

# Extraordinary actions: The use of Buyback and Spread Auctions – The Brazil National Treasury Experience

Helano Borges Dias\*  
Luís Felipe Vital Nunes Pereira♦  
Paulo de Oliveira Leitão Neto^

## 1 Introduction

Over the last decades, several countries went through important changes in economic policy design as a consequence of financial and sovereign debt crisis and its impacts across different markets. The need to guarantee a functional financial system and, simultaneously, deal with macroeconomic shocks raised the interaction between fiscal and monetary policies and debt management. In this environment, despite important advances in bond markets structure and debt management, the Brazil National Treasury (BNT) identified events of significant market distortions as investors reacted to economic, financial and political concerns. In some of those events, BNT announced extraordinary buyback or spread auctions as a tool to support markets and provide market references.

The complete assessment of market conditions and the decision on whether the Treasury should make an extraordinary action requires a permanent follow-up on economic and financial conditions. The Treasury liquidity reserve and assertive communication with investors are examples of important elements that must be taken into account. This working paper was constructed in this background, with the goal to assess the main elements on BNT extraordinary actions in recent years. On this regard, we discuss public debt management in Brazil and its idiosyncrasies, such as raising concerns over the last decade on fiscal issues and the ability to push a reform agenda, the official credit policy and the framework that describes the flows between BNT and the Central Bank.

These idiosyncrasies led Brazil to unusual conditions that guaranteed a very comfortable cash position in an environment of fiscal deterioration. Despite a positive situation in terms of solvency, the country had to deal with adversities resulted from more challenging debt forecasts. This fiscal deterioration had an immediate impact in bond markets, with more significant shocks in moments of higher uncertainties.

---

\* Federal Auditor of National Treasury, Investment Control Manager at Funpresp-Exe and PhD in Economics from the University of Brasília.

♦ Head of Public Debt Operations Office of National Treasury, CFA Charterholder and PhD in Economics from the Catholic University – corresponding author ([luís.n.pereira@tesouro.gov.br](mailto:luís.n.pereira@tesouro.gov.br)).

^ Federal Auditor of National Treasury and MSc in Economics from the University of Brasília.

*This work should not be quoted as representing the views of the National Treasury. The opinions expressed here are exclusively those of the authors and do not necessarily reflect the views of the National Treasury.*

In the following sections we present relevant aspects that will help the reader to understand the public debt management framework in Brazil, such as the interaction between fiscal and monetary policies, liability management transactions and the importance of the liquidity reserve. In the following section the reader will have a brief description of BNT's extraordinary actions under an historical perspective. Next, we estimate an econometric model that provides evidence of the main financial variables for extraordinary actions. Finally, we present some concluding remarks.

## **2 - Public Debt Management**

This section aims to briefly describe the processes related to public debt management. In the macroeconomic sphere, the interaction between public debt, fiscal and monetary policy is highlighted, as well as the importance of coordinating these fronts for the efficiency of the economic-financial system. In the specific scope of debt management, the instruments available to achieving the objectives related to the financing process are explored. In this sense, it is worth mentioning the actions aimed at improving the government bond portfolio and manage the liquidity reserve, with a focus on the institutional arrangement, the composition of indexes, maturity structure and, mainly, risk mitigation.

### **Liability Management**

Liability management is the process by which changes in the existing public debt outstanding are sought with the aim of improving the debt profile, given previously defined guidelines. These operations generally do not aim to provide additional short-term financing capacity, with emphasis on repurchase and exchange of government bonds with a focus prevailing over risk management. However, despite their strategic nature, liability management operations have increasingly been used for different purposes, such as market support in stress situations, cost reductions and diversification of the investor base [WB (2015)].

Given the spectrum of risk assessment, it is important to assess which ones inherent in the public financing process can affect the achievement of the debt manager's objectives. The literature usually groups these risks mainly into the following categories: a) market risk, related to movements in economic and financial indicators such as interest and exchange rates; b) rollover/refinancing risk, which refers to the ability to renew a certain debt exposure at maturity; c) liquidity risk, which refers to the availability of sufficient demand for a specific debt instrument, without generating price distortions; d) credit risk, which is associated with the ability to meet obligations; and e) operational risk, which includes technological aspects and settlement procedures [IMF and WB (2014)].

The public debt manager usually has a range of instruments available to mitigate these risks, so that the consideration of the economic scenario is very relevant for defining the liability management actions that will be adopted. In normal situations, the traditional instruments available to achieving specific debt management objectives are highlighted, especially repurchases and exchanges of securities. In case of crisis, in turn, a wide spectrum of actions may be necessary, including extraordinary actions with repurchases and exchanges of government bonds, simultaneous purchase

and sale auctions, cancellation of auctions or, at the limit, debt restructuring. Papaoannou (2014) highlighted, for example, the use of repurchase operations or securities exchanges as tools to deal with high levels and inadequate structures of public debt, as well as to reduce related vulnerabilities.

The process of implementing actions to achieve the debt manager's objectives usually allows for a distinction between planning activities<sup>1</sup> and operational management<sup>2</sup> which, despite being integrated, emphasize different time perspectives for the actions. In the set of planning activities, the analysis of the structural conditions of the economy gains relevance, highlighting the tools that emphasize the medium and long-term, which tend to be applied with the following purposes: to reduce the associated refinancing risk to the debt maturity structure, speed up the process of improving the debt composition, reducing the cost of financing, as well as projecting cash.

