Table 6 – Test of Hypothesis about difference between collateralized and uncollateralized PDs obtained for each risk class.

H_0: Collateralized PD - Uncollateralized PD = 0
H1: Collateralized PD - Uncollateralized PD < 0
Significance level of 5%

Class	*Collateralized PD*	*Uncollateralized PD*	*Difference between PDs*	*Test Statistic*	*Result*
AA	0.79%	1.27%	-0.48%	-7.5363	Rejects H0
A	2.06%	3.46%	-1.39%	-18.6137	Rejects H0
B	3.69%	6.64%	-2.95%	-21.4243	Rejects H0
C	6.83%	9.54%	-2.72%	-13.1658	Rejects H0
D	34.43%	37.16%	-2.73%	-2.3281	Rejects H0
Average PD	**4.30%**	**6.98%**	**-2.67%**	**-26.0184**	**Rejects H0**

3.3. Capital Charge Calculation

Capital Charge was calculated on the basis of June 30, 2006 data. Calculation of CC and the equivalence factor of the operations in each group can be monitored through Tables 7 and 8 below. In Tables 7a and 8a, capital requirement K of the IRB Foundation Approach was presented for each risk class. The value of K was calculated on the basis of average PD estimates of the two periods considered (Average PD) in the EAD amounts obtained, with an LGD of 45% and M of 2.5 years, as determined in the Basel II Accord. Risk weighted assets (RWA), expected losses (PD x LGD), capital charge (CC) and, finally, Total CC, defined as the sum of expected (PD x LGD) and unexpected losses (K) applied to EAD, were also presented.

Table 7a – Calculation of capital charge for uncollateralized operations according to the IRB-Foundation Approach

IRB – Foundation							
Class	***EAD (R$ thous)***	***K (%)***	***RWA (R$ thous)***	***PD x LGD (%)***	***CC (R$ thous)***	***Provision [18] (PDxLGDxEAD) (R$ thous)***	***Total Capital Charge (R$ thous)***
AA	16,264,170.94	7.69	11,368,011.99	0.50	1,250,481.32	82,087.70	1,332,569.02
A	12,803,355.23	10.93	12,721,903.83	1.68	1,399,409.42	214,579.89	1,613,989.31
B	8,169,984.74	12.85	9,547,154.33	2.75	1,050,186.98	224,715.04	1,274,902.02
C	3,574,562.55	15.14	4,920,615.47	4.27	541,267.70	152,463.44	693,731.14
D	736,297.86	19.61	1,312,624.76	16.25	144,388.72	119,645.45	264,034.17
E	284,969.60	-	-	45.00	-	128,236.32	128,236.32
F	304,675.53	-	-	45.00	-	137,103.99	137,103.99
G	232,980.68	-	-	45.00	-	104,841.31	104,841.31
H	993,749.24	-	-	45.00	-	447,187.16	447,187.16
Total	**43,364,746.37**		**39,870,541.41**		**4,385,759.56**	**1,610,860.29**	**5,996,619.85**

[18] The provisions of IRB Foundation were considered equivalent to expected losses.

Table 7b – Calculation of the capital charge for uncollateralized operations according to the Standardized Simplified Approach

Standardized Simplified Approach					
Class	***EAD – Prov (R$ thous)***	***Provision Resolution 2,682/99 (%)***	***CC (R$ thous)***	***Provision (R$ thous)***	***Total Capital Charge (R$ thous)***
AA	16,264,170.94	0.00	1,789,058.80	-	1,789,058.80
A	12,739,338.46	0.50	1,401,327.23	64,016.78	1,465,344.01
B	8,088,284.89	1.00	889,711.34	81,699.85	971,411.19
C	3,467,325.67	3.00	381,405.82	107,236.88	488,642.70
D	662,668.07	10.00	72,893.49	73,629.79	146,523.27
E	199,478.72	30.00	21,942.66	85,490.88	107,433.54
F	152,337.77	50.00	16,757.15	152,337.77	169,094.92
G	69,894.20	70.00	7,688.36	163,086.48	170,774.84
H	-	100.00	0.00	993,749.24	993,749.24
Total	**41,643,498.73**		**4,580,784.86**	**1,721,247.65**	**6,302,032.51**

Tables 7b and 8b show provision levels according to Resolution 2,682/99 for each risk category, as well as the respective CCs, according to the SSA.

Table 8a – Calculation of capital charge for collateralized operations according to the IRB Foundation Approach.

IRB Foundation							
Class	**EAD (R$ thous)**	**K (%)**	**RWA (R$ thous)**	**PD x LGD (%)**	**CC (R$ thous)**	**Provision (PDxLGDxEAD) (R$ thous)**	**Total Capital Charge (R$ thous)**
AA	6.384.821.69	6.29	3.649.973.31	0.30	401.497.06	18.983.39	420.480.46
A	5,710,519.23	7.45	3,867,943.81	0.46	425,473.82	26,338.71	451,812.53
B	3,115,221.33	8.97	2,539,350.36	0.83	279,328.54	25,722.31	305,050.85
C	2,181,535.85	11.22	2,224,879.12	1.83	244,736.70	39,873.81	284,610.51
D	487,358.25	18.36	813,368.78	7.66	89,470.57	37,331.51	126,802.08
E	167,497.66	-	-	45.00	-	75,373.95	75,373.95
F	58,744.76	-	-	45.00	-	26,435.14	26,435.14
G	50,836.18	-	-	45.00	-	22,876.28	22,876.28
H	428,461.74	-	-	45.00	-	192,807.78	192,807.78
Total	18,584,996.69		13,095,515.38		1,440,506.69	465,742.88	1,906,249.58

Table 8b – Calculation of capital charge for collateralized operations according to the Standardized Simplified Approach

Standardized Simplified Approach					
Class	**EAD – Prov (R$ thous)**	**Provision Resolution 2,682/99 (%)**	**CC (R$ thous)**	**Provision (R$ thous)**	**Total Capital Charge (R$ thous)**
AA	6,384,821.69	0.00	702,330.39	-	702,330.39
A	5,681,966.63	0.50	625,026.33	28,552.60	653,568.93
B	3,084,069.12	1.00	339,247.60	31,152.21	370,399.82
C	2,116,089.77	3.00	232,769.88	65,446.08	298,215.95
D	438,622.42	10.00	48,248.47	48,735.82	96,984.29
E	117,248.36	30.00	12,897.32	50,249.30	63,146.62
F	29,372.38	50.00	3,230.96	29,372.38	32,603.34
G	15,250.85	70.00	1,677.59	35,585.32	37,262.92
H	-	100.00	-	428,461.74	428,461.74
Total	17,867,441.24		1,965,418.54	717,555.45	2,682,973.99

The equivalence factor of 93% for the group of uncollateralized operations was obtained through equation (10). This is the factor that would make total CC calculated by the SSA equal to that calculated by the IRB Foundation Approach for the group of uncollateralized operations in the selected modalities. It should be stressed that the weighting factor is 100% in the SSA. The equivalence factor of 60.48% for the group of collateralized operations was obtained in the same way as the group of uncollateralized operations.

These two results must be observed with caution, considering that the LGD of 45% in the IRB Foundation Approach could be deemed highly optimistic for the Brazilian market.

Another parameter deserves attention, the maturity. Although, Basel II suggests the value of 2.5 years, in Brazil many banks maintain portfolios with operations of less than one year. In order to identify the sensitivity of the capital requirement (K) to the variation of M value for both collateralized and uncollateralized operations, a simulation was carried out with the variation of six months in the parameter. An increase of six months in the maturity leads to a linear increase in percentage points of the capital requirement (K) calculated according to the IRB Foundation Approach. Table 9 presents the results of this sensitivity according to risk classification.

