Risk-taking channel, bank lending channel and the "paradox of credibility"
Empirical evidence for Brazil

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Resumo

Se por um lado a credibilidade é importante para a condução da política monetária; por outro lado, maior credibilidade pode, eventualmente, estimular a criação de bolhas no mercado de crédito e nos preços dos ativos por meio do "canal de tomada de risco" (*risk-taking channel*), e, como conseqüência, trazer à realidade o "paradoxo da credibilidade". O "paradoxo da credibilidade" é o novo dilema colocado aos bancos centrais que buscam conciliar a política monetária com a regulação bancária sob o regimes de metas para inflação. Assim, o presente trabalho tem como objetivos: (i) analisar o impacto das ações dos bancos centrais e do ambiente macroeconômico sobre a percepção de risco dos bancos, e (ii) analisar a influência da percepção de risco dos bancos sobre o spread de crédito, considerando o "canal do crédito" (*credit channel*) e o "canal de tomada de risco" (*risk-taking channel*). Baseado em uma análise econométrica por OLS, GMM e System-GMM, o trabalho fornece evidências sobre: (i) o "paradoxo da credibilidade" e o canal de tomada de risco, (ii) a influência das políticas monetárias sobre a percepção de risco dos bancos e, como conseqüência, sobre o spread do crédito, (iii) a natureza pró-cíclica dos bancos em relação à atividade econômica, e (iv) a aderência do indicador contracíclico (chamado de *gap de crédito*), proposto em Basiléia III para o caso brasileiro.

Palavras-chave: canal de tomada de risco, canal do crédito, paradoxo da credibilidade, regulação.

Abstract

If from one hand credibility is important for the conduct of monetary policy; on the other hand, greater credibility may eventually stimulate the creation of bubbles in the credit market and asset prices through the *risk-taking channel*, and as a consequence, bring to reality the "paradox of credibility". The "paradox of credibility" is the new dilemma posed to central banking in the effort to conciliate monetary policy and banking regulation under inflation targeting regimes. Thus, the present work aims to: (i) analyze the impact of central bank actions and the macroeconomic environment on the risk perception of banks, and; (ii) analyze the influence of this risk perception of banks on the credit spread, considering both the credit channel and the risk-taking channel. Based on an econometric analysis through OLS, GMM and System-GMM, the work provides evidence about: (i) the "paradox of credibility" and the risk-taking channel; (ii) the influence of monetary policies on the risk perception of banks and, as a consequence, on the credit spread; (iii) the procyclical nature of banks in relation to economic activity, and; (iv) the adherence of the countercyclical indicator (called *credit gap*) proposed in Basel III for the Brazilian case.

Key words: risk-taking channel, credit channel, paradox of credibility, regulation

Área 3 - Macroeconomia, Economia Monetária e Finanças.

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1. Introduction

The explicit purpose of inflation targeting is to ensure an environment of low and stable inflation and to serve as a nominal anchor for the process of expectations formation. In this regime, the way to conduct monetary policy is closely related to the credibility of the regime, i.e., to the power of the nominal anchor. It is argued that the capacity of the regime to anchor inflation expectations is important because a higher credibility requires smaller changes in interest rates to control inflation (de Mendonça and de Guimarães e Souza, 2009).

Despite the success of several central banks in promoting stable prices through the conduct of monetary policy under inflation targeting, banking regulation has gained special interest with the financial crisis that began in 2007 in the US subprime market. This is because banks play a critical role and tend to amplify the effects of economic shocks during periods of financial crisis.

The banking industry is inherently procyclical, in the sense of reinforcing the business cycle: banks tend to decrease lending during recessions, because of their concern about loan quality and repayment probability – exacerbating the economic downturn as credit constrained firms decrease their real investment activity – and to increase it during expansions, thereby contributing to a potential overheating of the economy (Drumond, 2009). This is mainly due to the existence of asymmetric information and market imperfections.

Due to the fact that both price and financial stabilities are important for the proper functioning of the economy as a whole, credibility emerges as a key variable for both monetary policy and banking regulation. If from one hand credibility is important for the conduct of monetary policy; on the other hand, greater credibility may eventually stimulate the creation of bubbles in the credit market and asset prices through the *risk-taking channel*, and as a consequence, bring to reality what Borio (2005) called as "paradox of credibility". In this sense, following Borio (2005 and 2006), it is possible to argue that though credibility and the stable macroeconomic environment are significant achievements and should be preserved; both are able to amplify the financial system's procyclical behavior. The "paradox of credibility" is the new dilemma posed to central banking in the effort to conciliate monetary policy and banking regulation under inflation targeting regimes.

Based on the ideas above, the present work aims to: (i) analyze the impact of central bank actions and the macroeconomic environment on the risk perception of banks, represented by bank provisions, and; (ii) analyze the influence of this risk perception of banks on the credit spread, considering both the credit channel and the risk-taking channel.

The work contributes to the literature in the following ways: (i) provides evidence about the "paradox of credibility" and the risk-taking channel, and therefore the influence of credibility on the behavior of banks; (ii) provides evidence about the influence of monetary policies on the risk perception of banks and on bank provisions for expected losses on loans and, as a consequence, on the credit spread; (iii) presents evidence concerning the procyclical nature of banks in relation to economic activity, and; (iv) find evidence for the adherence of the countercyclical indicator (called *credit gap*) proposed in Basel III for the Brazilian case.

Besides this introduction, this paper is organized as follows. Next section presents the importance of both credibility and banking regulation for central banks operating under inflation targeting and the idea of "paradox of credibility". Section three presents the transmission mechanism of monetary policy through the bank lending

channel and the risk-taking channel. Section four presents a brief review of the empirical literature for the Brazilian case. Section five provides empirical evidence based on an econometric analysis through ordinary least squares (OLS), generalized method of moments (GMM) and System-GMM. Section six presents the conclusions of the paper.

2. Central bank credibility, "paradox of credibility" and banking supervision

The theoretical underpinnings of the importance of credibility can be found in the seminal article of Kydland and Prescott (1977): monetary authorities have an incentive to deviate from their announced policies in the short run and this leads the public to adjust inflation expectations accordingly. According to their model, the monetary authority can create surprise inflation in order to reduce unemployment. Due to the fact that private agents form expectations rationally, they recognize that the monetary authority has the incentive to inflate, and, as a consequence, they consider the effects of that inflation into their decisions. In equilibrium, the monetary authority's discretionary policy leads only to higher inflation and the unemployment rate will be in its natural level. As Ireland (2000) stressed, this is the classic time-consistency problem for monetary policy. As a consequence, successive attempts by the monetary authority to explore the trade-off between inflation and unemployment in the short term lead to occurrence of this problem and, consequently, to loss of credibility.

According to Blinder (2000, p. 1422), "*credibility is often identified with one of three things: strong aversion to inflation, incentive compatibility, or pre-commitment*". Thus, credibility may be understood as the degree of confidence that economic agents have in relation to the ability and determination of the monetary authority to maintain a commitment to the goal of low and stable inflation. Hence, a policy is credible when the public believes on the commitment of the central bank with a rule and/or a goal, and forms expectations according to this level of commitment.

Credibility is important for several and different reasons. Blinder (2000) emphasizes that grater credibility makes disinflation less costly, helps hold down inflation once it is low and makes it easier to defend the currency when necessary. In this sense, credibility plays a key role in the conduct of monetary policy.