Within the scope of operational management activities those related to short-term actions tend to gain relevance, such as monitoring the market situation, evaluating price formation, fine-tuning the debt strategy and diagnosing timing of exceptional situations. In this case, the activities aimed at contributing to stimulating liquidity and correcting distortions in the secondary market for government bonds stand out<sup>3</sup>. Actions aimed at stabilizing the market and restoring transparency in price formation tend to be taken during periods of stress.

Considering this broad spectrum, the public debt planning framework developed by the BNT highlights the importance of intertemporal programming capable of providing transparency, predictability and timing. In fact, the objective, guidelines and optimal composition formalize the desired Federal Public Debt (FPD) structure of long-term cost and risk. The transition strategy between the present and the long term, called medium-term planning, emphasizes the macroeconomic scenarios and the degree of development of the debt market to determine the speed of transition. The short-term action, in turn, is guided by the Annual Borrowing Plan (ABP) and by the monthly tactical management of the Public Debt Management Committee (COGED)<sup>4</sup>, with emphasis on the analysis of current market conditions and their implications for the financing process.

Despite the potential benefits of liability management operations, the execution of the financing process takes into account traditional actions through public offerings with competitive auctions, with predictability being an important attribute often promoted through the disclosure of an issuance calendar. Therefore, liability management tools tend to be used in a complementary way, as potential catalysts towards the optimal composition of debt in times of favorable economic conditions or as a buffer when unfavorable market conditions are observed.

---

<sup>1</sup> Activities associated with the determination of general objectives and guidelines.

<sup>2</sup> Activities associated with the day-to-day operations with government bonds, related to the market and business.

<sup>3</sup> The ability to remove devalued bonds from the market and refinance high-coupon bonds, for example, allows for the correction of market distortions, also helping to ease the government's budget constraint.

<sup>4</sup> National Treasury Ordinance no. 426, dated June 25, 2019, sets the attributions of the COGED.

Despite this consideration, the use of liability management tools has been increasingly frequent. Blommestein et al. (2012) report that, among OECD countries, repurchase operations are more frequent than exchange operations, being used by more than 80% of the debt managers consulted. In addition, almost 30% of managers stated that they use repurchases regularly<sup>5</sup>. The authors also identified that, after the 2008/09 financial crisis, many debt managers started to increase liquidity reserves, issuing above the financing need in order to expand the flexibility of actions and reduce the risks associated with the refinancing capacity and any adverse shocks.

Therefore, extraordinary actions must be treated as auxiliary. The possibility of holding extraordinary auctions can bring greater stability and security to the government bond market, as long as it does not put at risk the regularity of the ordinary issuance process. It is also opportune to point out that the use of these tools tends to depend on the degree of development, particularities of each economy, sophistication of the public securities market and specialization of debt managers.

### **The Role of the Liquidity Reserve**

Regardless of the size and development of local government bond markets, maintaining a liquidity reserve has been common practice among debt managers. The stated objective of liquidity reserve management is generally aimed at maintaining timely resources so as to ensure efficient fulfillment of obligations. Clearly, measures to ensure the availability of resources and the options exercised to invest or retain surplus resources have risk and cost implications, so that inappropriate practices and dysfunctional institutional arrangements can hamper the implementation of government policies.

The main approaches used to manage the liquidity reserve are traditional and modern. The first emphasizes the need to maintain a considerable amount of resources in order to guarantee payment in a timely manner, characterized by prudence, passive attitude and low emphasis on opportunity costs. In the modern view, in turn, the aim is to guarantee government obligations in light of the minimization of retained resources. In this case, the notion of efficiency is present due to the restriction of opportunity costs associated with the maintenance of the liquidity reserve.

Cruz and Koc (2018) carried out a survey with debt managers from OECD countries and identified that the liquidity reserve has the capacity to assist in the fulfillment of obligations, to mitigate refinancing risk, to increase market confidence, to allow dealing with possible volatility in demand in bond auctions or with the occurrence of temporary loss of market access. The authors pointed out some stylized facts among the countries surveyed: i) the main mechanisms for the accumulation of

---

<sup>5</sup> The form of action may differ among the thirty-three countries surveyed. The French government carries out operations in the secondary and primary market (reverse auction), while the German government operates daily buybacks in the secondary market, without informing the market and without disclosing operations statistics. The Japanese government, in turn, holds monthly auctions. There are also those countries that prefer to adopt an *ad hoc* methodology for carrying out repurchase operations, such as Italy, which carries out extraordinary auctions using resources from eventual fiscal surpluses and extraordinary revenues.

resources are issuances in volumes above maturities and positive primary fiscal results; ii) the reference for a liquidity reserve is defined in the number of months of debt service coverage; iii) the need for liquidity reserve is heterogeneous across countries, ranging from one week to one year; iv) the most common practice is to maintain a reserve level sufficient to cover budget expenses (including debt redemptions) for one month<sup>6</sup>.