Table 9 – Sensitivity of the Capital Requirement (K) calculated according to the IRB Foundation Approach to a Six Months Variation on Maturity*

Class	*Uncollateralized Operations (Percentage Points)*	*Collateralized Operations (Percentage Points)*
AA	0.511%	0.487%
A	0.488%	0.508%
B	0.474%	0.511%
C	0.464%	0.485%
D	0.298%	0.426%
E	0.000%	0.000%
F	0.000%	0.000%
G	0.000%	0.000%
H	0.000%	0.000%

*an increase of six months on maturity leads to an increase of the capital charge

The results show that the sensitivity is different among risk classifications due to the term of maturity adjustment (*b* in equation 6), which is dependent on the PD. In general, the sensitivity is higher among collateralized operations than among uncollateralized operations as maturity adjustment is higher for lower PDs. In other words, for a one-year portfolio, capital requirement would decrease, on average, by 1.5 percentage points in each risk classification among collateralized operations. Using the basis of June 30, 2006 data, this would mean a decrease of 14% on total Capital Charge.

Considering uncollateralized operations, for a one-year portfolio, capital requirement would decrease, on average, by 1.45 percentage points in each risk classification, which would mean a decrease of 10% on total Capital Charge

As mentioned in the section on Methodology, the impact of the use of the collateral mitigator on the CC of National Financial System institutions was evaluated in two different ways: variation of total CC between the group of uncollateralized operations and the group of collateralized operations and variation of the equivalence factor between the same groups of operations. The total CC of the group of uncollateralized operations represented 13.82% of the respective EAD, while the percentage was 10.26% in the case of the collateralized group. The equivalence factor was 93.33% in the first group and 60.48% in the second, utilizing an LGD of 45%. In this way, the effect was to reduce the capital required to cover credit risk in both assessments of the impact of the mitigation.

4. Conclusion

This paper had the objective of evaluating the impact of the collateral mitigation on National Financial System capital charges by measuring probability of default. In doing so, it compared the capital charge of the Standardized Simplified Approach with that obtained through the IRB Foundation Approach, in which estimates of the probability of default were obtained on the basis of two-year data for a specific segment of nonretail operations drawn from the Credit Information System. The study demonstrated that the probabilities of default were low in the segment of collateralized operations. This result was obtained from historical average probability of default methodology and was confirmed by the logistic regression model approach.

As a result, capital charges decreased. The results further indicated that the equivalent weighting factor between total capital charges of the Standardized Simplified Approach and the IRB Foundation Approach would be 93% for uncollateralized operations and 60% for collateralized operations. With regard to uncollateralized operations, the factor found was quite close to the 100% factor utilized in Central Bank of Brazil legislation on the Standardized Simplified Approach. On the other hand, the value encountered revealed a certain conservative bias for the grouping of collateralized operations, a characteristic considered inherent to preventive regulation.

Though this paper has not evaluated the quality and the value of the collateral, this preliminary result does represent an incentive for institutions to migrate to the IRB Foundation Approach, through adoption of an effective credit risk management model and an adequate monitoring of collateral, with the consequent possibility of reducing capital charges on their operations. One should underscore that these results were obtained on the basis of the 11% capital charge standard adopted by Brazil and Loss Given Default set at 45%, as suggested by Basel II for the IRB Foundation Approach.

This study restricted itself to comparing uncollateralized operations with collateralized operations. Future studies should encompass other mitigators, as well as include the retail banking book. A study on estimating Loss Given Default, as an alternative to the fixed percentage of 45% suggested by Basel II, would also be recommended.

5. References

CENTRAL BANK OF BRAZIL. Communiqué n. 12,746, dated December 9, 2004. Announces procedures for implementation of the new capital structure - Basel II. Brasília, 2004.

CENTRAL BANK OF BRAZIL. Public Hearing Report n. 26, dated May 22, 2006. Brasília, 2006.

BASEL COMMITTEE ON BANKING SUPERVISION. International Convergence of Capital Measurement and Capital Standards – A Revised Framework. BIS. 2004.

BASEL COMMITTEE ON BANKING SUPERVISION. An Explanatory Note on the Basel II IRB Risk Weight Functions. BIS. 2005.

BESANKO, D.; THAKOR, A.V. Competitive Equilibrium in the Credit Market under Asymetric Information. Journal of Economic Theory. Vol. 42 (June), pp.167-82. 1987.

BESTER, H.: "Screening vs. Rationing in Credit Markets with Imperfect Information." American Economic Review, Vol. 75, pp. 850-855,1985.

BOOT, A. W.A.; THAKOR, A.V.; UDELL, G. F. Secured Lending and Default Risk: Equilibrium Analysis, Policy Implications and Empirical Results, The Economic Journal, 101, pp. 458-472. 1991v

CARNEIRO, Fábio Lacerda; VIVAN, Gilneu Francisco Astolfi; KRAUSE, Kathleen. Novo Acordo da Basiléia: Estudo de caso para o Contexto Brasileiro (The New Basel Accord: A Case Study for the Brazilian Context). Resenha BM&F n. 163. São Paulo. 2005.

NATIONAL MONETARY COUNCIL- CMN. Resolution n. 2,682, dated December 21, 1999. Deals with criteria for classifying credit operations and rules for constituting provisions for bad loans. Brasília, 1999.

NATIONAL MONETARY COUNCIL- CMN. Resolution n. 2,390, May 22, 1997. Requires that client information be provided to the Central Bank of Brazil, for purposes of implementation of the Credit Risk Center. Brasília, 1997.

HOSMER, D. W.; LEMESHOW, S. Applied Logistic Regression. 2nd. Edition. Wiley. USA. 2000.

JIMENEZ, G.; SAURINA J. Collateral, Type of Lender and Relationship Banking as Determinants of Credit Risk. Journal of Banking and Finance Nº 28. 2004.

PARENTE, G. G. C.; COSTA, O, L, V. Avaliação da Utilização de Centrais Públicas de Informações de Crédito num Modelo de Previsão para Inadimplência. (Evaluation of the Use of Public Credit Information Centers in a Default Forecasting Model). Terceiro Encontro Brasileiro de Finanças. (Third Brazilian Encounter on Finance), São Paulo. Anais do Encontro (Annals of the Encounter). 2003.

SANTOS, C. Risco de Crédito e Garantias: a Proposta de um Sistema Nacional de Garantias de Crédito. UASF, SEBRAE. 2005v

SCHECHTMAN, Ricardo; GARCIA, V, S.; KOYAMA, S. M.; PARENTE, G. C. Credit Risk Measurement and the Regulation of Bank Capital and Provision Requirements in Brazil – A Corporate Analysis. 2004.

STIGLITZ, J. E.; WEISS, A. Credit Rationing in Markets with Imperfect Information, American Economic Review, vol. 71, pp. 393-410. 1981.

WETTE H. C.. Collateral in Credit Rationing in Markets with Imperfect Information: Note. The American Economic Review, Vol. 73, No. 3., pp. 442-445, Jun., 1983.

Appendix

Description of the explanatory variables used in the logistic regression model

Classification in Jun/2005 –categorical variable that represents the risk classification attributed by the financial institution to each operation at the base-date: AA, A, B, C, D. In the regression model, dummies were used to indicate each risk class.

