UNIVERSIDADE FEDERAL DO RIO DE JANEIRO

INSTITUTO COPPEAD DE ADMINISTRAÇÃO

FABIANO MACHADO DE ANDRADE

THE IMPACT OF BANK EFFICIENCY ON FINANCIAL INTERMEDIATION:
An Empirical Study in Brazil

Rio de Janeiro

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Master's dissertation presented to the COPPEAD Graduate School of Business, Universidade Federal do Rio de Janeiro, as part of the mandatory requirements in order to obtain the title of Master in Business Administration (M.Sc.).

Supervisor: Prof. Claudio Oliveira de Moraes

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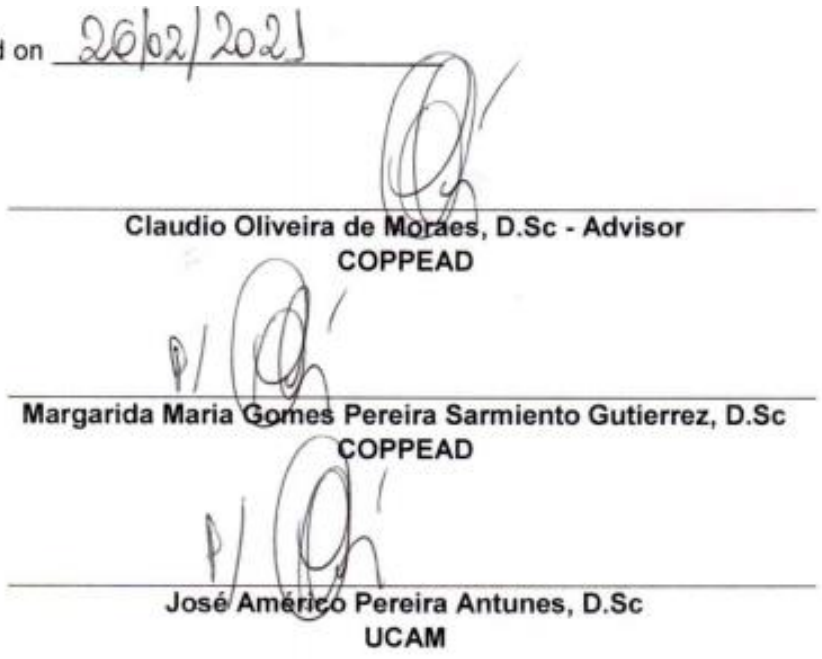

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RESUMO

ANDRADE, Fabiano Machado de. **O Impacto da Eficiência Bancária na Intermediação Financeira:** Um Estudo Empírico no Brasil. Rio de Janeiro, 2021. Dissertation (Master's Degree in Business Administration) - COPPEAD Graduate School of Business, Federal University of Rio de Janeiro, Rio de Janeiro, 2021.

O objetivo principal desta pesquisa é analisar empiricamente o impacto da eficiência bancária no custo da intermediação financeira, medido pelo spread de crédito. Aplica-se um modelo econométrico dinâmico a dados em painel obtidos na base de dados aberta do Banco Central do Brasil, que cobre os períodos de 2009 a 2019 e compreende 96 bancos no Brasil. Os resultados indicam que a eficiência dos bancos impacta o spread de crédito, representando o custo final da intermediação financeira. Em resumo, os resultados sugerem que os bancos brasileiros conseguem repassar à sociedade seus custos em termos de ineficiências bancárias por meio do spread de crédito.

Keywords: Bancos, Eficiência, Intermediação Financeira, Spread de Crédito, Brasil

ABSTRACT

ANDRADE, Fabiano Machado de. **The Impact of Bank Efficiency on Financial Intermediation:** An Empirical Study in Brazil. Rio de Janeiro, 2021. Dissertation (Master's Degree in Business Administration) - COPPEAD Graduate School of Business, Federal University of Rio de Janeiro, Rio de Janeiro, 2021.

The main objective of the present research is to empirically analyze the impact of bank efficiency on financial intermediation cost, measured by credit spread. It applies a dynamic econometric model to panel data obtained from the open database of Brazil Central Bank, which covers the periods from 2009 to 2019 and comprises 96 banks in Brazil. The results indicate that efficiency of banks impact credit spread, representing the final cost of financial intermediation. In summary, the results suggest that Brazilian banks are able to pass on their costs to society in terms of bank inefficiencies through credit spread.

Keywords: Banking, Efficiency, Financial Intermediation, Credit Spread, Brazil

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LIST OF ABREVIATIONS

BCB	Brazil Central Bank
CAR	Capital Adequacy Ratio
COPOM	Monetary Policy Committee
DGMM	Difference Generalized Method of Moments
GMM	Generalized Method of Moments
IHH	Herfindahl-Hirschman Index
IMF	International Monetary Fund
IPCA	Consumer Price Index
NPL	Non-Performing Loans
OLS	Ordinary Least Squares
OPEX	Operational Expenses
ROA	Return on Assets
ROE	Return on Equity
SELIC	Special System for Settlement and Custody

CONTENTS

1. INTRODUCTION

It is evident that economics plays an important role in modern economies, aiming to promote wellbeing to the society. In this sense, economic growth and financial development are important elements studied by economics to pursue this goal. A large body of economic research concentrating on the link between financial development and growth has shown that a well-functioning and market-oriented financial sector contributes to improved economic outcomes (Demirguc-Kunt & Levine, 2008; King & Levine, 1993; Rousseau & Wachtel, 2000). More specifically, financial intermediation performed by financial institutions is at the center of this complex system. Many researchers are becoming convinced that well-functioning financial systems can boost economic growth by ameliorating information and transaction costs (Beck & Levine, 2004; Bencivenga et al., 1995; King & Levine, 1993). Mishkin (1997) affirmed that banks play an important role in financial markets by providing information that facilitates investment and production in the economy. In this context, the present study intends to explore the following research question: how does the efficiency of banks impact financial intermediation?