In terms of inflation targeting regimes, when the target is credible and the monetary authority presents an increased capacity of affecting the public expectation, less effort is necessary to achieve the inflation target. The work of de Mendonça and de Guimarães e Souza (2009) tested the impact of different credibility indices on the volatility of interest rates. They found evidence that higher credibility implies lower variations in the interest rate for controlling inflation, i.e., due to the increased capacity of affecting the public expectations, the central bank needs less effort to achieve the inflation target. Furthermore, according to Calderón, Duncan and Schmidt-Hebbel (2004), the cyclical properties of macroeconomic policies depend critically on policy credibility. The evidence they found for emerging countries supports that countries with higher credibility are able to conduct countercyclical fiscal and monetary policies. Hence, the gain in credibility is a powerful instrument for reducing inflation without increasing social costs. This is because expectations are more strongly anchored to the inflation target and thus less effort is required by the central bank in terms of changes in interest rate.

Credibility represents a key variable to the effort of conducting monetary policy; but also a variable capable of amplifying the procyclical behavior of the financial system. If from one hand, the credibility acts in the building of a more stable

macroeconomic environment and thereby improves the process of expectations formation, decreases the volatility of interest rates and improves the agents' ability in terms of risk assessment (de Mendonça, 2007; de Mendonça and de Guimarães e Souza, 2009; Montes, 2010;); on the other hand, the better macroeconomic environment created by this greater credibility may eventually stimulate the creation of bubbles in the credit market and asset prices, i.e., the stable macroeconomic environment will lead to reduced interest rates, and these low interest rates will influence the postures of banks, which will assume riskier positions. This paradoxical case is denominated by Borio (2005) as "paradox of credibility". Borio (2005) argues that such stable context favors the creation of expectations that tend to amplify the procyclical behavior of the financial system. The "paradox of credibility" is the new dilemma posed to central banks under inflation targeting. In order to overcome this new challenge, a set of innovations on banking regulation and financial supervision was discussed in Basel III.

Basel III proposed new instruments of financial supervision and regulation in order to deal with failures identified in the subprime crisis.[1] Among the failures observed in this last crisis, the new regulatory approach seeks to identify and curb systemic financial risk and mitigate procyclical features of the regime.

In order to correct regulatory failures revealed by the crisis, the Basel III agreement incorporates new capital requirements designed to deal with systemic risk, liquidity risk, the identification of institutions that present the greatest systemic threat and mitigate the procyclical bias of existing standards. With specific regard to liquidity risk and pro-cyclicality of capital requirements, the new agreement suggests the formation of additional regulatory reserves that vary depending on the degree of leverage and the level of credit in the economy, which are called capital conservation and countercyclical capital. That countercyclical capital buffer[2] proposal aims at dampen excessive credit growth. Thus, following the proposal, this capital would be formed taking into account deviations of credit/GDP ratio from its long term trend. According to the document entitled "*Countercyclical Capital Buffer proposal*" of the Basel Committee on Banking Supervision:

> *"The primary aim of the proposal is to use a buffer of capital to achieve the broader macroprudential goal of protecting the banking sector from periods of excess aggregate credit growth that have often been associated with the build up of system-wide risk. Protecting the banking sector in this context is not simply ensuring that individual banks remain solvent through a period of stress, as the minimum capital requirement and capital conservation buffer are together designed to fulfil this objective. Rather, the aim is to ensure that the banking sector in aggregate has the capital on hand to help maintain the flow of credit in the economy without its solvency being questioned, when the broader financial system experiences stress after a period of excess credit growth. This should help to reduce the risk of the supply of credit being constrained by regulatory capital requirements that could undermine the performance of the real economy and result in additional credit losses in the banking system".* (BIS, 2010a)

The adoption of measures on banking supervision and macroprudential regulation is seen as solution to deal with the dilemma that arises with the "paradox of credibility". In a report entitled "*Rethinking Central Banking*", the Committee on International Economic Policy Reforms (CIEPR) recognizes that the traditional approach offered by the regime of inflation targeting is insufficient to resolve risks arising in the financial system and recommends: "... *central banks should go beyond their traditional emphasis on low inflation to adopt an explicit goal of financial*

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[1] For more details in relation to Basel III, see, BIS (2010b, 2010c and 2010d).
[2] For more details about countercyclical capital buffer, see, Drehmann, Borio, Gambacorta, Jimenez and Trucharte (2010).

stability. Macroprudential tools should be used alongside monetary police in pursuit of that objective." (CIEPR, 2011, p 4).

The recent financial (subprime) crisis showed that central banks must give great attention to institutions that are responsible for creating credit and liquidity. This is because such institutions are inherently procyclical and can cause a slowdown or even a stoppage of the economy, by restricting credit in times of economic collapse and uncertainties, and also because among the transmission channels of monetary policy to the economy, the credit channel is indicated by empirical evidence as being an important transmission mechanism (Bernanke and Blinder, 1992; Kashyap et al., 1993; Gertler and Gilchrist, 1993 and 1994; Kashyap and Stein, 2000; Iacoviello and Minetti, 2008; Auel and de Mendonça, 2011).

3. The bank lending channel and the risk-taking channel

The standard literature on monetary policy transmission mechanisms often emphasizes five transmission channels: interest rate, exchange rate, assets prices, credit and expectation (Mishkin, 1995). The well functioning of such channels are related to both financial stability and central bank credibility (Montes, 2010). Although an analysis concerning all these transmission channels might be relevant, recent episodes observed in the world, as the subprime crisis, increase the necessity to study the relevance of the credit market for the economy.[3]

In turn, another sort of monetary transmission mechanism has gained great attention and has been recently denominated as the *risk-taking channel*. This channel relates to how changes in monetary policy rates affect either risk perceptions or risk-tolerance (Borio and Zhu, 2008). According to this perspective, easy monetary conditions represent a standard ingredient in boom-bust type business fluctuations, i.e., low interest rates may lead to financial imbalances through a reduction in risk aversion of banks and other investors, affecting the supply of credit, the credit spread and, as a consequence, consumption and investment decisions, causing business fluctuations. Despite, several authors approached the relation between monetary policy and business fluctuations, Borio and Zhu (2008, p. 2) argue that "*insufficient attention appears to have been paid so far in the transmission mechanism to the link between monetary policy and the perception and pricing of risk by economic agents – what might be termed the 'risk-taking channel'*".

If from one hand, the empirical evidence regarding the functioning of credit channels in developed economies is well-known (Bernanke, 2007), on the other hand, empirical evidence for emerging economies are incipient. Furthermore, the literature concerning the risk-taking channel is new and scarce for emerging economies. Hence, due to the fact that there is a vacuum in the literature concerning the risk-taking channel and the transmission of economic shocks through the credit market in developing economies, the present study is particularly concerned about the bank lending channel and the risk-taking channel, and how monetary policies, financial regulation and macroeconomic aspects (such as output fluctuations and credibility) affect the risk perception of banks and the credit spread.

In the present study it is shown that there exist a close link between the risk-taking channel and the bank lending channel, and that it is possible to establish a

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[3] Despite the credit channel can be split into two different channels, the *bank lending channel* and the *balance sheet channel*, the present study focuses on the bank lending channel. This paper is not intended to provide detailed descriptions of these two channels. For more details, see Bernanke and Gertler (1995).

relationship involving monetary policy, the risk-taking channel, the "paradox of credibility" and the credit channel.

