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JUNG CHIK PARK

BUSINESS CYCLE AND BANK LOAN PORTFOLIO PERFORMANCE:

EMPIRICAL EVIDENCE FROM BRAZILIAN BANKS

SÃO PAULO

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Dissertação apresentada à Escola de Administração de Empresas de São Paulo da Fundação Getúlio Vargas, como requisito parcial à obtenção do título de Mestre em Administração de Empresas.

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ABSTRACT

This paper studies the effects of economic growth and interest rates on the performance of Brazilian commercial bank loan portfolios in the period 2000 to 2010.

The results provide empirical evidence that economic growth is the main "driver" for performance of the loan portfolio. No evidence has found on the interest rate variation on NPL.

Moreover, there is empirical evidence that performance reasoned by GDP is lagged by 2 quarters.

Furthermore, the results show that the GDP variations correlated significantly with the performance level variations of Brazilian commercial banks, with a two-quarter lag throughout the period of one year.

Finally, the results show that changes in GDP most significantly impact on the performance of the largest Brazilian commercial banks' loan portfolio. Due to the multiplier effect of the credit market, the bigger the bank, the higher the relative expansion of its loan portfolio, and the higher its non-performing loan, which is aggravated by the credit market concentration in Brazil.

Keywords: economic growth (GDP), interest rates, non-performing loan.

RESUMO

Este trabalho estuda os efeitos do crescimento econômico e da taxas de juros sobre o desempenho de carteiras de empréstimo dos bancos comerciais brasileiros no período de 2000 a 2010.

Os resultados empíricos mostram que o crescimento econômico é o principal "driver" para o desempenho da carteira de crédito. Não foram encontradas evidências estatísticas sginificativas de mudanças na taxa de juros sobre o desempenho das carteiras de empréstimos.

Além disso, há evidências empíricas de que o impacto do crescimento econômico sobre o desempenho da carteria de crédito tem efeito defasado de 2 trimestres.

Por fim, os resultados mostram que alterações de PIB impactam de forma mais significativa o desempenho da carteira de crédito dos bancos comerciais brasileiros maiores. Devido ao efeito multiplicador do mercado de crédito, quanto maior o banco, maior a expansão relativa de sua carteira de crédito e, conseqüentemente a taxa de inadimplência da carteira, que é agravada pela concentração do mercado de crédito no Brasil.

Palavras-chave: crescimento econômico (PIB), taxa de juros, desempenho da carteira de empréstimo.

1. INTRODUCTION

The global financial crisis experienced by loan granting institutions worldwide during the 2008-2009 time periods renewed the interest in understanding the performance of banks during the business cycle. In a global economy, developing countries have been steadily increasing their importance as evidenced by the emerging market crises of the 1990s. This has brought up a heightened level of concern expressed by regulators, analysts and investors regarding the overall strength of the banking system not only amongst the developed countries, but also, and more importantly, in the developing world.

In most modern banking systems, transactions involving the lending and issuance of credits are some of the primary activities that can potentially expose lending institutions to risks of loss. Credit risk can be defined as the risk of loss of principal or loss of a financial reward stemming from a borrower's failure to repay a loan or otherwise meet their contractual obligation. Credit risk also arises whenever a borrower's credit quality deteriorates and is expecting to use future cash flows to pay a current debt. Even though this does not result in an immediate loss of principal for the lending institution, there is a greater probability that a default will occur and this closely ties the risk to the potential return on an investment. Another notable instance being that the yields of bonds correlate strongly to their perceived credit risk. (Basel Committee on Banking Supervision, 1998).

Credit risk is affected by the likelihood of a potential borrower defaulting on his or her financial obligations with a lending institution. Thus, the quality of a bank's loan portfolio is mainly determined by the rate of defaults. Credit risk management must be the lending institution's primary line of defence in order to prevent transactions that will give credit to customers who will fail to meet the terms of the loans. Credit risk management is an important aspect of a bank's success and ensures that the lending institution will not take on undue risk.

Moreover, considering the propagating behaviour of the credit market, relatively small macroeconomic changes can engender a big oscillation in the economy. And this, in

turn, can have a significant impact on the rate of an economic expansion or recession. (Bernanke et al., 1998).

Despite a great deal of research on these macroeconomic determinants impact the immediate performance of banks, there are only a few studies which relate the performance of Brazilian banks and our macroeconomic environment, particularly when critical periods are factored into consideration.

In order to further contribute to our understanding of this relationship, this paper tested the effects of economic growth (GDP), as well as the changes in interest rate on the performance of Brazilian commercial bank loan portfolios from 2000 through 2010, taking into account the assessment model used by Glen and Velez (2010).

The empirical result showed that there is a strong correlation between economic growth (GDP) and the performance of the loan portfolios from Brazilian commercial lending institutions, while the variation in the interest rate has had no significant statistical effect. Furthermore, there is empirical evidence suggesting that the impact of the economic growth on the performance of the credit portfolio may not be immediate. In fact, it has historically taken an average of two quarters for the effect to be produced.

Finally, the results showed that changes in GDP most significantly impact on the performance of the largest Brazilian commercial banks' loan portfolio. Due to the multiplier effect of the credit market, the bigger the bank, the higher the relative expansion of its loan portfolio, and the higher its non-performing loan, which is aggravated by the credit market concentration in Brazil.

This paper is organized in the following way: section 2 presents the theoretical references; section 3 presents the utilized data, the sample selection, the empirical model, and the descriptive statistics; section 4 presents the results and discussions; and section 5 presents the conclusion of this paper.

Key words: economic growth, interest rate, performance of the loan portfolio, credit risk, financial crises.

2. THEORETICAL REFERENCE

2.1 History of the relation between the economic activity and the financial system

The relationship between the economic activity and the overall health of the financial system has become more clearly understood by economists due to advancements in macroeconomic theories.

According to Keynes (1936), the level of economic activity was determined by the level of aggregate demand. Additionally, he argued that capitalist economies were subject to periodic weakness in the aggregate demand generation process, resulting in unemployment.

In 1933, Fisher demonstrated that one of the main contributing factors to the severity of the Great Depression in 1929 was the ill preparedness of the financial markets at the time. The author introduced the concept of *debt deflation* in order to explain that the deflation of prices actually increased people's real indebtedness. This, in turn, caused them to cut down on their expenses and investments causing even further deflation, and, consequently, promoting a vicious cycle that inevitably lead to the instability in the world's economy. Also, in 1963, Friedman and Schwartz presented a strong positive correlation between monetary offers and production of goods, especially during the Great Depression, underscoring how pivotal the role of lending institutions is because they mobilize the currency across the financial market. Likewise, understanding their importance in the financial system is crucial to the recovery of the world's economy.

Furthermore, Bernanke's studies (1983) concluded that the banking crisis was serious enough to affect the real activity in the Great Depression because it interrupted the financial flow to certain sectors of the economy, revealing that the financial system is clearly important for the economy to be restored and Mishkin(1978) analysed that the relationship between financial factors and the

economic cycle had a significant impact on consumers' expenses, using data from the crisis of 1929.

Akerlof's studies in 1970 highlighted the imperfections in the credit market and their implications for the financial market at the microeconomic level, such as the imbalance of information and critical problems within the agency itself. According to Bernanke *et al.*(1998), the lack of consistency of information has an important role in the relation between creditors and debtors; concluding that the contracts, the monitoring cost and incentive policies all interfere in the credit market. Thus, the author presents a macroeconomic model which incorporates both the imbalanced information and the agency cost in loan relations, impacting on cycles of economic activity.

However, according to Gertler (1988), the macroeconomic literature which followed the publication of the General Theory practically ignored the potential link between the economic activity and the performance of the credit market.

In Brazil, research in this area started essentially during the early 1990's, fundamentally analysing the implications over the economic growth originated in the public infrastructure with the pioneering studies by Ferreira (1996), Garcia (1996), Ferreira and Malliagros (1998), and Rigolon (1998).

Specifically, where the role of the financial system in the process of the economic growth in Brazil is concerned, Gonçalves (1980) and Studart's (1993) contributions can be marked off. Arraes and Teles (2000) examined the productive issue with secondary focus over the credit role offered by the financial system, and Triner (1996)

2.2 Macroeconomic determinants in the performance of the credit portfolio

This section presents studies accomplished about macroeconomic determinants in the performance of banks' credit portfolio. Section 2.3 addresses determinants of the economic growth, section 2.4 addresses determinants of the interest rate, and section 2.5 addresses determinants of the credit risk and regulations.

In 2001, Chu investigated the main macroeconomic factors that helped explain banking default during the period from 1994 to 2000. The author inferred that the GDP, the Spread (difference between application rate and funding rate), Interest Rate and Unemployment are, respectively, the factors that Brazilian banks' expenditures and default are most sensitive to.

Takeda, in 2003, evaluated the effects of monetary policy on credit offer and concluded that the Central Bank Compulsory Deposits Rate (remunerated deposits) is one of the instruments of monetary policy, and he also demonstrated that there is a positive correlation between credit offer and the industrial GDP.

In 2003, Pain investigated the factors which explain the increase in loan loss provision amongst the eleven biggest UK banks. The result showed that macroeconomic factors, such as the Gross Domestic Product (GDP), the real interest rate, and loan portfolios, as well as specific factors, such as loans to certain segments of the economy, are associated with provision levels.

Motivated by the Greek financial crisis, Louzis, Vouldis and Metaxas carried out a study in 2010 that shows that the performance of Greek banks' loan portfolios can be explained mainly by the GDP, real interest rate, and employment rate, apart from the managerial quality of financial institutions.

Most recently, in 2010, Glen and Velez studied the effects of the GDP and the real interest rate upon the performance of commercial banks' credit portfolios from emerging countries, and demonstrated that the GDP is the main determinant in the performance of the loan portfolio, with the interest rate having a secondary effect. Moreover, the paper showed that emerging countries were, in general, resilient to the global crisis due to their GDP growth rates. Data from IMF's Global Financial Stability Report (April, 2010) showed that, although the non-performing credit level (default measured in percentage of total credit), in 2009, had been 3.5 times as high as it was noticed in 2007 for the U.S.A. and the U.K., this relation was 1.5 times as low in the case of Brazil, India, and China.