Regarding the Brazilian case, the National Treasury has an organizational structure for debt management that divides the attributions between back office (registration, control, payment and accounting activities), middle office (medium and long-term strategy activities) and front office (short-term strategy activities and operationalization of securities issues). In this perspective, the debt manager's mandate involves activities related to the indebtedness process and the cash flow to pay the debt, featuring a dual mandate, which has an important management instrument in the liquidity reserve.

However, part of the liquidity reserve of the Brazilian debt of more recent years did not necessarily result from the decision to use the traditional tools for accumulating resources, but mainly from the relationship structure between the National Treasury and the Brazil Central Bank (BCB)<sup>7</sup> and the partial reversal of the Federal Government's credit policy, especially early settlement of credit operations with BNDES<sup>8</sup>. This notion must be taken into account because the country has been living with relevant primary deficits since 2014 but has not experienced difficulties in honoring its obligations, even in more critical situations. The policy of accumulation of international reserves, established with the main objective of mitigating the vulnerability of the external sector, began to increasingly impact the results of the monetary authority from the end of the 2000s onwards. A distortion resulting from this new condition was contamination of the BCB's result by exchange rate volatility. In times of heightened uncertainty, in particular, the depreciation of the exchange rate contributed to the BCB's balance sheet showing positive results due to the marking to market of international reserves, which forced the monetary authority, as a result of the legal determination, to transfer the cash profits to the National Treasury. That is, a mechanism was established whereby the liquidity reserve tended to have an extra source of supply in adverse situations.

Additionally, it must be considered that the resources deposited in the Treasury Single Account (TSA) receive the average return on federal public securities held in the BCB portfolio. Although the allocation of this revenue is free, with no specific link to

---

<sup>6</sup> It is interesting to note that, in the case of Portugal, the reference value of the liquidity reserve was determined by analyzing the debt redemption profile and deviation expectations based on revenue and expenditure. The indicative level in 2018 was 40% of gross borrowing requirements in the following 12 months. The Turkish government, in turn, defines the liquidity reserve as the level of cash and other credit allocations readily available to withstand severe liquidity stresses for shorter periods. However, the actual reference level and the currency composition of the liquidity reserve are kept confidential, considering that the disclosure of its level could compromise the efficient functioning of the operations.

<sup>7</sup> See Bacha, E. *A Crise Fiscal e Monetária Brasileira*. Rio de Janeiro: Civilização Brasileira, 1<sup>ª</sup> ed., 2016.

<sup>8</sup> Banco Nacional de Desenvolvimento Econômico e Social (National Bank for Economic and Social Development).

debt payments, it is a source that helps to mitigate the need for new issues or primary resources to finance the Federal Government Budget.

In this sense, the institutional arrangement of the fiscal and monetary authorities contributed to creating a condition of decoupling between the solvency capacity and the need for primary fiscal results, the latter being fundamental to guaranteeing debt sustainability. The adverse implications of this construction led to a change in the legal bases that define the relationship between the National Treasury and the BCB<sup>9</sup>.

Despite the different implications that the existing institutional arrangement had on other dimensions of public finance, the volumes of the TSA destined to the liquidity reserve showed an increasing trend over the years, with the volumes reaching an honor capacity well above the three months of maturities of the internal debt on the market, a level that the BNT considers important to anticipate periods of greater concentration of maturities, mitigate risks and avoid putting pressure on the cost of debt.

Finally, it is important to highlight that, given the need to increase the transparency of debt management in the face of the fiscal challenges imposed by the Covid-19 crisis, the BNT included the maintenance of the liquidity reserve above its prudential level as a guideline and started the disclosure of the total resources of the liquidity reserve.

### **Extraordinary Interventions**

The cost and risk dimensions are clearly noted in defining the objective function of debt management in most countries<sup>10</sup>. In the case of FPD management, the goal is:

*“supply the Federal Government’s financing needs in an efficient manner, at the lowest cost in the long term, respecting the maintenance of prudent levels of risk and, additionally, seeking to contribute to the smooth functioning of the Brazilian government bond market”. [STN (2018)]*

This is the starting point for defining and analyzing the National Treasury's financing actions. The consideration of a contribution to the proper functioning of the securities market is an important consideration in the Brazilian case. When placing the public bond market within its objective function, the public debt manager must have instruments that help markets towards an efficient path. From this perspective, extraordinary debt operations should be interpreted when the dysfunctionalities of the government bond market become apparent. These moments are usually marked by significant price volatility, loss of reference rates, significant decrease in the number of daily trades, open spreads between buy and sell, etc. Under these conditions, the public debt authority can assess at its discretion the relevance of acting in order to re-establish the fundamentals and efficiency of the market.

---

<sup>9</sup> The Law No. 13.820/2019 brought important improvements to and reduces asymmetries in the regulatory framework governing the financial relationship between the National Treasury and BCB. A main premise is the improvement of the institutional arrangement regarding the distribution and coverage of the BCB's balance results, with special attention to the reduction of exchange equalization flows, which will make both the liquidity/inflation management and the FPD management more efficient.

<sup>10</sup> See the Table in the Annex.

From a legal point of view, the regulation that defines the powers of COGED<sup>11</sup> ensures the possibility of extraordinary meetings for the Committee to deliberate on matters within its competence in a timely manner, which brings flexibility to the process. In this way, during periods of high volatility in the financial market, the National Treasury can act in different ways to support the proper functioning of the market, without exerting excessive pressure on the cost of financing or abandoning the principles highlighted as good practices.

