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Monetary Policy and the Credit Channel in Brazil: An Analysis for the Period From 2014 to 2022

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Abstract: The objective of this study is to investigate the presence of the credit channel in transmitting monetary policy in Brazil from 2014 to 2022. The methodology used is based on Akinci et al. (2013) and allows for the assessment of how macroeconomic variables (such as Selic, GDP, and inflation) and bank characteristics (like size, liquidity, and capitalization) affect credit operations. Panel data and econometric estimations are used to measure the influence of these variables on credit supply. Stacked panel, fixed-effects, and random-effects models are estimated, and tests are conducted to determine the best model. The results support the hypothesis of the credit channel's presence in Brazil, with Selic showing significance in all models and with the expected impact. Additionally, liquidity is the only bank characteristic found to be significant, indicating that more liquid institutions are more responsive to monetary policy. Inflation is found to be relevant in all models, with the expected impact, while GDP is not a significant proxy for credit demand. In conclusion, the findings confirm the importance of the credit channel in transmitting monetary policy in Brazil and emphasize the crucial role of banks' liquidity in this process.

Key words: credit channel, monetary policy, bank characteristics, panel data
JEL codes: E42, E52, E58

1. Introduction

Monetary policy, a cornerstone of modern economies, exerts its influence on aggregate demand and inflation. The monetary authority steers this policy through the management of the basic interest rate, which in turn impacts the economy via various transmission channels. Of these, credit emerges as the central focus of our study, underscoring its pivotal role in the Brazilian economic landscape.

Given that the Brazilian economy has a Credit/GDP ratio lower than the world average[1], it is pertinent to ask whether changes in interest rates have a significant impact on the credit supply of institutions, and whether a bank loan channel exists in Brazil. This question is of relevance to the Brazilian economy, as it could shed light on the factors influencing credit supply and potentially inform monetary policy decisions.

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[1] According to The World Bank Data, in 2022 Brazil presented a credit-to-GDP ratio of 71.8, while the world average was 144.1, in South Africa, 92.2, Chile, 112.8, in China, 185, 4.

Passos and Meurer (2022), Evangelista and Araújo (2018), Abrita et al. (2014), Araujo (2012), and Marcatti (2011) have all provided evidence of the credit channel's existence in Brazil. However, the methodologies they used, except for Araujo (2012), relied on aggregate data to measure the supply and demand for credit in the economy. This approach, while informative, does not allow for a direct measurement of the impact of interest rate changes on credit supply, potentially underestimating the importance of the credit channel in Brazil.

To address this limitation, we adopt a novel approach in this study, drawing from the methodology of Matousek and Solomon (2018), Akinci et al. (2013), Matousek and Sarantis (2009), and Ehrmann et al. (2001). These scholars leveraged individual data from financial institutions to gauge the impact of interest rates and bank characteristics on credit supply. This method promises a more comprehensive analysis of bank credit supply, accounting for the unique traits of its providers, and yielding a more robust result compared to existing methodologies in Brazil.

Thus, the main objective of the research is to identify the presence of the credit channel in the Brazilian economy by inferring the relationship between changes in the interest rate of monetary policy and the supply of credit from financial institutions. The research seeks to infer the importance of banks' characteristics in such a relationship and, therefore, for the supply of credit. The current work aims to address the limitation highlighted by Boivin, Kiley, and Mishkin (2011, p. 415) in their discussion of the credit channel. They noted that "The literature in this area remains thin, and this thinness reflects difficulty in specifying the relevant mechanisms and finding the supporting empirical evidence".

In addition to this introduction and final considerations, the work is divided as follows: the second section presents the functioning of the credit channel and some empirical studies on the topic; the third describes the methodology and variables used; and finally, the fourth section exposes and analyzes the results of the econometric model.

2. Credit Channel and the Main Studies in Brazil and the World

2.1 Operation of the Credit Channel

As highlighted by Bernanke and Gertler (1995), the main agent of the credit channel in transmitting monetary policy is banks offering credit resources to consumers and companies. For them, the credit market has imperfect information, suffering from the asymmetry of information involving borrowers and depositors. Banks must be able to work with resources, considering the associated risks.

Bernanke and Gertler (1995) elucidate that the credit channel functions as a magnifier of the impacts of monetary policy, owing to the imperfect nature of the credit market and the influence of monetary policy on the external financing premium (spread). A rise in the base interest rate, they argue, would escalate the spread, while a decrease would contribute to a boost in credit supply, even in projects entailing greater information asymmetry.