2.3 Economic Growth Determinants

Gonzaga *et al.*(1995) studied the relevance of permanent shocks in the explanation of the product variance in typical periods of economic cycles. The author concluded that transitory shocks to the product are practically irrelevant when compared to the permanent ones. The author shows that anticyclical economic policies, which control transitory shocks (e.g.: monetary policies of added demand control), have extremely limited effectiveness, and that, given the importance of permanent shocks, it is necessary that economic determinants of long-term shocks over the product be investigated. The authors also researched the long-term effects of education, foreign investments, and economic growth. The authors inferred that, except for illiteracy rate, the tested series had a long-term relationship with the Brazilian prospective product.

In 1995, Fava and Cati investigated the reasons behind the trends found in the Brazilian gross domestic product, either stochastic or deterministic, by using the GDP series referring to data from 1900 through 1993. Based on the Dickey-Fuller unit root test and on the unit root tests proposed by Perron (1989 and 1993), the Additive Outlier Model (AO) and the Innovational Outlier Model (IO), they found evidence that Brazilian GDP did not have a stochastic tendency until 1980. The period during which the tendency was first observed coincided with economic crisis in the early 1980's.

According to Cardoso (1997), there are basically four factors which account for the economic growth in leading countries: The accumulation of physical capital; the accumulation of human capital; the accumulation of technology; and, the operation standards of the country’s institutions.

According to Ferreira and Issler (1997), the GDP of an economy presents two types of movements: the short-term of cyclic ones, that is, fluctuations that occur on a monthly basis or on a yearly basis, which are related to transitory shocks; and, the long-term, or tendency ones, which are related to permanent shocks and are the focus of research in economic growth theories. Also, according to the authors, the GDP and the prospective product move together and parallel. In the long run, this would mean that the GDP is mainly affected by the accumulation of production,

capital, and working factors, by the externalities which lead to bigger marginal productivities, by the long-term economic stability, by education, and by investments in human capital. In the short term, however, changes in the GDP are related to interest rates, currency control, and fiscal policies.

In 2003, based on Solow's economic growth model, Tonini evaluated the effects of the investment levels in education as well as the effects of physical capital storage on Brazilian economic growth, from 1975 through 2000. The author suggests that the investments in these two variables were low, which confirmed the low level of growth in Brazilian economy, especially in the 1980's.

2.4 Loan interest rate determinants

According to HO and SAUNDERS (1981), an elevation in the basic interest rate causes not only the market interest rates to increase, but also an increase in banking interest rates.

In 1989 Berger and Hannan proposed that the banking concentration has a considerable impact on the interest rates due to the fact that a more concentrated banking sector tends to act oligopolistically, thus, charging higher interest rates.

Research by Kashvap and Stein in 2000 concluded that smaller banks, particularly ones with low liquidity and capitalization, charge higher loan interest rates because investors charge higher bonuses due to the risk.

In Brazil, Koyama and Nakane (2002) evaluated the determinants of "banking spread", inferring that the most relevant component is related to the risk perception, which is related to the macroeconomic environment scenario of the country, mainly due to perspectives of economic growth.

In 2008, Gambacorta stated that better economic conditions increase the liquid value expected from investment projects, consequently increasing loan demand. Thus, loan interest rates would be positively related to the GDP evolution. On the side of credit offer, the increase of domestic income increases the potential of funding by the

banks, allowing them to loan more. Besides, the author enhances the fact that banking costs, along with resource funding, monitoring, maintenance of bank agencies, among others, also affect loan rates for such costs partly reflect on the level of banks' efficiency.

2.5 Credit Risk, Determinants and Regulation

Altman (1968) argued that the development of a new predictive model was necessary due to the growth in bankruptcies as well as the organizations' financial changes, aggravated by the drastic increase of the average size of bankrupted companies.

In 1974, The Basel Committee was formed by central banks of countries which comprised the Group of Ten (G-10): Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom, and the United States, after the bankruptcy of Herstatt Bank. The committee's decisions had neither legal power nor supranational supervising authority. Nevertheless, such decisions were widely accepted for they estimated the convergence of banking supervision techniques of the member countries to common standards and approaches, which made feasible the capital flow among countries without imposing barriers, as well as guaranteed the safety of such capitals.

In 1988, the Basel Accord, or Basel I, was signed and ratified by over 100 countries. This accord aimed to create minimum requirements of capital capital, which must be complied with by commercial banks, preventively against credit risk. Since then, capital requirement has been based on risk, establishing that the minimum capital requirements must comply with the economic loss anticipations of each financial institution.

Berger and Deyoung, in 1997, assumed that default credits can be caused by exogenous components, such as economy deceleration and companies' bankruptcies. On the other hand, the authors enhance the possibility of managerial inefficiency, an endogenous component, caused by managers' inefficient performance in monitoring credit portfolios, which affects the quality of loans and begets high default.

According to Bessis (1998), the credit risk can be defined by losses begotten by a debtor's default event or by the deterioration of its credit quality. The author stated that the deterioration of the debtor's credit quality does not result in an immediate loss for the financial institution, but in the increase of the probability that a default event happens. Thus, the credit risk can be evaluated from its components, which comprise the default risk, the exposure risk, and the recovery risk.

According to Caouette*et al*.(2000), credit generally involves the expectation of receiving a value in a certain period of time. In this sense, the author stated that the credit risk is the chance such an expectation will not be lived up to.

Houaiss (2001) defined the word "default" as: "[...] lack of complying with an obligation". Westgaard and Wijst (2001) stated that: "[...] defaulting is failing in paying an amount of money owed to a bank". Bessis (1998) presents the following definitions: "[...] neglecting to pay an obligation, breaking an agreement, starting a legal procedure or an economic default".

A wider definition was adopted by The Basel Committee on Banking Supervision (BCBS) in 2004: A default is regarded to have happened in relation to a specific debtor when one or both of the following events have occurred:

- The bank regards as improbable that the debtor pays the total amount of its obligations to the financial conglomerate without actions such as having the debtor give it guarantees (if possessed);

- The debtor is overdue for over 90 days regarding some material obligation with the financial institution.

According to Sicsú (2003), it is difficult to reach a consensus among credit analysts when it comes to an operational definition of default for the analysts' objectives can be conflicting. Some tend to adopt more rigorous criteria aiming to obtain a risk classification system which approves of credit operations more parsimoniously. However, other analysts, concerned with the creation of a system that limits banks' possible businesses, tend to adopt a less restrictive definition.

In 2009, Filippaki and Mamatzakis highlighted that bank managers oppose to risk so much that they could increase operational expenditures on loan assessments and monitoring, which reduces efficiency, in order to cut down default participation in their credit portfolios.

In Brazil, the biggest adjustment was due to the introduction of Resolution CMN nº 2682 from 12/21/1999, which establishes the classification criteria of credit operations for the constitution of loan loss provision (LLP).Such Resolution obliges banks to develop consistent credit models that allow the determined classification there under, according to table 1.

Table 1 – Provision per Risk Level

Risk level	Provision
AA	**0.00%**
A	**0.50%**
B	**1.00%**
C	**3.00%**
D	**10.00%**
E	**30.00%**
F	**50.00%**
G	**70.00%**
H	**100.00%**

Source: Resolution 2682/99, Banco Central do Brasil

According to the Resolution, the operation classification at risk levels must be reviewed, at least on a monthly basis, on the occasion of financial statement report, due to verified overdue payment of principal amount installments or charges installments, in compliance with the following:

a) 15 to 30 days overdue: level B risk, at least;
b) 31 to 60 days overdue: level C risk, at least;
c) 61 to 90 days overdue: level D risk, at least;
d) 91 to 120 days overdue: level E risk, at least;

e) 121 to 150 days overdue: level F risk, at least;
f) 151 to 180 days overdue: level G risk, at least;
g) overdue for more than 180 days: Level H risk;

According to Parente (2000), Resolution 2682/99, published to substitute Resolution 1748/90, has characteristics that dissociate it, in many aspects, from the provisioning rules forecast in its precedent. Thus, it came up to comply with the necessity of more rigor in such rules and of an adequacy of Brazilian norms to international standards.

Jorion (2003) highlighted that banking regulation is necessary to extinguish the effects caused by a probable mismanagement of the institution's resources, which puts its creditors and stockholders at risk.

According to Andrade (2003), credit risk models can be classified in three groups: risk classification models, stochastic models of credit risk and portfolio risk models. Risk classification models seek to assess either a debtor's risk or an operation risk, giving it a measure that represents the default risk expectation, generally expressed as a risk classification (rating) or score. Risk classification models are used by financial institutions in their credit award processes.

Schechtman *et al.* (2004) and Schechtman (2006) analyzed the adequacy of provision levels and regulating capital required by Brazil's Central Bank (Bacen) and infer that such levels are sufficiently robust to cover Brazilian financial institutions' credit risk exposure.

In 2008, Chang *et al.* presented evidence that approximately 10% of the banks of the domestic financial system account for practically the totality of loans in the banking market. In 2009, Tecles, Tabak, and Staub analyzed the loan market in Brazil from 2003 through 2008 to measure the diversification as well as the default rate of banks' portfolios. They inferred that the highest risk loans were in an increasing concentration, whereas the lowest risk ones were diversified. This happens due to the specialization in loans to certain sectors, through which banks have more conditions to monitor high risk credit.

Due to many bankruptcies of financial institutions in the 90's, in 2004, the Basel Committee launched a new document which substituted the 1988 Accord, named Basel II Capital Accord Basileia II, which is fixed on three pillars and 25 basic principles about accounting and banking supervision. According to BACEN (2004), Basel II Accord is an evolution of the one signed in 1988, which is underway in the Committee on bank monitoring. The new structure intends to improve itself by emphasizing the administration and the own control of banks in the managerial process of review and in the market discipline.

In this study, the *stricto sensu* concept of default, defined by Westgaard and Wijst (2001), and Bessis (1998) will be considered, namely: failure in paying a certain amount according to the original contract of the credit operation. As credit risk estimate of financial institutions, the loan loss provision (LLP) will be used, according to Resolution CMN nº2682, from 12/21/1999.