According to Čihák et al. (2012) and International Monetary Fund (IMF), efficiency of financial institutions in emerging markets is one of the factors that may hinder financial development when compared to advanced economies. It is important to highlight that, financial development might be more thoroughly defined as a combination of depth, access, and efficiency. Depth is related to the size and liquidity of markets. Access is defined as the ability of individuals and companies to access financial services. Efficiency is the ability of institutions to provide financial services at low cost and with sustainable revenues (Čihák et al., 2012).

In particular, financial institutions efficiency relies on three aspects: intermediation efficiency; operational efficiency; and profitability. The first, is the efficiency in intermediating savings to investment, as measured by the net interest margin and lending-deposit spread. The second, are operational efficiency measures, such as non-interest income to total income and overhead costs to total assets. The third, are profitability measures, such as return on assets and return on equity (Čihák et al., 2012).

Regarding financial institutions efficiency, it is possible to notice Brazil among other emerging economies stands out from its peers (IMF Financial Development Index 2018). It outperforms the emerging markets average in all criteria but financial institutions efficiency. Actually, for this criterion, Brazil operates at the same level of low-income economies group. Furthermore, an important factor of financial intermediation and efficiency, interest rate spread

is historically high in Brazil, being the second higher in 2017, according to data from the World Bank.

Therefore, Brazil presents a singular and relevant case, which deserves investigation but still lack empirical research and debate. For this intent, the present study proposes an empirical research based on a dynamic econometric model applied to a panel data retrieved from Brazil Central Bank (BCB). The main objective of the present research is to empirically analyze the impact of bank efficiency on financial intermediation cost. Thus, operational cost along with other factors is used as measure of bank efficiency and credit spread as a proxy of financial intermediation cost. In addition, the impact on credit spread is analyzed based on macroeconomic environment, banking industry aspects and types of banks. The main result indicates that efficiency of banks (operational cost) impact credit spread, representing the final cost of financial intermediation, which suggests Brazilian banks are able to pass on to society their operational inefficiency costs, among others, through credit spread.

Besides this introduction, this study is structured as follows: Section 2 the literature review. Section 3 describes the data, variables, models, and methods. Section 4 presents the estimation results and analysis. Section 5 a robustness analysis. Section 6 conveys the conclusion. Section 7 appendix and section 8 references.

2. LITERATURE REVIEW

2.1 FINANCIAL INTERMEDIATION

The behavior of financial intermediation is crucial to the understanding of economic performance (King & Levine, 1993). The absorption by the financial intermediaries of the information asymmetry in the lender–borrower relationship gives rise to credit risk, which is the potential loss arising from the possibility that a business will fail to fully meet its contractual obligations on time (Guo, 2013).

According to Dewatripont & Tirole (1994) and Freixas & Rochet (2008), capital markets imperfections allow for the emergence of the financial intermediary. The financial intermediary absorbs the frictions arising from information asymmetry and transaction costs present in the lender–borrower relationship. As a consequence, adverse selection and moral hazard arises, in addition to credit risk, a fundamental element in the financial intermediation activity. From the lender standpoint, information asymmetry counteracts to anticipate such behavior and avoid the risk.

The deterioration of the credit risk reduces the process of financial intermediation and act as a financial friction. In turn, this can be explained by the forward-looking behavior of banks in perspective of credit scenario depreciation. Information asymmetry is a regular problem of the credit market that can cause inefficiencies and may lead banks to increase their risk aversion causing impact on the credit spread (Jappelli & Pagano, 2000; Kwark, 2002; Ordoñez, 2013).

The studies on credit spreads began with the seminal article by Ho & Saunders (1981) on the net interest margin, when they attempt to explain the existence of the margin in the United States banking sector. Their model described a risk-averse bank acting as an intermediary between lenders and borrowers, setting interest rates on deposits and lending to maximize profits given the asymmetries of information in the credit market. Since information asymmetry creates uncertainties, banks will always require a positive interest spread as the price of financial intermediation. According to the authors, the net interest margin depends on the degree of risk aversion of banks, volatility of interest rates on deposits and loans, bank market structure and size of banking transactions.

The empirical evidence from the literature demonstrates that credit risk, operating costs, policy interest rate and inflation contribute to increase the credit spread. Moreover, the credit spread represents the financial margin of the banks (Angbazo, 1997; Birchwood et al., 2017; Carbó Valverde & Rodríguez Fernández, 2007; Cúrdia & Woodford, 2010; Entrop et al., 2015;

Hawtrey & Liang, 2008; Maudos & Fernández de Guevara, 2004; Nakane, 2002; Ugur & Erkus, 2010; Williams, 2007).

2.2 BANK EFFICIENCY AND BRAZILIAN ECONOMY

It is important to highlight that a strong banking sector enables the efficient management of financial resources and investments, improving the financial system and economy (Ayadi et al., 2015; Claessens & Laeven, 2005). In a context of a competitive banking industry, which is being intensified due to the advent of new technologies, banks are employing significant efforts to increase their performance and remain competitive (Menor & Roth, 2008; Wonglimpiyarat, 2014). In this context, Ahmad et al. (2020) conducted a citation-based systematic literature review on banking sector performance, mainly in terms of profitability, productivity, and efficiency. The study results convey that the number of publications in this research field have been growing considerably after the subprime financial crises of 2007. Nevertheless, a major part of the literature has been restricted to summarize the methodologies, issues, and developments. A categorization analysis of the top 100 papers identify content in five key themes: determinants of efficiency, methodology, ownership, financial crises, and scale economies.

According to the authors, banking efficiency methodology may be generally classified in two main groups: Frontier Analysis and Financial Ratio Analysis. Major part of the literature approach bank efficiency analysis by comparison among institutions and/or dealing with static models. In light of financial intermediation literature and the objective of this study, it is proposed to approach Brazilian case through a dynamic empirical analysis.