The transmission of monetary policy through credit supply can be bifurcated into two distinct channels: the bank loan channel and the balance sheet channel. The former, as the more conventional of the two, aligns with the concepts discussed in the preceding paragraphs. The latter, on the other hand, aims to elucidate how a shift in companies' net worth can curtail the credit supply extended by banks, thereby impacting the economy's consumption expenditures and productive investments.

The effects of the credit channel on the execution of monetary policy are observed in productive investment and consumption carried out by companies and families through raising resources by commercial banks. The offer of credit depends on the current interest rate and the guarantees (collateral) provided by borrowers. An increase in

the short-term interest rate carried out by the monetary authority can discourage the supply of credit by banks through the higher cost of funding and lower collateral from companies.

2.2 Studies on the Credit Channel

The methodology adopted in this article, which focuses on specific characteristics of banks, is based on studies such as Akinci et al. (2013), who estimated the impact of the monetary policy lending channel in Turkey from 1991 to 2007. Similarly, Matousek and Solomon (2018) used a similar methodology for Nigeria, Ehrmann et al. (2001) with data from Eurozone countries, and Matousek and Sarantis (2009) with data from Central and Eastern European countries. These studies, among others, provide a comprehensive understanding of the bank lending channel in various economies.

For Brazil, the works of Evangelista and Araújo (2018), Abrita et al. (2014), Marcatti (2011), and Passos and Meurer (2022) have delved into the complexities of the bank lending channel. However, they used aggregated variables, which make it challenging to separate credit supply and demand in the economy, thereby adding a layer of complexity to the research. Even the work carried out for the Brazilian economy using disaggregated data from financial institutions, such as Takeda, Rocha, and Nakane (2005), and Araujo (2012) have different aspects and, in some cases, objectives, further highlighting the intricacies of the subject.

Evangelista and Araújo (2018) used data from 2002 to 2012 in a Vector Autoregressive Model (VAR), concluding that the economy has a credit channel. Marcatti (2011) used data from 1996 to 2010, Granger causality tests, and Ordinary Least Squares (OLS) equations to identify the relationship between the credit market and the real product, concluding that the credit channel is important in the monetary policy transmission in Brazil. Abrita et al. (2014) analyzed the efficiency of the credit channel in executing monetary policy for the period from 2001 to 2011. To do so, they estimated an IS curve with and without the credit channel to verify the timing of monetary policy and the size of its impact. The estimation was performed using a Vector Error Correction (VEC) model. Passos and Meurer (2022) used macroeconomic data from 2011 to 2020, employing three econometric models: classic structural VAR; Reduced classical VAR, and Bayesian VAR. They concluded that the banking spread quickly and significantly impacted the economy, overflowing the SELIC variation in the credit market. Araujo (2012) used disaggregated bank data from 2000 to 2011, with macroeconomic variables (GDP, Inflation, and Selic) and bank characteristics (size, liquidity, and capitalization). He found that more capitalized and prudent banks are more sensitive to variations in monetary policy.

Matousek and Solomon (2018) sought to verify the importance of banking sector restructuring policies carried out from 2002 to 2008 and the presence of a credit channel in the Nigerian economy. They used the Generalized Method of Moments (GMM) with data from 23 banks and identified the credit channel and that restructuring policies helped develop this channel. Furthermore, it was observed that loan growth is more sensitive to changes in the size and capitalization of banks. Matousek and Sarantis (2009) used the same methodology for the countries of Central and Eastern Europe: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Republic, and Slovenia, with data from 1994 to 2003. They verified the presence of bank lending channel for all economies and that the size and liquidity of banks were the most sensitive characteristics of the model. With the same objective, Ehrmann et al. (2001) analyzed Italy, Germany, France, and Spain, using data relating to the period from 1992 to 1999. The results demonstrated that the bank lending channel is essential in the conduct of monetary policy and that liquidity is the most sensitive characteristic to a change in the interest rate.

Finally, research by Akinci et al. (2013) provided evidence for a bank lending channel in Turkey using data

from 25 banks from 1991 to 2007. The most important characteristic of banks for the channel effect was the level of capitalization.