3. METHODOLOGY

This section presents the data sources used in this paper, the empirical model, the dependent variables, the explanatory variables, the control variables, and the descriptive statistics.

3.1 Data Source

The financial data present herein were directly obtained from Banco Central do Brasil's website. The author used quarterly data from all accounting positions of banking institutions such as Bank Conglomerate and Independent Banking Institutions like Commercial Bank, Multiple Bank with Commercial Portfolio or Thrift and Savings Bank, which had credit portfolio, according to Central Bank's classification.

Financial data from banks were collected ranging from 2000 through 2010, with base date at the end of every quarter of the respective years, according to table 2.

Table 2 – Number of Banks per Quarter

YEAR	QUARTER	NUMBER OF BANKS
2000	1st.	109
	2nd.	110
	3rd.	110
	4th.	112
Total		**441**
2001	1st.	106
	2nd.	109
	3rd.	108
	4th.	108
Total		**431**
2002	1st.	105
	2nd.	105
	3rd.	105
	4th.	102
Total		**417**
2003	1st.	102
	2nd.	101
	3rd.	103
	4th.	102
Total		**408**
2004	1st.	101
	2nd.	100
	3rd.	100
	4th.	100
Total		**401**
2005	1st.	100
	2nd.	99
	3rd.	98
	4th.	97
Total		**394**
2006	1st.	97
	2nd.	97
	3rd.	96
	4th.	95
Total		**385**
2007	1st.	95
	2nd.	94
	3rd.	93
	4th.	93
Total		**375**
2008	1st.	93
	2nd.	93
	3rd.	95
	4th.	95
Total		**376**
2009	1st.	93
	2nd.	94
	3rd.	94
	4th.	94
Total		**375**
2010	1st.	93
	2nd.	92
	3rd.	93
	4th.	93
Total		**371**
General Total		**4374**

Source: Banco Central do Brasil

On the base date 12/31/2010, the credit portfolio (credit operations and leasing) of the 93 banks totalized BRL 1.37 trillion out of BRL 1.65 trillion from the total Domestic Financial System, that is, 83.03%. Non-participants in this study: credit cooperatives, non-banking institutions, banks without commercial portfolio, investment banks, and development banks, according to table 3.

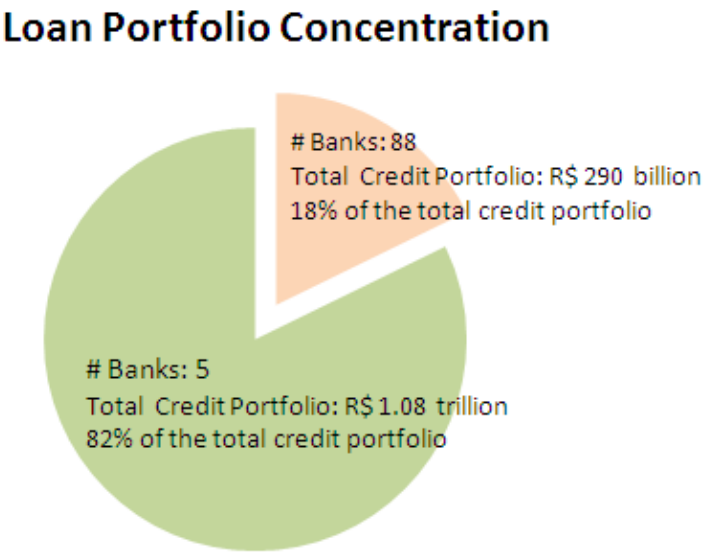
Table 3 – Credit portfolio per type of bank

BRL Thousands

Type of Bank	Number of Institutions	Credit Portfolio	% from Total
Commercial Bank, Multiple Bank with Commercial Portfolio or Thrift Savings Bank.	93	1.370.612.208,00	83,03%
Multiple Bank without Commercial Portfolio and Investment Bank	33	47.232.601,00	2,87%
Development Bank	4	185.457.777,00	11,26%
Total of System Fin. Domestic		**1.647.181.759,00**	**100,00%**

Source: Banco Central do Brasil (12/31/2010)

On 12/31/2000, the 5 largest commercial banks represented together 79% of the total commercial bank portfolio (USD 1.08 trillion), according to the graphic below:



Source: Banco Central do Brasil (12/31/2010)

3.2 Empirical Model

The empirical analysis of this paper was carried out by means of using panel econometrics with estimation per fixed effects. The decision to use this method was based on Hausman's test, in which the possibility of the non-existence of correlation between the non-observable effect and the explanatory variables throughout the whole period of the sample was rejected, thus eliminating the possibility of random effects estimation. Tests were done by considering, also, correction for heteroscedasticity.

Firstly, data referring to performance (NPL– non-performing loan, used as dependent variable), GDP and Interest Rate (central independent variables in the analysis), and other control explanatory variables (as presented in the following section) were groups by quarters from 2000 through 2010, with the sample organization in cross-sectional dimension.

Thus, according to Glen and Velez (2010), there is the following empirical model to be tested:

$$Nonperformance\ Loan\ (NPL)i,t = \beta 0i,t + \beta 1GDPi,t + \beta 2GDPi,t-1 + \beta 3GDPi,t-2 + \cdots + \beta 4GDPi,t-\mathrm{n} + \beta 5\Delta\ Interest\ Rate\ i,t + \beta 6Real\ Interest\ Rate\ i,t-1 + \beta 7Real\ Interest\ Rate\ i,t-2\ + \cdots + \beta 8Real\ Interest\ Rate\ i,t-\mathrm{n} + \beta 9\frac{Equity}{Assets}i,t + \beta 10\frac{Credit\ \ Portfolio}{Assets}i,t + \beta 11CDi,t + e$$

Where:

- *NPL i,t:* ratio of the loan loss provision, according to Resolution 2682/99 of Bacen, to net loan portfolio for bank i at time t.
- *GDP i,t: Variation of gross domestic product in the quarter compared to the same quarter of the previous year* for bank i at time t.
- *GDP i,t-1: Variation of gross domestic product in the previous quarter compared to the respective quarter of the previous year* for bank i at time t-1.

- *GDP i,t-2: Variation of gross domestic product in two previous quarters compared to the respective quarter of the previous year* for bank i at time t-2.
- *GDP i,t-n: Variation of gross domestic product in "n" previous quarters compared to the respective quarter of the previous year* for bank i at time t-n.
- *Δ Interest Rate i,t: Variation of interest rate of the quarter related to the previous one* for bank i at time t.
- *Real Interest Rate i,t-1: Real interest rate, that is, by deducting inflation of the period* for bank i at time t-1.
- *Real Interest Rate i,t-2: Real interest rate, that is, by deducting inflation two period* for bank i at time t-2.
- *Real Interest Rate i,t-n: Real interest rate of "n" previous period, that is, by deducting inflation of the respective period* for bank i at time t-n.
- *Equity/ Assets i,t: Total of Equity divided by Assets* for bank i at time t.
- *Credit Portfolio/Assets i,t: Total of Credit Portfolio divided by Assets* for bank i at time t.
- *CD i,t: Control dummy of crisis period* for bank i at time t.

The hypothesis, based on the results from the work by Glen and Velez (2010), is that the explanatory variable, GDP, has a significantly negative relation with the credit portfolio performance, while the interest rate has a positive relation. So, there are:

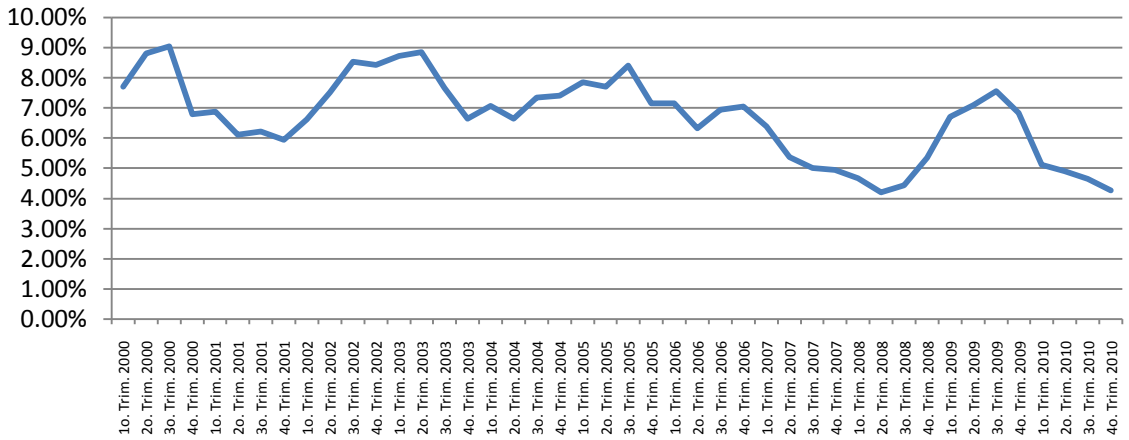
H1: Negative and significant relation between GDP and NPL

H2: Positive relation of the variation between interest rate and NPL

The dependent variable NPL (Nonperforming Loan) of the credit portfolio is the ratio of the loan loss provision, according to Resolution 2682/99 from Bacen, to net loan portfolio at a certain time. High default levels result in higher provisions; thus, default reserves can be regarded as a quality tool of the bank's credit portfolio.

Graphic 1 shows the evolution of NPL rate of the credit portfolio from the sample evaluated from 2000 through 2010.