Regarding the relationship between monetary policy (through the basic interest rate) and the risk-taking channel, Gambacorta (2009) and Altunbas, Gambacorta and Marqués-Ibáñez (2009) emphasize that there are two main ways in which low interest rates may influence bank risk-taking. First, low interest rates affect valuations, incomes and cash flows, which in turn can influence how banks measure risk (Adrian and Shin, 2009a and 2009b; Borio and Zhu, 2008). Second, low returns on investments, such as government (risk-free) securities, may increase incentives for banks, asset managers and insurance companies to take on more risk for behavioral, contractual or institutional reasons, for example to meet a nominal return target (Brunnermeier, 2001; Rajan, 2005).

Unequivocally, monetary policy represents an important ingredient able to influence the risk-taking of banks. However, there are other possible causes of changes in banks' risk perception, such as bank specific characteristics, macroeconomic factors and institutional characteristics at the national level (Altunbas, Gambacorta and Marqués-Ibáñez, 2010). With respect to macroeconomic factors, an environment of stable prices, with output growth, which results from high credibility, may induce banks to take riskier positions, thus stimulating the creation of bubbles in the credit market, and as a consequence make the "paradox of credibility" a reality. In other words, the environment of optimism, obtained from price stability and output growth, affects the risk perception of banks, which assume riskier positions regarding the process of credit supply. Hence, the optimistic environment, created by greater credibility, can increase the degree of risk exposure of banks, which create expectations of lower losses on loans for the future and, as a consequence, act reducing provisions and increasing both leverage and financial fragility.

4. Recent Empirical Literature for Brazil

The empirical literature that analyzes the influence of the monetary authority, taking into account also the influence of the monetary regime and the economic context on the domestic financial system though the bank lending channel and the risk-taking channel is still incipient for the Brazilian case. However, some important advances have been reported in the literature, especially after the subprime crisis.

The work of Tabak, Noronha and Cajueiro (2011) analyzes the relationship between economic cycle and capital buffers held by banks in Brazil. They evaluate the effects of bank capital on bank lending activity and how these effects vary among banks with different ownership structure. They use an unbalanced panel data of Brazilian institutions from 2000 to 2010 to estimate an equation for capital buffers and for loans' growth. The results reveal that the economic cycle negatively affects the surplus capital. These results have important implications for the discussion of capital regulations and the recent counter-cyclical proposal under Basel III.

The work of Tabak, Laiz and Cajueiro (2010) investigates the effects of monetary policy over banks' loans growth and non-performing loans for the period 2003-2009 in Brazil. The sample consists of a high frequency panel data, with 5183 observations. The results suggest the existence of a bank lending channel by showing that during periods of monetary tightening/loosing, banks have their loans decreased/increased. They also found that the financial crisis has had a large impact on lending activity, and that state-owned banks seem to respond more to monetary policy changes than foreign and private banks. Moreover, by analyzing the impacts of

monetary policy over non-performing loans, they found that during periods of interest rates increase/decrease, banks present a higher/lower growth rate of non-performing loans, which may aggravate/alleviate their performance. In addition, state-owned banks have a different lending profile, since they present a lower amount of non-performing loans. Furthermore, the results also support the existence of a risk-taking channel, in which lower monetary policy rates increase the banks' risk-taking. During periods of low interest rates, large and liquid banks increase their credit risk exposure.

In turn, the work of de Mendonça, Galvão and Loures (2011) seeks evidence about the impact of the changes in capital requirements on bank's risk and the trade-off between economic activity and the risk of financial institutions in the Brazilian economy. Based on dynamic panel data taking into account 73 banks and vector autoregression for the period from 2001 to 2008, the findings highlight that banks which adopt riskier strategies reach higher profitability. Moreover, the results suggest that the banking regulation is an important instrument for reaching the balance between the economic growth and the low exposition to the risk of banking firms in markets such as the Brazilian one.

The work of Auel and de Mendonça (2011) analyzes the macroeconomic relevance of the credit channel in Brazil. Based on data from 2002 to 2009, three sets of GMM models are considered, a GMM system model is built and a VAR analysis is made. The findings denote that the effects of economic shocks on credit supply and on credit spread are in accordance with the credit channel theory. Besides, it is observed that shocks on the interest rate are not transmitted directly to the economy but through the credit channels. In relation to the operation of credit channels for monetary policy, the work of Auel and de Mendonça (2011) points that empirical evidence for emerging economies is scarce.

The above references address topics related to monetary policy and financial regulation. Based on the arguments of Borio (2005) about the "paradox of credibility", and Borio and Zhu (2008) about the risk-taking channel, next section seeks to provide empirical evidence for the Brazilian economy that a higher credibility of the inflation targeting regime increases the risk exposure of banks. Besides, following the results found by Auel and de Mendonça (2011), it also examines the functioning of the credit channel in the Brazilian economy through the credit spread.

5. Empirical analysis

Brazil represents an interesting case study regarding the influence of the monetary authority – through its monetary policies and regulatory actions – and the influence of the macroeconomic environment on the risk perception of banks. This is because the country is one of the most important developing nations and, since June 1999 changed its framework of economic policy, adopting a floating exchange rate regime with inflation targeting. There is empirical evidence that the credibility gained by the regime of inflation targeting, in Brazil, contributed to the reduction of uncertainties, the better performance of the economy and the greater stability of the financial system (de Mendonça and Simão Filho, 2007; de Mendonça and de Guimarães e Souza, 2009). Thus, the present study seeks to analyze the effect of the macroeconomic environment and the actions of the monetary authority on the amount of resources provisioned by banks, i.e., on the expected losses by banks in relation to loans, and thus on the credit spread, after the adoption of inflation targeting in Brazil.

5.1 Data

The period of analysis runs from December 2001 to January 2011[4] (representing 110 observations). The (monthly) series used in this study are:

Provision (PROV) - This variable represents the amount provisioned by banks in relation to the expected losses in relation to loans. The calculation of this indicator was used by Tabak, Noronha and Cajueiro (2011), and the indicator is the difference between "Provisions of credit operations in the private financial system" and "Provisions of credit operations in the private financial system (total H)" which are in arrears for more than 180 days[5], divided by "Credit operations in the private financial system (total credit to private sector)". All series used in the calculation of this variable are provided by the Central Bank of Brazil (series 12929, 12977 and 4444). In considering the risk operations (risk H) as losses, this measure can be viewed as a proxy for the perception of ex-ante risk.

Spread (SPREAD). Series of average spread charged on credit operations with free resources in percentage points – provided by the Central Bank of Brazil (series 3955, named "Credit operations with nonearmarked funds (preset rate) - Average spread - General total").