However, from a practical standpoint, one of the biggest challenges for the debt manager is to effectively characterize market conditions. Broadly, two situations can be considered: i) market re-pricing – when there is a permanent increase in the interest curve to a new level; and ii) loss of reference – moments when the interest curve temporarily gains level and/or inclination, but returns to levels compatible with the historical average or previously recorded. In practice, the debt manager cannot know ex-ante which of the two situations the market is in. However, in both situations, the presence of the debt authority can help to determine the market balance, either by helping to minimize the asymmetry of information between investors and savers in the price formation process, or by making use of reputation and/or signaling to give direction to the market.

Accurate diagnosis help to define the instruments and intensities of actions available to the debt manager. Table 1 lists the main tools that can be used for actions by the National Treasury:

**Table 1 – Extraordinary Actions available for the Debt Manager<sup>12</sup>**

<b>Actions</b>	<b>Description</b>
<b>Reduction of Scheduled Auctions Size</b>	A change in the level of issuances in relation to historical or programmed levels can help reduce pressure on the yield curve or on the premiums of fixed-rate bonds. This type of action tends not to significantly pressure the liquidity reserve level, if adopted in a timely manner.
<b>Auction Cancellation</b>	The cancellation of scheduled auctions as a result of risk aversion or the need for a more accurate diagnosis of economic fundamentals can avoid the possibility of distortions in the price formation process. The existence of a liquidity reserve is a necessary condition for this type of action.
<b>Issuance of Floating Bonds</b>	The characteristics of domestic demand favor the issuance of these bonds, which help to increase the liquidity reserve and debt maturity, in addition to mitigating pressures on the interest rate curves. This type of action helps manage the market's assets and liabilities, increasing the interest rate risk of the public debt, with the benefit of reducing debt refinancing risk.
<b>Short Term Issuance</b>	The characteristics of domestic demand favor the issuance of these bonds, which benefit the increase in the liquidity reserve in the short term. Although

<sup>11</sup> National Treasury Ordinance no. 426 - dated June 25, 2019, which defines COGED's attributions, indicates in Article 7 that the president of COGED may convene extraordinary meetings to deal with matters within the competence of the Committee, such as definition of the annual financing strategy for the FPD and limits for its indicators, schedule of auctions, establishment of the monthly strategy for the FPD and deliberation on other matters related to the management of the DPF.

<sup>12</sup> The BNT issuances fixed-rate bonds (LTN and NTN-F), inflation-linked bonds (NTN-B) and floating bonds (LFT), which are indexed to the weighted average interest rate of the overnight interbank operations (SELIC).

	favor the management of market assets and liabilities, maintain pressure on market and debt refinancing risks.
<b>Buy-backs</b>	They can be useful in acute liquidity constraints, helping to provide liquidity to the security holder and to mitigate adverse impacts on the financial market. Holding a considerable volume of liquidity reserve is a necessary condition for this performance.
<b>Spread Auctions</b>	They can be useful in times of liquidity constraints in the secondary government bond market, helping to establish a price reference to the market. An adequate level of liquidity reserve is a necessary condition for this type of action.
<b>Exchange Auctions</b>	They can help tailor investors' portfolios to market conditions. The exchange of different bonds, whether term or index, can mitigate pressures on the public bond market. They do not exert pressure on the liquidity reserve level.

Source: authors.

Caution in using these market intervention tools is a desirable attribute. International practice does not recommend extraordinary actions to achieve short-term public debt cost objectives. Opportunistic use for this purpose can undermine the debt manager's credibility and undermine the integrity of the financing process, even hindering market development and raising costs in the long run. Attention to the participants' incentives is also relevant, as they can use the debt manager's presence to avoid market solutions. Therefore, despite the potential benefits of having some flexibility for extraordinary actions, there is the possibility of generating inadequate incentives for some investors and harming the general good functioning of the government bond market.

In addition, as holding a significant volume of liquidity reserve is a necessary condition for many forms of extraordinary action and considering that there are not negligible uncertainties in the determination of scenarios, especially for longer terms, a preventive attitude is desirable in order to have this instrument. In the Brazilian case, despite the fiscal difficulties that have not weakened cash management throughout the decade of 2010, the change in the legislation of the relationship between the National Treasury and the BCB, as well as the anticipation of a large part of the BNDES' returns, should impose a new dynamic for the liquidity reserve, making its management more challenging in the coming years.

It is also worth pointing out that the Brazilian government bond market does not have an automatic safeguard system as observed in the stock and futures markets through the circuit break, which establishes a temporary price limit. When these markets fall below the threshold value, trading is stopped for a predetermined period of time. One of the reasons for using circuit breakers is credit risk and loss of financial confidence. The arguments in favor of this mechanism are based on the premise that significant variations in market prices may not be consistent with the fundamentals of the economy or market efficiency. However, circuit breakers can interfere with the price formation process and inhibit the portfolio's hedging strategy, thus reducing liquidity in other markets.



