Journal of Business and Economics, ISSN 2155-7950, USA
August 2024, Volume 15, No. 8, pp. 430-456
DOI: 10.15341/jbe(2155-7950)/08.15.2024/003

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Risk and Capital Management in the Largest Brazilian Banks and the Strategic Component of the Provision for Credit Risk

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Abstract: The present work seeks to analyze the structures and processes of risk and capital management, and the behavior of the main related indicators of the largest financial institutions in Brazil, aiming to evaluate the effectiveness of management and the resilience of such indicators in the face of adverse scenarios such as the of Covid-19. The methodology adopted was documentary research with standardized techniques for collecting data from public sources from 2015 to 2022. The main risks incurred were analyzed, directly related to banking activity, such as credit, market, and liquidity risk. and operational, in addition to assessing the macroeconomic scenario, internal and external, and the risk environment. Furthermore, and aiming to estimate the possible effects of the COVID-19 and post-Covid period on the capital composition of banks, a linear regression is estimated with quarterly frequency panel data covering the period from the first quarter of 2010 to the first quarter of 2023. The results indicate that the largest Brazilian banks are adequately prepared to withstand scenarios of greater adversity in managing their risks, with their indicators proving resilient even in a stressed scenario with greater volatility. The pandemic period did not have significant effects on banks' capital indicators. These findings are useful for professionals in the banking market, risk managers, agents who work with financial market regulation, and the general population whose well-being depends on the economy's stability.

Key words: banking risks, risk management, macroeconomic, economic stability, coronavirus pandemic

JEL codes: G21, G24, G28, G32

1. Introduction

Over the years, faced with the need to preserve a stable financial system and avoid systemic crises, the Central Bank of Brazil (BACEN) has been publishing a series of regulations that require the improvement of the financial industry in terms of its processes and risk management. These actions seek to increase the economy's ability to absorb adverse impacts to reduce the possibility of a local crisis taking on global proportions (BACEN,

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2017).

Part of this regulatory framework is in Resolution of the National Monetary Council (CMN) No. 4,557/2017, which recommends the implementation of continuous and integrated risk and capital management structures and guides financial institutions regarding the need for integrated risk management, in addition It is important to highlight the importance of identifying, measuring, evaluating, monitoring, reporting, controlling and mitigating risks inherent to the banking business, both in normal and stressed scenarios.

The concept of risk has several interpretations, with subtle differences between the widespread meanings, but always converging on possible impacts, positive or negative, on the results or objectives of an organization. Risk can be conceptualized as the effect of uncertainty on objectives (ISO, 2018) and, due to the uncertain results it can cause in an organization, it must be managed appropriately to improve a company's ability to generate value continually (COSO, 2007).

The authors Padoveze and Bertolucci (2008) define risk as the probability of the achieved result being different from the expected result, and there must be a sustainable, continuous, and perennial risk management process to create value for a company. For the financial sector, according to Crouhy et al. (2001), the identification and control of risks must be supported by policies, processes, knowledge, and structures suitable for their effective management, which tends to provide more solid economic management and consistent results.

In scenarios of great volatility and uncertainty, such as that experienced in 2020 due to the new coronavirus (COVID-19) pandemic, adequate risk management becomes even more relevant for consistent results in the banking sector. In 2020, the economic and social impacts were on a global scale, with a slowdown in the economy, disruption to global supply chains, a fall in stock markets, and the cancellation of events that affected numerous sectors of the economy and caused the biggest economic downturn since the Great Depression. Depression (IMF, 2020).

In Brazil, the effects were severe both for the economy, which recorded a 4.1% drop in the Gross Domestic Product (GDP) in 2020, and for families and companies that had their income reduced in an abrupt and unforeseen manner, particularly affecting the low-income population and small and medium-sized companies without sufficient cash flow to cover fixed expenses during the period of inactivity (IBGE, 2021). The situation in the country was even more aggravated due to 58% of Brazilians not having any financial investment to cover expenses in times of crisis, according to a study carried out by the Brazilian Association of Financial and Capital Market Entities (ANBIMA, 2018).

Furthermore, small and medium-sized companies may have been more affected by measures to contain the new coronavirus because they work with very restricted cash flow that is insufficient to support unexpected drops in revenue for long periods. In this context, contingency measures such as emergency aid, job maintenance programs, and subsidized credits for small businesses were used by public authorities as a way of mitigating the effects of the crisis, even though these may be palliative actions with short-term effects (BACEN, 2020).

Therefore, the present work seeks to analyze the risk management structures and processes and the behavior of the main related indicators in the largest financial institutions in Brazil, aiming to evaluate the effectiveness of management and the resilience of such indicators in the face of adverse scenarios such as the one experienced. in 2020. There are several risks in the banking sector and they can vary depending on the particularities of each institution's business strategies (Dermine, 2009). However, for this sector, the main and most common sources of risk are credit, market, liquidity, and operational.

Thus, the behavior of the Provision for Doubtful Credits (PCLD) indicator for credit risk, the behavior of

price fluctuations in the banking business for market risk, short- and long-term liquidity indicators for liquidity risk, and the structures and processes implemented to manage operational risk sent by financial institutions to the Central Bank of Brazil from 2015 to 2022.

Additionally, linear regression with panel data is estimated seeking to identify possible effects of the Covid-19 and post-Covid periods on banks' capital indicators based on quarterly data covering the period from the first quarter of 2010 to the first quarter of 2023 It is important to highlight that it is outside the scope of this work to compare the severity of the pandemic in the low-income population and small companies — more vulnerable — compared to the impacts on the risk indicators of large banks — less vulnerable.

The results indicate that financial institutions can face scenarios of greater adversity in terms of managing their risks, with their indicators proving resilient even in a stressed scenario with greater volatility. This evidence contributes to the discussion about the systemic risk of the Brazilian economy and can be useful for investors, professionals working in the banking market, risk managers, and financial sector regulators.

In addition to this introduction, the work has four more sections. Section two provides a brief theoretical reference about risk management in financial institutions, section three explains the methodology and data characteristics, section four presents the results found and discusses them, and, finally, section five concludes.

2. Risk Management in Financial Institutions

Risk management, in general, is a process conducted in an organization by the board of directors, management, employees, and managers, being applied to the establishment of strategies and formulated to identify, throughout the organization, potential events capable of affecting it. Risks must be managed to keep them compatible with the organization's risk profile. Identifying, measuring, evaluating, monitoring, reporting, controlling, and mitigating the risks associated with the processes, routines, and activities performed are risk management steps of great relevance for the sustainability of results.

Increasing competitiveness requires financial institutions to have adequate exposure to risk with the desired results, something important to provide security to investors and support the decision-making process, making risk management an effective measure for achieving established goals and long-term sustainability. term. And, in this sense, risk management aims to mitigate or extinguish the negative risks that are identified, maximizing results and strengthening the company’s processes (COSO, 2007).

Risk management is iterative and aims to assist organizations in formulating their strategies, achieving objectives, and making decisions, integrating the companies’ governance structure (ISO, 2018). It is a fundamental part of an organization’s strategic planning, and there must be continuous, structured, particular, and comprehensive processes, with the involvement of senior management, employees at all levels, and other interested parties (Fraporti, 2018).

Analyzing the probability versus impact of a given event is essential for institutions to define and organize their risk management and treatment methods, aiming to focus efforts and resources on managing risks that may have the greatest impact on business objectives. According to Machado, Oliveira, and Leite (2021), risk management must be aligned with strategic objectives, as it contributes to the generation of value and sustainability of a financial institution, benefiting shareholders, employees, and society as a whole.

Likewise, for Padoveze and Bertolucci (2008), the risk management process is strategic and should be considered a management instrument aligned with the organization's strategic planning, focusing on sustainability

and generating value for shareholders. A company's strategy stems from its corporate objectives, which, in turn, stem from the goals set and the risk profile defined. If the correct adoption of strategies can define the future of a company, effective risk management means the possibility of having a future.

According to Lima (2018), risk analysis can be defined as the process of diagnosing, calculating, and analyzing exposures and inherent risks, which enables the generation of controls and inputs for decision-making, being a response to uncertainties and instabilities. Each organization has a risk profile, which can be used from different perspectives. Risk can be seen as an opportunity - when it is related to the concept of risk and return, it can be seen as a danger — when it is related to potentially negative events or financial losses, and it can also be seen as uncertainty — the results of an event are unpredictable, which can be negative or positive (Padovese and Bertolucci, 2008).

Carvalho (2020) explains that identifying risks appropriately allows for effective monitoring, implementation of mitigating actions, and greater predictability for business, and the consequences of a wrong choice in the decisions made must be analyzed. In a competitive environment, such as the banking market, new technologies, and innovative solutions tend to increase the risk of financial institutions, requiring the constant search for a balance between innovative practices and aggregate risk.

Risks must be measured in an integrated way, as there may be — in many cases — correlations between them. It is worth highlighting that integrated management presupposes not only the management of own risks but also the management of third-party risks, to prevent possible impacts on the business caused by failures or deficiencies in the services provided by relevant partners (Trapp, 2004). Integrated risk management allows financial institutions to rationalize the approach, measurement, and control of risks, providing a broad view of the risks incurred and the possible impacts that may occur on business profitability (Crouhy et al., 2001).

Another relevant point of risk management is transparency about the risks incurred not only to the regulator but also to internal employees and external partners as a form of collaborative management. This will allow everyone to understand the risks assumed, sizing them and adapting them to the institution’s business profile (Peleias & Macedo Da Silva, 2007).

According to Padoveze and Bertolucci (2008), the identification of risks is an important step in their management, in which for each identified risk an analysis must be carried out on the potential impact and probability of occurrence so that mitigating actions can be developed that enable the preservation of planned developments. For financial institutions, as they operate in an unstable and highly volatile environment, risk management is essential and extremely relevant, acting as an effective instrument to sustain and achieve projected results (Santos, 2006).