In order to assess the impact of bank efficiency on financial intermediation in Brazil, it is important to previous and briefly revisit the local and recent economic environment background. Before 1994, Brazilian economy severely suffered from monetary instability and long period of hyperinflation. By 1994, Brazilian Real was implemented as a new currency and by 1999 the recent inflation-targeting framework was adopted. To some extent, these initiatives were successful in tackling down the major issue of hyperinflation and inertial inflation. Nonetheless, since then Brazil still faces some level of high and volatile inflation and policy interest rates due to domestic factors such as political turbulences. In aftermath, Brazil used to be living a long history of high inflation, interest rate and credit spread.

According to Nakane (2001), bank interest spread in Brazil has shown a significant downward trend in the 90’s after inception of Brazilian Real. According to the author,

macroeconomic factors were the main drivers to reach this through stabilization of economy and focus on monetary policy during the period, however remained unclear if this effect would be able to progress further. Another important aspect raised by the author is a high and persistent cross-sectional dispersion of bank interest spreads in Brazil, which might indicate a market where productive inefficiencies and regulatory burden allowed that some banks were able to operate at higher rates than peers. Hence, the author suggested further reductions in spread were more likely to be driven by microeconomic factors in terms of bank industry efficiency.

According to World Bank and IMF, Brazil is still one of the countries with highest interest rate spreads at levels around 35% in 2008 to 38% in 2017, passing through 20% (2013) and 40% (2016), while world's aggregate ranged from levels around 6% to 5.5% in the same period. According to these institutions, in 2017, Brazil's interest rate spread is the second higher only after Madagascar at 45%; almost seven times higher than Upper Middle-Income group at 5.6%; five times higher than Latin American average at 7.5%; and almost three times the second highest in Latin America which is Paraguay at 14%. The recent past international economic context presents a declining trend of these economic indicators around the world, while in Brazil they are still maintained at higher levels around 32% in 2019.

Therefore, Brazil presents a singular and relevant case, which deserves further investigation but still lack empirical research and debate. Hence, there is an opportunity to further analyze and understand this important and chronic issue in Brazilian economy in light of financial intermediation and banking efficiency literature.

3. DATA AND METHODOLOGY

3.1 DATA AND VARIABLES

This is a quantitative research based on banking empirical data through econometric models. For this intent is used a banking data base provided by BCB comprised of quarterly frequency between 2009 to 2019 which covers 96 banks in Brazil, including private and state-owned institutions. On Table A.1 of the index is possible to see all the banks used in this study.

As pointed out by Nakane (2001), the credit spread may be explained by banking and macroeconomic variables. That study used non-performing loans, as a proxy of credit risk; return on assets, as a measure of profitability; monetary policy interest rate and bank concentration in order to evaluate the impact of economic environment and finally the capital adequacy ratio to capture the effect of regulation on credit spread. The variables used in this study are presented and described as follows:

SPREAD is defined as the lending-deposit interest rate spread operated by banks. It is calculated by the difference between the gross interest rate charged by banks on lending and the rate compensated on deposits, representing a funding cost. This can be regarded as a proxy of the gross profit margin of banks in financial intermediation activity. In the present study it is used to reflect the Financial Intermediation Cost.

Non-Performing Loans (NPL) is defined as the ratio of defaulting loans over total loans. Defaulting loans are defined as loans overdue at least by 90 days. It is used in the present study as a proxy of Credit Risk.

Operational Expenses (OPEX) represents the ratio of Operational Expenses to Total Assets. This division by Total Assets is important to reflect the expenses in proportion to the size and structure of the financial institutions. In addition, it is relevant to highlight some aspects of the Operational Expenses data. It is retrieved directly from the Income Statements reported by financial institutions to BCB. It reflects the gross amount of operational expenses, i.e., it disregards the net effect of other operational and non-operational revenues that may offset Operational Expenses in Financial Statement Reports. This consideration is crucial in order to properly reflect the Operational Expenses of financial institutions in relation to their main activity in financial intermediation. This variable is used in the proposed model as a proxy of Operational Efficiency.

Return on Assets (ROA) is included in the model in order to reflect the Profitability of the financial institutions in financial intermediation activity. It is relevant to mention the reason behind the option of ROA instead of Return on Equity (ROE). The understanding is ROA better reflects the economic nature and objective of the model. ROA represents the profitability of entire Assets allocated by financial institutions as well as their respective size and structure, while ROE is impacted by Debt-to-Equity funding composition reflecting leverage and the perspective of shareholders, which are not relevant to the present study. In summary, this variable is used in the proposed model in order to represent the Profitability of financial institutions.

The following describes the Controlling Variables used in the present study:

SELIC is the Brazilian official policy interest rate. According to BCB, this is the main tool used by the regulator in the implementation of the monetary policy. Under the inflation-targeting regime, the Monetary Policy Committee (COPOM) regularly sets the target for the SELIC rate. Within the relevant horizon for the monetary policy, COPOM aims to keep the official inflation rate (IPCA) around the target and anchor inflation expectations. Accordingly, the BCB performs daily open market operations to keep the effective SELIC rate at the target

set by COPOM. According to Tabak et al. (2013), the idea of including this variable in the analysis is to assess the impact of monetary policy on financial intermediation. In this sense, it is used as a proxy reflecting the macroeconomic environment conditions.

Capital Adequacy Ratio (CAR) represents the Regulatory Capital maintained by banks as required by BCB as regulator in light of Basel Accords. It is treated as an indicator of financial institution solvency. It reflects microeconomic industry specific conditions.

Herfindahl-Hirschman (IHH_AT) is the Index by Asset. According to Bikker & Haaf (2002), this index is designed to measure the market concentration of an industry and is the benchmark measure of concentration in the theoretical literature. It is calculated as the sum of the squares of bank sizes measured as market shares and can range from 0 to 10,000. Then, in order to properly fit to the magnitude of the other data, this index is adjusted by a division of 1,000. It reflects microeconomic industry specific conditions.