Graphic 1- Evolution of the NPL rate



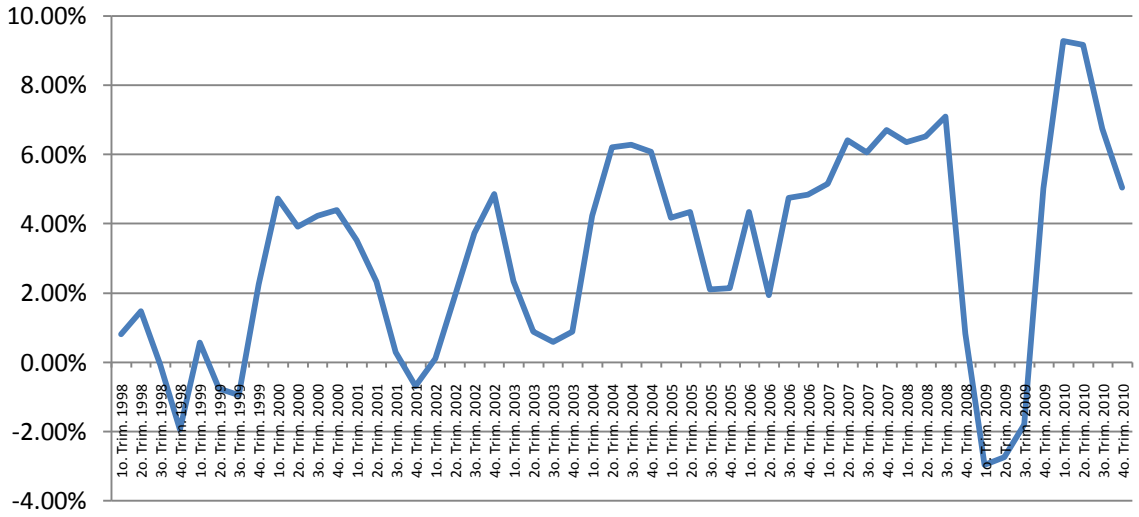
Source: Banco Central do Brasil

It is noticeable that the NPL rate decreased throughout the 3rd quarter of 2000, down from 9% to 5.98% in the 4th quarter of 2001. In 2002 and 2003, the NPL returned to its 9% level. From 2005 through 2008, the NPL rate kept decreasing until it reached around 4.10% in the 2nd quarter of 2008. In the 3rd quarter of 2009, an elevation of the NPL rate to 7.5% had occurred. In 2010, the rate returned to its low tendency, closing the year at 4.28%.

The gross domestic product (GDP) represents the sum (in monetary values) of all final goods and services produced in a certain region whether it is a country, a State, or a city), during a certain time (month, quarter, year, etc). The GDP is one of the most commonly used indicators in macroeconomics, and aims to measure the economic activity of a region.

There are two calculations of the GDP, one nominal and another one real. The former refers to the value of the GDP calculated at current prices, that is, in the year when the product was made and traded. The latter is calculated at steady prices, in which a base year is chosen so as to do the calculation of the GDP, eliminating, then, the inflation effect. For more consistent assessments, the Real Quarterly GDP was used, which is the comparison between the real GDP of the quarter to the real GDP of the equivalent quarter in the previous year. Graphic 2 presents the evolution of Brazil's Real GDP from 2000 through 2010.

Graphic 2 – Evolution of real GDP (% per quarter)



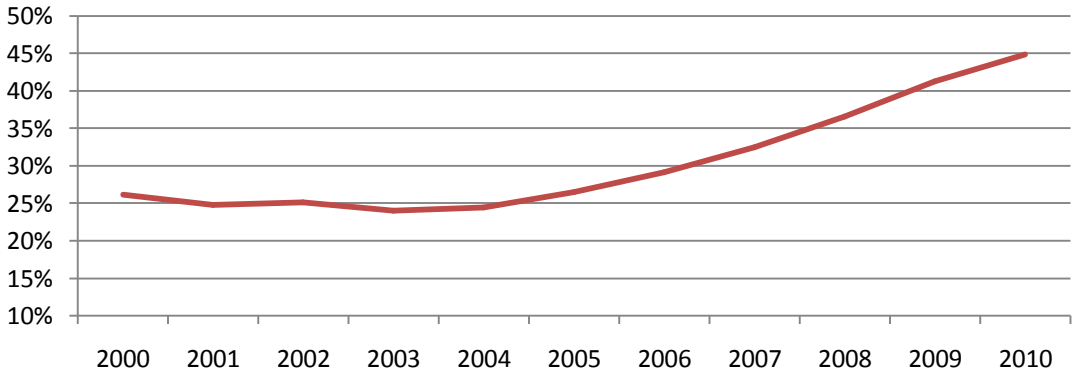
Source: IBGE

It is noticeable an increase in the GDP in 2000 and a plunge in 2001. The same occurred in 2002-2003. From 2003 on, there was a strong increase in the economic growth, reaching 7.10% in the 3rd quarter of 2008. In 2009, it is noticed a downturn in the economy, plummeting -2.98% in the 3rd quarter. In 2010, there is an accentuated recovery of Brazilian economic activity, rocketing 9.3% in the 1st quarter.

An explanation for the bad performance in 2009 would be the drops in the industrial production volumes, as well as the strong reduction of investments, from respectively 5.5% and 9.9%, due to the global subprime crisis triggered in September, 2008.

Graphic 3 shows the evolution of the relation between the total bank loans and the real GDP from 2000 to 2010.

Graphic 3 – Volume of Credit Portfolio over the real GDP



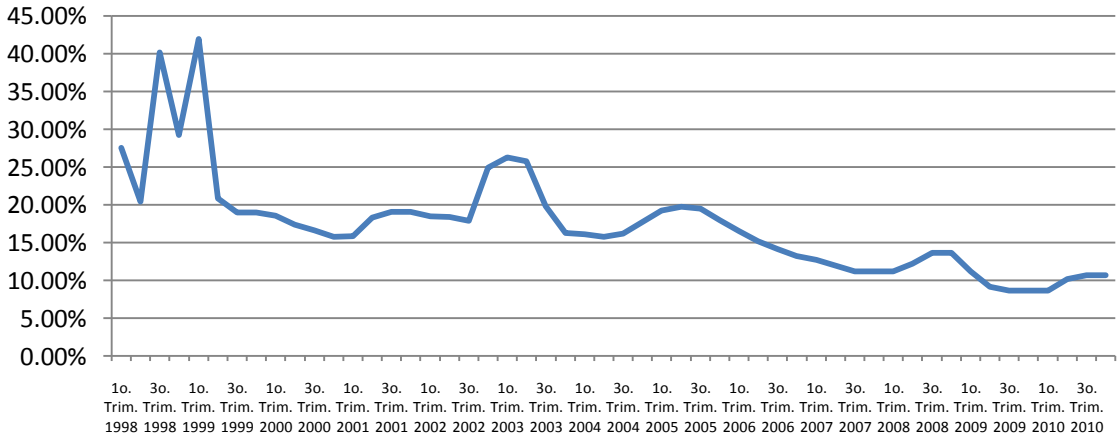
Source: Banco Central do Brasil

It is noticed from 2005 an increase in the relation between the volume of bank loans and the GDP, rocketing from 25% to 45% in 2010, being the credit volume in the country the highest since the beginning of the Brazilian Real Plan.

According to Bacen, the Selic rate is obtained through the calculation of the weighted average rate and adjusted from the one-day financing operations, spread in federal public bonds and passed in either the referred system or in compensation chambers and assets liquidation as buyback transactions. From the content present, it can be inferred that the Selic rate is originated from the interest rate effectively observed in the market.

Graphic 4 presents the variation of the interest rate from 2000 through 2010.

Graphic 4 – Variation of Interest Rate (% per year)



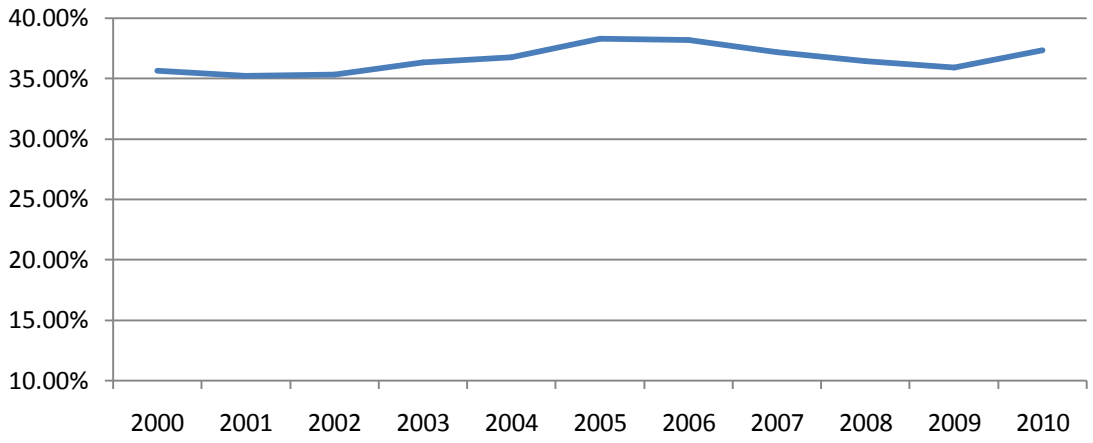
Source: Banco Central do Brasil

Since 2002, the interest rates have been decreasing gradually from 25% per year to the level of 10% per year in 2009/2010.

Based on J. Glen and Velez C. M.'s research (2010), the control variables tested in this paper are:

– The relation between the loan portfolio and banks' assets. Graphic 5 presents the evolution of this relation from 2000 through 2010.

Graphic 5 – Total of Credit Portfolio over Total of Assets

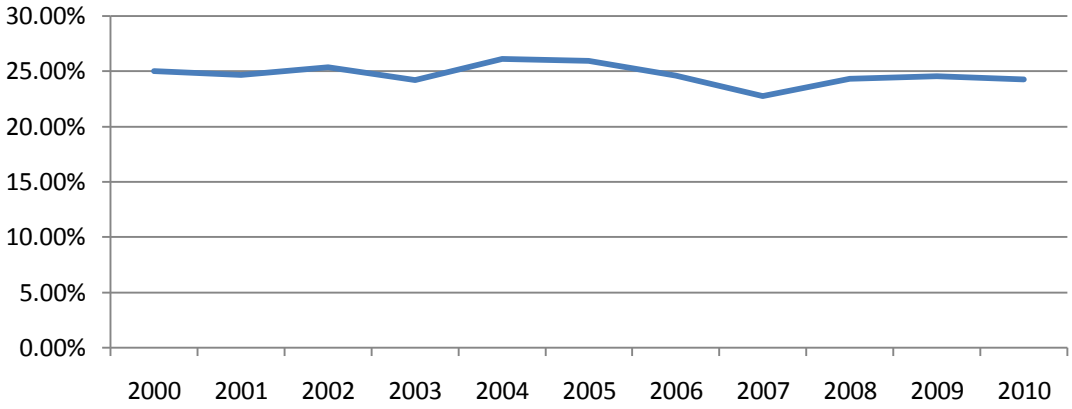


Source: Banco Central do Brasil

It can be noticed that the relation between the volume of the credit portfolio and assets remained stable, between 35% and 37% in the period.