Dummy of Delay in Financial Institution – The variable assumes 1 if the borrower possesses past due credits or write-offs in the financial institution at the base-date and assumes 0 otherwise.

Dummy of Delay in Brazilian Financial System – The variable assumes 1 if the borrower possesses past due credits or write-offs in the financial system at the base-date and assumes 0 otherwise.

Dummy of Increase in Financial Institution – The variable assumes 1 if the borrower' total debt in the financial institution in Jun/2005 (base-date) is larger than its total debt in Jun/2004. The variable assumes 0 otherwise.

Dummy of Collateral - The variable assumes 1 if the operation is collateralized and assumes 0 otherwise.

Dummy of Default 12 Months in Financial Institution - The variable assumes 1 if the borrower is classified from E to HH in any of the 12 months before the base-date. The variable assumes 0 otherwise.

Dummy of Write Off in Financial Institution – The variable assumes 1 if the proportion of past due credits and write-offs of the borrower in the financial institution in relation to its total debt, including write-offs, in the financial institution is larger than 10%. The variable assumes 0 otherwise.

Dummy of Write Off in Brazilian Financial System - The variable assumes 1 if the proportion of past due credits and write-offs of the borrower in the financial system in relation to its total debt, including write-offs, in the financial system is larger than 10%. The variable assumes 0 otherwise.

Exposure in Brazilian Financial System – Logarithm of the borrower' total debt in the financial system at the base-date.

Proportion of Debt in Financial Institution – proportion of the borrower' total debt in a specific operation within the financial institution in relation to borrower' total debt in the financial institution.

Modality - categorical variable that identifies the credit modalities of the operation. This variable was decomposed into dummies in the regression model.

Worst Classification in Financial Institution – categorical variable that identifies the borrower' worst risk classification in the financial institution along the 12 months

before the base-date. It varies from HH to AA. This variable was decomposed into dummies in the regression model.

Worst Classification in Financial Institution in Limited Brazilian Financial System[19] - categorical variable that identifies the borrower' worst risk classification in the Limited Brazilian Financial System along the 12 months before the base-date. It varies from HH to AA. This variable was decomposed into dummies in the regression model.

Expiration Period – number of days between the base-date and the operation' maturity date.

Relationship Period - number of days between the base-date and the beginning of the relationship between the borrower and the financial institution.

Proportion of Delay in Financial Institution – proportion of the past due credits and write-offs of the borrower in the financial institution in relation to borrower' total debt in the financial institution.

Proportion of Delay in Brazilian Financial System - proportion of the past due credits and write-offs of the borrower in the Brazilian financial system in relation to borrower' total debt in the Brazilian financial system.

Number of Lenders – quantity of financial institutions where the borrower possesses credit operations at the base-date.

Total Debt - Logarithm of the total debt of the credit operation at the base-date.

Effective Interest Rate of Operation – Annual interest rate of the credit operation.

[19] Limited Brazilian Financial System – it consists of a subset of all the operations registered on CIS in Jun/2005. This subset contains all the operations of the initial sample selected for this study, before the filters' implementation.

Table A – Estimated default probabilities for all operations stratified according to modalities and risk classification

Modality	*Class*	*Uncollateralized Operations*				*Collateralized Operations*			
		Total June 30, 2004	*PD June 30, 2004 to June 30, 2005*	*Total June 30, 2005*	*PD June 30, 2005 to June 30, 2006*	*Total June 30, 2005*	*PD June 30, 2005 to June 30, 2006*	*Total June 30, 2004*	*PD June 30, 2004 to June 30, 2005*
special overdraft checks and accounts	AA	9,934	1.34%	3,482	1.78%	9,739	0.40%	10,377	0.61%
	A	17,794	4.19%	13,469	3.46%	4,785	3.62%	4,862	1.52%
	B	15,944	5.33%	19,229	5.71%	2,206	6.71%	1,858	4.25%
	C	13,766	6.88%	12,606	7.48%	4,340	4.56%	2,834	3.95%
	D	2,216	28.38%	2,306	36.51%	460	27.17%	406	22.91%
	E	675	0.00%	702	0.00%	236	0.00%	109	0.00%
	F	444	0.00%	390	0.00%	187	0.00%	133	0.00%
	G	431	0.00%	566	0.00%	97	0.00%	31	0.00%
	H	1,811	0.00%	1,879	0.00%	464	0.00%	228	0.00%
Total		**63,015**		**54,629**		**22,514**		**20,838**	
personal credit - excluding payroll-deducted loans	AA	614	1.14%	740	2.43%	126	3.97%	126	0.79%
	A	2,146	3.96%	1,437	5.50%	874	3.09%	377	2.92%
	B	1,751	5.37%	1,455	7.56%	340	4.71%	188	6.91%
	C	1,298	13.79%	870	15.17%	573	9.77%	65	24.62%
	D	309	41.75%	280	34.64%	71	25.35%	15	33.33%
	E	120	0.00%	70	0.00%	15	0.00%	4	0.00%
	F	58	0.00%	79	0.00%	8	0.00%	63	0.00%
	G	48	0.00%	67	0.00%	10	0.00%	3	0.00%
	H	289	0.00%	385	0.00%	135	0.00%	28	0.00%
Total		**6,633**		**5,383**		**2,152**		**869**	
working capital credits with maturities of more than 30 days	AA	2,453	3.06%	1,644	3.28%	1,491	1.21%	1,798	1.11%
	A	9,692	3.76%	3,985	4.89%	12,367	1.03%	4,044	0.64%
	B	6,112	8.20%	5,722	8.81%	2,666	1.28%	2,867	0.73%
	C	5,806	9.47%	3,712	15.81%	6,333	4.71%	3,037	0.69%
	D	1,318	28.38%	822	37.96%	345	38.55%	139	28.78%
	E	447	0.00%	499	0.00%	120	0.00%	43	0.00%
	F	482	0.00%	454	0.00%	104	0.00%	27	0.00%
	G	283	0.00%	158	0.00%	103	0.00%	11	0.00%
	H	1,213	0.00%	868	0.00%	427	0.00%	201	0.00%
Total		**27,806**		**17,864**		**23,956**		**12,167**	