For Lemgruber et al. (2001), risk is present in any financial market operation and the implementation of a risk management process must be a decision that involves senior management and is present in the daily routine of the financial institution, to establish control employees that guarantee the financial health of the company. Another relevant factor is the transparency of the process and the use of effective methodologies for continuous risk monitoring. To achieve efficient risk management, it is necessary to invest in technology, equipment, and qualified personnel that will provide a safe financial institution that is aware of its strengths and weaknesses regarding the risk and return of its investments (Lembruber et al., 2001).

It can also be highlighted that risk is a fundamental element that directly influences financial behavior and, therefore, decisions must always be made considering its aspects. Due to their relevance — increasingly — risk measurement, analysis, and control actions require sophisticated mathematical and computational tools, with

recurring applications of probability theories, estimation, optimization, and technology for data in methodologies developed for risk management (Crouhy et al., 2001; Lima, 2018).

The risk management process requires an adequate structure and involves the systematic application of policies, procedures, controls, treatment, and monitoring defined by an organization, with personalized application, at the strategic and operational levels (ISO, 2018). Lima (2018) also highlights that banks are exposed to different types of risks when considering the variety of products and services offered to their customers and, despite numerous risks that they incur in banking activities and the business particularities of financial institutions, this work considers only the main and most common risks in the sector, such as credit, market, liquidity, and operational risk.

Despite subtle differences in the concepts presented, all authors are unanimous in highlighting the importance of having effective risk management to achieve organizational objectives and that risk management must be integrated with the decisions taken in an organization. Another point to highlight is that risk management should not be characterized as an impediment to doing business and, rather, should be understood as one of the main instruments for carrying out profitable and sustainable business.

3. Methodology

3.1 Data

The Central Bank of Brazil, through CMN Resolution No. 4,553/2017, establishes criteria for segmenting financial institutions into five distinct segments: Segment 1 (S1), Segment 2 (S2), Segment 3 (S3), Segment 4 (S4) and Segment 5 (S5). Brazilian banks, in segments 1 (S1), 2 (S2), 3 (S3), and 4 (S4), due to regulation — BACEN Circular No. 3,930/2019 — must make public, through a report called “Report of Pillar 3”, detailed information on structure, processes, exposures and risk management indicators for normal scenarios and stressed situations.

Thus, the data used is information about the credit, market, liquidity, and operational risks of the six Brazilian financial institutions classified in Segment 1 (S1) — which concentrates on the largest national banks — and has a quarterly frequency for the period that covers 2015 to 2022. In addition, regulatory standards issued by the Central Bank of Brazil and information on macroeconomic indicators obtained from the Brazilian Institute of Geography and Statistics are considered. Table 1 presents the financial institutions considered.

Table 1 Segment 1 (S1) Financial Institutions

	Financial Institution	Total Exposure (R$ thousand)	Assets Abroad (R$ thousand)
1	Banco Itaú S.A.	2,321,527,610	153,157,379
2	Banco do Brasil S.A.	2,066,761,608	41,602,143
3	Caixa Econômica Federal	1,640,498,358	-
4	Bradesco S.A.	1,639,736,361	20,029,137
5	Santander do Brasil S.A.	1,065,742,018	43,914,068
6	BTG Pactual	522,688,943	19,402,949

The importance of Segment 1 banks can be illustrated in the figure below. It presents the comparison between the risk-weighted assets (RWA) for banks in this segment versus the RWA for all banks of the consolidated banking type in category b1. This category corresponds to commercial banks, multiple banks with a commercial portfolio, and savings banks. It can be seen in the graph that banks in the S1 segment represent a significant portion of the RWA of banks in category b1. In fact, in the fourth quarter of 2022, the RWA of the six

largest banks represented 79% of the RWA of banks in the b1 category.

Risk-weighted assets (RWAs) are a critical concept in banking regulation and risk management. They provide a measure of a bank's assets adjusted for their associated risks, forming the basis for determining minimum capital requirements for banks. Each asset on a bank's balance sheet is assigned a risk weight based on its inherent risk and the probability of loss associated with it. For example, cash or government bonds may have a risk weight of zero or close to zero, reflecting their low risk, while loans may have higher risk weights due to their higher probability of default. Figure 1 presents the trajectory of risk-weighted assets.

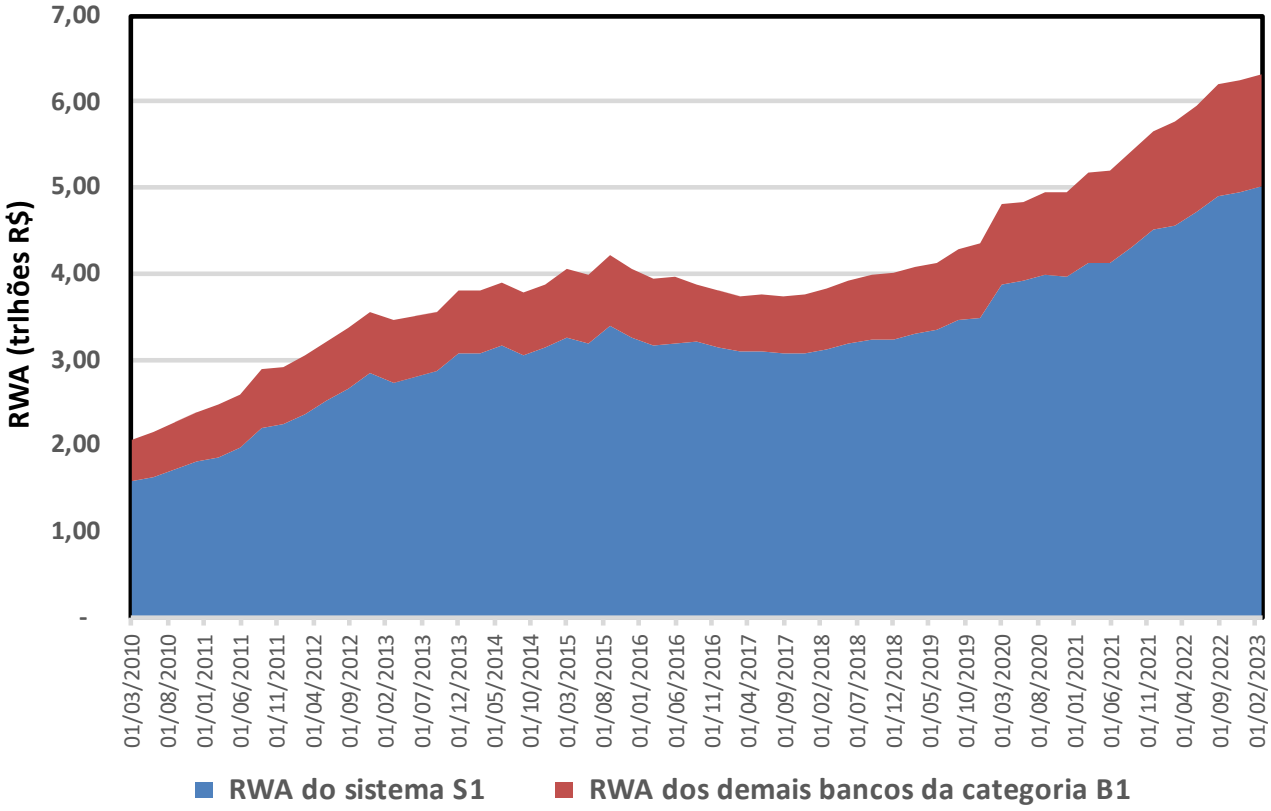

Figure 1 RWA of Brazilian Banks

Calculating RWAs involves assigning a risk weight to each asset class based on regulatory guidelines, and then summing the products of these risk weights and asset values. Regulatory frameworks such as Basel III set minimum capital requirements for banks based on their RWAs. Common metrics include the ratio of core capital to total RWA, the ratio of tier 1 capital to total RWA, and the ratio of reference equity to RWA. In doing so, regulatory standards ensure that banks maintain capital commensurate with their risk profiles.

Risk weights account for several types of risk, including credit risk, market risk, and operational risk. Credit risk weights, for example, can be determined based on the credit strength of borrowers, while market risk weights can be influenced by asset price volatility. The calculation of RWAs also considers credit risk mitigation techniques, such as collateralization, which can reduce the risk associated with certain assets and, consequently, lower RWAs.

By adjusting assets for risk, RWAs encourage banks to diversify their asset portfolios to minimize risk. A diversified portfolio with a mix of low- and high-risk assets can help reduce the overall risk profile and,

consequently, the amount of capital the bank needs to hold.

3.2 Ordinary Least Squares

The econometric method with panel data regression (Wooldridge, 2010, 2012) is used. The database comprises the first quarter of 2010 to the first quarter of 2023, totaling 53 observations per financial institution and a total of 318 observations, in order to analyze the influences of the Covid-19 period and the post-Covid period on the main capital indicators of financial institutions considered through the estimated equation:

$$y_{i,t} = \beta_i + \gamma C_t + \lambda P_t + \delta R_t + \epsilon_{i,t} \quad (1)$$

where $y_{i,t}$ are the capital indicators, and different regressions are estimated for each capital indicator contained in the dependent variable $y_{i,t}$. The term β_i corresponds to the idiosyncratic fixed effect of the financial institution i, and C_t corresponds to the level dummy variable for the period referring to the first quarter of 2020 to the first quarter of 2021.

The variable R_t corresponds to a dummy for the period before the publication of CMN Resolution No. 4,557, in February 2017, aiming to capture possible changes in the behavior of financial institutions due to the new regulation. The term ϵ_(i,t) corresponds to the panel regression residuals. The variance-covariance matrix of the coefficients was obtained using robust estimators for the possible presence of heteroskedasticity and serial autocorrelation.

Finally, the term P_t corresponds to a third dummy variable, aiming to capture potential effects of Covid-19, in the period after the incidence of the pandemic. This dummy is constructed with values 1 from the first quarter of 2022, and zero in previous periods, aiming to capture possible effects of the increase in losses with provisions for loan losses. The idiosyncratic effects β_i are obtained via fixed effects estimators, which allow there to be a correlation between these fixed effects and the residuals $\epsilon_{i,t}$. For further details, see Wooldridge (2010 and 2012).