3. Methodology and Description of Variables

3.1 Structuring the Econometric Model

The model proposed by Matousek and Solomon (2018) and Akinci et al. (2013) is constructed using data on banks' loan supply, basic interest rate, inflation, economic growth, and some of the banks' main characteristics (asset size, liquidity, and capitalization). The equation is described as follows:

$$\Delta lnL_{it} = \alpha_i + \beta_1 \Delta lnL_{it-1} + \sum_{j=0}^{1} \gamma_j \Delta R_{t-j} + \sum_{j=0}^{1} \delta GDP_{t-j} + \sum_{j=0}^{1} \lambda INF_{t-j} + \sum_{j=0}^{1} \theta_k Z_{kit-1} + \sum_{k=1}^{3} \sum_{j=0}^{1} \phi_{kj} Z_{kit-1} \Delta R_{t-j} + \varepsilon_{it} \quad (1)$$

where, L_{it} represents the loans of the nth bank in period t, R the basic interest rate, GDP is the real growth rate of the economy, INF the inflation rate, Z_k as the three characteristics of the bank: Size (S_{it}), Liquidity (LIQ_{it}) and Capitalization (CAP_{it}), such variables are calculated as:

$$S_{it} = lnA_{it} - \frac{\sum_{i=1}^{Ni} lnA_{it}}{N_i} \quad (2)$$

$$LIQ_{it} = \frac{LA_{it}}{A_{it}} - \frac{\sum_{i=1}^{Ni} (LA_{it}/A_{it})}{N_i} \quad (3)$$

$$CAP_{it} = \frac{C_{it}}{A_{it}} - \frac{\sum_{i=1}^{Ni} (C_{it}/A_{it})}{N_i} \quad (4)$$

where A is the total assets of the nth bank in period t, LA is the liquidity of the nth bank in period t and C is the equity capital and bank reserves of the nth bank in period t. Thus, normalization[2] is performed on all variables with the aim of guaranteeing a zero sum of deviations.

3.2 Description of Variables

The period analyzed covers monthly data from January 2014 to December 2022. The data was extracted from the Central Bank of Brazil (BCB) and the Brazilian Institute of Geography and Statistics (IBGE). All variables that belong to the banks' structure are taken from their respective consolidated balance sheets, available through the BCB's COSIF (Consolidated SFN Accounting) system.

The choice of banks is made based on the BCB's classification into five segments. The BCB orders these institutions based on their size, classifying them between S1 and S5, with the largest belonging to S1 and the smallest to S5. Banks without classification and institutions classified as S4 and S5 were excluded from the sample. Institutions that did not have all the accounts necessary to calculate the characterization indices, development banks[3] and those that did not have a main activity related to offering credit. After these exclusions, the total number of participating institutions was reduced to 44, all of which belonged to groups S1, S2 and S3 and were effectively affected by the basic interest rate.

For the variable called credit supply, the "credit operations" account from the accounting balance sheet is chosen. The Selic rate is assumed to be the economy's basic interest rate. The variable growth of the economy is

[2] In the works of Araujo (2012) and Akinci et al. (2013) the normalization of banking characteristics was carried out for the entire period (T). In the present work, normalization is the average of institutions in month t. This process more assertively separates institutions above and below average at each moment in time.

[3] Excluded development banks are Banco Nacional do Desenvolvimento (BNDES) and Banco Regional de Desenvolvimento do Extremo Sul (BRDE), both of which are insensitive to changes in the basic interest rate.

represented by the variation in the quarterly Gross Domestic Product (GDP), with an interpolation being made to arrive at the monthly growth[4]. To represent inflation, the Broad Consumer Price Index (IPCA) is used. For total assets, the sum of "Realizable assets" and "Permanent assets" of the accounting balance sheet is considered. For the liquidity measure, the values of the accounts are added: "Cash"; "Interbank liquidity applications" and "Securities and derivative financial instruments". The equity variable is chosen to represent the bank's capital.

Table 1 shows greater variance in credit operations and total assets of financial institutions. This is because there is a large discrepancy between the size of the banks, which makes the sample larger. Capitalization, in turn, is the one with the lowest variance. Among the macroeconomic variables, the largest variance is in GDP, which is explained by the COVID-19 period that brought strong fluctuations in economic performance.

Table 1 Summary of Variables

Variable	Mean	Standard Deviation	Minimum	Maximum
Credit*	88.897,47	211.404,23	0,13	994.019,23
Total assets *	248.495,18	540.264,86	347,15	2.313.780,15
Liquidity	0,4088	0,2115	0,0045	0,9520
Capitalization	0,1096	0,0604	0,0202	0,9074
Selic	0,7081	0,3187	0,1345	1,2152
IPCA	0,4917	0,4178	-0,6800	1,6200
GDP	0,0747	3,0693	-25,2088	13,0331

Source: Own preparation, based on data from the BCB and IBGE.
*Values in millions of reais at December 2022 prices.