Modality	*Class*	*Uncollateralized Operations*				*Collateralized Operations*			
		Total June 30, 2004	*PD June 30, 2004 to June 30, 2005*	*Total June 30, 2005*	*PD June 30, 2005 to June 30, 2006*	*Total June 30, 2005*	*PD June 30, 2005 to June 30, 2006*	*Total June 30, 2004*	*PD June 30, 2004 to June 30, 2005*
other loans	AA	5,756	0.45%	6,152	0.26%	428	0.23%	242	0.83%
	A	1,462	3.56%	1,739	2.07%	578	2.60%	602	1.66%
	B	1,185	5.23%	1,193	6.37%	1,926	2.08%	290	3.45%
	C	848	27.71%	834	25.42%	530	31.89%	123	43.90%
	D	1,388	44.67%	748	48.40%	812	39.04%	226	26.99%
	E	493	0.00%	428	0.00%	243	0.00%	42	0.00%
	F	447	0.00%	340	0.00%	201	0.00%	32	0.00%
	G	293	0.00%	185	0.00%	118	0.00%	16	0.00%
	H	2,647	0.00%	1,818	0.00%	1,150	0.00%	180	0.00%
Total		**14,519**		**13,437**		**5,986**		**1,753**	
consumer loans - other goods	AA	163	0.61%	280	1.79%	415	2.89%	356	2.53%
	A	1,780	3.09%	319	5.33%	1,542	4.22%	340	4.71%
	B	795	5.66%	84	5.95%	1,152	5.03%	96	5.21%
	C	1,692	5.79%	174	6.32%	1,424	6.53%	38	21.05%
	D	94	32.98%	27	55.56%	98	45.92%	23	30.43%
	E	39	0.00%	11	0.00%	43	0.00%	7	0.00%
	F	21	0.00%	11	0.00%	38	0.00%	7	0.00%
	G	35	0.00%	6	0.00%	19	0.00%	1	0.00%
	H	139	0.00%	38	0.00%	113	0.00%	6	0.00%
Total		**4,758**		**950**		**4,844**		**874**	
other financing	AA	1,391	0.29%	1,942	0.21%	154	0.00%	140	0.00%
	A	3,046	2.56%	2,497	3.32%	12,401	0.10%	9,334	0.05%
	B	475	4.00%	744	4.57%	5,919	0.19%	5,541	0.27%
	C	211	14.69%	258	21.71%	2,210	0.36%	2,625	0.50%
	D	102	43.14%	167	35.33%	1,490	2.01%	1,133	3.97%
	E	38	0.00%	64	0.00%	12	0.00%	6	0.00%
	F	32	0.00%	46	0.00%	10	0.00%	7	0.00%
	G	10	0.00%	33	0.00%	2	0.00%	4	0.00%
	H	203	0.00%	386	0.00%	51	0.00%	69	0.00%
Total		**5,508**		**6,137**		**22,249**		**18,859**	
Import financing	AA	1,023	0.88%	1,120	0.18%	324	0.00%	306	0.00%
	A	894	0.89%	781	0.13%	176	0.00%	118	0.00%

Modality	*Class*	*Uncollateralized Operations*				*Collateralized Operations*			
		Total June 30, 2004	*PD June 30, 2004 to June 30, 2005*	*Total June 30, 2005*	*PD June 30, 2005 to June 30, 2006*	*Total June 30, 2005*	*PD June 30, 2005 to June 30, 2006*	*Total June 30, 2004*	*PD June 30, 2004 to June 30, 2005*
	B	736	2.17%	620	0.48%	58	0.00%	34	0.00%
	C	494	4.45%	292	1.71%	72	0.00%	61	3.28%
	D	120	19.17%	40	2.50%	11	18.18%	5	0.00%
	E	22	0.00%	2	0.00%	8	0.00%	5	0.00%
	F	15	0.00%	20	0.00%	4	0.00%	4	0.00%
	G	6	0.00%	6	0.00%	5	0.00%	0	0.00%
	H	80	0.00%	38	0.00%	11	0.00%	9	0.00%
Total		**3,390**		**2,919**		**669**		**542**	
other credits/debtors for purchases of securities and goods	AA	68	0.00%	40	2.50%	60	3.33%	39	5.13%
	A	296	3.72%	192	11.46%	229	4.37%	234	2.99%
	B	188	6.91%	153	13.73%	196	9.18%	232	6.47%
	C	274	10.95%	148	10.14%	77	14.29%	135	15.56%
	D	127	45.67%	103	44.66%	181	22.10%	153	22.22%
	E	26	0.00%	20	0.00%	22	0.00%	21	0.00%
	F	7	0.00%	6	0.00%	5	0.00%	6	0.00%
	G	11	0.00%	5	0.00%	8	0.00%	8	0.00%
	H	146	0.00%	169	0.00%	55	0.00%	45	0.00%
Total		**1,143**		**836**		**833**		**873**	
Total das Operações		**126,772**		**102,155**		**83,203**		**56,775**	

Banco Central do Brasil

Trabalhos para Discussão

Os Trabalhos para Discussão podem ser acessados na internet, no formato PDF, no endereço: http://www.bc.gov.br

Working Paper Series

Working Papers in PDF format can be downloaded from: http://www.bc.gov.br

1	**Implementing Inflation Targeting in Brazil** *Joel Bogdanski, Alexandre Antonio Tombini and Sérgio Ribeiro da Costa Werlang*	Jul/2000
2	**Política Monetária e Supervisão do Sistema Financeiro Nacional no Banco Central do Brasil** *Eduardo Lundberg*	Jul/2000
	Monetary Policy and Banking Supervision Functions on the Central Bank *Eduardo Lundberg*	Jul/2000
3	**Private Sector Participation: a Theoretical Justification of the Brazilian Position** *Sérgio Ribeiro da Costa Werlang*	Jul/2000
4	**An Information Theory Approach to the Aggregation of Log-Linear Models** *Pedro H. Albuquerque*	Jul/2000
5	**The Pass-Through from Depreciation to Inflation: a Panel Study** *Ilan Goldfajn and Sérgio Ribeiro da Costa Werlang*	Jul/2000
6	**Optimal Interest Rate Rules in Inflation Targeting Frameworks** *José Alvaro Rodrigues Neto, Fabio Araújo and Marta Baltar J. Moreira*	Jul/2000
7	**Leading Indicators of Inflation for Brazil** *Marcelle Chauvet*	Sep/2000
8	**The Correlation Matrix of the Brazilian Central Bank's Standard Model for Interest Rate Market Risk** *José Alvaro Rodrigues Neto*	Sep/2000
9	**Estimating Exchange Market Pressure and Intervention Activity** *Emanuel-Werner Kohlscheen*	Nov/2000
10	**Análise do Financiamento Externo a uma Pequena Economia Aplicação da Teoria do Prêmio Monetário ao Caso Brasileiro: 1991–1998** *Carlos Hamilton Vasconcelos Araújo e Renato Galvão Flôres Júnior*	Mar/2001
11	**A Note on the Efficient Estimation of Inflation in Brazil** *Michael F. Bryan and Stephen G. Cecchetti*	Mar/2001
12	**A Test of Competition in Brazilian Banking** *Márcio I. Nakane*	Mar/2001

13	**Modelos de Previsão de Insolvência Bancária no Brasil** *Marcio Magalhães Janot*	Mar/2001
14	**Evaluating Core Inflation Measures for Brazil** *Francisco Marcos Rodrigues Figueiredo*	Mar/2001
15	**Is It Worth Tracking Dollar/Real Implied Volatility?** *Sandro Canesso de Andrade and Benjamin Miranda Tabak*	Mar/2001
16	**Avaliação das Projeções do Modelo Estrutural do Banco Central do Brasil para a Taxa de Variação do IPCA** *Sergio Afonso Lago Alves*	Mar/2001
	Evaluation of the Central Bank of Brazil Structural Model's Inflation Forecasts in an Inflation Targeting Framework *Sergio Afonso Lago Alves*	Jul/2001
17	**Estimando o Produto Potencial Brasileiro: uma Abordagem de Função de Produção** *Tito Nícias Teixeira da Silva Filho*	Abr/2001
	Estimating Brazilian Potential Output: a Production Function Approach *Tito Nícias Teixeira da Silva Filho*	Aug/2002
18	**A Simple Model for Inflation Targeting in Brazil** *Paulo Springer de Freitas and Marcelo Kfoury Muinhos*	Apr/2001
19	**Uncovered Interest Parity with Fundamentals: a Brazilian Exchange Rate Forecast Model** *Marcelo Kfoury Muinhos, Paulo Springer de Freitas and Fabio Araújo*	May/2001
20	**Credit Channel without the LM Curve** *Victorio Y. T. Chu and Márcio I. Nakane*	May/2001
21	**Os Impactos Econômicos da CPMF: Teoria e Evidência** *Pedro H. Albuquerque*	Jun/2001
22	**Decentralized Portfolio Management** *Paulo Coutinho and Benjamin Miranda Tabak*	Jun/2001
23	**Os Efeitos da CPMF sobre a Intermediação Financeira** *Sérgio Mikio Koyama e Márcio I. Nakane*	Jul/2001
24	**Inflation Targeting in Brazil: Shocks, Backward-Looking Prices, and IMF Conditionality** *Joel Bogdanski, Paulo Springer de Freitas, Ilan Goldfajn and Alexandre Antonio Tombini*	Aug/2001
25	**Inflation Targeting in Brazil: Reviewing Two Years of Monetary Policy 1999/00** *Pedro Fachada*	Aug/2001
26	**Inflation Targeting in an Open Financially Integrated Emerging Economy: the Case of Brazil** *Marcelo Kfoury Muinhos*	Aug/2001
27	**Complementaridade e Fungibilidade dos Fluxos de Capitais Internacionais** *Carlos Hamilton Vasconcelos Araújo e Renato Galvão Flôres Júnior*	Set/2001