– Equity over banks' assets suggests that a bigger capitalization of banks is a "barrier" against cyclic effects. Graphic 6 presents the relation between Equity over Brazilian banks' assets from 2000 through 2010.

Graphic 6 – Total of Equity over Total Assets



Source: Banco Central do Brasil

Through the observed period, the relation between Equity and Assets remained stable throughout the period, at approximately 25%.

– Crisis Period. Crisis dummies will be inserted in order to check features of specific periods of crisis. Crisis periods were regarded as: second half of 2001 (terrorist attempt on 09/11/2001); the year 2002 (Lula's presidential election); second half of 2008, and the year 2009 (subprime crisis).

Table 4 presents the descriptive statistic of the explanatory variables used in the study of the relations between performance of the credit portfolio (NPL), the interest rate, and the economic growth (GDP). All the data are consolidated and include those from the parent company and its controlled undertaking. The analyzed period was 2000 through 2010.

The correlation matrix between variables lies in appendix.

Table 4 – Descriptive Statistic on the Explanatory Variables

The credit portfolio corresponds to the totality of credit operations and commercial leasing. The loan loss provision was determined based on the information provided by Banco Central do Brasil (Central Bank of Brazil), which determines provisioning percentages of credit operations (LLP) according to their overdue periods, as in Resolution CMN 2682/99. The NPL (performance) of the credit portfolio is given by dividing the LLP by the total amount of the credit portfolio. The interest rate corresponds to the Selic rate of the equivalent year, that is, the basic interest rate used as a reference by the monetary policy. The variation in the interest rate equivalent to the percentage level of the change in the Selic interest rate related to the previous quarter. The interest rate t-n is the Selic interest rate done in "n" previous quarter. The GDP corresponds to the quarterly growth rate of the sum (in monetary values) of all goods and services produced in the country throughout the period compared to the equivalent quarter of the previous year. GDP t-n corresponds to the economic growth rate noticed in "n" previous quarter. The bank's loan level (Credit Portfolio/Assets is given by the relation between the credit portfolio and its total assets. The level of assets financing per own capital (Equity/ Assets) is given by the relation between Equity and Assets of each financial institution. Ln(assests)* Delta Interest Rate is the natural log of assets of each financial institution multiplied by interest rate variation. Ln(assets)*GDP is the natural log of assets of each financial institution multiplied by the quarterly economic growth rate.

Variables	Remark	Average	Standard Deviation	Minimum	Maximum
NPL	4374	0.6754	0.1020	0.0000	1.3026
Credit Portfolio/Assets	4374	0.3522	0.2317	0.0000	1.0344
Equity/ Assets	4374	0.2226	0.2067	-0.1285	0.9950
ln(assets)*Interest Rate Variation	4374	-0.1075	1.4231	-4.3979	7.4836
ln(assets)*GDP	4374	0.5027	0.4212	-1.6396	1.8893
Interest Rate Variation	4374	-0.0078	0.1018	-0.2292	0.3911
Interest Rate t-1	4374	0.0898	0.0267	-0.0034	0.1344
Interest Rate t-2	4374	0.0911	0.0267	-0.0034	0.1344
Interest Rate t-3	4374	0.0935	0.0282	-0.0034	0.1756
Interest Rate t-4	4374	0.0999	0.0452	-0.0034	0.3894
Interest Rate t-5	4374	0.1067	0.0570	-0.0034	0.3894
Interest Rate t-6	4374	0.1139	0.0671	-0.0034	0.3894
Interest Rate t-7	4374	0.1191	0.0719	-0.0034	0.3894
Interest Rate t-8	4374	0.1227	0.0725	-0.0034	0.3894
GDP	4374	0.0364	0.0281	-0.0297	0.0927
GDP t-1	4374	0.0357	0.0281	-0.0297	0.0927
GDP t-2	4374	0.0339	0.0285	-0.0297	0.0927
GDP t-3	4374	0.0318	0.0279	-0.0297	0.0927
GDP t-4	4374	0.0298	0.0267	-0.0297	0.0710
GDP t-5	4374	0.0282	0.0276	-0.0297	0.0710
GDP t-6	4374	0.0284	0.0271	-0.0297	0.0710
GDP t-7	4374	0.0292	0.0259	-0.0297	0.0710
GDP t-8	4374	0.0299	0.0246	-0.0195	0.0710

Source: own elaboration

4. RESULTS AND ANALYSES

Various panel regression analyses were conducted with estimated fixed effects. This particular method of choice was based on tests conducted by Hausman et al. Appropriate corrections for heteroscedasticity of the financial system were taken into consideration.

Data referring to performance (NPL- non-performing loan, used as dependent variable), GDP and Interest Rate and other explanatory control variables from 2000 through 2010 were compiled into quarters, with the sample organization in cross-sectional dimension.

Firstly, the following specification was tested:

$$NPLi,t = \beta 0i,t + \beta 1GDPi,t + \beta 2GDPi,t-1 + \beta 2\Delta Int.Rate\ i,t + \beta 3Real\ Int.Rate\ i,t-1 + e\ (1)$$

The estimates derived from this specification are presented in column 1 of Table 5. It demonstrates that the only variable that showed a statistical significance was the variable GDP t-1 with p<0.05 and beta of -0.188.

In the second specification (column 2 of Table 5), the control variables “Credit Portfolio/Assets”, “Equity/Assets”, and "Crisis Dummy” were added.

$$NPLi,t = \beta 0i,t + \beta 1GDPi,t + \beta 2GDPi,t-1 + \beta 3\Delta Int.Rate\ i,t + \beta 4Real\ Int.Rate\ i,t-1 + \beta 5\frac{Credit\ \ Portfolio}{Assets}i,t + \beta 6\frac{Equity}{Assets}i,t + \beta 7CDi,t + e\ (2)$$

As a result of this new specification, the signs for the GDP as well as for the Interest Rate were consistent with expectations, that is, the GDP had a negative effect on the NPL, while the Interest Rate had a positive effect. In other words, the performance (NPL) of the portfolios from Brazilian commercial banks improves when the GDP

rises, and worsens when the interest rate rises. Nevertheless, these results were similar to the ones previously obtained: it also only showed that the GDP t-1 was the single statistically significant variable being statistically.

Table 5 – Provision to Non-Performing Loans (NPL) Regressions on Quarterly Lags of GDP and of Interest Rates, as well as other banking system characteristics

Table 5 presents the panel result with estimation per fixed effects, considering the correction for heteroscedasticity. GDP stands for quarterly economic growth rate, GDP t-n is the GDP growth rate verified in "n" previous quarter. Interest rate Var. means the variation of interest rate equivalent to the verified year throughout the period. Interest rate t-n corresponds to the Selic interest rate verified in the "n" previous quarter. Credit Portfolio/Assets is the bank's loan level, given by the relation between the credit portfolio and its total assets. Equity/ Assets is the financing level of assets per own capital, given by the relation between Equity and Assets of each financial institution. Crisis is a Dummy Control variable, which corresponds to the periods from October, 2001, to December, 2002, and October, 2008, to December, 2009. *, ** and *** indicate significance of 10%, 5%, and 1%, respectively.

NPL on Quarterly Lag of GDP and Interest Rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GDP	0,000	-0,058	-0,143	-0.189*	-0.217*	-0.170*	-0.177*	-0.173*	-0,154
	(0,073)	(0,077)	(0,092)	(0,105)	(0,117)	(0,096)	(0,098)	(0,093)	(0,096)
GDP t-1	-0.188**	-0.221**	-0,056	-0,103	-0.121*	-0.172*	-0.119*	-0,101	-0.147**
	(0,075)	(0,085)	(0,085)	(0,078)	(0,072)	(0,094)	(0,068)	(0,069)	(0,069)
GDP t-2			-0.148**	0,055	0,000	-0,008	-0,062	-0.113*	-0,084
			(0,069)	(0,048)	(0,044)	(0,040)	(0,099)	(0,064)	(0,068)
GDP t-3				-0.220**	-0,052	-0,048	-0,053	-0,005	-0,097
				(0,094)	(0,060)	(0,048)	(0,048)	(0,098)	(0,068)
GDP t-4					-0.195*	-0,112	-0,111	-0,104	0,025
					(0,101)	(0,074)	(0,084)	(0,081)	(0,098)
GDP t-5						-0,077	-0,002	0,010	-0,017
						(0,090)	(0,073)	(0,063)	(0,070)
GDP t-6							-0,078	-0.156**	-0,108
							(0,116)	(0,072)	(0,068)
GDP t-7								0,051	-0,110
								(0,121)	(0,091)
GDP t-8									0,163
									(0,126)
Δ Interest Rate	0,009	0,026	0,024	0,015	0,016	0,018	0,017	0,016	0,024
	(0,022)	(0,024)	(0,023)	(0,022)	(0,023)	(0,023)	(0,022)	(0,020)	(0,021)
Interest Rate t-1	0,171	0,125	0,124	0,093	0,086	0,085	0,092	0,075	0,126
	(0,106)	(0,101)	(0,112)	(0,113)	(0,109)	(0,105)	(0,108)	(0,099)	(0,080)
Interest Rate t-2			0,005	0,055	0,022	0,037	0,040	0,049	0,007
			(0,077)	(0,083)	(0,079)	(0,066)	(0,072)	(0,074)	(0,073)
Interest Rate t-3				-0,028	0,025	0,010	0,007	0,044	0,038
				(0,087)	(0,090)	(0,095)	(0,083)	(0,107)	(0,117)
Interest Rate t-4					-0,015	-0,056	-0,067	-0,125	-0,105
					(0,086)	(0,082)	(0,085)	(0,086)	(0,087)
Interest Rate t-5						0,046	0,020	0,055	0,000
						(0,064)	(0,038)	(0,049)	(0,049)
Interest Rate t-6							0,028	0.0661*	0.0935**
							(0,056)	(0,037)	(0,038)
Interest Rate t-7								-0,051	-0,001
								(0,039)	(0,025)
Interest Rate t-8									-0,039
									(0,040)
Cred. Portfolio/Assets		-0,022	-0,021	-0,020	-0,020	-0,019	-0,019	-0,019	-0,019
		(0,032)	(0,032)	(0,032)	(0,032)	(0,032)	(0,032)	(0,032)	(0,032)
Equity/Assets		0,094	0,094	0,094	0,093	0,093	0,093	0,093	0,093
		(0,065)	(0,065)	(0,065)	(0,065)	(0,065)	(0,065)	(0,065)	(0,065)
Crisis		-0,007	-0,008	-0,007	-0,007	-0,006	-0,005	-0,005	-0,006
		(0,006)	(0,006)	(0,006)	(0,006)	(0,007)	(0,007)	(0,007)	(0,007)
Constant Term	0.059***	0.055***	0.057***	0.060***	0.065***	0.063***	0.064***	0.064***	0.062***
	(0,010)	(0,017)	(0,017)	(0,018)	(0,018)	(0,018)	(0,018)	(0,018)	(0,019)
R-squared	0,006	0,017	0,018	0,020	0,021	0,022	0,022	0,022	0,023