Credit gap (C_GAP). The credit gap is obtained following the methodology of the BIS (2010a and 2010d). The gap is the difference between the credit/GDP ratio and its trend (calculated by the Hodrick-Prescott filter). The series of credit/GDP ratio is available at the Central Bank of Brazil (series 17473). Considering the new recommendations of the BIS (2010), formalized in the document "*Guidance for National Authorities Operating the Countercyclical Capital Buffer*", this indicator should be used by regulators of the financial system as a criterion for activation of countercyclical capital buffer. The goal is to increase the capacity of financial institutions to absorb losses above the minimum in good times of the economic cycle, so that in times of stress, the increased capital is used.[6] As empirical evidence suggest[7], due to capital requirements formalized in Basel II present pro-cyclical behavior, it is expected that the variable *CRED_GAP* shows a positive correlation with economic activity. Thus, it is expected a positive relationship between this variable, the level of provisions and the average spread charged in the domestic financial system.

Basic interest rate (Selic) (IR). In Brazil, the interest rate (Selic) is the main instrument of monetary policy under the regime of inflation targeting. The series used is provided by the Central Bank of Brazil (series 4189). Following Cajueiro, Noronha and Tabak (2010), the idea of including this variable in the analysis is to assess the impact of monetary policy on the financial system's exposure to credit risk. It is expected to obtain a positive relationship between the variable *IR* and the degree of perceived risk in the

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[4] The justification for using this period is that the market expectations series available from the Central Bank of Brazil started in December 2001.

[5] The exclusion of operations classified as "risk H" is due to the fact that the provisions required for this level of risk are of 100%.

[6] According to BIS (2010d, p. 9): "*The specification of the credit-to-GDP gap has a number of advantages over credit growth. Being expressed as a ratio to GDP, the indicator variable is normalised by the size of the economy. This means it is not influenced by the normal cyclical patterns of credit demand. Being measured as a deviation from its long-term trend, the credit-to-GDP gap allows for the well known secular financial deepening trend. Being a ratio of levels, it is smoother than a variable calculated as differences in levels, such as credit growth, and minimises spurious volatility (no large quarter-to-quarter swings).*"

[7] Ayuso et al. (2004); Jokipii and Milne (2008); Lindquist (2004); Stolz and Wedow (2011); Gambacorta and Mistrulli (2004); Tabak, Noronha and Cajueiro (2011).

financial system posed by *PROV* and *SPREAD* variables. This relationship is explained by the presence of asymmetric information in financial markets, leading banks to increase provisions and the spread charged on credit operations when the basic interest rate increases.

Output gap (O_GAP). This indicator was constructed from the series of GDP accumulated in 12 months, provided by the Central Bank of Brazil (series 4190). The output gap is obtained by the difference between the series of GDP and its long-term trend obtained through the Hodrick-Prescott filter. It is expected that variations in the economic cycle affect the process of lending and, consequently, the amount provisioned by the banks. Due to the fact that increased economic activity stimulates lending, it is expected a negative relationship between OUTP_GAP and PROV.

Bovespa index (IBOV). The series of Bovespa index was obtained from the Central Bank of Brazil (series 7845). According to Auel and de Mendonça (2011), the variable "*IBOV*" represents a proxy for the behavior of asset prices in the domestic financial market. It is expected that positive movements in the stock market are related to decreases in the credit spread.

Credibility index (CI). Based on the argument presented by Agénor and Taylor (1992) and Svensson (1993, 2000) that series of inflation expectations could be used in the creation of credibility indices, and based on the work of Cecchetti and Krause (2002) which presented a credibility index for the central bank the work of de Mendonça (2007) developed a credibility index which considers inflation expectations, the inflation target and the tolerance intervals. The credibility index has a value equal to 1 when the annual expected inflation ($E(\pi)$) is equal to the target inflation and decreases in a linear way while inflationary expectation deviates from the announced target. Therefore, the credibility index shows a value between 0 and 1 strictly if the expected inflation is situated between the maximum and minimum limits (π_t^*) established for each year and assumes a value equal to 0 when the expected inflation exceeds one of these limits.

The credibility index (*credib*) used in the present work follows the methodology presented by de Mendonça (2007):

$$
ci = \begin{cases} 1 & se \ \ E(\pi) = \pi_t^c \\ 1 - \dfrac{1}{\pi_t^* - \pi_t^c}[E(\pi) - \pi_t^c] & se \ \ \pi_{tMin}^* < E(\pi) < \ se \ \pi_{tMax}^* \\ 0 & se \ \ E(\pi) \geq se \ \pi_{tMax}^* \ ou \ E(\pi) \leq se \ \pi_{tMin}^* \end{cases}
$$

This variable is included in the analysis in order to find evidence about the "paradox of credibility", i.e., it seeks to assess whether the anchoring of inflation expectations, provided by the regime of inflation targeting, influences the exposure of financial institutions to credit risk. It is expected that the higher the credibility, the lower the *ex-ante* perception of risk represented by reduction of provisions and credit spread.

Default rate (DEFAULT). The default rate represents the level of losses incurred by banks in their credit operations. It is expected that an increase in the default level worsens the credit market conditions, i.e., both the level of provisions and the credit spread increase. The series is provided by the Central Bank of Brazil (series 13673).

**Reserve requirement rate** (R_REQ). This instrument of monetary policy has a direct impact on the volume of credit and thus on the willingness of the financial system to take risks. The data used to construct this series are available on the website of the Central Bank of Brazil (series 1883, 1884, 1886 and 17633). It is expected that an increase in this rate implies fewer available resources for applications by banks and

greater aversion to losses of the financial system, which in turn promotes a decrease in credit supply, an increase of provisions and an increase in the credit spread.

5.2 Scheme of analysis and methodology

The scheme expressed in Figure 1 represents the analysis by Auel and de Mendonça (2011). The scheme illustrates the credit channel in Brazil, i.e., how shocks on macroeconomic variables as interest rate, reserve requirement rate, country risk, Bovespa, and exchange rate affect the spread and thus imply effects on the industrial production.

Figure 1 – Credit channel in the Brazilian economy
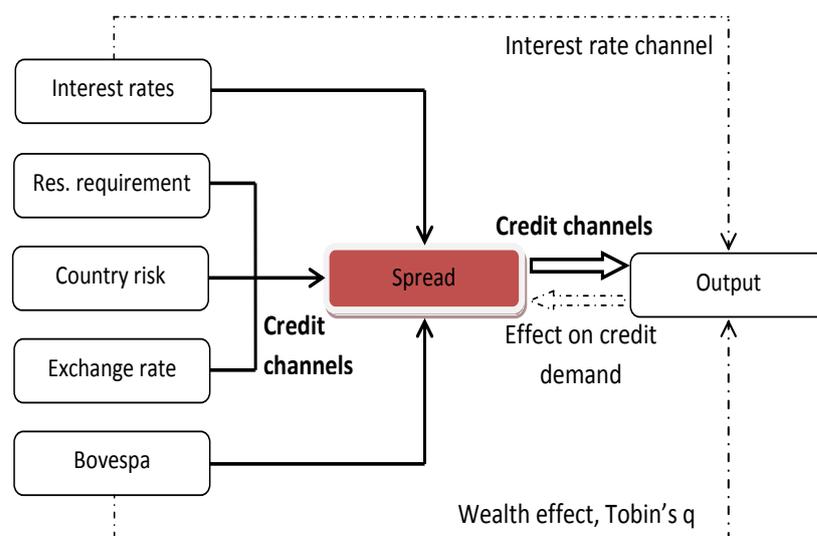
*Source: Auel and de Mendonça (2011).*