### 3 Overview of Extraordinary Actions

This section aims to analyze the economic and financial factors that were historically important for extraordinary actions in the Brazilian government bond market, especially during the COVID-19 crisis, which caused an unprecedented adverse shock to the Brazilian economy. Thus, the main qualitative elements that were behind the extraordinary actions are described in order to help identify the variables used in the quantitative model in the next section. In fact, the BNT constantly monitors general market conditions in order to maintain the soundness of the government bond market. In this sense, the analysis of different variables (such as asset volatility, liquidity, price reference, risk sentiment and asset repricing) allows a characterization of the main elements involved in debt management in Brazil.

In fact, from a historical perspective, it is possible to analyze some conditions and some challenges that have arisen over time for the Brazilian debt manager. For example, in the late 1990s, increased risk aversion towards emerging markets hit the Brazilian economy and generated a significant outflow of capital, in a context of high current account deficit. At that time, the structure for conducting the economic policy that ensured stabilization began to show clear signs of exhaustion in the face of the challenges imposed by the external environment. Thus, after an intense outflow of capital and a significant reduction in international reserves, the country faced difficulties in managing the debt. According to Carvalho et al. (2009) the crises of the late 1990s delayed the process of changing the public debt profile. The hostile environment made it difficult to increase the participation of fixed rate bonds, as well as the growing concentration of short-term debt. In this way, the National Treasury sought to reduce the refinancing risk and increase the participation of floating bonds (indexed to overnight interest rates). Difficulties were also observed in the early 2000s, notably in the period of exchange of governments. However, as the support for obtaining robust fiscal surpluses was consolidated, there was a gradual reduction in uncertainties regarding the necessary adjustments to the economy, which allowed for the construction of a favorable cycle for debt management.

Even in the face of gradually more favorable conditions, Pereira et al. (2009) report that, as a result of adverse impacts on the international market, the BNT carried out two simultaneous auctions of purchase and sale of short term fixed rate bonds in May 2004. Similar operations were also carried out with floating bonds in order to provide transparency and provide pricing parameters for the secondary market. The authors also highlighted that, later, in May 2006, uncertainties regarding the conduct of monetary policy in the US restricted Brazilian market liquidity, with a worsening in government bond prices. As a result, non-resident investors holding longer-term inflation-linked bonds did not find buyers in the secondary market, leading the BNT to act, through purchase and sale auctions, to minimize market imbalance. According to the authors, this action reduced the stress initially seen in the long-term inflation-linked market, which was contaminating other markets.

In the following years, debt management continued to improve in terms of profile. In 2008, Brazil's long-term external debt, for example, was rated investment grade by two of the main credit rating agencies – Standard and Poor's (S&P) and Fitch Rating –, reflecting its ability to honor obligations related to the debt, which helped to

achieve better financing conditions by reducing funding costs and additional demand for government bonds from institutional investors that had regulatory restrictions for investments in countries without this sovereign rating reference.

However, the external economic and financial crisis in September 2008 brought excessive volatility to the markets and caused a retraction in global activity. During this period, the BNT carried out four simultaneous long-term fixed rate bonds spread auctions. These auctions were intended to give price references to investors, as well as to avoid opening premiums. The BCB, in turn, based on a diagnosis of lack of liquidity in the foreign exchange market, opted to provide liquidity through different instruments in foreign currency. Coordinated actions contributed to lower interest rates and allowed some investors to change positions without putting pressure on those interested in holding the position. This action involved a low financial volume in relation to the outstanding and was based on the objective of helping the soundness of the secondary market for government bonds.

After the initial shock of the Subprime crisis, perceptions about Brazil's performance evolved towards a vision of consistent recovery. This change was accompanied by an improvement in the external environment and had a direct impact on the reduction of financial volatility, helping to manage the public debt. Then, in the early 2010s, there was a deterioration in the domestic economy. As of 2013, some adverse economic aspects became acute (interventions on administered prices, increased public spending, reduced transparency in fiscal policy and a complex external environment) and began to have negative impacts on the domestic bond market, imposing difficulties for improve the public debt profile.

Due to the increase in risk aversion in 2013, when interest rates on government bonds proved to be excessively volatile given the prospect of anticipating the reduction of monetary stimuli in the US, the BNT returned to action through extraordinary purchase and sale auctions fixed rate bonds and inflation-linked bonds in June and August of that year. Still from the perspective of reducing global liquidity, the BNT carried out two extraordinary repurchase auctions in February 2014. At that time, there was a diagnosis of distortion in demand for fixed rate bonds and the extraordinary repurchase auctions helped to provide liquidity to holders of these bonds and indicate a price reference.

In 2015, in turn, the negative aspects related to the internal political environment still accumulated, so that there was deterioration in debt composition with increase share of floating interest bonds and reduction share of fixed rate and inflation-linked bonds, interrupting a long trend of advances in this direction. Furthermore, the trajectory of the FPD/GDP began to rise, revealing the fiscal difficulties that the country was facing. A remarkable fact of that year was the draft of the Annual Budget Law containing a primary deficit of BRL 30 billion in 2016, indicating the fiscal and political articulation difficulties, which led to the loss of investment grade in the classification from the S&P agency.

With deteriorating of economic conditions, BNT adopted measures between the end of September and the beginning of October 2016, canceling the auctions for the sale of fixed rate bonds and the exchange of inflation-linked bonds, followed by the announcement of one-off simultaneous auctions of purchase and sale of fixed rate

bonds and inflation-linked bonds, as well as an extraordinary floating bonds sale auction. The sequence of actions adopted was possible thanks to the flexibility brought about by the liquidity reserve.