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: own elaboration

From the third through the ninth specification, quarterly lags of the GDP and the Interest Rate were added because the default levels and, consequently, banks' provisions can be significantly affected in the aftermath of major macroeconomic changes.

With the test of the third specification,

$$NPLi,t = \beta 0i,t + \beta 1GDPi,t + \beta 2GDPi,t - 1 + \beta 3GDPi,t - 2 + \beta 4\Delta Int.Rate\ i,t + \beta 5Real\ Int.Rate\ i,t - 1 + \beta 6Real\ Int.Rate\ i,t - 2 + \beta 7\frac{Credit\ Portfolio}{Assets}i,t + \beta 8\frac{Equity}{Assets}i,t + \beta 9CDi,t + e\ (3)\ ,$$

it is shown that the addition of variables GDP t-2 and Interest Rate t-2 (table5, column 3) caused the GDP t-2 to become significant at 5%. However, GDP and GDP t-1 were not statistically significant, and the explanatory variables for interest rate continue to show lack of significance.

In the fourth specification (column 4), by adding variables GDP t-3 and Interest Rate t-3, both GDP and GDP t-3 behaved as expected and showed significance at 10% and 5%, respectively. GDP t-1 and GDP t-2 were not significant. The interest rate variables continued to show expected trends, but not yet statistically significant.

In the fifth specification (column 5), it is noticed that the GDP, GDP t-1, and GDP t-4 were significant at 10%. The interest rate variables remain statistically insignificant.

In the sixth specification (column 6) and seventh specification (column 7), the variables GDP and GDP t-1 remained significant at 10%.

In the eighth specification (column 8), the variables GDP and GDP t-2 remained statistically significant at 10% and the variable GDP t-6 was significant at 5%.

In the ninth specification (column 9), the variable GDP was not statistically significant while GDP t-1 rose, with level of significance at 5%.

Due to the change of significance of the GDP's, variations of lagged GDP with longer cycles were tested. Thus, lags of two quarters of GDP and Interest Rate were assessed, and the other control variables were kept, as presented in Table 6.

Table 6 – Provision to Non-Performing Loans (NPL) on Two-Quarter Lags of GDP and of Interest Rates, as well as other banking system characteristics

Table 6 presents panel result with estimation per fixed effects, considering the correction for heteroscedasticity. GDP stands for quarterly economic growth rate, GDP t-n is the GDP growth rate verified in "n" previous quarters. Delta Interest rate means the variation of interest rate equivalent to the verified year throughout the period. Interest rate t-x corresponds to the Selic interest rate verified in the "n" previous quarter. Credit Portfolio/Assets is the bank's loan level, given by the relation between the credit portfolio and its total assets. Equity/ Assets is the financing level of assets per own capital, given by the relation between Equity and Assets of each financial institution. Ln(assests)* Delta Interest Rate is the natural log of assets of each financial institution multiplied by interest rate variation. Ln(assets)*GDP is the natural log of assets of each financial institution multiplied by the quarterly economic growth rate. Crisis is the is a Dummy Control variable, which corresponds to the periods from October, 2001, to December, 2002, and October, 2008, to December, 2009. *, ** and *** indicate significance of 10%, 5%, and 1%, respectively.

NPL on Two-Quarte Lag of GDP and Interest Rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GDP	-0.176*	-0.272**	-0.234**	-0.232**	-0.236**	-0.941**	-1.009**
	(0.098)	(0.124)	(0.100)	(0.094)	(0.093)	(0.422)	(0.483)
GDP t-2	-0.167***	-0.094	-0.152	-0.199***	-0.181**	-0.189***	-0.191***
	(0.061)	(0.061)	(0.097)	(0.071)	(0.071)	(0.072)	(0.073)
GDP t-4		-0.215**	-0.140*	-0.043	-0.053	-0.073	-0.073
		(0.096)	(0.082)	(0.096)	(0.098)	(0.102)	(0.102)
GDP t-6			-0.077	-0.153**	-0.138**	-0.141**	-0.144**
			(0.091)	(0.065)	(0.065)	(0.065)	(0.067)
GDP t-8				0.089	0.093	0.075	0.072
				(0.120)	(0.118)	(0.122)	(0.123)
Δ Interest Rate	0.025	0.015	0.016	0.023	-0.024	0.025	0.084
	(0.024)	(0.022)	(0.021)	(0.020)	(0.060)	(0.020)	(0.089)
Interest Rate t-2	0.110	0.113	0.123	0.131	0.138	0.145	0.145
	(0.092)	(0.114)	(0.118)	(0.118)	(0.117)	(0.116)	(0.116)
Interest Rate t-4		-0.010	-0.055	-0.089	-0.077	-0.077	-0.077
		(0.072)	(0.072)	(0.062)	(0.049)	(0.049)	(0.049)
Interest Rate t-6			0.035	0.0881*	0.083*	0.083*	0.083*
			(0.061)	(0.048)	(0.048)	(0.049)	(0.048)
Interest Rate t-8				-0.037	-0.032	-0.029	-0.030
				(0.035)	(0.036)	(0.036)	(0.036)
ln(assets) * Δ Interest Rate					0.003		0.004
					(0.004)		(0.005)
ln(assets) * GDP						0.049*	0.055*
						(0.026)	(0.030)
Cred. Portfolio/Assets	-0.022	-0.020	-0.020	-0.020	-0.019	-0.024	-0.025
	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.033)
Equity / Assets	0.094	0.093	0.093	0.094	0.093	0.102	0.103
	(0.065)	(0.065)	(0.065)	(0.065)	(0.065)	(0.063)	(0.063)
Crisis	-0.007	-0.006	-0.004	-0.006	-0.006	-0.006	-0.006
	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)
Constant Term	0.058***	0.065***	0.065***	0.065***	0.062***	0.063***	0.063***
	(0.018)	(0.018)	(0.018)	(0.020)	(0.020)	(0.021)	(0.021)
R-squared	0.018	0.021	0.021	0.022	0.022	0.027	0.027

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: own elaboration

In the first specification (Table 6, column 1),

$$NPLi,t = \beta 0i,t + \beta 1GDPi,t + \beta 2GDPi,t - 2 + \beta 3\Delta Int.Rate\ i,t + \beta 4Real\ Int.Rate\ i,t - 2 + \beta 5\frac{Credit\ \ Portfolio}{Assets}i,t + \beta 6\frac{Equity}{Assets}i,t + \beta 7CDi,t + e\ (1)\ ,$$

GDP and GDP t-2 behaved according to our expectation with significance levels well below 10% and 1%, respectively and their betas were higher -0.176 and -0.167, respectively. Therefore, this result supports the theory that the performance loan portfolios of Brazilian commercial banks improves when the GDP increases. However, the interest rate variables remained insignificant.

In the second specification (Table 6, column 2), GDP and GDP t-4 presented significance levels below 5% and their betas, -0.272 and -0.215 respectively, were higher than the previous specifications.

In the third specification (Table 6, column 3), the GDP presented significance levels at 5%, and GDP t-4 at 10%, but their betas were lower than the previous specification. The interest rate variables remained insignificant.

In the fourth specification (Table 6, column 4), GDP and GDP t-6 presented significance levels at 5% and GDP t-2 at 1% with betas of -0.232, -0.153 and -0.199 respectively. Thus, it is noticed that NPL responds better to GDP variation with two-quarter lags.

From the fifth through the seventh specification, control variables “natural log of assets” of each financial institution multiplied by Interest Rate (ln(assets) x interest rate variation) and “natural log of assets” multiplied by quarterly economic growth (ln(assets)*GDP) were added because the assets size of banks can significantly affect the loan portfolio performance of the banks.

With the test of the fifth specification,

$$NPLi,t = \beta 0i,t + \beta 1GDPi,t + \beta 2GDP\ i,t-2 + \beta 3GDP\ i,t-4 + \beta 4GDPi,t\ -6 + \beta 5GDP\ i,t-8 + \beta 6\Delta Int.Rate\ i,t + \beta 7Real\ Int.Rate\ i,t-2 + \beta 8Real\ Int.Rate\ i,t-4 + \beta 9Real\ Int.Rate\ i,t-6 + \beta 10Real\ Int.Rate\ i,t-8 + \beta 11\ln(\text{assets})\ \text{x}\Delta Int.Rate\ i,t + \beta 12\frac{Credit\ \ Portfolio}{Assets}i,t + \beta 13\frac{Equity}{Assets}i,t + \beta 14CDi,t + e\ (5)$$

it is shown that the addition of variable “ln(assets)*interest rate variation” (table 6, column 5) was not statistically significant, and the explanatory variables for GDP and interest rate kept the statistical significant levels of the previous specifications.