4. Results

4.1 External Macroeconomic Scenario

In the macroeconomic scenario, the years 2020 and 2021 were quite volatile, due to the severe effects of the Covid-19 pandemic on economies worldwide. While the year 2020 was marked by a strong deterioration in the economic scenario, the post-pandemic year 2021 was characterized by a robust global economic recovery, reflecting the fiscal and monetary stimuli granted and the progress in the implementation of immunization programs against the virus. Covid-19 in the world's main economies (BACEN, 2021).

In the United States, a fiscal incentive package called the Consolidated Appropriations Act was approved in December 2020, with US$886 billion in additional stimulus, and, in March 2021, a new fiscal package called the American Recovery Plan Act was approved. US$1.862 trillion, to support the job market and accelerate the recovery of economic activity in the country (IMF, 2021).

With the same objectives, the European Council approved the Recovery and Resilience Facility, which foresees the release of €672 billion by 2026 and the United Kingdom approved the budget for 2021 foreseeing new programs in the order of £59 billion, with £43 billion for employment support, tax exemptions and discounts for companies and £15.7 billion to finance measures to encourage the resumption of growth (IMF, 2021).

The fiscal stimuli implemented throughout 2020 were important to mitigate the effects of the pandemic on consumption and employment, however, the expansion of fiscal spending and the drop in revenue led to an increase in public debt from 84% to 98% of the global aggregate output in 2020 (IMF, 2021). As presented in the

Inflation Report of the Central Bank of Brazil (2022), the year 2022 showed a decrease in the pace of recovery of the global economy, reflecting the new outbreaks of COVID-19 in China and the war in European territory, which put pressure on prices of the supply chain, bringing greater volatility and inflationary pressures.

The Central Banks of developed and emerging countries adopted — in general — contractionary policies, to mitigate the effects of inflationary pressure and reduce risk aversion (BACEN, 2022).

4.2 Domestic Macroeconomic Scenario

Regarding domestic economic activity, Brazilian GDP fell 3.3% in 2020, a drop well below what was projected in the market. This smaller drop in GDP is attributed to the various measures to mitigate the effects of the Covid crisis, including actions for the financial sector. For the year 2021, GDP growth was calculated at 4.6%, and later revised to 5% - by IBGE - denoting the scenario of the gradual recovery of the economy, even with the reduction in income recovery programs (BACEN, 2022).

For 2022, Brazilian GDP grew 2.9%, driven mainly by the service sectors (growth of 4.2%) and industry (growth of 1.6%), which reinforces the economic recovery environment. For 2023, GDP grew 1.0% in the first quarter and 0.9% in the second quarter of the year, according to data released by IBGE.

Concerning the level of domestic prices, inflation closed 2020 with an increase of 4.52%, the highest since 2016 (6.29%), according to the IPCA, released by IBGE. In 2021, the IPCA closed the year at 10.06%, the biggest increase since 2015, as a consequence of the impacts of COVID-19 on the global economy and the national economy, disorganizing production chains around the world.

There was a cooling of inflationary pressures in 2022, the year in which the IPCA closed at 5.78%, largely as a consequence of monetary policy, such as the Central Bank setting the SELIC at 13.75%. For the year 2023, in August the accumulated IPCA of the last twelve months was 4.61%. This improvement in price behavior led Bacen to reduce the SELIC rate at the COPOM meeting in September to the level of 12.75%.

4.3 Banking Sector Risk Environment

Inflationary pressure in Brazil, the consequent increase in the internal interest rate, and the external macroeconomic environment caused a decrease in the momentum of the economic recovery and a slowdown in credit, once again increasing uncertainties and risks for the banking sector in the short term. term. The combination of several factors, such as high inflation, rising interest rates, shortages of inputs, and lower government subsidies, should impact the quality of banks' credit portfolios throughout 2022.

Another consequence may be greater difficulty and increased cost in raising funds for small and medium-sized Financial Institutions, which operate leveraged on credit with extended terms and shorter funding, with consequent liquidity restrictions, increasing the risk in this more volatile and uncertain situation (Riskbank, 2022).

The banks’ history of conservatism in granting credit, investments in technology, efficiency gains with cost reduction, in addition to the recent reinforcement of prudential provisions to cover loans classified as higher risk, a movement observed especially among the largest banks from the 1st half of 2020, therefore, it appears that the large banks, in addition to being more diversified, are more liquid and capitalized, having more robustness to face this new cycle (Riskbank, 2022).

4.4 Banking Sector: Results and Challenges of Large Banks

Throughout 2020, the profitability of the banking sector was pressured, in particular, by the increase in

expenses with provisions and the decrease in revenue from services, reflecting the slower pace of the national economy. According to the Central Bank of Brazil (2021), the consolidated net profit of the banking sector showed a decline of 26% in 2020, when compared to the year 2019, and the return on equity accumulated over 12 (twelve) months, Return on Equity (ROE), was 11.5% on average, which is the lowest in the historical series measured by the system regulator.

Provisions set up to cover expected losses from credit operations increased by around R$30 billion between the months of February and December 2020, reflecting the sector's concern about the effects of the pandemic on the income of people and companies (BACEN, 2021). However, even amid the ongoing effect of the Covid-19 pandemic, the largest publicly traded Brazilian banks, BB, Bradesco, Itaú, and Santander, showed significant improvements in their results in 2021, with consolidated revenues 76.6% higher compared to the previous year (Economática®, 2022).

The consolidated net profit of the four large banks in 2021 was R$18.5 trillion, which is 35.2% higher than that observed in the previous year and, in the same sense, the total assets of financial institutions in the 4th quarter of 2021 presented a growth of 9.1% compared to the same period in 2020, which demonstrates the robustness of large national banks (Economática®, 2022).

However, despite positive and consistent results from the banking sector, increased competition and innovations in the National Financial System, such as Pix (Brazilian instant payment) and Open Banking, which allows customers to share their information between different financial institutions, bring challenges and opportunities for service revenues in the coming years, especially for large national banks.

The greater incentive for competition can affect incomes in the short term, on the other hand, it opens up new opportunities for attracting and retaining customers, opportunities for providing new services, and partnerships with fintechs (companies that introduce innovations in financial markets through the use intense technology) and payment and cost reduction institutions (BACEN, 2021).

In recent years, the growth in administrative expenses (general expenses, such as advertising expenses, third-party services, and installations), has followed the trend of variation in the Broad National Consumer Price Index (IPCA), which reflects the cost control by Financial Institutions.

In 2021, the result of cost reduction strategies was no different, expenses increased by 5% in the period, but there were significant effects of exchange rate variation on the expenses of branches and subsidiaries of Financial Institutions abroad, due to the devaluation of the national currency, the Real, against the main international currencies, the Dollar and the Euro (BACEN, 2022).

4.5 Structure and Processes for Risk Management

Regarding the structure for risk management, the 06 (six) banks that make up the sample, according to information extracted from the risk reports, have dedicated teams, resources, techniques, periodic reports, and methodologies developed for continuous risk management, describing how to act in normal and adverse situations, including testing the main risk indicators in stressed scenarios.

Another relevant point identified and which is common to the banks in the sample was the existence of exclusive bodies or committees for risk management, integrated into the internal governance structure of the institutions, which strengthens the management process and enables awareness and involvement of the Senior Management with the theme.

It is noteworthy that the continuous commitment of Senior Management to risk management, meaning,

generating purpose, leading, integrating, providing resources, and organizing, is fundamental for the engagement of all employees and interested parties, and for the alignment of risk management. risks with strategic planning, business objectives, and company culture (ISO, 2018).

As highlighted, risk management is an integral part of organizations' strategic planning and, therefore, maximum exposure to risks must reflect business objectives to obtain expected results and improve the ability to generate value. The value tends to be increased when seeking a balance between risk assumption and investment return, that is, aligning the risk profile with the strategy employed and establishing continuous controls and monitoring so that risk exposure is within levels defined as acceptable (COSO, 2007).

In the Brazilian banking sector, acceptable levels of risk must be documented and presented to the regulator in a document entitled Risk Appetite Declaration (RAS), presenting — at a minimum — the types of risks and the maximum levels supported by the financial institution, the ability to manage risks, strategic objectives and competitive conditions (BACEN, 2017).

The six banks in the sample have a document, which correlates the business strategy with the risk limits to be assumed by the institution in its main lines of business. This document, which is approved by the institution's Board of Directors, serves as a negotiating guide and denotes the maximum level of risk supported.

An important aspect of effective risk management, in terms of preventive action, is the existence of documented plans for business continuity in situations of crisis and/or adversity, with the identification of critical activities and the establishment of contingency routines to avoid their discontinuity and/or limit losses resulting from possible interruption. Contingency plans must be prepared following three (3) criteria: reliability, operational availability, and sustainability, with their quality and prompt response to crises being proportional to the time and effort used in their design (Assi, 2012).

These banks have a published document, containing the contingency plan for adverse situations, which seeks to ensure the continuity of the institutions' main business activities. Said document, according to published information and by current regulations, is approved by the institution's Board of Directors. Clearly defining roles and responsibilities in risk management, at all levels of organizations, is one of the premises for effective and efficient management. Risk management must permeate the entire structure and all employees, being a collective, personalized responsibility and preferably integrated into other activities and processes (ISO, 2018).

Risk management must be carried out by all members of an organization, from members of the Board of Directors and Executive Board, Internal Auditors, and other employees, each with their defined role and responsibilities within the company structure and, explicitly or implicitly in the position held (COSO, 2007).

In this context, a model commonly used by financial institutions, which emerged more than 20 years ago and which establishes roles and responsibilities within the organization, is the Lines of Defense model, which consists of engagement at all levels, from the operational management units, classified as the 1st Line of Defense, through the specialized risk and internal control units, classified as the 2nd Line of Defense and, finally, the internal audit units, defined, in this model, as 3rd Line units. Line of defense.

Each of the Lines of Defense must have appropriate procedures and policies for managing the risks of its processes and activities and/or other activities of the organization, in the case of 2nd Line and 3rd Line of Defense units. There must be coordination of the different lines, to guarantee efficiency and effectiveness in the adoption of the model (IAA, 2013).