Although of political difficulties and intense recession in economic in 2016, there was a perspective of overcoming the deep crisis. Part of the favorable perspectives came from the progress in the fiscal agenda, especially with the approval of Constitutional Amendment No. 95 (Expending Cap). However, the last quarter of the year was marked by a resumption of risk aversion, given the frustration with internal activity, the result of the North American elections and uncertainties in the European and Chinese economy. In view of these adversities, in November 2016, the BNT announced a program of extraordinary auctions for long term fixed rate bonds buybacks, as well as the cancellation of an auction for the sale of short and long terms fixed rate bonds. At the time, the objective was to remove interest rate risk from the market in order to mitigate excess volatility in the fixed rate markets.

In 2017, concerns about the structural adjustments needed for the Brazilian economy, such as the delay in approving the Social Security reform, in addition to uncertainties related to political support for the reformist agenda of the executive branch pressured the market. The month of May was marked by a significant deterioration in the political environment and financial conditions. In this scenario, the BNT canceled two auctions of fixed rate and floating bonds, as well as extraordinary auctions for the purchase and sale of fixed rate and inflation-linked bonds (causing a total net redemption of approximately BRL 2.1 billion). On that occasion, the BNT sought not to change the trend of asset repricing, but to avoid sharp short-term fluctuations that could hamper the proper functioning of the bond market and other related markets.

The year 2018 brought the expectation of volatility as a result of the political issues of the election year. In May, the domestic financial market was affected by greater uncertainties. The conjunction of internal elements (truck drivers strike, elections, political difficulties, blocking the reform agenda, etc.) and external elements (tensions in international trade, Brexit, economic weakness of some countries in the Eurozone and Emergentes, etc.) put pressure on the yield curve's rates at the medium and long-term, with an increase in risk premiums. The short-term rates also rose in anticipation of a more restrictive monetary policy, mainly due to exchange rate depreciation.

In this context, the BNT carried out extraordinary auctions and canceled some of the scheduled auctions, with the objective of removing pressures on the supply side and guaranteeing the functionality of the public securities market, mitigating the impacts of excessive volatility. Between late May and early July 2018, extraordinary fixed rate and inflation-linked bonds auctions were held. Additionally, the following traditional auctions were cancelled: i) two auctions of fixed rate and inflation-linked bonds, scheduled for May; ii) the entire month of June, with the exception of one auction of floating bonds; and iii) auction of long term fixed rate bond for early July. In total, seventeen extraordinary auctions were carried out, resulting in a net repurchase of approximately BRL 24.3 billion. On this occasion, there was an increase in the share of floating bonds to the detriment of fixed rate bonds. The actions of the BNT aimed at

reducing interest rate risk (level of DV01) and the liquidity reserve position remained quite comfortable.

The BCB acted in a coordinated manner in this episode. Investor demand for shorter bonds and the monetary authority to carry out an extraordinary repurchase operation with a 9-month term, usually the offered terms of repurchase agreements were between 3 and 6 months. The BCB also operated in the foreign exchange market through currency swaps, which correspond to the sale of dollars in the futures market. The coordinated actions were not intended to change the trend of asset repricing, but to avoid excessive fluctuations that would harm the functioning of the financial market.

### **Adverse Shock of the COVID-19 Pandemic**

The year 2020 was marked by an unprecedented adverse shock to the Brazilian economy, resulting from the COVID-19 pandemic. The impacts of the spread of the virus were observed in different segments, with health, social and economic impacts that resulted in the decree of a state of public calamity throughout 2020. The intensity of the crisis impacted the financial markets and brought uncertainty and volatility. In this context, the BNT acted in an extraordinary manner in the government bond market with the objective of mitigating adverse risks on financing needs and financial system.

Between March 12th and 26th, 2020 extraordinary auctions were held for the purchase and sale of fixed rate and inflation-linked bonds. Additionally, the following traditional auctions were cancelled: i) fixed rate, inflation-linked and floating bonds scheduled for March 12, 17, 19 and 26; and ii) long term fixed rate scheduled for April 2, 9 and 16. All these auctions were on the annual schedule. In total, the net repurchase was approximately BRL 35.6 billion. Additionally, on March 25, it was defined that floating bonds auctions would have two vertices: a long one maturing on jan/2026 and a short one maturing on jan/2022. Subsequently, on April 1st, the decision was taken to make floating bonds auctions weekly rather than biweekly.

In view of the scale of the crisis, the National Congress approved Constitutional Amendment 106/2020 to support some economic policy actions while the situation of public calamity persisted. Within the scope of public debt management, emphasis is given to the authorization given to the BCB to trade in the secondary market for public and private securities. This provision eliminated the legal uncertainty for the monetary authority to act in the public bond market. Although not triggered, this instrument precaution was important given the strong increase in the financing needs, which were under pressure because the fiscal policy against the crisis.

Other challenge for debt management on the crisis was the increase of federal government borrowing requirements at a time of great uncertainty and risk aversion from investors, who raised precautionary demand for liquidity. Therefore, resources migrated from government bonds to repo operations, which have shorter maturities and virtually no price volatility.