It is possible to observe below a summary presenting the descriptive statistics of the database and variables (Table 1).

Table 1 - Descriptive Statistics

	SPREAD	NPL	OPEX	ROA	SELIC	CAR	IHH_AT
Mean	0.14	0.07	0.01	0.02	0.10	0.26	1.38
Median	0.08	0.05	0.01	0.01	0.10	0.17	1.36
Maximum	2.29	0.91	0.48	0.91	0.14	7.86	1.50
Minimum	-0.33	0.00	0.00	-0.99	0.06	-0.07	1.28
Std. Dev.	0.23	0.09	0.02	0.07	0.03	0.42	0.07
Observations	3,143	3,143	3,143	3,143	3,143	3,143	3,143

3.2 METHODOLOGY

This study analyzes the impact of bank efficiency, decomposed by its main factors, on financial intermediation, represented by interest rate spread. In order to achieve this, it proposes an alternative approach, by the employment of dynamic panel data econometric techniques.

According to Čihák et al. (2012), credit spread may also be regarded as a proxy for Intermediation Efficiency in his Financial Institutions Efficiency model. In this sense, on the present study Lagged SPREAD is an important factor in order to structure the dynamic model proposed, as well as to reflect this alternative aspect of Intermediation Efficiency and to assess a possible element of persistence in credit spread. Hence, the proposed model presents the following dynamic panel specification:

$$SPREAD_{i,t} = \beta_0 + \beta_1 SPREAD_{i,t-1} + \beta_2 NPL_{i,t-1} + \beta_3 OPEX_{i,t-1} + \beta_4 ROA_{i,t-1} + \beta_5 Z_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

where the subscript i = 1, 2, . . ., 96 is the financial institution; t = 1, 2, . . ., 39 is the period, β is the coefficient to be estimated and ε is the disturbance.

Firstly, SPREAD is stated as the dependent variable representing the financial intermediation cost. The independent variables are: Lagged SPREAD reflecting the dynamic nature of model and representing the Intermediation Efficiency; NPL – Non-Performing Loans reflecting the Credit Risk; OPEX – Operational Expenses to Total Assets reflecting the Operational Efficiency and ROA – Return on Assets representing the Profitability.

Subsequently, Z represents the additional Controlling Variables, which are included incrementally to the baseline model, being SELIC – Policy Interest Rate, reflecting the macroeconomic environment; and CAR – Regulatory Capital along with IHH_AT – HH Index by Total Assets, reflecting the industry specific microeconomic environment.

Finally, Dummy Variables are used to portion the sample in specific groups to be analyzed: Top 5; Non-Top 5 and State-owned Banks. The objective of this exercise is to test the sensibility of these relevant groups, through their interaction to SPREAD, in order to assess whether they operate differently, absorbing or not their business inefficiency costs on credit spread. The models including interactions may be represented by the following equations:

$$SPREAD_{i,t} = \beta_0 + \beta_1 SPREAD_{i,t-1} + \beta_2 NPL_{i,t-1} + \beta_3 OPEX_{i,t-1} + \beta_4 ROA_{i,t-1} + \beta_5 Z_{i,t-1} + \beta_6 SPREAD_{i,t-1} \times TOP5 + \varepsilon_{i,t} \quad (2)$$

$$SPREAD_{i,t} = \beta_0 + \beta_1 SPREAD_{i,t-1} + \beta_2 NPL_{i,t-1} + \beta_3 OPEX_{i,t-1} + \beta_4 ROA_{i,t-1} + \beta_5 Z_{i,t-1} + \beta_6 SPREAD_{i,t-1} \times C\_TOP5 + \varepsilon_{i,t} \quad (3)$$

$$SPREAD_{i,t} = \beta_0 + \beta_1 SPREAD_{i,t-1} + \beta_2 NPL_{i,t-1} + \beta_3 OPEX_{i,t-1} + \beta_4 ROA_{i,t-1} + \beta_5 Z_{i,t-1} + \beta_6 SPREAD_{i,t-1} \times STATE + \varepsilon_{i,t} \quad (4)$$

where the subscript i = 1, 2, . . ., 96 is the financial institution; t = 1, 2, . . ., 39 is the period, β is the coefficient to be estimated and ε is the disturbance.

The empirical part of this study employs Generalized Method of Moments (GMM), an approach developed by Arellano & Bond (1991). The application of this method is important to the present study because it allows to reflect the dynamic nature of financial intermediation and business management performed by banks. In addition, it permits to assess the existence of a possible persistence on financial intermediation cost, reflecting an inertial element on interest spread in Brazil.

Moreover, it is an appropriate technique to be applied to panel data as it handles the estimation problems that arise in the application of Ordinary Least Squares (OLS) techniques. Aiming to eliminate the individual fixed effects, it is applied the first difference of the model. The Arellano & Bond (1991) estimators based on this technique is called Difference-GMM (DGMM). In order to assess the proper specification and validity of the model, overidentification and autocorrelation are checked by the application of Hansen (J-Statistic) and Arellano-Bond (AR(1) and AR(2)) tests.

4. RESULTS

Firstly, by analyzing the Scatter Plot Graphs (Figure 1) it is possible to notice SPREAD presenting positive correlation to all three independent variables in the baseline model – NPL, OPEX, and ROA. Among them, NPL seems to be the strongest while ROA the weakest. By checking the correlation matrix (Table 2), the variables convey the same general idea, nonetheless presenting OPEX almost at the same correlation level of NPL. This suggests a relationship between OPEX and Credit Spread; in addition to Credit Risk and Credit Spread, which is explained by the literature.