According to information extracted from risk management reports, the six banks in the sample adopt the three) Lines of Defense model for the integrated management of their risks, with segregated and independent

action, to maximize efficiency and effectiveness in management. Table 2 summarizes the results of the research on the existence of instruments for managing the risks of banks classified in segment 1 (S1).

Table 2 Risk Management of Financial Institutions in Segment 1 (S1)

	Financial Institution	(a)	(b)	(c)	(d)	(e)	(f)
1	Itaú S.A.	X	X	X	X	X	X
2	Banco do Brasil S.A.	X	X	X	X	X	X
3	Caixa Econômica Federal	X	X	X	X	X	X
4	Bradesco S.A.	X	X	X	X	X	X
5	Santander do Brasil S.A.	X	X	X	X	X	X
6	BTG Pactual	X	X	X	X	X	X

Where:

a) Publication of Risk Management Policy and Report;

b) Existence of a dedicated structure for Risk Management;

c) Committees dedicated to Risk Management;

d) Existence of a Risk Appetite Declaration;

e) Existence of a Business Continuity Plan;

f) Adoption of the Lines of Defense model.

Considering Table 2, it is noticeable that Brazilian banks in Segment 1 (S1) have structures, processes, and instruments implemented and, in theory, adequate and personalized for managing their risks, both for normal and stressed scenarios.

4.6 Credit Risk

Credit risk is the possibility of losses associated with non-compliance by the borrower or counterparty with their respective financial obligations under agreed terms, the devaluation of a credit contract resulting from the deterioration in the borrower's risk classification, the reduction in earnings or remuneration, the advantages granted in the renegotiation and the recovery costs (CMN, 2017).

Credit operations granted must be classified according to their level of risk, between the first and third stages, which is assigned by the internal models of financial institutions, and must consider, among other aspects, the economic-financial situation and the degree of indebtedness customer, the guarantees offered, regarding sufficiency and liquidity and the value of the operation (CMN, 2021).

The Provision for Doubtful Debts or Provision for Doubtful Debts must be constituted and recalculated by banks every month, with a percentage of the value of the operation varying according to the level of risk, with the highest percentage being a provision for the worst level of risk, which can vary from 0.0% to 100.0% of the value of the operation, as provided for in Resolution of the National Monetary Council (CMN) No. 4,966/2021.

Commonly, in normal credit market scenarios, an increase in the volume of Provision for Doubtful Debts is related to the deterioration of the credit portfolio, which may have already been captured by credit risk systems or may be related to future perspectives of the portfolio, as the internal models of financial institutions use retrospective and prospective scenarios to measure the amount to be provisioned. It is worth noting that the increase in the volume of the credit portfolio also has the effect of increasing the Provision for Doubtful Debts balance, due to the direct relationship between the two.

However, in stressed scenarios, a direct correlation cannot always be observed between the movement of the

Provision for Doubtful Debts balance with the default rate of the credit portfolio, and there is a non-explicit strategic component to justify the increase or decrease in the PCLD balance of banks. Table 3 presents the institutions' Provision for Doubtful Debts.

Table 3 Provision for Doubtful Debts

	Financial Institution	2017	2018	2019	2020	2021	2022
1	Itaú S.A.	37,309	34,261	39,747	52,158	48,931	56,590
2	Banco do Brasil S.A.	36,686	34,351	39,800	45,170	47,270	50,697
3	Caixa Econômica Federal	37,502	36,990	35,032	34,570	38,815	46,428
4	Bradesco S.A.	36,527	35,084	36,796	45,339	45,236	57,741
5	Santander do Brasil S.A.	17,461	18,789	21,408	25,067	27,131	34,453
6	BTG Pactual	0,871	0,979	1,179	1,882	2,360	2,534

Note: Values in billions (R$).

The data presented in Table 3, expressed in billions of reais, refer to the balance of the Provision for Doubtful Debts stock in the last quarter of each year and were collected from the financial information reports of the sample banks, available on the institutions' websites. From the results collected and displayed in Table 3, between the years 2019 and 2021, it was noted that the banks that are part of Segment 1 (S1) increased the amount maintained as Provision for Doubtful Credits, in particular, due to fears associated with the increase in defaults due to the new coronavirus pandemic. At the end of 2022, there was a new considerable increase in the amount held as PCLD, considering the deterioration observed in banks' credit portfolios with an increase in the default rate.

Increasingly, it was found that Banco BTG Pactual increased its volume in Provision for Doubtful Debts, comparing 2019 with 2021, by 100.2%, Itaú by 36.8%, Bradesco by 33.0%, Santander at 31.4% and Banco do Brasil at 18.8%. Contrary to the other banks, Caixa Econômica Federal was the only bank in the sample that reduced the volume of Provision for Doubtful Debts, comparing the end of 2019 with the end of 2021. In its published financial information, CAIXA justifies that the volume of Provision for Doubtful Debts is appropriate to the risk of its credit portfolio, which, according to the bank, is heavily backed by real guarantees, due to the predominance of real estate credit in its operations.

In the case of other banks, the justifications presented for the increase in the volume of Provision for Doubtful Debts, between the years 2019 and 2021, are related to the uncertainties regarding the impacts of the new coronavirus pandemic on the increase in default and consequently the increase in risk. credit from bank portfolios. To deepen and evaluate the behavior of Provision for Doubtful Debts throughout 2020, impacted by the new coronavirus pandemic, quarterly data were collected for the period from December 2019 to March 2021 and displayed in Table 4.

Table 4 Provision for Doubtful Debts of Financial Institution

	Financial Institution	Dec 2019	Mar 2020	Jun 2020	Sep 2020	Dec 2020	Mar 2021
1	Itaú S.A.	39.747	47.083	49.267	51.140	52.158	51.244
2	Banco do Brasil S.A.	39.800	42.010	41.677	42.350	45.170	44.677
3	Caixa Econômica Federal	35.032	34.807	33.938	34.046	34.570	35.388
4	Bradesco S.A.	36.796	40.466	43.209	44.894	45.339	46.030
5	Santander do Brasil S.A.	21.408	21.703	25.394	25.000	25.067	25.728
6	BTG Pactual	1.179	1.882	1.711	1.774	1.882	1.296

Note: Values in billions (R$).

The data presented in Table 4, expressed in billions and reais, refer to the Provision for Doubtful Debts balance in the last quarter of each year and were collected from the financial information reports of the sample banks, available on the institutions' websites. Banco Itaú showed an increasing movement of Provision for Doubtful Debts throughout 2020, in all quarters, and began a movement to reduce the balance in the first quarter of 2021.

At CAIXA, the only bank in the sample where no increase in the Provision for Doubtful Debts balance was identified between 2019 and 2021, in the detailed observation of the quarters, no significant fluctuations were identified in the amount provisioned for credit risk. Banco Bradesco showed a similar movement to Banco Itaú, with a growing increase in the volume of Provision for Doubtful Debts in the quarters of 2020, however, a new increase was observed in the first quarter of 2021.

At Banco do Brasil, throughout the quarters observed, there was an increase in the volume of PCLD in the quarters of March, September, and December, compared to the previous quarters, and a reduction in the balance of Provision for Doubtful Debts, in a smaller volume, in the quarters of June 2020 and March 2021.

Observing the movement of Santander, there was a greater increase in the Provision for Doubtful Debts balance in the June 2020 quarter, oscillating in smaller volumes, more or less, in the other quarters observed. In the case of Banco BTG Pactual, a significant increase, in percentage terms, was observed in the first quarter of 2020 and, in the same significant way, a reduction in the volume of Provision for Doubtful Debts was observed in the first quarter of 2021.

From the data obtained and observations made, it was noted that banks have different methodologies and strategies for measuring the volume necessary to provide for credit risk, some with greater sensitivity to future macroeconomic projections and preventive action, others adopting strategies to wait for possible impacts of deterioration of the credit portfolio to constitute the provision.

To corroborate the studies, Tables 5 and 6, detail the default rate of the banks in the sample, obtained from the public financial reports of the aforementioned institutions. It is clarified that the default rate is the relationship between operations overdue for more than 90 (ninety) days and the balance of the active credit portfolio and, the lower the indicator, the better quality of credits granted is assumed. It is worth highlighting that the balance of the active portfolio corresponds to the sum of the outstanding balance of credit contracts for loan and financing operations.

Table 5 Default Rate

	Financial Institution	2017	2018	2019	2020	2021	2022
1	Itaú S.A.	3.70	3.51	3.35	2.69	2.47	2.94
2	Banco do Brasil S.A.	3.71	2.53	3.27	1.90	1.75	2.51
3	Caixa Econômica Federal	2.25	2.18	2.17	1.73	1.95	2.09
4	Bradesco S.A.	4.70	3.50	3.30	2.20	2.80	4.30
5	Santander do Brasil S.A.	3.20	3.10	2.90	2.10	2.66	3.05
6	BTG Pactual	3.94	1.54	0.05	0.74	0.95	2.15

Note: Values in percentage (%).

Analyzing the results in Table 5, comparing in particular the years 2020 and 2021, except Itaú, the other banks showed an increasing movement in the default rate of the credit portfolio. However, it should be highlighted that for these banks — except BTG — the default rate seen in 2021 is lower than the default rate seen in 2019, which can be considered a positive result for the banks analyzed, as it means that no whether or not there was a

significant deterioration in the quality of the active credit portfolio during the period assessed.

It is noted that BTG's default rate showed a greater fluctuation throughout the period evaluated, justified by the characteristic of the bank's credit portfolio, which is significantly smaller and, therefore, larger volume credits, defaulted or recovered, produce an effect considerable in the indicator. Furthermore, it is observed that at the end of 2022, in general among banks, credit portfolios show signs of deterioration, increasing the default rate for the period.