During this period, liquidity reserves helped the BNT flexibility to adjust issuances according to market conditions and to increase bond issuances timely. With the increase in borrowing requirements, the financial volume raised through

government bond issuances reached historical highs. While the financial volume monthly average in 2019 was BRL 58 billion, during the second half of 2020 it hit BRL 126.7 billion. Amidst a scenario of uncertainties, risk aversion and a steepening yield curve, the debt issuance average maturity declined, implying a shortening of the public debt maturity structure.

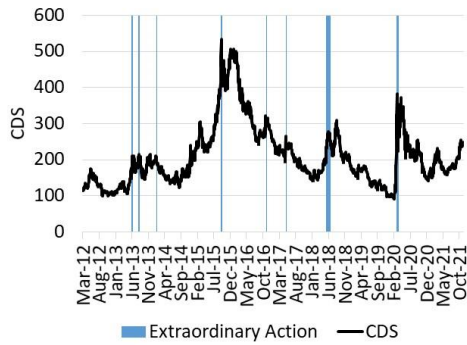
The BNT also promoted adjustments to its borrowing plan to meet the sudden rise of the borrowing requirements and to adapt the plan to the changing market conditions. The addition of certain on-the-run bonds throughout 2020 was a key factor to the success of the borrowing strategy, as it also provided flexibility to the debt management. With the market demand concentrated in short-term bonds, in particular, 6-and 12-month, and considering the steepening yield curve, the BNT increased the list of on-the-run bonds. With this measure, the Treasury intended to meet the sudden increase of borrowing requirements imposed by the pandemic while minimizing the consequences to the refinancing risk.

The financial volume raised through the issuance of domestic bonds in 2020 was BRL 1,298.6 billion. This amount was approximately 71.5% higher than the average of the previous four years. The sudden increase in government borrowing requirements explains the shock on government bonds offers. Furthermore, an environment of uncertainties and risk aversion explains the significant share of short-term maturities bonds in the borrowing strategy.

In 2021, the prospect of economic overcoming of the pandemic was consolidated with the spread of vaccination in the country. Internal uncertainties related to fiscal consolidation and the political environment are important challenges, but so far no extraordinary actions have been necessary in the public debt market. In this context, debt management has been gradually recovering its guidelines, mainly with the increase in the maturities of issues.

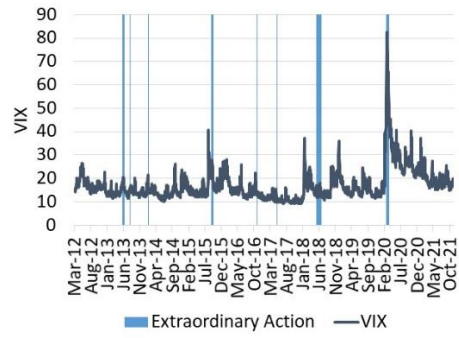
The crisis caused by the COVID-19 pandemic imposed unprecedented challenges for economies and global markets. In Brazil, the reaction caused a temporary increase in government expenditures. However, the timing and the magnitude of the measures succeed in mitigating the negative impacts over the main macroeconomic variables. In this context, the FPD management played its role in fulfilling the federal government borrowing requirements and guaranteeing the proper functioning of the federal government bond market. Aspects of the FPD management, such as the increase of a liquidity reserve, a mainly domestic debt composition and a developed and organized government bond market proved to be important mechanisms to mitigate the COVID-19 crisis effects.

**Chart 1 – 5-Year CDS – Brazil**



Source: Bloomberg and BNT.

**Chart 2 – VIX**



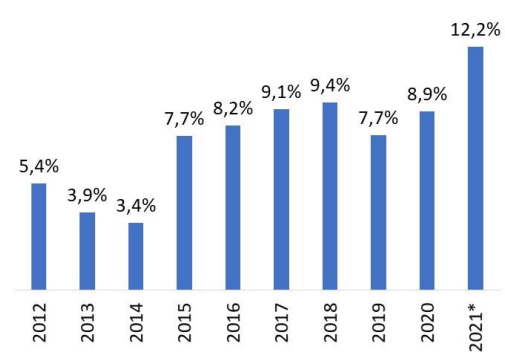
Source: Bloomberg and BNT.

**Chart 3 – Domestic FPD Bond Issuance**



\*Year to June.  
Source: BNT.

**Chart 4 – Liquidity Reserve/GDP**



\*Year to June.  
Source: BNT.

This historical analysis indicates that actions of BNT were associated with moments of risk aversion. It is also important to note that, although peaks in the BNT's actions are related to moments of stress, the action of economic authorities can mitigate abrupt movements in asset prices, whether government bonds or foreign currency. In other words, an event of extreme volatility may not have occurred as a result of the action of the economic authorities, despite the construction of an adverse scenario.

On the other hand, it is noteworthy that the constant presence of the debt manager tends to lead to strategic behavior on the part of financial market agents, which can increase the appetite for risk, confident that they will be able to count on the BNT's performance during scenarios of instability. Such behavior may result in an increase in volatility events and/or income transfer between agents with different positions in the market. Another possible problem with the premature or excessive use of extraordinary auctions is the loss of effectiveness of such a strategy and, consequently, difficulty in re-establishing normal business conditions.