28	**Regras Monetárias e Dinâmica Macroeconômica no Brasil: uma Abordagem de Expectativas Racionais** *Marco Antonio Bonomo e Ricardo D. Brito*	Nov/2001
29	**Using a Money Demand Model to Evaluate Monetary Policies in Brazil** *Pedro H. Albuquerque and Solange Gouvêa*	Nov/2001
30	**Testing the Expectations Hypothesis in the Brazilian Term Structure of Interest Rates** *Benjamin Miranda Tabak and Sandro Canesso de Andrade*	Nov/2001
31	**Algumas Considerações sobre a Sazonalidade no IPCA** *Francisco Marcos R. Figueiredo e Roberta Blass Staub*	Nov/2001
32	**Crises Cambiais e Ataques Especulativos no Brasil** *Mauro Costa Miranda*	Nov/2001
33	**Monetary Policy and Inflation in Brazil (1975-2000): a VAR Estimation** *André Minella*	Nov/2001
34	**Constrained Discretion and Collective Action Problems: Reflections on the Resolution of International Financial Crises** *Arminio Fraga and Daniel Luiz Gleizer*	Nov/2001
35	**Uma Definição Operacional de Estabilidade de Preços** *Tito Nícias Teixeira da Silva Filho*	Dez/2001
36	**Can Emerging Markets Float? Should They Inflation Target?** *Barry Eichengreen*	Feb/2002
37	**Monetary Policy in Brazil: Remarks on the Inflation Targeting Regime, Public Debt Management and Open Market Operations** *Luiz Fernando Figueiredo, Pedro Fachada and Sérgio Goldenstein*	Mar/2002
38	**Volatilidade Implícita e Antecipação de Eventos de *Stress*: um Teste para o Mercado Brasileiro** *Frederico Pechir Gomes*	Mar/2002
39	**Opções sobre Dólar Comercial e Expectativas a Respeito do Comportamento da Taxa de Câmbio** *Paulo Castor de Castro*	Mar/2002
40	**Speculative Attacks on Debts, Dollarization and Optimum Currency Areas** *Aloisio Araujo and Márcia Leon*	Apr/2002
41	**Mudanças de Regime no Câmbio Brasileiro** *Carlos Hamilton V. Araújo e Getúlio B. da Silveira Filho*	Jun/2002
42	**Modelo Estrutural com Setor Externo: Endogenização do Prêmio de Risco e do Câmbio** *Marcelo Kfoury Muinhos, Sérgio Afonso Lago Alves e Gil Riella*	Jun/2002
43	**The Effects of the Brazilian ADRs Program on Domestic Market Efficiency** *Benjamin Miranda Tabak and Eduardo José Araújo Lima*	Jun/2002

44	**Estrutura Competitiva, Produtividade Industrial e Liberação Comercial no Brasil** *Pedro Cavalcanti Ferreira e Osmani Teixeira de Carvalho Guillén*	Jun/2002
45	**Optimal Monetary Policy, Gains from Commitment, and Inflation Persistence** *André Minella*	Aug/2002
46	**The Determinants of Bank Interest Spread in Brazil** *Tarsila Segalla Afanasieff, Priscilla Maria Villa Lhacer and Márcio I. Nakane*	Aug/2002
47	**Indicadores Derivados de Agregados Monetários** *Fernando de Aquino Fonseca Neto e José Albuquerque Júnior*	Set/2002
48	**Should Government Smooth Exchange Rate Risk?** *Ilan Goldfajn and Marcos Antonio Silveira*	Sep/2002
49	**Desenvolvimento do Sistema Financeiro e Crescimento Econômico no Brasil: Evidências de Causalidade** *Orlando Carneiro de Matos*	Set/2002
50	**Macroeconomic Coordination and Inflation Targeting in a Two-Country Model** *Eui Jung Chang, Marcelo Kfoury Muinhos and Joanílio Rodolpho Teixeira*	Sep/2002
51	**Credit Channel with Sovereign Credit Risk: an Empirical Test** *Victorio Yi Tson Chu*	Sep/2002
52	**Generalized Hyperbolic Distributions and Brazilian Data** *José Fajardo and Aquiles Farias*	Sep/2002
53	**Inflation Targeting in Brazil: Lessons and Challenges** *André Minella, Paulo Springer de Freitas, Ilan Goldfajn and Marcelo Kfoury Muinhos*	Nov/2002
54	**Stock Returns and Volatility** *Benjamin Miranda Tabak and Solange Maria Guerra*	Nov/2002
55	**Componentes de Curto e Longo Prazo das Taxas de Juros no Brasil** *Carlos Hamilton Vasconcelos Araújo e Osmani Teixeira de Carvalho de Guillén*	Nov/2002
56	**Causality and Cointegration in Stock Markets: the Case of Latin America** *Benjamin Miranda Tabak and Eduardo José Araújo Lima*	Dec/2002
57	**As Leis de Falência: uma Abordagem Econômica** *Aloisio Araujo*	Dez/2002
58	**The Random Walk Hypothesis and the Behavior of Foreign Capital Portfolio Flows: the Brazilian Stock Market Case** *Benjamin Miranda Tabak*	Dec/2002
59	**Os Preços Administrados e a Inflação no Brasil** *Francisco Marcos R. Figueiredo e Thaís Porto Ferreira*	Dez/2002
60	**Delegated Portfolio Management** *Paulo Coutinho and Benjamin Miranda Tabak*	Dec/2002