Table 6 Default Rate

	Financial Institution	Dec 2019	Mar 2020	Jun 2020	Sep 2020	Dec 2020	Mar 2021
1	Itaú S.A.	3.35	3.52	3.21	2.62	2.69	2,69
2	Banco do Brasil S.A.	3.27	3.17	2.84	2.43	1.90	1.95
3	Caixa Econômica Federal	2.17	3.14	2.48	1.87	1.73	2.04
4	Bradesco S.A.	3.30	3.70	3.00	2.30	2.20	2.50
5	Santander do Brasil S.A.	2.90	3.00	2.40	2.10	2,10	2.10
6	BTG Pactual	0.05	1.52	1.45	0.67	0,74	0.34

Note: Values in percentage (%).

From Table 6, evaluating the quarterly information, it was noted that Itaú, Caixa Econômica Federal, Bradesco, Santander, and BTG, showed an increase in the default rate in the first quarter of 2020, however, there was a movement decrease in the following quarter. Banco do Brasil showed a decline in the index throughout 2020 and a slight increase in the indicator in the first quarter of 2021.

The movement of the indicator in the period evaluated, except BTG due to the characteristics of its credit portfolio, can be considered positive for the other banks in the sample, as, even in an adverse scenario such as the new coronavirus pandemic, the quality of the portfolio of credit fluctuated positively, with an improvement in the banks' default rate when comparing the last quarter of 2019 with the first quarter of 2021.

Comparing the movement of the Provision for Doubtful Debts balance with the default rate of the credit portfolio of the banks in the sample and the period observed, it was noted that, based on the analysis, the relationship between the two is not direct, with a non-explicit strategic component existing. to justify the increase or decrease in banks' Provision for Doubtful Debt balance, that is, provision expenses tend to be used by banks to manage their results.

Among the main risks in the sector, credit risk has had the greatest impact on the financial results of a financial institution, with a positive or negative bias, depending on the period and the strategies adopted by financial institutions. It is worth highlighting that, throughout 2020, the volume of renegotiated or renegotiated operations was around a third of the total credit portfolio in the National Financial System, which, at the time, suggested the possibility of relevant losses for banks, considering the scenario of loss of purchasing power for a large part of the population and the closure of numerous companies.

Finally, to have an idea of the evolution of the movement of the Provision for Doubtful Debts balance throughout the 2010s and early 2020s, the following graph shows the 4-quarter moving averages for total losses with provisions for doubtful debts, for each of the six financial institutions in the S1 segment. Moving averages of 4 quarters were used to eliminate possible seasonal effects when accounting for these losses. The series starts in the first quarter of 2010 and extends until the first quarter of 2023. Figure 2 shows the trajectory of losses with provision for doubtful loans.

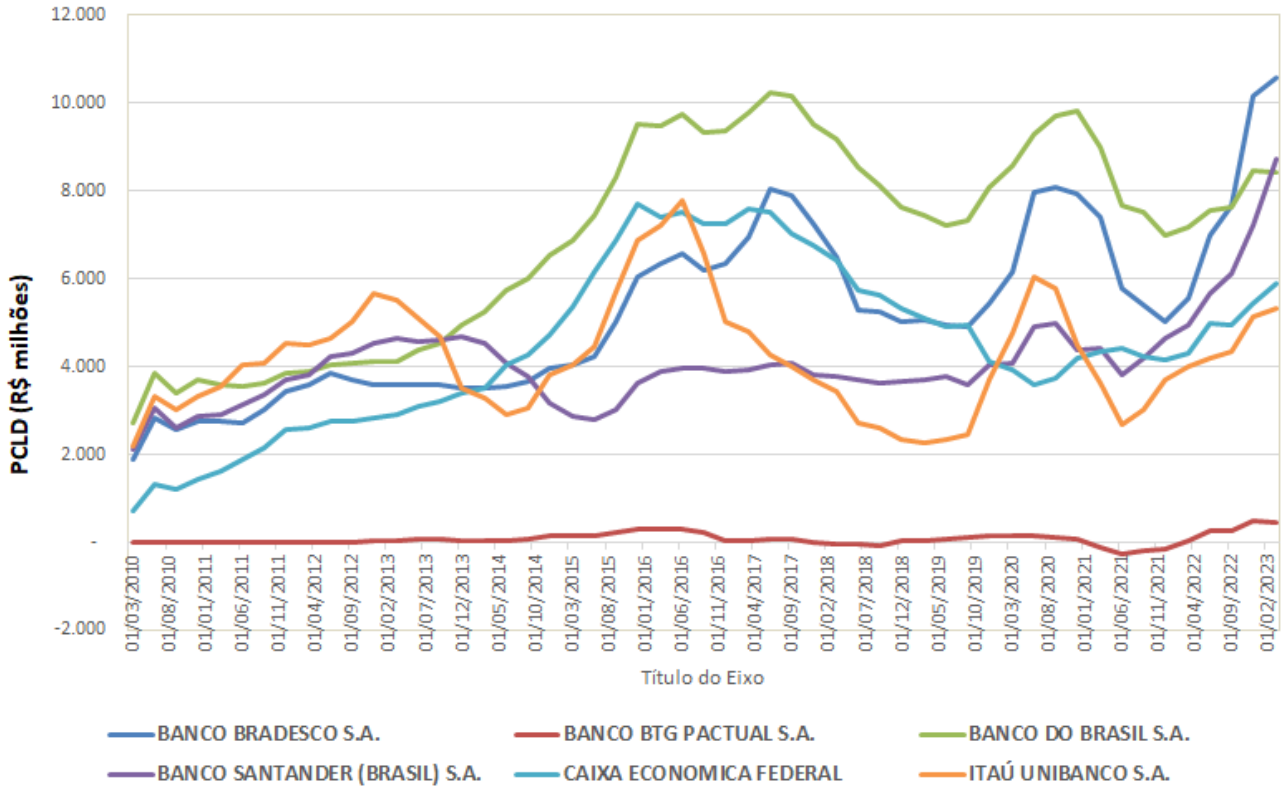

Figure 2 Loss Trajectory With Provisions for Doubtful Debts

With Figure 2, it is possible to identify three periods of increased losses with provisions for doubtful debts: a period of the 2015/2016 crisis, a period of COVID-19, and a more recent period, possibly due to the effects of post-Covid and account of the financial problems faced by a large retail group, with repercussions on the entire system of suppliers and creditors.

4.7 Liquidity Risk

Liquidity Risk is the possibility of not being able to efficiently honor expected and unexpected, current and future obligations, including those arising from binding guarantees, without affecting daily operations and without incurring significant losses, and also of not being able to negotiate a position at market price, due to its large size about the volume normally traded or due to some discontinuity in the market (CMN, 2017).

For the banking sector, especially for banks classified in segment 1 (S1), two main indicators must be continuously monitored and reported to the regulator, aiming to guarantee the solvency of institutions and — consequently — preserve the solvency of the National Financial System.

4.7.1 Risco de Liquidez de Curto Prazo

The Liquidity Coverage Ratio (LCR) is the indicator that measures short-term liquidity, and its objective is to identify the amount of free assets considered to be highly liquid versus the amount needed to meet the projected cash outflows over a horizon of 30 days in a standardized stress scenario (BACEN, 2015).

$$\text{LCR} = \frac{\text{HQLA}}{\sum \text{Outflow} - \text{mín}\left(\sum \text{Inflow}; 75\% \sum \text{Outflow}\right)}$$

As established in BACEN Circular No. 3,749/2015:

a) HQLA (High-Quality Liquid Assets) High Liquidity Assets: assets that can be quickly monetized with little or no loss of value, even in stressed scenarios (free from blockages, easy and certain pricing, and low risk);

b) Outflows: total cash outflows predicted over a 30-day horizon for a standard stress scenario;

c) Inflows: total cash inflows expected over a 30-day horizon for a standard stress scenario.

In summary, the LCR corresponds to the ratio between the stock of high-quality liquid assets (HQLA) and the total net cash outflows (net cash outflows = cash outflows — cash inflows, with cash inflows being limited to 75% of cash outflows), for a period of 30 (thirty) days and, the higher the percentage of the indicator, the greater the short-term liquidity of the financial institution, which can be considered positive.

The LCR indicator, which came into force in 2015, is mandatory for financial institutions classified in segment 1 (S1), as provided for in National Monetary Council Resolution No. 4,553/2017, with a minimum requirement of 100%. To analyze the behavior of the LCR indicator, data were extracted from the banks selected in the sample, as set out in Table 7.

Table 7 LCR of Financial Institutions

	Financial Institution	2017	2018	2019	2020	2021	2022
1	Itaú S.A.	190.2%	171.7%	149.1%	194.6%	159.1%	164.4%
2	Banco do Brasil S.A.	234.5%	242.5%	337.1%	314.4%	228.9%	211.5%
3	Caixa Econômica Federal	269.0%	320.3%	391.2%	370.9%	245.3%	170.8%
4	Bradesco S.A.	156.2%	171.8%	143.8%	178.4%	138.1%	160.1%
5	Santander do Brasil S.A.	123.0%	146.6%	126.7%	170.7%	148.5%	137.5%
6	BTG Pactual	146.0%	205.0%	233.0%	273.0%	183.0%	232.9%

The information in Table 7, expressed as a percentage, refers to the last quarter of each year and was collected from the risk management reports of the sample banks, available on the institutions' websites. For the banks in the sample, highly liquid assets (HQLA) are mostly composed of Brazilian federal public bonds and the return of compulsory reserves collected with the Central Bank of Brazil. Outflows for large retail banks are mostly made up of loss of deposits (savings and current account) and inflows are mainly due to credit operations (loans and financing).

With the results collected and displayed in Table 7, it is noticeable that the banks that makeup Segment 1 (S1) maintained the LCR indicator above the minimum required, which is 100%, throughout the entire period evaluated, signaling sufficient liquidity in the short term. Considering the average LCR for the 06 (six) banks in the sample during the pandemic period, the 2020 result of 250.3% is higher than the result observed in 2019, of 230.2%. The median of the indicator for 2020 is 233.8%, also higher than that of 2019, which was 191.1%.

Among the reasons for the improvement in the indicator, when comparing the periods of 2019 with 2020, we can highlight — especially — the liquidity increase measures announced by the regulator to combat the effects of the pandemic. The 2021 numbers, with the end of the regulator’s measures, are lower, with an average of 183.8% and a median of 171.1%, however, still above the minimum required for the indicator. In 2022 it is observed that banks continue to present short-term liquidity sufficiency levels.