Figure 1 – Scatter Plot Graphs

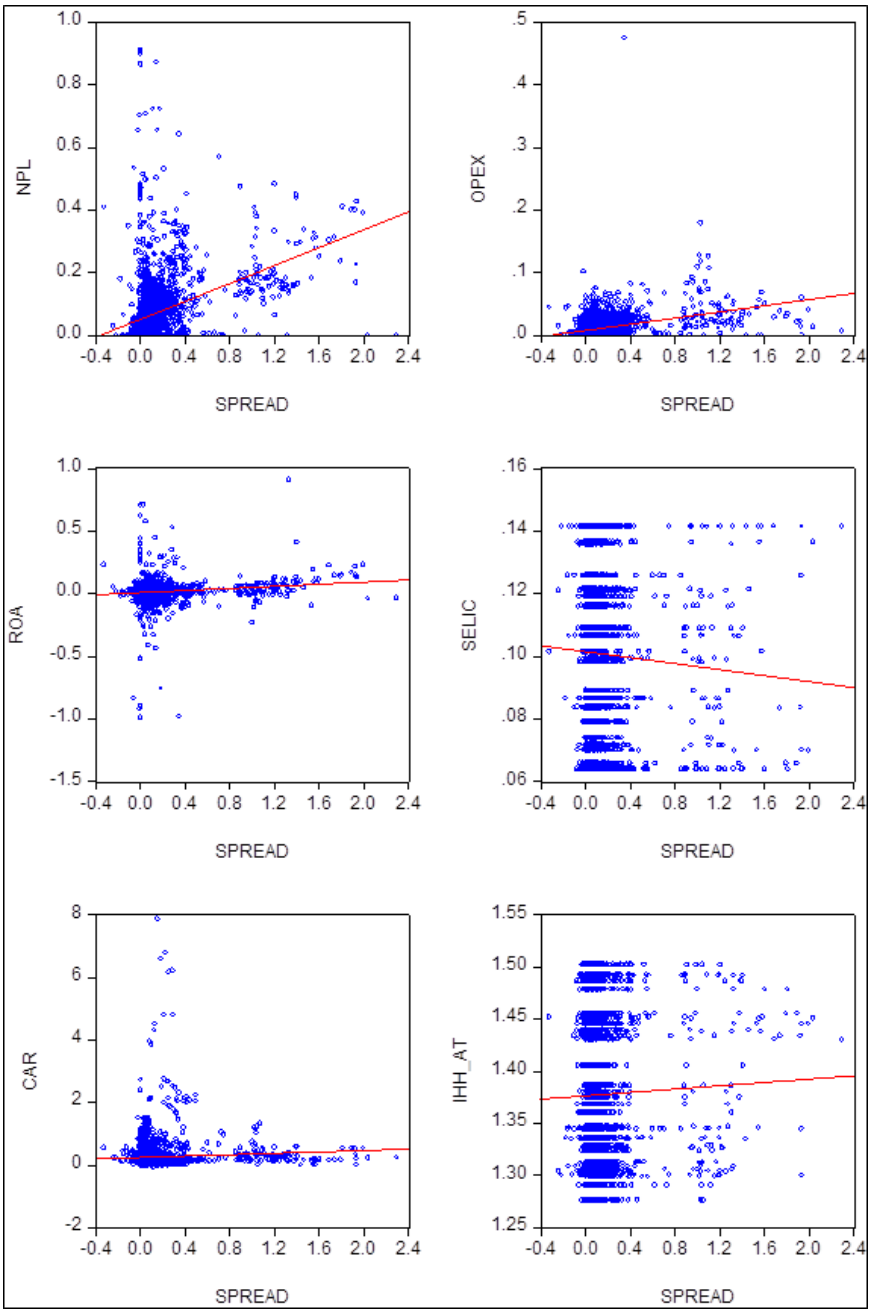

Table 2 - Correlation Matrix

	SPREAD	NPL	OPEX	ROA	SELIC	CAR	IHH_AT
SPREAD	1.0000						
NPL	0.3627	1.0000					
OPEX	0.3707	0.2298	1.0000				
ROA	0.1378	-0.1649	-0.1545	1.0000			
SELIC	-0.0414	0.0667	-0.0171	0.0194	1.0000		
CAR	0.0606	0.0430	0.1131	0.0622	-0.0040	1.0000	
IHH_AT	0.0273	0.0151	-0.1280	0.0275	-0.3428	-0.0489	1.0000

The empirical results are presented in models 1 to 4 (Table 3). Overidentification and autocorrelation tests passed on all models (see J-statistic, AR(1), and AR(2)). All estimates are statistically significant.

Firstly, NPL indicative of Credit Risk, presents estimate results in positive correlation to SPREAD, which is aligned to theoretical intuition and literature as noted in De Moraes et al. (2018). It is possible to observe not only this, but other efficiency metrics present comparable weight in the model. This result indicates in the direction of the sensitiveness of bank efficiency other than the Credit Risk alone as relevant factors to explain spread in Brazil. Moreover, empirical findings as per Tabak et al. (2010), suggests bank efficiency explains NPL, not otherwise.

Furthermore, OPEX estimate results present positive correlation to SPREAD according to literature as pointed out by Nakane (2001). Staub et al. (2010) supports that Brazilian banks present low levels of cost efficiency when compared to banks in Europe and United States. In the proposed model, OPEX is used as a proxy for Operational Efficiency as per Čihák et al., (2012). It is important to highlight, this metric is presented in ratio to Total Assets in order to reflect the size and structure of respective financial institutions. In this sense, this research present empirical results, which corroborates to the hypothesis that Operational Efficiency of banks is relevant to explain spread in Brazil.