In the sixth specification (Table 6, column 6), the variable “ln(assets)xGDP” was added.

$$NPLi,t = \beta 0i,t + \beta 1GDPi,t + \beta 2GDP\ i,t-2 + \beta 3GDP\ i,t-4 + \beta 4GDPi,t\ -6 + \beta 5GDP\ i,t-8 + \beta 6\Delta Int.Rate\ i,t + \beta 7Real\ Int.Rate\ i,t-2 + \beta 8Real\ Int.Rate\ i,t-4 + \beta 9Real\ Int.Rate\ i,t-6 + \beta 10Real\ Int.Rate\ i,t-8 + \beta 11\ln(\text{assets})\text{x}GDP\ i,t + \beta 12\frac{Credit\ \ Portfolio}{Assets}i,t + \beta 13\frac{Equity}{Assets}i,t + \beta 14CDi,t + e\ (5)$$

As a result of this new specification, the variable "ln(assets) x GDP" was statistically significant at 10% with positive sign, which shows that the size of assets affects negatively the performance of Brazilian commercial banks’ loan portfolio. Moreover, we can conclude that the GDP changes have more influence on banks with greater assets.

In the seventh specification (Table 6, column 7), both variables “ln(assets) x Interest Rate Variation” and GDP” “ln(assets)xGDP” were added. The results were similar to the ones previously obtained, only “ln(assets)xGDP” showed statistical significant at 10% level.

Due to lack of statistical significance from the interest rate, analyses with only two-quarter lag for the GDP were carried out. The variables of interest rate variations and Interest Rate t-1, along with other control variables were kept constant, according to

Glen and Velez's model, and the variable “ln(assets)xGDP” was kept because its statistical significance level. The results are presented in Table 7.

Table 7 – Provision to Non-Performing Loans (NPL) Regressions on Two-Quarter Lags of GDP and Interest Rate

Table 7 presents panel result with estimation per fixed effects, considering the correction for heteroscedasticity GDP stands for quarterly economic growth rate, GDP t-n is the GDP growth rate verified in “n” previous quarters. Interest rate Var. means the variation of interest rate equivalent to the verified year throughout the period. Interest rate t-1 corresponds to the Selic interest rate verified in the previous quarter. Ln(assets)*GDP is the natural log of assets of each financial institution multiplied by the quarterly economic growth rate. Credit Portfolio/Assets is the bank’s loan level, given by the relation between the credit portfolio and its total assets. Equity/ Assets is the financing level of assets per own capital, given by the relation between Equity and Assets of each financial institution. Crisis is a Dummy Control variable, which corresponds to the periods from October, 2001, to December, 2002 e Out, 2002, and October, 2008 a Dez.2008, to December, 2009. *, ** and *** indicate significance of 10%, 5%, and 1%, respectively.

NPL on Lag of Two Quartes of GDP

	(1)	(2)	(3)	(4)
GDP	-0.837**	-0.978**	-0.948**	-0.945**
	(0.418)	(0.432)	(0.422)	(0.426)
GDP t-2	-0.185***	-0.105*	-0.142*	-0.154***
	(0.065)	(0.055)	(0.080)	(0.059)
GDP t-4		-0.223**	-0.175**	-0.152
		(0.097)	(0.069)	(0.096)
GDP t-6			-0.087	-0.110
			(0.103)	(0.068)
GDP t-8				0.048
				(0.134)
Δ Interest Rate	0.024	0.014	0.011	0.012
	(0.024)	(0.022)	(0.021)	(0.021)
Interest Rate t-1	0.160	0.142	0.150	0.158
	(0.112)	(0.111)	(0.114)	(0.105)
ln(assets)*GDP	0.048*	0.050*	0.051*	0.050*
	(0.026)	(0.026)	(0.026)	(0.026)
Credit Portfolio / Assets	-0.025	-0.024	-0.024	-0.024
	(0.033)	(0.033)	(0.033)	(0.033)
Equity / Assets	0.102	0.102	0.102	0.102
	(0.064)	(0.063)	(0.063)	(0.064)
Crisis	-0.007	-0.006	-0.004	-0.005
	(0.006)	(0.006)	(0.006)	(0.007)
Constant Term	0.054***	0.062***	0.062***	0.061***
	(0.018)	(0.018)	(0.018)	(0.019)
R-squared	0.023	0.026	0.026	0.026

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: own elaboration

In the first specification (Table 7, column 1),

$$NPLi,t = \beta 0i,t + \beta 1GDPi,t + \beta 2GDPi,t-2 + \beta 3\Delta Int.Rate\ i,t + \beta 4Real\ Int.Rate\ i,t-1 + \beta 5 \ln(\text{assets}) \text{ x} GDP\ i,t + \beta 6 \frac{Credit\ \ Portfolio}{Assets} i,t + \beta 7 \frac{Equity}{Assets} i,t + \beta 8CDi,t + e\ (1),$$

GDP and GDP t-2 presented the expected signs and significant at 1%, reinforcing the fact that GDP variations explain more significantly the variations of the level of performance of Brazilian commercial banks, with a two-quarter lag, and that the interest rate variation has no statistical significance to explain the level of performance of banks' credit portfolio. Besides, the GDP and GDP t-2 betas were high, -0.170 and 0.178, respectively. The ln(assets)*GDP variable presented the expected signs and significant at 10%.

In the second specification (Table 7, column 2), with the addition of the GDP t-4 variable, GDP and GDP t-4 were significant at 5%, and GDP t-2, at 10%.

In the third specification (Table 7, column 3), with the addition of the GDP t-6 variable, GDP, GDP t-2 and GDP t-4 kept the significant levels of the previous specification, but their betas were worse. The GPD t-6 did not present statistical significance.

In the fourth specification (Table 7, column 4), with the addition of the GDP t-8 variable, only GDP and GDP t-2 were significant at 5% and 1%, respectively.

Thus, it is noticed that NPL (provision for non-performing loan) responds better to GDP variations with two-quarter lags, considering a 1-year timeframe.

For endogeneity testing purpose, the second specification was used, because it responds better to GDP variation, on the conditions described above.

$$NPLi,t = \beta 0i,t + \beta 1GDPi,t + \beta 2GDPi,t-2 + \beta 3GDPi,t-4 + \beta 4\Delta Int.Rate\ i,t + \beta 5Real\ Int.Rate\ i,t-1 + \beta 6\ln(\text{assets})\ \text{x}GDP\ i,t + \beta 7\frac{Credit\ Portfolio}{Assets}i,t + \beta 8\frac{Equity}{Assets}i,t + \beta 9CDi,t + e \quad (2)$$

The results are described in the table below:

Table 8 – Testing for Endogeneity (Hausman Test)

Table 8 presents the results of the Hausman Test, which evaluates the significance of an estimator versus an alternative estimator. GDP stands for quarterly economic growth rate, GDP t-n is the GDP growth rate verified in "n" previous quarters. Interest rate Var. means the variation of interest rate equivalent to the verified year throughout the period. Interest rate t-1 corresponds to the Selic interest rate verified in the previous quarter. Ln(assets)*GDP is the natural log of assets of each financial institution multiplied by the quarterly economic growth rate. Credit Portfolio/Assets is the bank's loan level, given by the relation between the credit portfolio and its total assets. Equity/ Assets is the financing level of assets per own capital, given by the relation between Equity and Assets of each financial institution. Crisis is a Dummy Control variable, which corresponds to the periods from October, 2001, to December, 2002, and October, 2008, to December, 2009.

	Coefficients (b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
GDP	-.9779311	-.9779311	0	0
GDP t-2	-.1049911	-.1049911	0	0
GDP t-4	-.2234083	-.2234083	0	0
Int. Rate Var.	.0142931	.0142931	0	0
Int. Rate t-1	.1421371	.1421371	0	0
ln(assets)*GDP	.0501958	.0501958	0	0
Credit Port./Assets	-.0239835	-.0239835	0	0
Equity/Assets	.1020832	.1020832	0	0
Crisis	-.0062528	-.0062528	0	0

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(0) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 0.00
Prob>chi2 = .
(V_b-V_B is not positive definite)

Source: own elaboration

Through the Hausman test, we have H0=0 as a test of exogeneity. Therefore, as the result is the hypothesis null, H0 can be rejected, providing evidence for endogeneity. To fix the model, a two-stage regression (2SLS) was performed. The results are presented in Table 9.

Table 9 – Results of 2SLS regression

Table 9 presents the results of the second stage of two-stage regression (2SLS Regression) with robust standard errors. GDP stands for quarterly economic growth rate, GDP t-n is the GDP growth rate verified in "n" previous quarters. Interest rate Var. means the variation of interest rate equivalent to the verified year throughout the period. Interest rate t-1 corresponds to the Selic interest rate verified in the previous quarter. Ln(assets)*GDP is the natural log of assets of each financial institution multiplied by the quarterly economic growth rate. Credit Portfolio/Assets is the bank's loan level, given by the relation between the credit portfolio and its total assets. Equity/ Assets is the financing level of assets per own capital, given by the relation between Equity and Assets of each financial institution. Crisis is a Dummy Control variable, which corresponds to the periods from October, 2001, to December, 2002, and October, 2008, to December, 2009. *, ** and *** indicate significance of 10%, 5%, and 1%, respectively.

VARIABLES	NPL
GDP	-1.197***
	(0.18)
GDP t-2	-0.142**
	(0.06)
GDP t-4	-0.220***
	(0.07)
Δ Interest Rate	0.024
	(0.02)
Interest Rate t-1	0.238***
	(0.06)
ln(assets)xGDP	0.0638***
	(0.01)
Cred. Portfolio/Assets	-0.0111*
	(0.01)
Equity / Assets	0.125***
	(0.01)
Crisis	-0.00925*
	(0.00)
Constant	0.0477***
	(0.01)
Observations	4,374
R-squared	0.065

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: own elaboration

All of the variables remained constant. GDP, GDP t-2 and GDP t-4 continued to be statistically significant at 1%, 5% and 1% levels with betas of -1.197, -0.142 and -0.220 respectively. Supporting the fact that GDP rate variation is a better predictor of the variations in the level of performance of Brazilian commercial banks, with a two-quarter lag, when considering a one-year timeframe. The Interest Rate variation kept not presenting statistical significance. The variable "ln(assets) x GDP" was statistically significant at 1% with positive sign, which shows that the size of assets affects negatively the performance of Banks and that GDP changes have more influence on banks with greater assets.