In the present study, the analysis by Auel and de Mendonça (2011) is extended. In determining the credit spread, the expected losses by banks in relation to loans are also considered. Thus, the amount provisioned by banks to account for these losses, i.e., the variable *PROV* is entered as an explanatory variable of the credit spread. Besides, variables that reflect the macroeconomic context and the actions of the monetary authority are considered in the analysis about the amount provisioned by banks. In turn, the choice of the credit spread as monetary policy transmission mechanism through the credit channel is justified by the results found by Auel and de Mendonça (2011, p. 977):

> *"However, it is not possible to assure that a decrease in the credit supply implies negative effects on the output, which in turn suggests that the credit channels do not work completely through this variable.(...)*
> *Concerning the credit spread, the results presented by the models confirm the theoretical argument that an increase in the interest rate, reserve requirement rate, exchange rate, and country risk provoke an increase in the SPREAD while the contrary effect is observed due to an increase in Bovespa. Concomitantly, it is verified that an increase in the SPREAD has a negative effect on output and thus suggests that the credit channels work through this variable in a complete way. It is observed that a shock transmitted by the SPREAD implies a decrease in the growth rate of the industrial production."*

Figure 2 below illustrates the empirical analysis done in this work and makes explicit the complementary nature of this study with the work done by Auel and de Mendonça (2011).

Figure 2 – Scheme of analysis
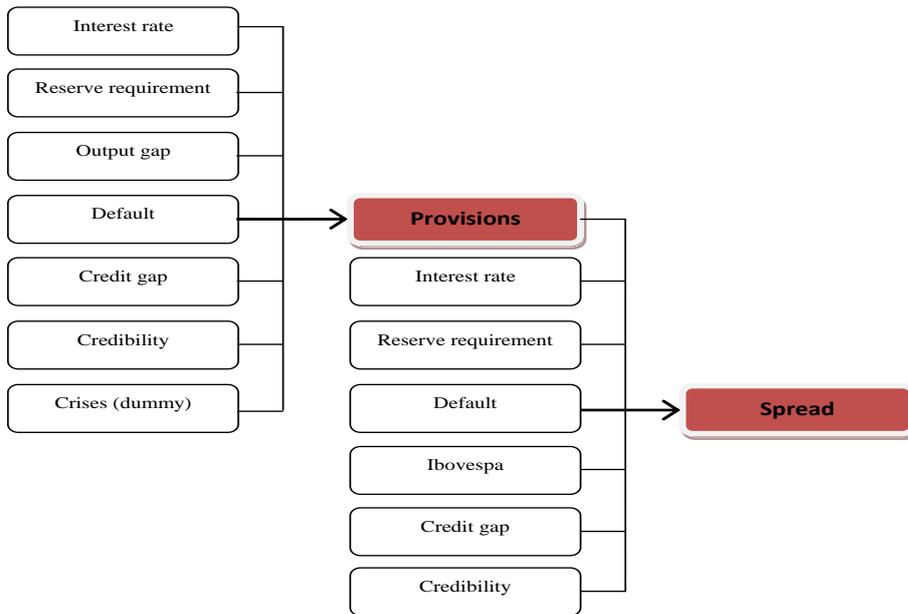
Source: authors' elaboration.

The empirical analysis makes use of ordinary least squares (OLS)[8] and generalized method of moments (GMM). One reason for using GMM is that while OLS estimates have problems of serial autocorrelation, heteroskedasticity or non-linearity, which is typical in macroeconomic time series, this method provides consistent estimators for the regression (Hansen, 1982). As pointed out by Wooldridge (2001, p. 95), "*to obtain a more efficient estimator than two-stage least squares (or ordinary least squares), one must have overriding restrictions*". The weighting matrix in the equation was chosen to enable the GMM estimates to be robust, considering the possible presence of heteroskedasticity and autocorrelation of unknown form.

It is important to note that the coefficients estimated by GMM are consistent only if the instrumental variables used in the analysis are exogenous. Therefore, the hypothesis of exogeneity of instruments requires that these variables do not directly affect the dependent variable. In this sense, a standard procedure that guarantees such hypothesis is based on Johnston (1984), i.e., the chosen instruments were dated to the period *t-1* or earlier.

Regarding the GMM technique, Cragg (1983) pointed out that overidentification analysis has an important role in the selection of instrumental variables to improve the efficiency of the estimators. Hence, a standard J-test was performed with the objective of testing this property for the validity of the overidentifying restrictions (Hansen, 1982). The estimates were performed using the software E-Views 7.0.

A first condition to be analyzed before applying the econometric analysis is to check if series are stationary. Therefore, the KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test, for stationarity, was applied (Table A.1 at the appendix). The advantage of this test results from the powerless of conventional tests, as these tend to not reject the null hypothesis too often (Franses and Haldrup, 1994; Cati, Garcia and Perron 1999).

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[8] The reported t-statistics in the OLS estimates are based on the estimator of Newey and West (1987), which is consistent in the presence of both heteroskedasticity and autocorrelation of unknown form.

5.3 Estimates for the influence of macroeconomic variables, monetary policies and credibility on provisions

Aiming to find evidence for the risk-taking channel and for the "paradox of credibility", the following complete specification was estimated:[9]

(1) $PROV_t = \beta_1 + \beta_2 IR_{t-1} + \beta_3 R\_REQ_{t-1} + \beta_4 O\_GAP_{t-1} + \beta_5 DEFAULT_{t-3} + \beta_6 C\_GAP_{t-3} + \beta_7 D\_CI_{t-1} + \beta_8 DUMMY + \varepsilon_{1,t}$

Where, ε is an error term. The partial derivatives express the expected relations:

$$\frac{\partial PROV}{\partial IR} > 0; \ \frac{\partial PROV}{\partial R\_REQ} > 0; \ \frac{\partial PROV}{\partial O\_GAP} < 0; \ \frac{\partial PROV}{\partial DEFAULT} > 0; \ \frac{\partial PROV}{\partial C\_GAP} > 0; \ \frac{\partial PROV}{\partial D\_CI} < 0$$

Regarding OLS estimates, Table 1 shows that the F-statistic of all equations indicates that the regressions are significant; besides, the outcomes of the Ramsey RESET test indicate that the estimations do not present problems of model specification. In terms of GMM estimations[10], the results of the J-test indicate that all models are correctly specified.

Concerning the risk-taking channel and thus the influence of monetary policy on the provisions, the estimates confirm the expected relations. Thus, the positive relation between the basic interest rate (IR) and the variable PROV can be interpreted as a result of information asymmetries (adverse selection and moral hazard) that arise in the credit market, when, for example, the central bank raises the short-term interest rate. Regarding the influence of the variable R_REQ, the estimates show that by limiting the resources available for lending, this monetary policy instrument makes credit operations more costly and increase, at the same time, the risk aversion of financial institutions.

In turn, regarding the influence of economic activity, the variable O_GAP showed statistical significance and the estimated coefficients presented the expected signs. Therefore, the inverse relation between the level of activity and the variable PROV is explained by the pro-cyclicality of banking activity. Thus, as shown by the evidence, in times of economic expansion, the expectations of default decrease and the degree of exposure to risk increases.

Regarding the influence of default rate (DEFAULT) on the variable PROV, the evidence indicates that an increase in the default rate promotes an increase in the provisions. Therefore, banks increase provisions and reduce the risk exposure when the default rate increases. Estimates related to this variable presented the expected sign and statistical significance.