For the dependent variable "credit operations" the natural logarithm and the first difference are applied. The Selic is also transformed into a first difference to measure the variation and not the absolute value. The bank characteristics variables (size, liquidity, and capitalization) were normalized, as shown in equations 2, 3, and 4. The first difference and the lags that are used in the variables are applied in the 6-month period. The choice for a lag of this magnitude was due to the time needed for the effects of a change in the interest rate to reach the credit supply, as highlighted by Goodhart (2017), and on the characteristics of the banks. This procedure reduced the sample's degrees of freedom but was not significant due to the large number of observations.

4. Results

To measure and seek evidence of the credit channel in the Brazilian economy, the main results of the regressions carried out using the econometric model following Akinci et al. (2013). All variables underwent stationarity, autocorrelation, and heteroscedasticity tests and, when necessary, a covariance matrix of coefficients was used, and the model was estimated again for adjustment. The method used was HC3 (Heteroscedasticity and Autocorrelation Consistent covariance matrix estimator 3) from the R sandwich package. The correction already transforms the model presented in the following subsection.

In works such as those by Matousek and Solomon (2018) and Akinci et al. (2013) the models were estimated in GMM (Generalized Method of Moments), OLS (Ordinary Least Squares) and FEM (Fixed Effects Model). In both studies, the GMM model was used due to the low number of observations available. For this work, the OLS,

[4] The interpolation was carried out depending on the proportion of variation in the IBC-Br (BCB) with the GDP growth data (IBGE). The IBC-Br was chosen because it is the monthly production indicator that most adheres to the official estimate of quarterly GDP and because it is a base indicator used by the BCB to conduct monetary policy.

and REM models (random effects model) are estimated and tests are carried out to verify which is the most appropriate.

4.1 Estimation of the Specific and General Econometric Model

Specific models were estimated with each isolated banking characteristic and a general model containing all of them. The regression of the general model includes all macroeconomic variables and bank characteristics. The model equation is described as:

$$\Delta lnL_{it} = \alpha_i + \beta_1 \Delta lnL_{it-6} + \beta_2 \Delta R_t + \beta_3 \Delta R_{t-6} + \beta_4 PIB_t + \beta_5 PIB_{t-6} + \beta_6 IPCA_t + \beta_7 IPCA_{t-6} + \beta_8 S_{it-6} + \beta_9 S_{it-6} \Delta R_t + \beta_{10} S_{it-6} \Delta R_{t-6} + \beta_{11} LIQ_{it-6} + \beta_{12} LIQ_{it-6} \Delta R_t + \beta_{13} LIQ_{it-6} \Delta R_{t-6} + \beta_{14} CAP_{it-6} + \beta_{15} CAP_{it-6} \Delta R_t + \beta_{16} CAP_{it-6} \Delta R_{t-6} + \varepsilon_{it} \quad (5)$$

The econometric model is estimated in OLS, FEM and REM. The tests recommended by Gujarati and Porter (2009) were conducted to determine the most suitable model for the analysis. The test is performed between the fixed effects model against the stacked model (OLS) and the test between the random effects model against the fixed effects model. The results are presented using *pFtest* and p*hFtest*. Table 2 shows the estimates of models according to the tests carried out. Based on this, the p-value of both tests was very low, and the preferred model was the fixed effect model.

Table 2 Result for Specific and General Models

Models	Size	Liquidity	Capital	General model
Effect	Fixed Effects (FE)	Fixed Effects (FE)	Random Effects	Fixed Effects (FE)
Intercept	-	-	0,04544896 *	-
$\Delta \ln L_{it-6}$	-0,12666217 *	-0,16434000 ****	-0,1370113 ***	-0,11969000 *
ΔR_t	0,65453297 *	0,65420000 *	0,64626184 *	0,66065000 *
ΔR_{t-6}	-0,42358827 *	-0,52425000 *	-0,53807101 *	-0,42378000 **
GDP_t	0,00303229	0,01413400	0,00154886	0,00259110
GDP_{t-6}	0,00045167	-0,00003974	-0,00034998	0,00050667
$IPCA_t$	-0,03856270	-0,04326900 *	-0,04493507	-0,04842700
$IPCA_{t-6}$	-0,08116967 *	-0,06195700 **	-0,06151570 *	-0,08183100 **
S_{it-6}	-0,40984281	-	-	-0,32220000
$S_{it-6}\Delta R_t$	-0,00369164	-	-	-0,20288000
$S_{it-6}\Delta R_{t-6}$	0,03760450	-	-	0,10081000
LIQ_{it-6}	-	1,35540000 ****	-	1,18330000 ***
$LIQ_{it-6}\Delta R_t$	-	-0,26333000	-	-0,47132000
$LIQ_{it-6}\Delta R_{t-6}$	-	0,31799000	-	0,24427000
CAP_{it-6}	-	-	1,42287351	1,35830000
$CAP_{it-6}\Delta R_t$	-	-	-9,98025756	-12,77100000
$CAP_{it-6}\Delta R_{t-6}$	-	-	1,45343384	3,61370000
R^2	0.12384	0.10184	0.10806	0.17644
R^2 adjusted	0.11115	0.088827	0.10565	0.16314
p-value	0,00000 ****	0,00000 ****	0,00000 ****	0,00000 ****
pFtest (EF, OLS)	0,00000 ****	0,00000 ****	0,00000 ****	0,00000 ****
pHtest (EA, EF)	0,00000 ****	0,00000 ****	0,9416	0,00000 ****
N	3713	3713	3713	3713