4.1 Robustness Check

To test the robustness of the significance of NPL, the measures of GPD and Interest Rates was replaced by GPD and Interest Rates with different lags. The results are described in the table below:

Table 10 – Robustness Check

Table 10 presents the results of the second stage of two-stage pooled regression (2SLS Regression) with robust standard errors. GDP stands for quarterly economic growth, GDP t-n is the GDP growth verified in "n" previous quarters. Interest rate Var. means the variation of interest rate equivalent to the verified year throughout the period. Interest rate t-1 corresponds to the Selic interest rate verified in the previous quarter. Ln(assets)*GDP is the natural log of assets of each financial institution multiplied by the quarterly economic growth rate. Credit Portfolio/Assets is the bank's loan level, given by the relation between the credit portfolio and its total assets. Equity/ Assets is the financing level of assets per own capital, given by the relation between Equity and Assets of each financial institution. Crisis is a Dummy Control variable, which corresponds to the periods from October, 2001, to December, 2002, and October, 2008, to December, 2009. *, ** and *** indicate significance of 10%, 5%, and 1%, respectively.

VARIABLES	(1)	(2)	(3)
GDP	-1.197***	-1.140***	-1.158***
	(0.183)	(0.185)	(0.187)
GDP t-2	-0.142**	-0.202***	-0.194**
	(0.064)	(0.072)	(0.085)
GDP t-4	-0.220***	-0.138	-0.124
	(0.073)	(0.086)	(0.094)
GDP t-6		-0.143*	-0.119
		(0.080)	(0.086)
Δ Interest Rate	0.024	0.0179	0.0298
	(0.019)	(0.020)	(0.020)
Interest Rate t-1	0.238***	0.248***	
	(0.063)	(0.063)	
Interest Rate t-2			0.227***
			(0.074)
Interest Rate t-4			-0.0541
			(0.052)
Interest Rate t-6			0.0469
			(0.036)
ln(assets)xGDP	0.0638***	0.0646***	0.0644***
	(0.011)	(0.011)	(0.011)
Cred. Portfolio/Assets	-0.0111*	-0.0110*	-0.0112*
	(0.007)	(0.007)	(0.007)
Equity / Assets	0.125***	0.126***	0.125***
	(0.008)	(0.008)	(0.008)
Crisis	-0.00925*	-0.005	-0.00593
	(0.005)	(0.005)	(0.005)
Constant	0.0477***	0.0466***	0.0481***
	(0.010)	(0.010)	(0.010)
Observations	4,374	4,374	4,374
R-squared	0.065	0.066	0.066

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: own elaboration

The test shows that for 2 regressions (2 and 3), the values and statistical significance level for GDPs as well as those for Interest Rates and ln(assets)xGDP remained as expected, consistent with the main regression 1 (negative for GDP, positive for Interest Rates and positive for ln(assets)xGDP), which proved its robustness.

5. CONCLUSION

This paper tested the effects of economic growth (GDP), as well as the interest rate upon the performance of loan portfolios of Brazilian commercial banks from 2000 through 2010, taking into account the assessment model used by Glen and Velez (2010).

The empirical result showed that the economic growth (GDP) is the main driver of the performance of the credit portfolio of Brazilian commercial banks, and that the variation in the interest rate has no significant effects on it. Such fact could be explained by the practice of renegotiation, debts lengthening, and by the adoption of a conservative credit policy conducted by Brazilian banks, which occur more frequently during periods of crisis.

Furthermore, the results showed that the GDP variations correlated significantly with the performance level variations of Brazilian commercial banks, with a two-quarter lag throughout the period of one year.

Finally, the results showed that changes in GDP most significantly impact on the performance of the largest Brazilian commercial banks' loan portfolio. Due to the multiplier effect of the credit market, the bigger the bank, the higher the relative expansion of its loan portfolio, and the higher its non-performing loan, which is aggravated by the credit market concentration in Brazil.

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APPENDIX – CORRELATION MATRIX

	NPL	GDP	GDP t-1	GDP t-2	GDP t-3	GDP t-4	GDP t-5	GDP t-6	GDP t-7	GDP t-8	Δ Interest Rate	Interest Rate t-1	Interest Rate t-2	Interest Rate t-3	Interest Rate t-4	Interest Rate t-5	Interest Rate t-6	Interest Rate t-7	Interest Rate t-8	Credit Portfolio / Assets	Equity / Assets	Crisis
NPL	1																					
GDP	-0.0474	1																				
signif.	0.0017																					
GDP t-1	-0.0546	0.7145	1																			
signif.	0.0003	0																				
GDP t-2	-0.0496	0.2329	0.7109	1																		
signif.	0.001	0	0																			
GDP t-3	-0.0439	-0.2163	0.2332	0.7183	1																	
signif.	0.0037	0	0	0																		
GDP t-4	-0.031	-0.5083	-0.2397	0.2178	0.6954	1																
signif.	0.0401	0	0	0	0																	
GDP t-5	-0.0187	-0.418	-0.4776	-0.1799	0.2427	0.7065	1															
signif.	0.2152	0	0	0	0	0																
GDP t-6	-0.0248	-0.2267	-0.3936	-0.395	-0.0711	0.3707	0.7713	1														
signif.	0.1014	0	0	0	0	0	0															
GDP t-7	-0.0278	-0.0132	-0.2069	-0.3313	-0.3035	0.0459	0.4361	0.7554	1													
signif.	0.0661	0.3822	0	0	0	0.0024	0	0														
GDP t-8	-0.0255	0.1304	0.0232	-0.1206	-0.2146	-0.1914	0.1261	0.4018	0.7302	1												
signif.	0.0914	0	0.1245	0	0	0	0	0	0													
Δ Interest Rate	-0.0128	0.438	0.4369	0.1932	-0.1459	-0.306	-0.2655	-0.1534	0.0011	0.0769	1											
signif.	0.3971	0	0	0	0	0	0	0	0.9394	0												
Interest Rate t-1	0.0666	-0.2285	-0.0748	0.0524	0.0736	0.0455	0.0538	-0.0495	-0.162	-0.265	-0.026	1										
signif.	0	0	0	0.0005	0	0.0026	0.0004	0.0011	0	0	0.0858											
Interest Rate t-2	0.0669	-0.2848	-0.2016	-0.0523	0.0652	0.0948	0.0451	-0.0338	-0.1358	-0.2454	-0.1438	0.8489	1									
signif.	0	0	0	0.0005	0	0	0.0028	0.0255	0	0	0	0										
Interest Rate t-3	0.0643	-0.2316	-0.2495	-0.2023	-0.0757	0.0589	0.0422	-0.0929	-0.1495	-0.2468	-0.1985	0.692	0.8345	1								
signif.	0	0	0	0	0	0.0001	0.0052	0	0	0	0	0	0									
Interest Rate t-4	0.0465	-0.0409	-0.1549	-0.2603	-0.2373	-0.1074	-0.1121	-0.1677	-0.2055	-0.259	-0.1155	0.4182	0.537	0.7567	1							
signif.	0.0021	0.0069	0	0	0	0	0	0	0	0	0	0	0	0								
Interest Rate t-5	0.0512	0.0356	-0.0103	-0.1728	-0.3093	-0.2687	-0.1756	-0.2774	-0.2795	-0.2934	-0.1065	0.3942	0.3877	0.569	0.723	1						
signif.	0.0007	0.0185	0.4953	0	0	0	0	0	0	0	0	0	0	0	0							
Interest Rate t-6	0.0485	0.0738	0.0329	-0.0748	-0.2318	-0.3249	-0.3198	-0.3049	-0.361	-0.3655	-0.1045	0.3321	0.4025	0.4893	0.7001	0.7711	1					
signif.	0.0013	0	0.0297	0	0	0	0	0	0	0	0	0	0	0	0	0						
Interest Rate t-7	0.0349	0.0517	0.1003	0.0344	-0.1005	-0.249	-0.3193	-0.4276	-0.4005	-0.4381	-0.1328	0.2627	0.3163	0.4063	0.3917	0.7185	0.7274	1				
signif.	0.0211	0.0006	0	0.0229	0	0	0	0	0	0	0	0	0	0	0	0	0					
Interest Rate t-8	0.0251	0.0222	0.0611	0.0885	0.024	-0.1049	-0.2647	-0.398	-0.5093	-0.4853	-0.0523	0.2084	0.279	0.3544	0.4041	0.4029	0.7071	0.6981	1			
signif.	0.0975	0.1419	0.0001	0	0.1132	0	0	0	0	0	0.0005	0	0	0	0	0	0	0				
Credit Portfolio / Assets	-0.0581	-0.0034	0.0046	0.0178	0.027	0.0281	0.021	0.0176	0.0097	0.0051	0.0067	-0.0009	0.0034	-0.0016	-0.0119	-0.0181	-0.0091	-0.0012	0.0088	1		
signif.	0.0001	0.8206	0.7619	0.2399	0.0738	0.0629	0.1654	0.2445	0.5219	0.7351	0.6571	0.9506	0.8211	0.9183	0.4329	0.2318	0.549	0.9368	0.5586			
Equity / Assets	0.2141	-0.0048	-0.005	0.0029	0.0101	0.0093	0.0121	0.0175	0.0203	0.0265	-0.0099	-0.0184	-0.0166	-0.0164	-0.0184	-0.0253	-0.0199	-0.0224	-0.0223	-0.1219	1	
signif.	0	0.7496	0.7403	0.8479	0.5027	0.5372	0.4224	0.248	0.1798	0.0796	0.5146	0.2247	0.2726	0.278	0.2245	0.0949	0.1877	0.1392	0.1412	0		
Crisis	0.0022	-0.5079	-0.5153	-0.3339	-0.0796	0.208	0.4246	0.4794	0.4481	0.3205	0.0992	-0.0784	-0.083	-0.1092	-0.1625	-0.2031	-0.2277	-0.2369	-0.214	0.0148	0.0074	1
signif.	0.8819	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3268	0.6267	

Source:own elaboration