Regarding the variable C_GAP, the positive sign of the estimated coefficient shows the adherence of the countercyclical indicator proposed in Basel III for the Brazilian case. The estimated coefficients show statistical significance for all estimations.

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[9] In order to capture the international financial shocks on the Brazilian economy from the subprime mortgage crisis and the crisis of government debt in Europe, a DUMMY variable was included. The DUMMY assumes value 1 to the period from 2008.10 to 2011.01 and zero otherwise. It is expected the estimation of positive coefficients for this variable, because, turbulent environments, generated by crises, create uncertainties that induce banks to increase provisions and thus constrain credit, as for example, by increasing the credit spread.

[10] Instrumental variables: $PROV_{-1}$, C_GAP_{-2}, C_GAP_{-3}, C_GAP_{-4}, C_GAP_{-5}, C_GAP_{-6}, IR_{-2}, IR_{-3}, IR_{-4}, IR_{-5}, IR_{-6}, O_GAP_{-2}, O_GAP_{-3}, O_GAP_{-4}, O_GAP_{-5}, O_GAP_{-6}, O_GAP_{-7}, R_REQ_{-2}, R_REQ_{-3}, R_REQ_{-4}, R_REQ_{-5}, $DEFAULT_{-2}$, $DEFAULT_{-3}$, $DEFAULT_{-4}$, $DEFAULT_{-5}$, $DEFAULT_{-6}$, $DEFAULT_{-7}$, D_CI_{-2}, D_CI_{-3}, D_CI_{-4}, D_CI_{-5}.

In relation to the influence of credibility, the estimates presented statistical significance and the coefficients the expected signs. Thus, the empirical evidence suggest that an environment of high credibility of the regime of inflation targeting provides a positive assessment in terms of credit risk in the financial system, i.e., an environment of stable prices reduces the risk perception of financial institutions and leads banks to reduce their provisions because they believe that with the stability, the default level will drop. If, on the one hand, this leads to greater efficiency in terms of resource allocation, on the other hand, amplifies the pro-cyclical behavior of the banking system, justifying the introduction of new standards of financial regulation like those proposed in Basel III. This finding suggests the existence of the phenomenon called "paradox of credibility" (Borio, 2005). According to Borio (2005),

> "*The credibility of the central bank's anti-inflation commitment can be a double-edged sword. On the one hand, the credibility reinforces other structural factors that may put a lid on inflationary pressures. On the other, by helping to anchor longer-term inflation expectations around the central bank's inflation objectives, that credibility makes it more likely that unsustainable booms could take longer to show up in overt inflation. This 'paradox of credibility' means that the central bank can be a victim of its own success (Borio and Lowe, 2002a). Conquering inflation can contribute to changes in the dynamics of the system that could mask the risks arising in the economy*".

That is, with macroeconomic stability, and the banks more exposed to risk, the economic imbalances that follow are manifested more in the form of bubbles in financial and credit markets than in the form of inflationary processes.

Table 1 – OLS and GMM estimates (dependent variable: PROV)

	OLS			GMM		
Explanatory variables	Eq(1a)	Eq(1b)	Eq(1c)	Eq(1a)	Eq(1b)	Eq(1c)
C	3.4485 **	1.4397	1.8067	4.0798 ***	1.8669	2.4808 *
	(1.3732)	(1.6799)	(1.7178)	(0.8973)	(1.1804)	(1.3652)
	[2.5111]	[0.8570]	[1.0517]	[4.5464]	[1.5815]	[1.8171]
IR(-1)	0.0436 ***	0.0360 ***	0.0375 ***	0.0519 ***	0.0442 ***	0.0466 ***
	(0.0081)	(0.0075)	(0.0078)	(0.0039)	(0.0049)	(0.0053)
	[5.3878]	[4.7408]	[4.8156]	[13.3076]	[8.9856]	[8.7583]
R_REQ(-1)	-0.1276	0.7434	0.6740	0.403135	1.2968 *	1.1917 *
	(1.0523)	(1.0286)	(1.0386)	(0.6734)	(0.6726)	(0.6791)
	[-0.1213]	[0.7227]	[0.6489]	[0.5985]	[1.9279]	[1.7547]
O_GAP(-1)	-2.5481 **	-3.6534 ***	-3.8932 ***	-3.1692 ***	-3.8548 ***	-4.1491 ***
	(1.2346)	(1.1119)	(1.0801)	(0.8103)	(0.7149)	(0.7019)
	[-2.0638]	[-3.2854]	[-3.6042]	[-3.9111]	[-5.3918]	[-5.9112]
DEFAULT(-3)	0.3150 ***	0.2943 ***	0.2872 ***	0.2427 ***	0.2462 ***	0.2445 ***
	(0.0788)	(0.0751)	(0.0739)	(0.0448)	(0.0438)	(0.0483)
	[3.9972]	[3.9191]	[3.8823]	[5.4160]	[5.6199]	[5.0595]
C_GAP(-3)		3.1211 **	3.0179 *		2.7890 **	2.4659 *
		(1.5390)	(1.5316)		(1.1775)	(1.2941)
		[2.0279]	[1.9703]		[2.3685]	[1.9056]
d_CI(-1)			-0.2938 *			-0.3917 *
			(0.1634)			(0.2271)
			[-1.7981]			[-1.7248]
DUMMY	0.5456 ***	0.4961 ***	0.5007 ***	0.7019 ***	0.6568 ***	0.6654 ***
	(0.1282)	(0.1202)	(0.1196)	(0.0681)	(0.0651)	(0.0668)
	[4.2549]	[4.1255]	[4.1852]	[10.3111]	[10.0873]	[9.9521]
R^2	0.74	0.75	0.76	0.73	0.74	0.74
Adjusted R^2	0.73	0.74	0.74	0.71	0.72	0.73
F-statistic	58.85	51.69	45.16			
Prob(F-statistic)	0.00	0.00	0.00			
J-statistic				13.54	13.68	14.75
Prob. (J-statistic)				0.92	0.88	0.79
Ramsey RESET (1)	1.24	0.25	0.53			
Prob.(Ramsey RESET)	0.26	0.62	0.46			
Heteroskedasticity ARCH (1)	161.60	152.06	147.55			
Prob.(Heteroskedasticity)	0.00	0.00	0.00			
Breusch-Godfrey-LM Test (1)	131.98	139	136.88			
Prob.(Breusch-Godfrey-LM Test)	0.00	0.00	0.00			

Marginal Significance Levels: *** denotes 0.01, ** denotes 0.05 and *10%. Standard errors in parentheses ant t-statistics in square brackets.