4.7.2 Long-Term Liquidity Risk

The Net Stable Funding Ratio (NSFR) is the indicator that measures long-term liquidity, to identify whether the total stable resources available are sufficient to support the total stable resources required over a horizon of

one year, that is, seeks to verify whether the financial institution has a stable source of financing to support its assets (BACEN, 2017).

$$\text{NSFR} = \frac{\text{Available Stable Resources}}{\text{Required Stable Resources}}$$

As established in BACEN Circular No. 3,869/2017:

a) Available Stable Resources: sum of the balances of products recorded in the institutions' liabilities and equity, by the respective weighting factors, which differ depending on the characteristics and maturity date of the financial instrument;

b) Required Stable Resources: sum of the balances of products recorded in assets and exposures not accounted for in the institution's balance sheet, by the respective weighting factors, which differ depending on the characteristic and maturity period of the financial instrument.

The NSFR indicator, which came into force in 2018, is mandatory for financial institutions classified in segment 1 (S1), as provided for in National Monetary Council Resolution No. 4,553/2017, with a regulatory minimum of 100%. Table 8 presents the NSFR of the Institutions.

Table 8 NSFR of Institutions

	Financial Institution	2017	2018	2019	2020	2021	2022
1	Itaú S.A.	-	127.7%	122.2%	126.0%	121.1%	124.9%
2	Banco do Brasil S.A.	-	113.2%	116.2%	123.2%	114.4%	115.4%
3	Caixa Econômica Federal	-	124.6%	144.0%	135.5%	131.3%	124.2%
4	Bradesco S.A.	-	126.1%	115.2%	120.1%	117.1%	120.5%
5	Santander do Brasil S.A.	-	117.3%	112.3%	114.1%	111.7%	108.3%
6	BTG Pactual	-	107.7%	110.7%	100.9%	108.7%	104.2%

The data presented in Table 8, expressed as a percentage, refers to the last quarter of each year and was collected from the risk management reports of the sample banks, available on the institutions' websites. Considering the validity of the NSFR indicator, the data made available by financial institutions begins in 2018.
The stable resources available are mainly composed of customer deposits, funding, and equity and the stable resources required are credit operations, compulsory loans, and permanent assets, among others. Caixa Econômica Federal and Banco do Brasil S/A have a significant portion of available stable resources made up of judicial deposits.

From the results collected and displayed in Table 8, it was noted that the banks that make up Segment 1 (S1) maintained the NSFR indicator above the minimum required, which is 100%, throughout the entire period evaluated, signaling liquidity sufficiency to long-term. Considering the average NSFR for the 06 (six) banks in the sample during the pandemic period, the 2020 result of 119.9% is slightly lower than the result observed in 2019, of 120.1%. The median of the indicator for 2020 is 121.6%, higher than that of 2020, which was 115.7%. In 2021, the average of the indicator was 117.4% and the median was 115.7%. In 2022 it is observed that banks continue to present levels of long-term liquidity sufficiency.

Analyzing the data collected in Tables 7 and 8, it is concluded that the large Brazilian banks in Segment 1 (S1) are currently in a comfortable liquidity situation, which allows, depending on the business strategy of each of them, to maintain their financial operations and credit concessions.

The short and long-term indicators appear resilient over the 5 (five) years evaluated and, even in an adverse scenario, such as in the case of the new coronavirus pandemic (COVID-19), they remained above the minimum required for all the banks. Furthermore, to deepen and evaluate possible impacts and fluctuations in the LCR and NSFR indicators throughout 2020, impacted by the pandemic, quarterly data were collected for the period from December 2019 to March 2021 and displayed in Tables 9 and 10.

Table 9 LCR 2020/2021

	Financial Institution	Dec 2019	Mar 2020	Jun 2020	Sep 2020	Dec 2020	Mar 2021
1	Itaú S.A.	149.1%	165.5%	179.1%	195.0%	194.6%	191.0%
2	Banco do Brasil S.A.	337.1%	297.6%	338.1%	353.6%	314.4%	314.7%
3	Caixa Econômica Federal	391.2%	399.3%	404.0%	391.0%	370.9%	336.1%
4	Bradesco S.A.	143.8%	141.6%	170.1%	184.6%	178.4%	162.9%
5	Santander do Brasil S.A.	126.7%	130.8%	158.3%	170.8%	170.7%	170.9%
6	BTG Pactual	233.0%	185.0%	154.0%	140.0%	273.0%	238.0%
	Average	230.2%	220.0%	233.9%	239.2%	250.3%	235.6%
	Median	191.1%	175.3%	174.6%	189.8%	233.8%	214.5%
	Standard Deviation	1.11	1.06	1.09	1.05	0.82	0.75

According to the data in Table 9, the LCR indicator was resilient throughout the analyzed period, always above the minimum required, with the lowest value observed for the sample average being in March 2020 with 220.0% and the lowest value observed for the sample median was in June 2020 with a result of 174.6%.

Table 10 NSFR 2020/2021

	Financial Institution	Dec 2019	Mar 2020	Jun 2020	Sep 2020	Dec 2020	Mar 2021
1	Itaú S.A.	122.2%	116.8%	122.5%	123,6%	126,0%	125,0%
2	Banco do Brasil S.A.	116.2%	113.3%	116.6%	119,3%	123,2%	117,9%
3	Caixa Econômica Federal	144.0%	143.3%	137.4%	133,1%	135,5%	134,9%
4	Bradesco S.A.	115.2%	110.7%	120.6%	120,9%	120,1%	114,8%
5	Santander do Brasil S.A.	112.3%	105.0%	111.3%	110,5%	114,1%	110,2%
6	BTG Pactual	110.7%	108.1%	104.8%	108,2%	100,9%	102,9%
	Average	120.1%	116.2%	118.9%	119,3%	120,0%	117,6%
	Median	115.7%	112.0%	118.6%	120.1%	121,7%	116,4%
	Standard Deviation	0.12	0.14	0.11	0.09	0,12	0,11

According to the data in Table 10, the NSFR indicator was resilient throughout the analyzed period, always above the minimum required, with the lowest value observed for the sample average being in March 2020 with 116.2% and the lowest value observed for the sample median was in March 2020 with 112.0%.

Analyzing the data collected from Tables 9 and 10, it is concluded that the large Brazilian banks in Segment 1 (S1), throughout the quarters from December 2019 to March 2021, maintained short and long liquidity indicators term above the minimum required, denoting their resilience to adverse scenarios.

4.8 Market Risk

Market risk is defined as the possibility of losses resulting from fluctuations in the market values of instruments held by the institution, that is, the risk of fluctuations in interest rates impacting, positively or negatively, the results of financial institutions (CMN, 2017). According to Dermine (2009), market risk can be

characterized by the loss of revenue resulting from unfavorable movements in interest rates, exchange rates, and prices of securities and commodities, and, in the case of financial institutions, it must be differentiated the interest rate risk between the negotiable portfolio and the non-negotiable portfolio (bank portfolio), considering the differences in the pricing of the assets that make up said portfolios.

For the banking sector, the trading book comprises operations with financial instruments and commodities, including derivatives, carried out with the intention of trading, while the banking book comprises operations arising from the banking business, such as loans or deposits, and related to the management of the institution's balance sheet, carried out without the intention of trading and with a medium and long-term time horizon.

According to analysis in public documents made available by banks, the 06 (six) financial institutions in the sample have a dedicated and specialized technical team for managing market risk and use similar instruments for its management, with variations in internal methodology and limits of risks according to business strategies.

The banks in the sample commonly use the Value At Risk (VaR), or Value at Risk, methodology, which establishes the maximum expected loss for an assigned confidence interval and a defined time horizon. VaR, through the use of historical data, seeks to identify what the potential loss of value could be in the future, being considered a simple and easy-to-understand methodology, but of great importance and wide use in managing market risk. (Giambiagi, 2017).

In addition to VaR, also a common instrument for the banks in the sample, is the use of stress tests, to evaluate the behavior of market risk indicators in simulated adverse scenarios, which can be prospective and historical, standardized by the regulator or through institutions' statistical methodologies. Stress tests consist of evaluating risks in projected scenarios of relevant and extreme situations, with the use of VaR being an integrated methodology for managing market risk (Giambiagi, 2017).

Combined with these two instruments, VaR and stress testing, the banks in the sample, in a continuous monitoring process, use loss control, called Stop Loss, which are maximum levels of losses, limits, which, Once exceeded or close to being exceeded, they are alerted to the institutions' governance bodies for timely assessment and decision-making, which may, depending on the severity and risk profile of the institution, lead to the temporary suspension of operations.

According to Giambiagi (2017), the use of combined methodologies for risk management guarantees reliability and comprehensiveness in the tests carried out and is in line with best market practices. In this context, it is noted that the 06 (six) banks in the sample use a combination of VaR, stress test, and Stop Loss methodologies in market risk management.

4.9 Operational Risk

Operational Risk can be defined as the possibility of losses resulting from external events or failure, deficiency or inadequacy of internal processes, people, and systems, including in this definition the legal risk associated with inadequacy or deficiency in contracts signed by the Institution, as well as such as sanctions due to non-compliance with legal provisions and compensation for damages to third parties resulting from the activities carried out by the Institution (CMN, 2017). The Operational Risk factors, which can be internal and external, are characterized as set (COSO, 2007):

- Internal Factors: Processes (process modifications without adequate changes in administrative protocols, execution errors, fiscal supervision), people (faults, deficiencies, or inadequacies in the performance of duties by workers and collaborators, involving aspects relating to work accidents, fraudulent activities,

misconduct), technology (failures, deficiencies or inadequacies in systems, apparent security, unforeseen downtime, unavailability), infrastructure (availability and capacity).

- External Factors: External events that may affect the fulfillment of business objectives, such as changes of government, adverse weather conditions, changes in legislation, environment, economic and social aspects, among others.