61	**O Uso de Dados de Alta Freqüência na Estimação da Volatilidade e do Valor em Risco para o Ibovespa** *João Maurício de Souza Moreira e Eduardo Facó Lemgruber*	Dez/2002
62	**Taxa de Juros e Concentração Bancária no Brasil** *Eduardo Kiyoshi Tonooka e Sérgio Mikio Koyama*	Fev/2003
63	**Optimal Monetary Rules: the Case of Brazil** *Charles Lima de Almeida, Marco Aurélio Peres, Geraldo da Silva e Souza and Benjamin Miranda Tabak*	Feb/2003
64	**Medium-Size Macroeconomic Model for the Brazilian Economy** *Marcelo Kfoury Muinhos and Sergio Afonso Lago Alves*	Feb/2003
65	**On the Information Content of Oil Future Prices** *Benjamin Miranda Tabak*	Feb/2003
66	**A Taxa de Juros de Equilíbrio: uma Abordagem Múltipla** *Pedro Calhman de Miranda e Marcelo Kfoury Muinhos*	Fev/2003
67	**Avaliação de Métodos de Cálculo de Exigência de Capital para Risco de Mercado de Carteiras de Ações no Brasil** *Gustavo S. Araújo, João Maurício S. Moreira e Ricardo S. Maia Clemente*	Fev/2003
68	**Real Balances in the Utility Function: Evidence for Brazil** *Leonardo Soriano de Alencar and Márcio I. Nakane*	Feb/2003
69	**r-filters: a Hodrick-Prescott Filter Generalization** *Fabio Araújo, Marta Baltar Moreira Areosa and José Alvaro Rodrigues Neto*	Feb/2003
70	**Monetary Policy Surprises and the Brazilian Term Structure of Interest Rates** *Benjamin Miranda Tabak*	Feb/2003
71	**On Shadow-Prices of Banks in Real-Time Gross Settlement Systems** *Rodrigo Penaloza*	Apr/2003
72	**O Prêmio pela Maturidade na Estrutura a Termo das Taxas de Juros Brasileiras** *Ricardo Dias de Oliveira Brito, Angelo J. Mont'Alverne Duarte e Osmani Teixeira de C. Guillen*	Maio/2003
73	**Análise de Componentes Principais de Dados Funcionais – uma Aplicação às Estruturas a Termo de Taxas de Juros** *Getúlio Borges da Silveira e Octavio Bessada*	Maio/2003
74	**Aplicação do Modelo de Black, Derman & Toy à Precificação de Opções Sobre Títulos de Renda Fixa** *Octavio Manuel Bessada Lion, Carlos Alberto Nunes Cosenza e César das Neves*	Maio/2003
75	**Brazil's Financial System: Resilience to Shocks, no Currency Substitution, but Struggling to Promote Growth** *Ilan Goldfajn, Katherine Hennings and Helio Mori*	Jun/2003

76	**Inflation Targeting in Emerging Market Economies** *Arminio Fraga, Ilan Goldfajn and André Minella*	Jun/2003
77	**Inflation Targeting in Brazil: Constructing Credibility under Exchange Rate Volatility** *André Minella, Paulo Springer de Freitas, Ilan Goldfajn and Marcelo Kfoury Muinhos*	Jul/2003
78	**Contornando os Pressupostos de Black & Scholes: Aplicação do Modelo de Precificação de Opções de Duan no Mercado Brasileiro** *Gustavo Silva Araújo, Claudio Henrique da Silveira Barbedo, Antonio Carlos Figueiredo, Eduardo Facó Lemgruber*	Out/2003
79	**Inclusão do Decaimento Temporal na Metodologia Delta-Gama para o Cálculo do VaR de Carteiras Compradas em Opções no Brasil** *Claudio Henrique da Silveira Barbedo, Gustavo Silva Araújo, Eduardo Facó Lemgruber*	Out/2003
80	**Diferenças e Semelhanças entre Países da América Latina: uma Análise de *Markov Switching* para os Ciclos Econômicos de Brasil e Argentina** *Arnildo da Silva Correa*	Out/2003
81	**Bank Competition, Agency Costs and the Performance of the Monetary Policy** *Leonardo Soriano de Alencar and Márcio I. Nakane*	Jan/2004
82	**Carteiras de Opções: Avaliação de Metodologias de Exigência de Capital no Mercado Brasileiro** *Cláudio Henrique da Silveira Barbedo e Gustavo Silva Araújo*	Mar/2004
83	**Does Inflation Targeting Reduce Inflation? An Analysis for the OECD Industrial Countries** *Thomas Y. Wu*	May/2004
84	**Speculative Attacks on Debts and Optimum Currency Area: a Welfare Analysis** *Aloisio Araujo and Marcia Leon*	May/2004
85	**Risk Premia for Emerging Markets Bonds: Evidence from Brazilian Government Debt, 1996-2002** *André Soares Loureiro and Fernando de Holanda Barbosa*	May/2004
86	**Identificação do Fator Estocástico de Descontos e Algumas Implicações sobre Testes de Modelos de Consumo** *Fabio Araujo e João Victor Issler*	Maio/2004
87	**Mercado de Crédito: uma Análise Econométrica dos Volumes de Crédito Total e Habitacional no Brasil** *Ana Carla Abrão Costa*	Dez/2004
88	**Ciclos Internacionais de Negócios: uma Análise de Mudança de Regime Markoviano para Brasil, Argentina e Estados Unidos** *Arnildo da Silva Correa e Ronald Otto Hillbrecht*	Dez/2004
89	**O Mercado de *Hedge* Cambial no Brasil: Reação das Instituições Financeiras a Intervenções do Banco Central** *Fernando N. de Oliveira*	Dez/2004

90	**Bank Privatization and Productivity: Evidence for Brazil** *Márcio I. Nakane and Daniela B. Weintraub*	Dec/2004
91	**Credit Risk Measurement and the Regulation of Bank Capital and Provision Requirements in Brazil – a Corporate Analysis** *Ricardo Schechtman, Valéria Salomão Garcia, Sergio Mikio Koyama and Guilherme Cronemberger Parente*	Dec/2004
92	**Steady-State Analysis of an Open Economy General Equilibrium Model for Brazil** *Mirta Noemi Sataka Bugarin, Roberto de Goes Ellery Jr., Victor Gomes Silva, Marcelo Kfoury Muinhos*	Apr/2005
93	**Avaliação de Modelos de Cálculo de Exigência de Capital para Risco Cambial** *Claudio H. da S. Barbedo, Gustavo S. Araújo, João Maurício S. Moreira e Ricardo S. Maia Clemente*	Abr/2005
94	**Simulação Histórica Filtrada: Incorporação da Volatilidade ao Modelo Histórico de Cálculo de Risco para Ativos Não-Lineares** *Claudio Henrique da Silveira Barbedo, Gustavo Silva Araújo e Eduardo Facó Lemgruber*	Abr/2005
95	**Comment on Market Discipline and Monetary Policy by Carl Walsh** *Maurício S. Bugarin and Fábia A. de Carvalho*	Apr/2005
96	**O que É Estratégia: uma Abordagem Multiparadigmática para a Disciplina** *Anthero de Moraes Meirelles*	Ago/2005
97	**Finance and the Business Cycle: a Kalman Filter Approach with Markov Switching** *Ryan A. Compton and Jose Ricardo da Costa e Silva*	Aug/2005
98	**Capital Flows Cycle: Stylized Facts and Empirical Evidences for Emerging Market Economies** *Helio Mori e Marcelo Kfoury Muinhos*	Aug/2005
99	**Adequação das Medidas de Valor em Risco na Formulação da Exigência de Capital para Estratégias de Opções no Mercado Brasileiro** *Gustavo Silva Araújo, Claudio Henrique da Silveira Barbedo,e Eduardo Facó Lemgruber*	Set/2005
100	**Targets and Inflation Dynamics** *Sergio A. L. Alves and Waldyr D. Areosa*	Oct/2005
101	**Comparing Equilibrium Real Interest Rates: Different Approaches to Measure Brazilian Rates** *Marcelo Kfoury Muinhos and Márcio I. Nakane*	Mar/2006
102	**Judicial Risk and Credit Market Performance: Micro Evidence from Brazilian Payroll Loans** *Ana Carla A. Costa and João M. P. de Mello*	Apr/2006
103	**The Effect of Adverse Supply Shocks on Monetary Policy and Output** *Maria da Glória D. S. Araújo, Mirta Bugarin, Marcelo Kfoury Muinhos and Jose Ricardo C. Silva*	Apr/2006