5.4 Estimates for the influence of macroeconomic variables on credit *Spread*

In order to verify the relation between the risk-taking channel, the credit channel and, the "paradox of credibility", i.e., aiming to verify the importance of previous results for the functioning of the credit channel in the regime of inflation targeting, and based on the results obtained by Auel and de Mendonça (2011), The following complete specification was tested for the variable *SPREAD*:

(2) $SPREAD_t = \theta_1 + \theta_2 IR_{t-5} + \theta_3 R\_REQ_{t-5} + \theta_4 DEFAULT_{t-1} + \theta_5 IBOV_{t-1} + \theta_6 C\_GAP_{t-1} + \theta_7 D\_CI_{t-5} + \theta_8 PROV_{t-1} + \mu_{1,t}$

Where, μ is an error term. The relations to be expected, expressed in the form of partial derivatives, are:

$$\frac{\partial SPREAD}{\partial IR} > 0; \quad \frac{\partial SPREAD}{\partial R\_REQ} > 0; \quad \frac{\partial SPREAD}{\partial DEFAULT} > 0; \quad \frac{\partial SPREAD}{\partial IBOV} < 0; \quad \frac{\partial SPREAD}{\partial C\_GAP} > 0; \quad \frac{\partial SPREAD}{\partial D\_CI} < 0; \quad \frac{\partial SPREAD}{\partial PROV} > 0$$

In terms of OLS estimates, Table 2 shows that the F-statistic of all equations indicates that the regressions are significant; besides, the outcomes of the Ramsey RESET test indicate that the estimations do not present problem of model specification. In terms of GMM estimations[11], the results of the J-test indicate that all models are correctly specified.

Similar to the findings of Auel and de Mendonça (2011) for the influence of monetary policies on credit spread, the estimated coefficients for the variables IR and R_REQ were positive and statistically significant. The evidence indicate that the variable SPREAD is a good indicator for the manifestation of the credit channel in the regime of inflation targeting in Brazil, because during periods of contractionary monetary policies credit spreads tend to increase.

Regarding the default rate (DEFAULT), the estimates showed statistical significance and a positive relation with the credit spread. This result is contrary to that found in the work of Auel and de Mendonça (2011). Thus, the findings suggest that the default rate promotes changes in the credit spread according to the credit channel theory.

In turn, results similar to those presented by Auel and de Mendonça (2011) were found regarding the inverse relation between the Ibovespa and the credit spread. The findings suggest the idea that defines the use of this variable: a *"valorization of assets increases the power of firms offering a guarantee for banking loans. It is expected that an increase in Bovespa promotes an improvement in the credit market (increase in credit supply and decrease in the credit spread)."* (Auel and de Mendonça, 2011, p. 967).

The positive sign found for the variable C_GAP shows the adherence of the countercyclical indicator proposed in Basel III for the Brazilian case. Therefore, the expansion of credit risk (measured by the variable C_GAP) is reflected in the increase of provisions, but also in the increase of the credit spread.

Regarding the coefficient for the variable credibility (CI), the estimates showed a negative relation with the credit spread. Since the macroeconomic environment has become more stable (i.e., lower variations in prices and output), and thus the conduct of monetary policy became less abrupt (de Mendonça and de Guimarães and Souza, 2009),

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[11] Instrumental variables: $SPREAD_{-1}$, $SPREAD_{-2}$, $SPREAD_{-3}$, $SPREAD_{-4}$, IR_{-6}, IR_{-7}, IR_{-8}, R_REQ_{-6}, $DEFAULT_{-2}$, $DEFAULT_{-3}$, $DEFAULT_{-4}$, $DEFAULT_{-5}$, $DEFAULT_{-6}$, $DEFAULT_{-7}$, $IBOV_{-2}$, $IBOV_{-3}$, C_GAP_{-2}, C_GAP_{-3}, D_CI_{-6}, D_CI_{-7}, D_CI_{-8}, $PROV_{-2}$, $PROV_{-3}$, $PROV_{-4}$, $PROV_{-5}$, $PROV_{-6}$, $PROV_{-7}$, $PROV_{-8}$.

information asymmetries were reduced and therefore the predictive ability of financial institutions increased. Thus, the credibility of the regime of inflation targeting and the greater economic stability allowed banks to reduce the credit spread and take more risks, suggesting the idea of "paradox of credibility".

Regarding the estimates for the influence of provisions on the credit spread, this variable is added to other factors that determine the functioning of the credit channel in the regime of inflation targeting in Brazil. The estimates establish a positive relation between provisions and the credit spread. The evidence found are relevant since they complement the analysis developed by Auel and de Mendonça (2011) and indicate that when banks expect more losses on loans, the spreads charged on credit operations also increase.

Table 2 – OLS and GMM estimates (dependent variable SPREAD)

Explanatory variables	OLS			GMM		
	Eq(2a)	Eq(2b)	Eq(2c)	Eq(2a)	Eq(2b)	Eq(2c)
C	-47.7998 ***	-48.5066 ***	-53.4865 ***	-63.7147 ***	-61.3897 ***	-62.7311 ***
	(15.8073)	(15.5271)	(16.2613)	(9.0526)	(8.3294)	(9.0230)
	[-3.0239]	[-3.1239]	[-3.2892]	[-7.0382]	[-7.3702]	[-6.9523]
IR(-5)	0.2799 ***	0.3105 ***	0.2889 ***	0.2347 ***	0.2909 ***	0.2592 ***
	(0.0893)	(0.0787)	(0.0944)	(0.0604)	(0.0553)	(0.0589)
	[3.1338]	[3.9426]	[3.0607]	[3.8846]	[5.2541]	[4.4001]
R_REQ(-5)	37.1319 ***	36.0468 ***	38.9902 ***	42.5116 ***	38.4692 ***	40.9555 ***
	(12.2276)	(11.7408)	(11.1661)	(6.1480)	(5.7182)	(5.5517)
	[3.0367]	[3.0702]	[3.4918]	[6.9146]	[6.7274]	[7.3770]
DEFAULT(-1)	1.4688 **	1.4034 **	0.548532	1.643946	1.3945 ***	0.7459 *
	(0.5669)	(0.5464)	(0.5406)	(0.3323)	(0.3218)	(0.3954)
	[2.5907]	[2.5681]	[1.0145]	[4.9459]	[4.3333]	[1.8864]
IBOV(-1)	-0.0001 ***	-0.0001 ***	-0.0001 ***	-0.0001 ***	-0.0001 ***	-0.0001 ***
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
	[-7.1804]	[-6.7898]	[-6.4179]	[-9.1679]	[-9.5565]	[-8.8671]
C_GAP(-1)	69.0017 ***	69.5624 ***	72.5456 ***	83.8736 ***	82.5051 ***	82.7281 ***
	(13.3443)	(12.8582)	(13.8066)	(7.0271)	(6.4465)	(7.1006)
	[5.1708]	[5.4099]	[5.2544]	[11.9356]	[12.7983]	[11.6507]
d_CI(-5)		-1.765261	-1.784915		-4.6257 ***	-4.3793 ***
		(1.5068)	(1.4373)		(1.5521)	(1.4146)
		[-1.1714]	[-1.2418]		[-2.9802]	[-3.0957]
PROV(-1)			1.7264 *			1.2423 **
			(0.9498)			(0.5579)
			[1.8177]			[2.2266]
R^2	0.91	0.91	0.92	0.91	0.91	0.91
Adjusted R^2	0.90	0.90	0.91	0.90	0.90	0.90
F-statistic	201.53	166.56	152.79			
Prob(F-statistic)	0.00	0.00	0			
J-statistic				16.44	16.15	15.80
Prob. (J-statistic)				0.83	0.81	0.78
Ramsey RESET (1)	2.76	3.03	1.33			
Prob.(Ramsey RESET)	0.10	0.08	0.25			
Heteroskedasticity ARCH (1)	15.50	15.72	12.48			
Prob.(Heteroskedasticity)	0.00	0.00	0.00			
Breusch-Godfrey-LM Test (1)	61.23	65.22	58.4			
Prob.(Breusch-Godfrey-LM Test)	0.00	0.00	0.00			

Marginal Significance Levels: *** denotes 0.01, ** denotes 0.05 and *10%. Standard errors in parentheses ant t-statistics in square brackets.