Subsequently, ROA estimate results indicate positive correlation to SPREAD, as banks are encouraged to increase credit spread in order to obtain higher returns as observed in literature (de Moraes et al., 2018; Pires Tiberto et al., 2020). On SPREAD, it is relevant to highlight the intuition on SPREAD and lagged SPREAD. On one hand, it is possible to regard the SPREAD as a proxy of financial intermediation price operated by banks, so it is expected that all direct and indirect costs are already accounted in that price, resulting at the end on the return of the business at the bottom line. On the other hand, SPREAD may also be regarded as a proxy of intermediation efficiency as per Čihák et al. (2012). In this sense, the dynamic model allows the representation of both aspects through the use of SPREAD and lagged SPREAD variables, respectively.

Therefore, the results presenting lagged SPREAD statistically significant and relevant in the model in addition to all other variables may suggest the presence of some level of Intermediation Efficiency costs of banks in Brazil. This interpretation of the results is aligned to the concept of spread and credit risk impacting financial intermediation activity as a financial friction as pointed out by Ordoñez, (2013). Another possible interpretation is these results of lagged SPREAD might reflect an inertial factor, suggesting some level of persistence of credit

spread in Brazil due to historical series of high and volatile inflation and policy interest rates. This indication has some level of support on the forward-looking and risk aversion behavior of banks impacting credit risk as discussed by Jappelli & Pagano (2000) and Kwark (2002).

Finally, on a macroeconomic standpoint, SELIC estimates present positive correlation to SPREAD according to literature (de Moraes et al., 2018). These results indicate monetary policy interest rate directly impact credit spread. Hence, on one hand, a restrictive monetary policy increasing SELIC increases credit spread. On the other hand, an expansionist monetary policy, decreasing SELIC tends to reflect in a decrease in credit spread. In addition, the forward looking, and risk aversion behavior of banks as discussed by Jappelli & Pagano (2000) and Kwark (2002), tends to anticipate an increase, and postpone a decrease, reflecting banks expectations of deterioration on macroeconomic environment. In this context, the empirical results and literature support the hypothesis of persistence in credit spread in Brazil. On a banking industry standpoint, CAR present positive while IHH_AT negative estimates in relation to SPREAD. The direct relation concerning CAR and SPREAD indicates a possible trade-off between financial stability (safety and soundness) and financial intermediation efficiency measured by SPREAD. The more the capital required by regulator, impacting bank capital, the more the interest rates charged by banks on credit, therefore increasing credit spread in a compensatory measure. IHH_AT results are not aligned to economic intuition as expectation is that a more concentrated industry has market power to operate higher prices than a less concentrated one (Bikker & Haaf, 2002). However, this result suggests the asset concentration in Brazilian banking industry does not reflect necessarily on higher credit spread, but possibly the opposite as banks presenting more assets would be more capable to diversify their portfolio in order to reduce their risk exposure and consequently their credit spread. Thus, this also corroborates to the hypothesis of bank efficiency impact on credit spread in Brazil, since empirical results present positive and relevant impact of business management over industry concentration aspects on credit spread.

In summary, the results of this empirical study suggest that, in a context of historically high and volatile interest rate and credit spread as in Brazil, all the variables statistically significant in addition to lagged SPREAD, may indicate some level of persistence of credit spread while banks are able to pass on through it the credit risk, intermediation and operational inefficiency costs to society.

Table 3 - SPREAD Estimation – All Banks

Regressors	Model 1		Model 2		Model 3		Model 4	
SPREAD (-1)	0.183	***	0.158	***	0.153	***	0.144	***
	(0.000)		(0.000)		(0.000)		(0.000)	
NPL (-1)	0.427	***	0.244	***	0.328	***	0.353	***
	(0.001)		(0.001)		(0.001)		(0.001)	
OPEX (-1)	0.003	***	0.054	***	0.144	***	0.193	***
	(0.001)		(0.001)		(0.001)		(0.002)	
ROA (-1)	0.150	***	0.232	***	0.255	***	0.251	***
	(0.001)		(0.000)		(0.001)		(0.000)	
SELIC (-1)			0.667	***	0.272	***	0.241	***
			(0.003)		(0.003)		(0.004)	
CAR (-1)					0.239	***	0.178	***
					(0.001)		(0.000)	
IHH_AT (-1)							-0.185	***
							(0.001)	
Obs.	2,670		2,763		2,482		2,482	
N. Banks	94		94		93		93	
N Instr. /N Cross Sec.	1.00		1.00		1.00		1.00	
J-statistic	90.54		91.22		89.80		90.49	
p-value	0.46		0.41		0.40		0.35	
AR(1)	-2.79		-2.80		-2.48		-2.47	
p-value	0.01		0.01		0.01		0.01	
AR(2)	1.28		1.32		1.02		1.04	
p-value	0.20		0.19		0.31		0.30	

Note: Levels of significance (***) denotes 0.01, (**) denotes 0.05, and (*) denotes 0.1. Standard errors between parentheses. N.Inst / N. Cross sec. should be at most equal to 1 in each regression, in order to avoid excessive use of instruments. The J-test indicates that the models are correctly identified. The autocorrelation tests AR (1) and AR (2) reject the hypothesis of the presence of autocorrelation.

Subsequently, an additional exercise is run with the objective to test the sensibility of specific bank types, through their interaction to SPREAD, in order to assess whether they

operate differently, absorbing or passing on their business inefficiency costs on credit spread. In order to achieve this, Dummy Variables are used to portion the sample in relevant groups as follows: *TOP5* representing the Top 5 banks in Brazil, *C_TOP5* reflecting the entire list of banks in the sample excluding the Top 5 and *STATE*, which refers to the state-owned banks in the sample. The Top 5 banks are identified in terms of Total Assets, nonetheless in Brazil they also represent the Top 5 in other metrics such as Credit Portfolio and Number of Clients. *STATE* represents the state-owned banks, which controlling interest is held by government irrespective of level of federal entity. A complete list of financial institutions and the ones composing the referred subsets may be found in Section 7 Appendix (Table A.1).

The empirical results are presented in models 1 to 3 (Table 4). Overidentification and autocorrelation tests passed on all models (see J-statistic, AR(1), and AR(2)). All estimates are statistically significant.