104	**Extração de Informação de Opções Cambiais no Brasil** *Eui Jung Chang e Benjamin Miranda Tabak*	Abr/2006
105	**Representing Roommate's Preferences with Symmetric Utilities** *José Alvaro Rodrigues Neto*	Apr/2006
106	**Testing Nonlinearities Between Brazilian Exchange Rates and Inflation Volatilities** *Cristiane R. Albuquerque and Marcelo Portugal*	May/2006
107	**Demand for Bank Services and Market Power in Brazilian Banking** *Márcio I. Nakane, Leonardo S. Alencar and Fabio Kanczuk*	Jun/2006
108	**O Efeito da Consignação em Folha nas Taxas de Juros dos Empréstimos Pessoais** *Eduardo A. S. Rodrigues, Victorio Chu, Leonardo S. Alencar e Tony Takeda*	Jun/2006
109	**The Recent Brazilian Disinflation Process and Costs** *Alexandre A. Tombini and Sergio A. Lago Alves*	Jun/2006
110	**Fatores de Risco e o *Spread* Bancário no Brasil** *Fernando G. Bignotto e Eduardo Augusto de Souza Rodrigues*	Jul/2006
111	**Avaliação de Modelos de Exigência de Capital para Risco de Mercado do Cupom Cambial** *Alan Cosme Rodrigues da Silva, João Maurício de Souza Moreira e Myrian Beatriz Eiras das Neves*	Jul/2006
112	**Interdependence and Contagion: an Analysis of Information Transmission in Latin America's Stock Markets** *Angelo Marsiglia Fasolo*	Jul/2006
113	**Investigação da Memória de Longo Prazo da Taxa de Câmbio no Brasil** *Sergio Rubens Stancato de Souza, Benjamin Miranda Tabak e Daniel O. Cajueiro*	Ago/2006
114	**The Inequality Channel of Monetary Transmission** *Marta Areosa and Waldyr Areosa*	Aug/2006
115	**Myopic Loss Aversion and House-Money Effect Overseas: an Experimental Approach** *José L. B. Fernandes, Juan Ignacio Peña and Benjamin M. Tabak*	Sep/2006
116	**Out-Of-The-Money Monte Carlo Simulation Option Pricing: the Join Use of Importance Sampling and Descriptive Sampling** *Jaqueline Terra Moura Marins, Eduardo Saliby and Joséte Florencio dos Santos*	Sep/2006
117	**An Analysis of Off-Site Supervision of Banks' Profitability, Risk and Capital Adequacy: a Portfolio Simulation Approach Applied to Brazilian Banks** *Theodore M. Barnhill, Marcos R. Souto and Benjamin M. Tabak*	Sep/2006
118	**Contagion, Bankruptcy and Social Welfare Analysis in a Financial Economy with Risk Regulation Constraint** *Aloísio P. Araújo and José Valentim M. Vicente*	Oct/2006

119	**A Central de Risco de Crédito no Brasil: uma Análise de Utilidade de Informação** *Ricardo Schechtman*	Out/2006
120	**Forecasting Interest Rates: an Application for Brazil** *Eduardo J. A. Lima, Felipe Luduvice and Benjamin M. Tabak*	Oct/2006
121	**The Role of Consumer's Risk Aversion on Price Rigidity** *Sergio A. Lago Alves and Mirta N. S. Bugarin*	Nov/2006
122	**Nonlinear Mechanisms of the Exchange Rate Pass-Through: a Phillips Curve Model With Threshold for Brazil** *Arnildo da Silva Correa and André Minella*	Nov/2006
123	**A Neoclassical Analysis of the Brazilian "Lost-Decades"** *Flávia Mourão Graminho*	Nov/2006
124	**The Dynamic Relations between Stock Prices and Exchange Rates: Evidence for Brazil** *Benjamin M. Tabak*	Nov/2006
125	**Herding Behavior by Equity Foreign Investors on Emerging Markets** *Barbara Alemanni and José Renato Haas Ornelas*	Dec/2006
126	**Risk Premium: Insights over the Threshold** *José L. B. Fernandes, Augusto Hasman and Juan Ignacio Peña*	Dec/2006
127	**Uma Investigação Baseada em Reamostragem sobre Requerimentos de Capital para Risco de Crédito no Brasil** *Ricardo Schechtman*	Dec/2006
128	**Term Structure Movements Implicit in Option Prices** *Caio Ibsen R. Almeida and José Valentim M. Vicente*	Dec/2006
129	**Brazil: Taming Inflation Expectations** *Afonso S. Bevilaqua, Mário Mesquita and André Minella*	Jan/2007
130	**The Role of Banks in the Brazilian Interbank Market: Does Bank Type Matter?** *Daniel O. Cajueiro and Benjamin M. Tabak*	Jan/2007
131	**Long-Range Dependence in Exchange Rates: the Case of the European Monetary System** *Sergio Rubens Stancato de Souza, Benjamin M. Tabak and Daniel O. Cajueiro*	Mar/2007
132	**Credit Risk Monte Carlo Simulation Using Simplified Creditmetrics' Model: the Joint Use of Importance Sampling and Descriptive Sampling** *Jaqueline Terra Moura Marins and Eduardo Saliby*	Mar/2007
133	**A New Proposal for Collection and Generation of Information on Financial Institutions' Risk: the Case of Derivatives** *Gilneu F. A. Vivan and Benjamin M. Tabak*	Mar/2007
134	**Amostragem Descritiva no Apreçamento de Opções Européias através de Simulação Monte Carlo: o Efeito da Dimensionalidade e da Probabilidade de Exercício no Ganho de Precisão** *Eduardo Saliby, Sergio Luiz Medeiros Proença de Gouvêa e Jaqueline Terra Moura Marins*	Abr/2007

135	**Evaluation of Default Risk for the Brazilian Banking Sector** *Marcelo Y. Takami and Benjamin M. Tabak*	May/2007
136	**Identifying Volatility Risk Premium from Fixed Income Asian Options** *Caio Ibsen R. Almeida and José Valentim M. Vicente*	May/2007
137	**Monetary Policy Design under Competing Models of Inflation Persistence** *Solange Gouvea e Abhijit Sen Gupta*	May/2007
138	**Forecasting Exchange Rate Density Using Parametric Models: the Case of Brazil** *Marcos M. Abe, Eui J. Chang and Benjamin M. Tabak*	May/2007
139	**Selection of Optimal Lag Length inCointegrated VAR Models with Weak Form of Common Cyclical Features** *Carlos Enrique Carrasco Gutiérrez, Reinaldo Castro Souza and Osmani Teixeira de Carvalho Guillén*	Jun/2007
140	**Inflation Targeting, Credibility and Confidence Crises** *Rafael Santos and Aloísio Araújo*	Aug/2007
141	**Forecasting Bonds Yields in the Brazilian Fixed income Market** *Jose Vicente and Benjamin M. Tabak*	Aug/2007
142	**Crises Análise da Coerência de Medidas de Risco no Mercado Brasileiro de Ações e Desenvolvimento de uma Metodologia Híbrida para o *Expected Shortfall*** *Alan Cosme Rodrigues da Silva, Eduardo Facó Lemgruber, José Alberto Rebello Baranowski e Renato da Silva Carvalho*	Ago/2007
143	**Price Rigidity in Brazil: Evidence from CPI Micro Data** *Solange Gouvea*	Sep/2007
144	**The Effect of Bid-Ask Prices on Brazilian Options Implied Volatility: a Case Study of Telemar Call Options** *Claudio Henrique da Silveira Barbedo and Eduardo Facó Lemgruber*	Oct/2007
145	**The Stability-Concentration Relationship in the Brazilian Banking System** *Benjamin Miranda Tabak, Solange Maria Guerra, Eduardo José Araújo Lima and Eui Jung Chang*	Oct/2007
146	**Movimentos da Estrutura a Termo e Critérios de Minimização do Erro de Previsão em um Modelo Paramétrico Exponencial** *Caio Almeida, Romeu Gomes, André Leite e José Vicente*	Out/2007
147	**Explaining Bank Failures in Brazil: Micro, Macro and Contagion Effects (1994-1998)** *Adriana Soares Sales and Maria Eduarda Tannuri-Pianto*	Oct/2007
148	**Um Modelo de Fatores Latentes com Variáveis Macroeconômicas para a Curva de Cupom Cambial** *Felipe Pinheiro, Caio Almeida e José Vicente*	Out/2007
149	**Joint Validation of Credit Rating PDs under Default Correlation** *Ricardo Schechtman*	Oct/2007