5.5 System of Equations for Provisions and Spread

The previous analysis indicates that tight monetary policies through interest rate and reserve requirements affect provisions and increase the credit spread, strengthening the idea that both the risk-taking channel and the credit channel are operating in Brazil. Besides, the findings indicate that the macroeconomic stability is crucial for the reduction of information asymmetries, and thus for creating a favorable environment for

banks to offer credit at lower costs in the economy; however, it also leads banks to expose themselves to more risks, suggesting the "paradox of credibility". A way of testing the validity of the equations and coefficients previously achieved through GMM is the estimation through system of equations. For treating possible problems of endogeneity, the use of system of equations which applies GMM is adequate for estimating non-biased coefficients.[12]

Therefore, to check robustness of the results previously obtained in individual estimates, the following system of equations was estimated (where ϑ and φ are random error terms).

$$\textbf{\textit{System}} \begin{cases} PROV_t = \delta_0 + \delta_1 IR_{t-1} + \delta_2 R\_REQ_{t-1} + \delta_3 O\_GAP_{t-1} + \delta_4 DEFAULT_{t-3} + \delta_5 C\_GAP_{t-3} + \delta_6 d\_CI_{t-1} + + \delta_7 DUMMY + \vartheta_t \\[2ex] SPREAD_t = \alpha_0 + \alpha_1 IR_{t-5} + \alpha_2 R\_REQ_{t-5} + \alpha_3 DEFAULT_{t-1} + \alpha_4 IBOV_{t-1} + \alpha_5 C\_GAP_{t-1} + \alpha_6 D\_CI_{t-5} + \alpha_7 PROV_{t-1} + \varphi_t \end{cases}$$

Table 3 shows the estimation of the system.[13] All coefficients have signs in accordance with the theoretical view, and with statistical significance. It is noteworthy that the coefficients obtained by the system are more accurate than those estimated in the individual specifications, as can be seen the standard errors are smaller.

Table 3 – System GMM (*PROV* e *SPREAD*)

System GMM – PROV and SPREAD			
Dependent Variables	**PROV**		**SPREAD**
Explanatory Variables		Explanatory Variables	
C	2.6902 ***	C	-64.5163 ***
	(0.6365)		(4.7820)
	[4.2261]		[-13.4913]
IR(-1)	0.0489 ***	IR(-5)	0.2734 ***
	(0.0030)		(0.0394)
	[15.8561]		[6.9372]
R_REQ(-1)	1.1165 **	R_REQ(-5)	40.8062 ***
	(0.4576)		(3.2937)
	[2.4395]		[12.3890]
O_GAP(-1)	-3.9308 ***	DEFAULT(-1)	0.6159 **
	(0.4640)		(0.2580)
	[-8.4715]		[2.3868]
DEFAULT(-3)	0.2536 ***	IBOV(-1)	-0.0001 ***
	(0.0272)		(0.0000)
	[9.3185]		[-14.9316]
C_GAP(-3)	1.9795 ***	C_GAP(-1)	83.2998 ***
	(0.6486)		(3.6633)
	[3.0520]		[22.7386]
d_CI(-1)	-0.5183 ***	d_CI(-5)	-3.9711 ***
	(0.1433)		(0.9103)
	[-3.6159]		[-4.3622]
DUMMY	0.7152 ***	PROV(-1)	1.7134 ***
	(0.0354)		(0.3314)
	[20.1545]		[5.1698]
R^2	0.73		0.92
Adjusted R^2	0.71		0.91
J-statistic		0.18	
Prob. (J-statistic)		0.97	

Marginal Significance Levels: *** denotes 0.01, ** denotes 0.05 and *10%. Standard errors in parentheses ant t-statistics in square brackets.

The system reveals the procyclical nature of banks, and shows evidences for the risk-taking channel, the credit channel and the "paradox of credibility". It is possible to

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[12] The System-GMM applies the same instrumental variables of the GMM.

[13] Instruments and lags are the same as those applied in the estimation of the individual equations.

observe that reductions in both interest rate and reserve requirements induce banks to take more risks, thus reducing both the amount provisioned for future losses as well as the spreads on credit operations. These are evidence for the risk-taking channel and the credit channel, and the results corroborate the findings in the works of Auel and de Mendonça (2011) and Tabak, Laiz and Cajueiro (2010). Furthermore, the system reinforces the idea of "paradox of credibility" presented by Borio (2005 and 2006); the findings reveal that the credibility induces banks to take more risks, i.e., when the credibility increases, banks reduce the amount provisioned for future losses as well as the spreads on credit operations. It was also found evidence for the procyclical behavior of banks in Brazil, since the greatest exposure to credit risk is related to periods of output expansions.

6. Concluding remarks

The present study sought evidence for the procyclicality of banking institutions, and at the same time, in an unprecedented way, sought evidence regarding the "paradox of credibility" in Brazil. For this, the work made use of the literature on monetary transmission mechanisms, with emphasis on the credit channel (in particular, the bank lending channel) and the risk-taking channel.

The findings indicate that the bank lending channel and the risk-taking channel are operating in Brazil. Banks react to monetary policy (either when the central bank changes the basic interest rate or reserve requirements) by changing the amount of provisions and also the spread in credit operations. For situations of both interest rate and reserve requirements decreasing, banks take more risks by reducing their provisions and the credit spreads. In this context, the supply of credit in the economy is expanded.

Moreover, the study found evidence that banks increase loans when the economy presents signs of warming, which reinforces the procyclical nature of banking institutions.

In turn, an important novelty of the study is the evidence found for the "paradox of credibility". The stable environment and the high credibility may lead banks to expect lower losses on loans, stimulating them to reduce their provisions and the spreads on credit operations and, as a consequence, inducing them to take more risks. In other words, the credibility encourages the procyclical nature of banking institutions. This does not mean that the credibility is undesirable; in fact, it is an important goal of the monetary authority. However, price stability and credibility are as important as financial stability. In this sense, banking supervision and thus regulation are important tasks that may not be neglected by central banks. Therefore, mechanisms that reduce the procyclicality and the systemic risk are needed to reduce the possibility to occur an economic collapse.

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Appendix

Table A.1 – KPSS test

Series	KPSS				
	Bandwidth	Test	Critical value 1%	Critical value 5%	Critical value 10%
PROV	8	0.153 a	0.739	0.463	0.347
C_GAP	8	0.126 a	0.739	0.463	0.347
IR	8	0.051 b	0.216	0.146	0.119
O_GAP	8	0.045 a	0.739	0.463	0.347
CI	8	0.147 b	0.216	0.146	0.119
D_CI	2	0.116 a	0.739	0.463	0.347
R_REQ	8	0.076 b	0.216	0.146	0.119
DEFAULT	8	0.099 a	0.739	0.463	0.347
SPREAD	8	0.056 b	0.216	0.146	0.119
IBOV	8	0.070 b	0.216	0.146	0.119

Note: the final choice of lag was made based on Bartlett-Kernel criterion. [a] denotes intercept, [b] denotes intercept and trend.