In the banking sector, internal methodologies are commonly used to measure the operational risk of operations and businesses, based on two main variables: probability and impact of losses. Probability is correlated to the number of operational loss events identified and the impact is the value of the operational losses, usually expressed in currency. Due to the characteristics of banking operations, in most cases, the volume of operational loss incidents is high, however, the values are low. Incidents of large-value operational losses are lower in volume (Dermine, 2009).

As established in CMN Resolution No. 4,557/2017, financial institutions must have policies, controls, processes, systems, structure, and resources for managing operational risk, which are compatible with the size and activities carried out by the bank. Furthermore, they must create a database with values of operational losses, provisions, and expenses related to each identified event.

An assessment of exposure to losses must be carried out periodically, in normal and stressful scenarios, correlating the maximum loss with the institution’s risk profile. For the sample studied, according to information extracted from the institutions’ risk management reports, banks fully comply with the items provided for in current national regulations, documenting, in a specific chapter of the report, the policies, controls, processes, systems, structure, and resources used in operational risk management.

4.10 Capital Indicators

To analyze in aggregate the solidity of Brazilian banks in the S1 segment, we analyzed the main capital indicators, notably the main capital index, the level 1 capital index, and the Basel index. These indicators are intrinsically linked to the leverage capacity that banks have to carry out their credit operations.

According to Basel rules, financial institutions are required to maintain a minimum level of so-called regulatory capital, and these rules are implemented and supervised in each country by its competent authority. The most comprehensive regulatory capital is called reference equity, and it is made up of tier 1 capital and tier 2 capital.

Tier 1 capital is considered a bank's most robust capital, and is crucial for absorbing losses without the bank having to cease operations. This type of capital demonstrates a bank's core financial strength to regulators. According to the Basel III framework, Tier 1 capital is divided into core capital and complementary Tier 1 capital. The main capital is made up of the following components:

(i) common shares, these being the common shares issued by the bank that hold voting rights;

(ii) surplus shares (from the issuance of common shares), and represent the premium received by the bank over the nominal value of the shares;

(iii) retained profits, which correspond to profits not distributed as dividends, but kept to cover future losses or for reinvestment;

(iv) common share premium, which is the additional capital received from shareholders;

(v) other income, which includes items such as unrealized gains and losses on available-for-sale securities;

(vi) other disclosed reserves, which may be legal, capital reserves, or other regulatory reserves.

The ratio between core capital and total risk-weighted assets (RWA) is called the financial institution's core capital ratio. Figure 3 shows the evolution of the main capital index for the six banks in the S1 segment and also a minimum required capital floor, according to this index, considering CMN Resolution number 4,958, of 2021 (BACEN, 2021).

According to Article 6 of this regulation, banks are required to maintain a minimum core capital ratio of 4.5%. In addition, there may be an additional 4.5%, representing the ACP portion, which corresponds to the additional principal capital (which can reach 3.5% for banks in the S1 segment).

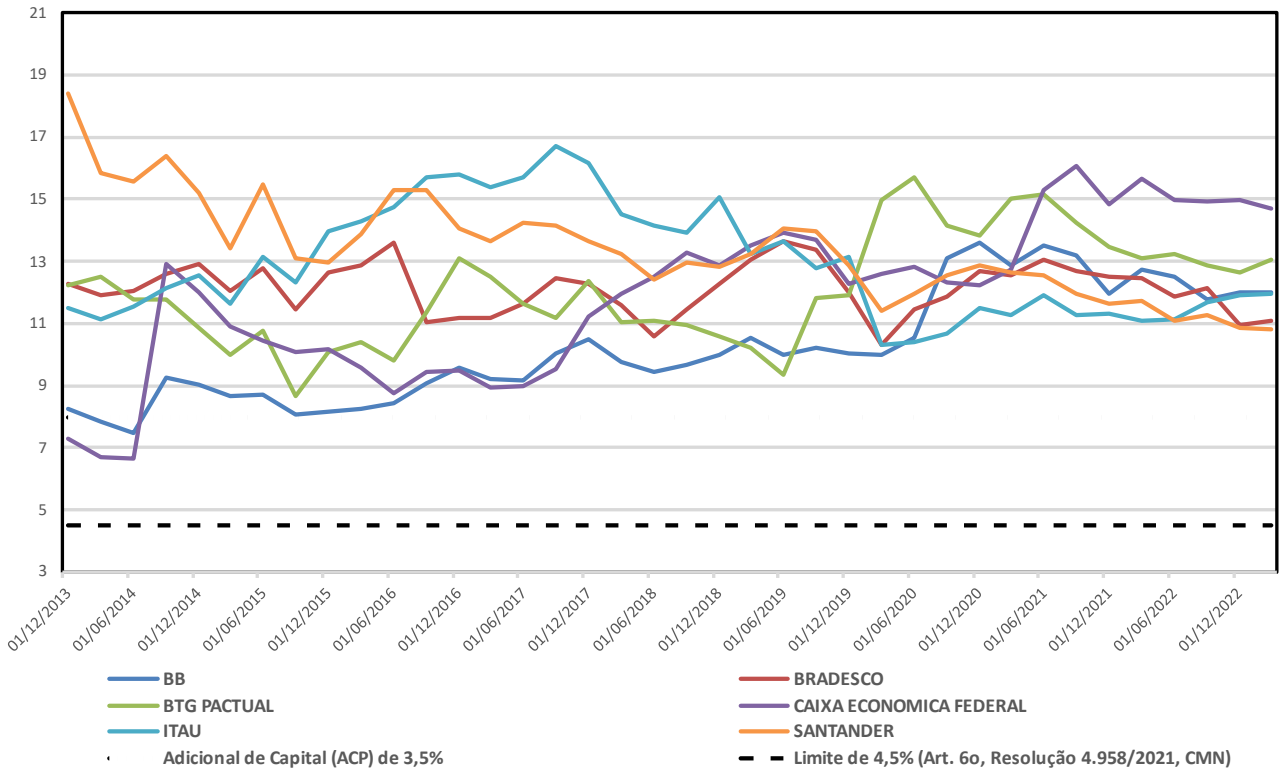

Figure 3 Recent Developments in the Core Capital Ratio

The second component of Tier 1 capital, is known as supplementary Tier 1 capital, or supplementary capital, and is a category of regulatory capital as stipulated by the Basel III framework, intended to ensure that financial institutions have a sufficient cushion to absorb losses. and continue operations under adverse conditions. It is part of the broader Tier 1 capital, and unlike core capital, which consists primarily of common shares and retained earnings, supplemental capital can accommodate a more diverse range of financial instruments and is structured to be loss-absorbent by being subordinated to Tier 2 capital.

The components of complementary tier 1 capital include perpetual debt instruments, which do not have a stipulated maturity date. This ensures that the capital provided by these instruments is permanent and available to absorb losses indefinitely. Additionally, discretionary dividends are included, which implies that the bank has the right to cancel dividend payments without triggering a default event. In this case, the non-cumulative nature of these dividends gives the bank the right not to pay a dividend in a given period, and these dividend payments do not accumulate for payment in future periods.

Supplemental Tier 1 capital is subordinate to most other claims in the event of liquidation, ranking above

core capital but below Tier 2 capital and other senior claims. The terms of supplemental Tier 1 capital instruments can be structured with a high degree of flexibility to meet regulatory requirements while optimizing the bank's capital structure. Supplementary Tier 1 capital instruments often have callable features that allow the issuing bank to redeem the instruments after a certain period, subject to regulatory approval.

The issuance and terms of supplementary Tier 1 capital instruments require approval from regulatory authorities to ensure they meet Basel III criteria for loss absorption and other characteristics. The design of supplementary capital aims to strike a balance between improving a bank's loss-absorbing capacity and providing a degree of flexibility in capital management. This is vital to ensure banks maintain robust capital positions, thereby promoting financial stability within the wider banking sector.

Total Tier 1 capital is crucial to ensuring a bank's ability to absorb losses on an ongoing basis. The quality and quantity of Tier 1 capital are direct indicators of a bank's financial strength and resilience in the face of economic headwinds. For this reason, banking regulators around the world closely monitor banks' Tier 1 capital levels and require maintenance of certain ratios of Tier 1 capital to risk-weighted assets (RWA).

The ratio between total tier 1 capital and RWA is called the tier 1 capital index. Figure 4 shows the recent evolution of this indicator. The lower limit in this case is 6%, according to article 5 of CMN Resolution number 4,958, of 2021 (BACEN, 2021), with the incidence of ACP for banks in the S1 segment on this value, can reach 3.5%.