Source: Own elaboration based on the results of R, using data from the BCB and IBGE.
**** significant at the 0.1% level; *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

According to the above estimate, the results of the specific and general models are similar with four

macroeconomic variables are significant with at least 10%: $\Delta \ln L_{it-6}$; ΔR_t; ΔR_{t-6}; $IPCA_{t-6}$. All came following economic theory. For credit operations, it is expected that after an increase in credit in period t, there will be credit rationing in the coming months due to the lower liquidity that the offer generated. An increase in the Selic in period t may initially lead to an increase in the balance of operations backed by the basic interest rate. Therefore, its signal may be positive.

On the other hand, with the lag, the effect of monetary policy can be better identified, and financial institutions start to offer less credit with an increase in the Selic, as demonstrated by the regression result. Finally, for the IPCA with a lag, financial institutions are expected to offer less credit in an inflation scenario, as their real profit from operations decreases for contracts with a fixed rate and not linked to inflation. The results are similar to those of Matousek and Solomon (2018) and Akinci et al. (2013) in Nigeria and Türkiye, respectively. Both showed a negative sign for inflation and interest rates, although inflation was significant only in Nigeria. Unlike observed for Turkey (Akinci et al., 2013), GDP is not significant, which may be associated with the low mobility of credit demand in the Brazilian economy and low economic growth during the period analyzed compared to the supply of credit.

The variables representing the size characteristic were not significant in Brazil. This result can be attributed to the high banking concentration in the six banks, with little variability between them. For Turkey, no evidence was found regarding the impact of size on credit supply. In Nigeria, this characteristic was identified as significant. The capitalization level was also irrelevant, although it came with expected signs.

The liquidity variable was found to be significant at 0.1% and with a positive sign. This suggests that financial institutions with higher liquidity are more likely to offer credit than those with lower liquidity. The significance of liquidity in the supply of credit was only found for the Turkish economy, as per the work of Matousek and Solomon (2018) and Akinci et al. (2013). However, this impact was only identified when an interaction between liquidity and capitalization was conducted, and liquidity alone was not relevant to the research carried out in Nigeria and Turkey. Furthermore, the work of Araujo (2012) was not significant for the liquidity of institutions. This result may indicate a shift in the importance of this variable for the supply of credit by banking institutions between the first and second decades of the 21st century, which could have significant implications for the banking industry.

Summarizing the above, it becomes evident that the monetary policy adjustment variable (Selic) is a crucial factor in the credit operations of financial institutions. Inflation also emerges as a significant variable, with its significance and sign aligning with predictions. In other words, as the inflation rate rises, institutions are expected to respond with a smaller credit supply. The importance of bank liquidity in the supply of credit to Brazilian financial institutions is underscored, with the significance of isolated liquidity being an unprecedented result when compared with estimates for the Turkish and Nigerian economies. This underscores a unique characteristic of the Brazilian financial system.

5. Final Considerations

The results presented in this study support the hypothesis of the importance of the credit channel, particularly the bank loan channel, for the transmission of monetary policy in Brazil. Prior research in Brazil had identified the existence of the credit channel, but it had limitations due to the use of aggregated data, which made it challenging to differentiate credit supply from demand and neglected the impact of banking characteristics on supply. This study's primary contribution is to confirm the significance of banks' liquidity for the functioning of the credit channel in Brazil.

The results demonstrate that more liquid banks are more likely to extend credit when monetary policy is loosened. The study also identifies the impact of interest rate changes on financial institutions' credit operations. Furthermore, it underscores the relevance of interest rates, inflation, and previous credit operations, emphasizing their importance in dictating monetary policy and reinforcing the existence of the credit channel in Brazil.

Hence, this study, with its methodology and analyzed period, emphasizes a crucial element in understanding the operations of the credit channel in Brazil: the liquidity condition of banking institutions. Future research aims to further refine these findings, specify other influential characteristics impacting the channel's operations in the Brazilian economy, and explore alternative measures of bank liquidity.

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