The main observation it is possible to highlight from the results of this exercise in addition to the ones already discussed relies on the interactions estimates. Model 1 reflecting the Top 5 banks presents positive relation, while Model 2 and 3 referring to Non-Top 5 and State-owned banks respectively present negative relation to SPREAD. Additionally, absolute value of Model 1 and 2 interaction estimates are significantly higher than Model 3 and lagged SPREAD estimate for all banks. The results suggest these specific bank groups operate differently in relation to credit spread. On one hand, regarding State-owned and Non-Top 5 banks, the negative sign on estimate interaction to Lagged SPREAD indicates absorption of spread persistence, which may suggest a relevant role of these banks on the reduction of credit spreads operated on the market. Concerning the State-owned banks, it possible to understand this as they are usually subject of some level of government management in order to lead credit facilities and promote social programs. Relating to the Non-Top 5, the interpretation is that smaller banks tend to be forced to decrease the credit spread operated in order to compete in the market, absorbing their business inefficiency costs. On the other hand, the empirical results suggest Top 5 banks is the relevant group which is able pass on to credit spread any business inefficiencies they may present as macroeconomic and industry environment allows it, and eventually pressuring the persistence of credit spread in Brazil.

Table 4 - SPREAD Estimation - Interactions

Regressors	Model 1		Model 2		Model 3	
SPREAD (-1)	0.132	***	13.770	***	0.156	***
	(0.000)		(1.526)		(0.000)	
NPL (-1)	0.330	***	0.330	***	0.475	***
	(0.001)		(0.001)		(0.002)	
OPEX (-1)	0.083	***	0.083	***	0.278	***
	(0.002)		(0.002)		(0.002)	
ROA (-1)	0.272	***	0.272	***	0.256	***
	(0.000)		(0.000)		(0.001)	
SELIC (-1)	0.432	***	0.432	***	0.080	***
	(0.006)		(0.006)		(0.004)	
CAR (-1)	0.111	***	0.111	***	0.194	***
	(0.001)		(0.001)		(0.001)	
IHH_AT (-1)	-0.113	***	-0.113	***	-0.257	***
	(0.001)		(0.001)		(0.002)	
SPREAD(-1)*TOP5	13.639	***				
	(1.526)					
SPREAD(-1)*C_TOP5			-13.639	***		
			(1.526)			
SPREAD(-1)*STATE					-5.430	***
					(0.237)	
Obs.	2,482		2,482		2,482	
N. Banks	93		93		93	
N Instr. /N Cross Sec.	1.00		1.00		1.00	
J-statistic	90.54		90.54		87.38	
p-value	0.32		0.32		0.41	
AR(1)	-2.93		-2.93		-2.82	
p-value	0.00		0.00		0.00	
AR(2)	1.18		1.18		1.14	
p-value	0.24		0.24		0.25	

Note: Levels of significance (***) denotes 0.01, (**) denotes 0.05, and (*) denotes 0.1. Standard errors between parentheses. N.Inst / N. Cross sec. should be at most equal to 1 in each regression, in order to avoid excessive use of instruments. The J-test indicates that the models are correctly identified. The autocorrelation tests AR (1) and AR (2) reject the hypothesis of the presence of autocorrelation.

5. ROBUSTNESS ANALYSIS

Considering the fact that Credit Spread is a factor of banks profitability, the same methodology applied in the previous section is used for robustness analysis, though swapping SPREAD and ROA in the baseline model 1 and variation models 2 to 4 (Table 5). For this exercise ROA is the only lagged variable to reflect the dynamic model but not the others, due to the nature of ROA as a residual return after all factors, different from SPREAD which reflects the gross profit margin of banks in financial intermediation activity.

The empirical results are presented in models 1 to 4 (Table 5). Overidentification and autocorrelation tests passed on all models (see J-statistic, AR(1), and AR(2)). All estimates are statistically significant.

According to economic intuition and literature discussed, it is expected that SPREAD and SELIC to be positively related whereas OPEX and NPL negatively related to ROA.

The estimates present only OPEX negatively related to ROA and all the remainder ones are positively related. This negative sign of OPEX is a relevant point to be highlighted, as it denotes that inefficient banks negatively affect the profitability of the business, which corroborates to the relevance of this variable as a proxy of Operational Efficiency.

Additionally, NPL estimate is positively correlated to ROA in opposite to economic intuition in case NPL is approached as a proxy of realized losses. Although, approaching NPL as a proxy for risk, this may reflect a risk premium in a positive risk-return relation. This second interpretation corroborates to the results found on the main model (Table 3). Moreover, recent findings by Tabak et al. (2010) reject the hypothesis that credit risk would be exogenous factor impacting bank efficiency, which related costs would be absorbed by banks. In opposite, according to the author, the causality test suggests that bank efficiency explains NPL, not otherwise.

Therefore, this robustness analysis, regarding ROA, additionally conveys empirical evidence on the importance of Operational Efficiency impact on Credit Spread representing financial intermediation cost as one of the main contributions of the present study.

In summary, the results corroborate to the hypothesis that bank efficiency is relevant to explain credit spread in Brazil and suggests that high levels of spread is likely to reinforce its persistence as the industry would be able to pass on credit risk, intermediation and operational inefficiency costs to society while preserving business profitability.