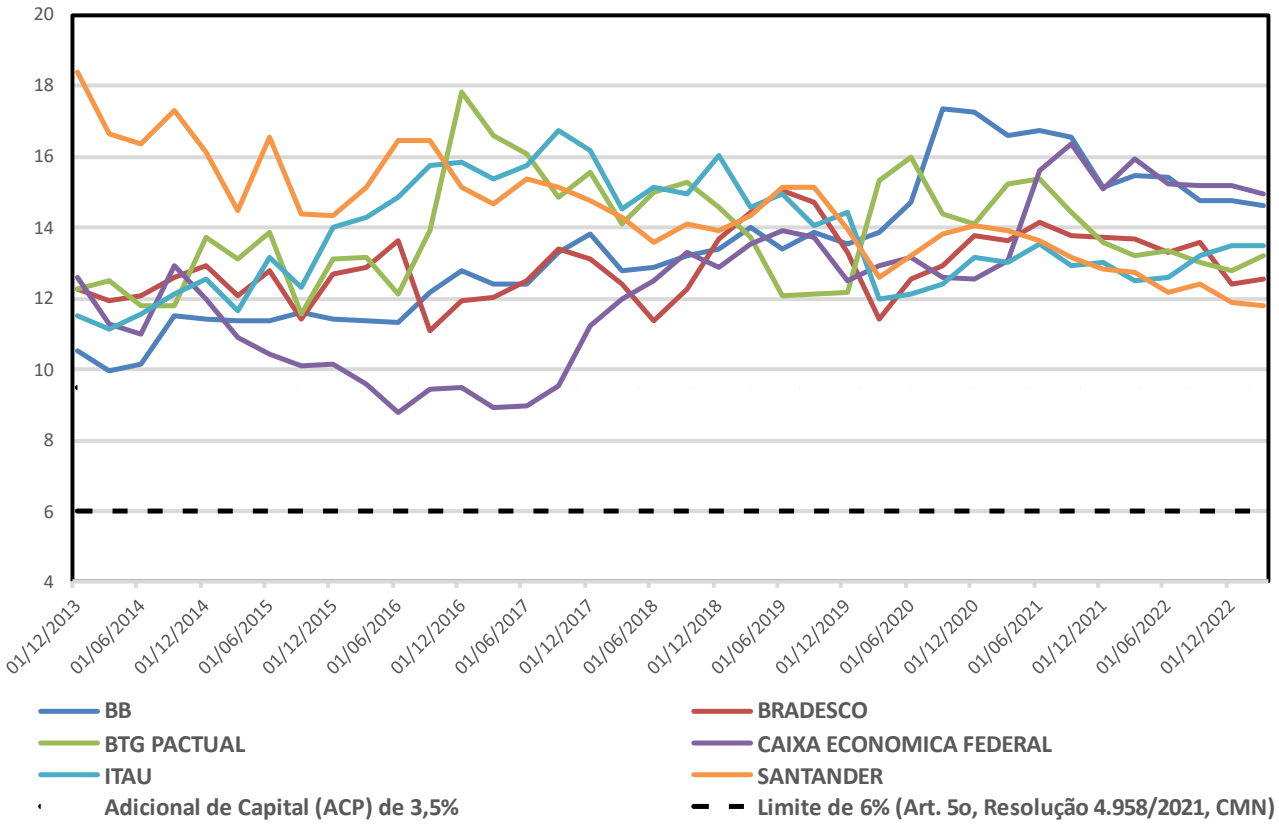

Figure 4 Recent Evolution of the Tier 1 Capital Ratio

Finally, tier 2 capital, also known as supplementary capital, is a component of a bank's regulatory capital based on the Basel III framework. It is considered less permanent than Tier 1 capital but still plays a crucial role in

promoting financial stability and resilience. The components of Tier 2 capital include:

(i) subordinated debt, which consists of the main instrument of tier 2 capital, having a maturity of at least five years, and its outstanding value is amortized in the books as it approaches maturity;

(ii) undisclosed reserves, which are reserves created or increased through revenue recognition and are accepted by regulatory authorities as a component of tier 2 capital;

(iii) hybrid instruments, which have characteristics of both debt and equity and which can also be categorized as tier 2 capital if they meet specific regulatory criteria, generally having long-term maturities;

(iv) revaluation reserves, which arise from the revaluation of assets, such as real estate or investments, representing an increase in the value of the asset and may be included as tier 2 capital, subject to regulatory approval;

(v) general provisions and loan loss reserves, which are provisions created against unidentified future losses may qualify as tier 2 capital;

(vi) collective impairment provisions, which are similar to general provisions, but are often based on a portfolio basis, rather than specific assets.

Tier 2 capital provides a secondary layer of loss protection for a bank. It is designed to absorb losses in the event of a liquidation and thus offers a lesser degree of protection to depositors and senior creditors compared to tier 1 capital. The flexibility and supplementary nature of tier 2 capital supports the capital of a bank, enabling it to meet regulatory requirements and maintain a healthy level of capitalization, which in turn inspires confidence among investors and other stakeholders regarding the bank's financial stability.

The ratio between Tier 2 capital and RWA is known as the Basel ratio. Figure 5 shows the recent evolution of this indicator. The lower limit in this case is 8%, according to article 5 of CMN Resolution number 4,958, of 2021 (BACEN, 2021), with the incidence of ACP for banks in the S1 segment on this value, can reach 3.5%.

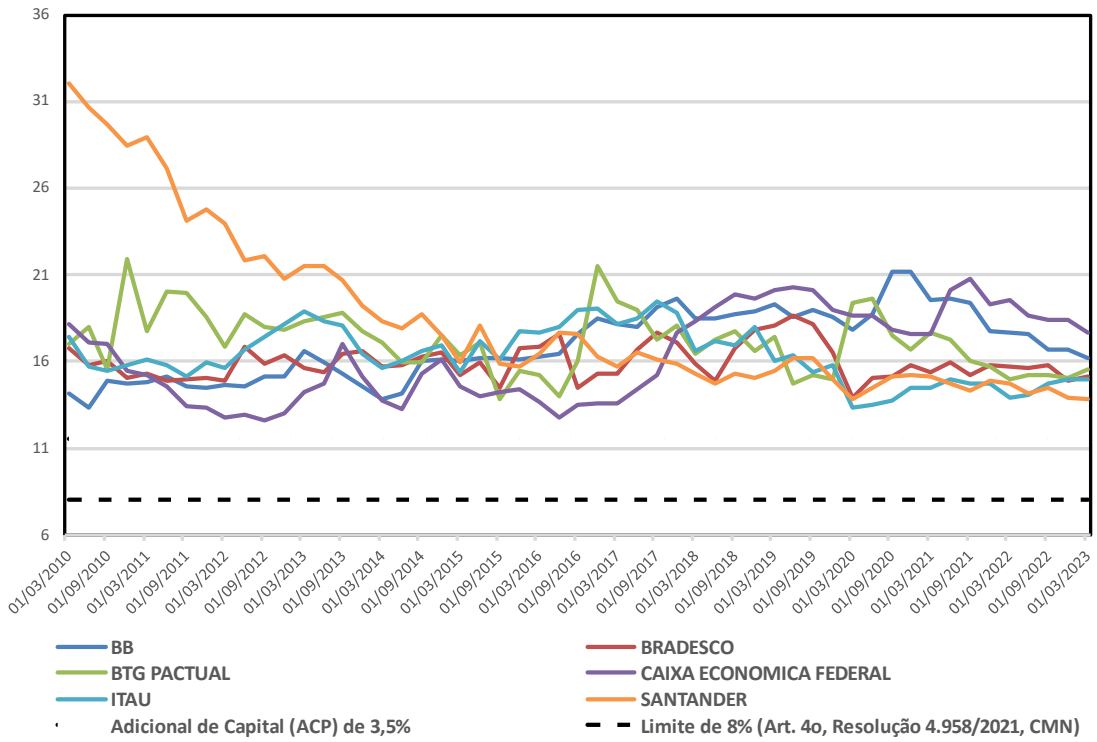

Figure 5 Recent Evolution of the Basel Index

4.11 Influences of Covid-19 on Capital Indicators

Throughout the COVID-19 pandemic, there appear to have been no significant changes to the capital indicators of these banks. To test this hypothesis statistically, Table 11 presents the results of the econometric exercise — Equation 1, using regression with panel data, in which the main capital, tier 1 capital, and Basel index indicators are considered as dependent variables.

Table 11 Estimated Coefficients for the Models

Dummies Coefficients	Basel Index		Tier 1 Capital Ratio		Core Capital Ratio	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Res. 4557	-0.2337	0.4691	-1.1198	0.0000	-0.7956	0.0033
Covid-19	-0.5591	0.2744	-0.0866	0.7855	-0.0074	0.9842
Post-Covid	-1.3598	0.0024	-0.2482	0.4883	0.0619	0.8747

The results in Table 11 indicate that the COVID period did not bring statistically significant impacts on the three main capital indicators of the financial institutions analyzed, as expected according to a visual inspection of Figures 3, 4, and 5. In the case of the Basel index, there appears to have been an average reduction in this indicator of around 1.36, in the post-Covid period, with this reduction being statistically significant.

However, there is no evidence of a reduction in the other indicators (main capital and tier 1 capital) in this post-Covid period analyzed. Finally, Resolution 4557/2017, of the National Monetary Council, appears to have had a positive effect on the main capital and tier 1 capital indicators, in the order of 0.8 and 1.12, respectively.

5. Conclusion

This paper sought to investigate the risk and capital management structures and processes of the largest Brazilian banks, aiming to understand the behavior of their indicators in stressed scenarios such as the COVID-19 pandemic. To this end, a documentary research methodology was used, capable of analyzing the reports of these financial institutions from 2015 to 2022, and linear regression with quarterly data for the period comprising the first quarter of 2010 to the first quarter of 2023 to identify possible effects of a period of the pandemic in the capital indicators of these banks.

With the analyses carried out, it is possible to verify that the national banks classified in Segment 1 (S1) — objects of the sample — have structure, processes, and methodologies that enable, in an adequate and personalized way, the management of their main risks, the monitoring of their exposures and monitoring its indicators and risk limits, both in normal situations and also in stressed scenarios, aligned with the strategic definitions of each institution.

The instruments used by financial institutions to manage the sector's main risks were evaluated, such as credit risk, credit risk, market risk, and operational risk, analyzing the behavior of the main correlated indicators. Regarding credit risk, it is clear that the banks in the sample have appropriate structures and methodologies for managing this risk, however, the strategies used are specific and aligned with the particularities of each institution.

For all banks, the provision balance is presented as appropriate to the level of risk of the credit portfolio, by current regulations, and the default indicators do not present significant manifestations of the quality of the credit portfolio. Regarding liquidity risk, liquidity indicators for the short and long term reached resilience, remaining, throughout the period considered in the studies, above the required regulatory level.

Therefore, the market risk indicators, throughout the evaluated period, proved to be resilient, denoting adequate management and control of this risk. About operational risk, institutions have a dedicated and specialized technical team to manage this risk, in compliance with regulatory requirements. Thus, it is possible to see that the banks in the sample are designed to manage their risks, both in normal scenarios and in stressed scenarios, such as the one experienced throughout 2020, and the risk indicators appear to be resilient throughout the period. paid out.

The results of the estimated linear regression indicate that the Covid-19 period did not have statistically significant effects on the three main capital indicators of the financial institutions highlighted. These findings are useful for investors, professionals working in the banking market, risk managers, financial market regulators, and the general population whose well-being depends on economic stability.

It is suggested, as future research, an analysis of statistical models used by financial institutions, to measure the amount provisioned for credit risk, considering the possible use of expenses with forecast doubtful credit to manage results by part of the banks.

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