150	**A Probabilistic Approach for Assessing the Significance of Contextual Variables in Nonparametric Frontier Models: an Application for Brazilian Banks** *Roberta Blass Staub and Geraldo da Silva e Souza*	Oct/2007
151	**Building Confidence Intervals with Block Bootstraps for the Variance Ratio Test of Predictability** *Eduardo José Araújo Lima and Benjamin Miranda Tabak*	Nov/2007
152	**Demand for Foreign Exchange Derivatives in Brazil: Hedge or Speculation?** *Fernando N. de Oliveira and Walter Novaes*	Dec/2007
153	**Aplicação da Amostragem por Importância à Simulação de Opções Asiáticas Fora do Dinheiro** *Jaqueline Terra Moura Marins*	Dez/2007
154	**Identification of Monetary Policy Shocks in the Brazilian Market for Bank Reserves** *Adriana Soares Sales and Maria Tannuri-Pianto*	Dec/2007
155	**Does Curvature Enhance Forecasting?** *Caio Almeida, Romeu Gomes, André Leite and José Vicente*	Dec/2007
156	**Escolha do Banco e Demanda por Empréstimos: um Modelo de Decisão em Duas Etapas Aplicado para o Brasil** *Sérgio Mikio Koyama e Márcio I. Nakane*	Dez/2007
157	**Is the Investment-Uncertainty Link Really Elusive? The Harmful Effects of Inflation Uncertainty in Brazil** *Tito Nícias Teixeira da Silva Filho*	Jan/2008
158	**Characterizing the Brazilian Term Structure of Interest Rates** *Osmani T. Guillen and Benjamin M. Tabak*	Feb/2008
159	**Behavior and Effects of Equity Foreign Investors on Emerging Markets** *Barbara Alemanni and José Renato Haas Ornelas*	Feb/2008
160	**The Incidence of Reserve Requirements in Brazil: Do Bank Stockholders Share the Burden?** *Fábia A. de Carvalho and Cyntia F. Azevedo*	Feb/2008
161	**Evaluating Value-at-Risk Models via Quantile Regressions** *Wagner P. Gaglianone, Luiz Renato Lima and Oliver Linton*	Feb/2008
162	**Balance Sheet Effects in Currency Crises: Evidence from Brazil** *Marcio M. Janot, Márcio G. P. Garcia and Walter Novaes*	Apr/2008
163	**Searching for the Natural Rate of Unemployment in a Large Relative Price Shocks' Economy: the Brazilian Case** *Tito Nícias Teixeira da Silva Filho*	May/2008
164	**Foreign Banks' Entry and Departure: the recent Brazilian experience (1996-2006)** *Pedro Fachada*	Jun/2008
165	**Avaliação de Opções de Troca e Opções de *Spread* Européias e Americanas** *Giuliano Carrozza Uzêda Iorio de Souza, Carlos Patrício Samanez e Gustavo Santos Raposo*	Jul/2008

166	**Testing Hyperinflation Theories Using the Inflation Tax Curve: a case study** *Fernando de Holanda Barbosa and Tito Nícias Teixeira da Silva Filho*	Jul/2008
167	**O Poder Discriminante das Operações de Crédito das Instituições Financeiras Brasileiras** *Clodoaldo Aparecido Annibal*	Jul/2008
168	**An Integrated Model for Liquidity Management and Short-Term Asset Allocation in Commercial Banks** *Wenersamy Ramos de Alcântara*	Jul/2008
169	**Mensuração do Risco Sistêmico no Setor Bancário com Variáveis Contábeis e Econômicas** *Lucio Rodrigues Capelletto, Eliseu Martins e Luiz João Corrar*	Jul/2008
170	**Política de Fechamento de Bancos com Regulador Não-Benevolente: Resumo e Aplicação** *Adriana Soares Sales*	Jul/2008
171	**Modelos para a Utilização das Operações de Redesconto pelos Bancos com Carteira Comercial no Brasil** *Sérgio Mikio Koyama e Márcio Issao Nakane*	Ago/2008
172	**Combining Hodrick-Prescott Filtering with a Production Function Approach to Estimate Output Gap** *Marta Areosa*	Aug/2008
173	**Exchange Rate Dynamics and the Relationship between the Random Walk Hypothesis and Official Interventions** *Eduardo José Araújo Lima and Benjamin Miranda Tabak*	Aug/2008
174	**Foreign Exchange Market Volatility Information: an investigation of real-dollar exchange rate** *Frederico Pechir Gomes, Marcelo Yoshio Takami and Vinicius Ratton Brandi*	Aug/2008
175	**Evaluating Asset Pricing Models in a Fama-French Framework** *Carlos Enrique Carrasco Gutierrez and Wagner Piazza Gaglianone*	Dec/2008
176	**Fiat Money and the Value of Binding Portfolio Constraints** *Mário R. Páscoa, Myrian Petrassi and Juan Pablo Torres-Martínez*	Dec/2008
177	**Preference for Flexibility and Bayesian Updating** *Gil Riella*	Dec/2008
178	**An Econometric Contribution to the Intertemporal Approach of the Current Account** *Wagner Piazza Gaglianone and João Victor Issler*	Dec/2008
179	**Are Interest Rate Options Important for the Assessment of Interest Rate Risk?** *Caio Almeida and José Vicente*	Dec/2008
180	**A Class of Incomplete and Ambiguity Averse Preferences** *Leandro Nascimento and Gil Riella*	Dec/2008
181	**Monetary Channels in Brazil through the Lens of a Semi-Structural Model** *André Minella and Nelson F. Souza-Sobrinho*	Apr/2009

182	**Avaliação de Opções Americanas com Barreiras Monitoradas de Forma Discreta** *Giuliano Carrozza Uzêda Iorio de Souza e Carlos Patrício Samanez*	Abr/2009
183	**Ganhos da Globalização do Capital Acionário em Crises Cambiais** *Marcio Janot e Walter Novaes*	Abr/2009
184	**Behavior Finance and Estimation Risk in Stochastic Portfolio Optimization** *José Luiz Barros Fernandes, Juan Ignacio Peña and Benjamin Miranda Tabak*	Apr/2009
185	**Market Forecasts in Brazil: performance and determinants** *Fabia A. de Carvalho and André Minella*	Apr/2009
186	**Previsão da Curva de Juros: um modelo estatístico com variáveis macroeconômicas** *André Luís Leite, Romeu Braz Pereira Gomes Filho e José Valentim Machado Vicente*	Maio/2009