Table 5 - ROA Estimation – All Banks

Regressors	Model 1		Model 2		Model 3		Model 4	
ROA (-1)	0.008	***	0.034	***	0.043	***	0.075	***
	(0.000)		(0.006)		(0.008)		(0.010)	
NPL	0.067	***	0.267	***	0.225	***	0.271	***
	(0.000)		(0.028)		(0.047)		(0.056)	
OPEX	-1.427	***	-0.71	***	-0.67	***	-0.885	***
	(0.001)		(0.195)		(0.213)		(0.271)	
SPREAD	0.117	***	0.21	***	0.179	***	0.223	***
	(0.000)		(0.015)		(0.014)		(0.019)	
SELIC			0.153	***	0.134	***	0.225	***
			(0.042)		(0.049)		(0.055)	
CAR					0.27	***	0.311	***
					(0.015)		(0.028)	
IHH_AT							0.363	***
							(0.057)	
Obs.	2,955		2,955		2,952		2,952	
N. Banks	96		96		96		96	
N Instr. /N Cross Sec.	1.00		0.41		0.41		0.41	
J-statistic	92.88		42.23		39.79		41.16	
p-value	0.45		0.16		0.19		0.13	
AR(1)	-3.45		-3.35		-3.41		-3.42	
p-value	0.00		0.00		0.00		0.00	
AR(2)	0.54		0.39		0.21		0.12	
p-value	0.59		0.70		0.84		0.91	

Note: Levels of significance (***) denotes 0.01, (**) denotes 0.05, and (*) denotes 0.1. Standard errors between parentheses. N.Inst / N. Cross sec. should be at most equal to 1 in each regression, in order to avoid excessive use of instruments. The J-test indicates that the models are correctly identified. The autocorrelation tests AR (1) and AR (2) reject the hypothesis of the presence of autocorrelation.

6. CONCLUSION

The present research empirically analyzes the impact of bank efficiency on financial intermediation in Brazil. It applies a dynamic econometric model to panel data from Brazil Central Bank, covering 2009 to 2019 and 96 banks in Brazil. Bank efficiency is approached as a composition of operational efficiency, intermediation efficiency and profitability.

The results of the study confirm the hypothesis, conveying that efficiency of banks impact credit spread representing financial intermediation cost in Brazil. Moreover, the proposed dynamic model indicates the possibility of spread persistence in Brazil. It is relevant to highlight that the use of the dynamic model, in which the lagged dependent variable is used as an explanatory variable, allows to analyze additional impacts of bank efficiency, as credit spread represents the final cost of financial intermediation. In this sense, all bank efficiency variables statistically significant when controlled by lagged spread, suggest banks in Brazil present significant level of inefficiency costs which are incorporated to credit spread. More specifically, the empirical exercise conducted on relevant bank groups suggested Top 5 banks is the main one passing on their inefficiency costs to spread and pressuring its persistence, while Non-Top 5 and State-owned ones tend to absorb theirs. In summary, the results suggest that Brazilian banks at industry level are able to pass on their costs to society in terms of operational and intermediation inefficiencies through credit spread.

This study is relevant due to its alternative approach and findings. First, the empirical econometric approach using a dynamic model and second, the indication that bank efficiency and a possible persistence factor may contribute to explain the high level of interest rate spread in Brazil. To industry and policymakers, it may be useful as an indication to rethink the operational and regulatory environment aiming for industry efficiency. In general, it is beneficial in contribution to the literature and the discussion of this significant issue in Brazilian economy, especially in a context of historical low policy interest rates and credit spread worldwide.

7. APPENDIX

Table A.1 - List of Financial Institutions

ABC-BRASIL	BCO YAMAHA MOTOR SA
AGIBANK	BCOOB
ALFA	BMG
BANESTES**	BNP PARIBAS
BANRISUL**	BOFA MERRILL LYNCH
BARIGUI	BONSUCESSO
BB***	BPN BRASIL BM SA
BBM	BR PARTNERS
BCO AJ RENNER SA	BRADESCO*
BCO AZTECA DO BRASIL SA	CAIXA ECONOMICA FEDERAL***
BCO BVA SA	CITIBANK
BCO CAPITAL SA	COMMERZBANK BRASIL
BCO CARGILL SA	CONCÓRDIA
BCO CATERPILLAR SA	CREDIBEL
BCO CBSS	CREDIT SUISSE
BCO CEDULA SA	CREFISA
BCO CNH INDUSTRIAL CAPITAL SA	DEUTSCHE
BCO CSF SA	FATOR
BCO DA AMAZONIA SA**	HAITONG
BCO DAYCOVAL SA	HONDA
BCO DE LAGE LANDEN BRASIL SA	HSBC
BCO DO NORDESTE DO BRASIL SA**	ICBC DO BRASIL BM SA
BCO FIBRA SA	INDUSTRIAL DO BRASIL
BCO FIDIS	INTER
BCO FORD SA	INTERCAP
BCO GMAC SA	ITAU*
BCO GUANABARA SA	JOHN DEERE
BCO IBM SA	MÁXIMA
BCO INDUSCRED DE INVESTIM SA	MERCANTIL DO BRASIL
BCO KEB HANA DO BRASIL SA	MERCEDES-BENZ
BCO KOMATSU DO BRASIL	MORGAN STANLEY
BCO LA NACION ARGENTINA	OMNI
BCO LUSO BRASILEIRO SA	ORIGINAL
BCO MAXINVEST SA	OURINVEST
BCO MODAL SA	PAN
BCO MONEO SA	PARANÁ BCO
BCO PORTO REAL DE INVESTSA	PINE
BCO RABOBANK INTL BRASIL SA	PLURAL
BCO RANDON SA	PSA FINANCE
BCO REP ORIENTAL URUGUAY BCE	RENDIMENTO
BCO RIBEIRAO PRETO SA	SAFRA
BCO RODOBENS SA	SANTANDER*
BCO SEMEAR	SCANIA BCO SA
BCO SUMITOMO MITSUI BRASIL SA	SICREDI
BCO TRIANGULO SA	SOCOPA
BCO VOLKSWAGEN SA	SOFISA
BCO VOLVO BRASIL SA	STANDARD CHARTERED BI SA
BCO WOORI BANK DO BRASIL SA	VOTORANTIM

Note: (*) Top 5 Banks; (**) State-owned Banks and (***) State-owned and Top 5 Banks.

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