## 4 Quantitative Analysis

This section aims to develop statistical tools to assess the conditions of extraordinary actions by the BNT. For this purpose, we used two methods: i) an econometric model was used, which allows evaluating how and which financial indicators were important for the performance; and ii) the other metric used was principal component analysis, which allows an aggregated assessment of how financial volatility behaved at the time of operation. It is important to emphasize that these quantitative exercises are incapable of evaluating the efficiency of the actions. For example, aspects such as gains/losses, incentives or reputation of the debt authority are not covered in this analysis. Furthermore, the model refers to the debt manager's past analysis and is not necessarily a guide for future actions

To assess the need for intervention by the BNT in the public bonds market, the following research strategy was adopted: i) survey of the moments of action; ii) definition of market variables that can give rise to extraordinary actions; iii) econometric analysis using extraordinary actions as a dependent variable and market indicators as independent variables; iv) definition of a volatility index based on the indicators and an *ad hoc* metric that can suggest moments of high volatility in the financial market, an environment that can give rise to extraordinary actions.

To assess the BNT's actions, binary models were chosen<sup>13</sup>, which are frequently used in studies that assess agents' exclusive choices, suitable for situations in which the agent has only two alternatives. In the case in question, between acting or not in the government bond market. Additionally, based on the Principal Component Analysis (PCA)<sup>14</sup> of the series of indicators, a series of financial volatility was constructed from the 10 indicators evaluated and it was defined as a rule that results above the 95th percentile would be characterized as an extreme measure of risk.

The variables used in the evaluation are divided into 5 distinct categories, which demonstrate both domestic and external market conditions, namely: i) level of volatility; ii) lack of liquidity; iii) lack of price reference; iv) feeling of risk; and v) asset repricing. A total of 11 variables were analyzed and are described in Appendix I. The analysis period chosen comprised the interval between 08/01/2013 and 11/22/2021, with data on a daily basis. Econometric estimation using a Probit or Logit model requires that the series be stationary, a procedure that was verified in the variables used (Annex I). The results of the econometric estimation are shown in Table 2. The estimates for the coefficients of the independent variables showed the expected signs and were statistically significant up to the 10% level in all models. Regarding statistics, in general, the Log-Likelihood, Akaike and Schwarz signaled a marginally superior adjustment of the Probit in relation to the Logit model. The Ordinary Least Squares

---

<sup>13</sup> According to the methodological description in Annex I.

<sup>14</sup> Principal Component Analysis (PCA) is a method used to reduce the dimensionality of multivariate data, that is, it allows the expression of available information in fewer variables. The principal components are able to extract the variability of the original variables, allowing data analysis to be simplified. The purpose of PCA is to combine the variables ( $X_1, \dots, X_i$ ) and create index ( $Z_1, \dots, Z_i$ ) that are uncorrelated and that explain the variation in the data.

(MQO) model was estimated for comparison purposes only. It is noteworthy that Table 2 only reports the model with the best test statistics.

**Table 2 – Regression Results**

	<b>PROBIT</b>	<b>LOGIT</b>	<b>MQO</b>
<b>C</b>	-3.74*** 0.30	-7.44*** 0.68	-0.08*** 0.02
<b>AMPLITUDE_DI(-3)</b>	37.47*** 6.81	72.16*** 14.33	5.57*** 1.16
<b>VOLUME_DI(-3)</b>	1.83*** 0.00	3.74** 0.00	0.07 0.00
<b>CDS_BRAZIL(-3)</b>	2.37*** 2.37	15.38*** 5.47	0.76*** 0.28
<b>IMPLICIT_VOL_EXCHANGE_RATE(-3)</b>	3.61*** 0.01	8.39*** 0.03	0.006 0.00
Akaike info criterion	0.19	0.20	-0.88
Schwarz criterion	0.21	0.21	-0.87
Log likelihood	106.27	103.61	
H-L Statistic	4.94	4.06	
Obs with Dep=0	1430	1430	1430
Obs with Dep=1	42	42	42
Obs Total	1472	1472	1472

Notes: Standard deviations are in parentheses. Akaike and Schwarz indicate the model's fit information criteria. LL stands for Log Likelihood. H-L Statistic of fit adequacy evaluation for binary specification. The p-value of the t-statistic is given by: \* if  $p < 0.10$ , \*\* if  $p < 0.05$  and \*\*\* if  $p < 0.01$ .

Source: authors.

The fit of binary choice models is usually assessed in the form of a comparison between predicted values and realized values. Wooldridge (2010) suggests that using the success fraction of the complete sample as a limit or cut-off point is the most adequate way to assess the correctly predicted percentage of the model. That is, if the total of extraordinary actions corresponded to 3.0%, every time the model indicates a probability greater than 3.0%, there will be an indication of extraordinary action. In this perspective, the total forecast accuracy (acting and not acting) was 83.6% =  $(1,197+34)/1,472$ . Type II Error (not predicting action when it occurs) of 0.7% =  $8/1,205$ . The estimated series considered 42 BNT actions, of which the model predicted 34, that is, 81.0%. A pertinent criticism of the model is that it accuses many possibilities of actions, 233. In other words, there are many indications of actions, an aspect that is counterintuitive to the practice of public debt management, since they must have an exceptional character.



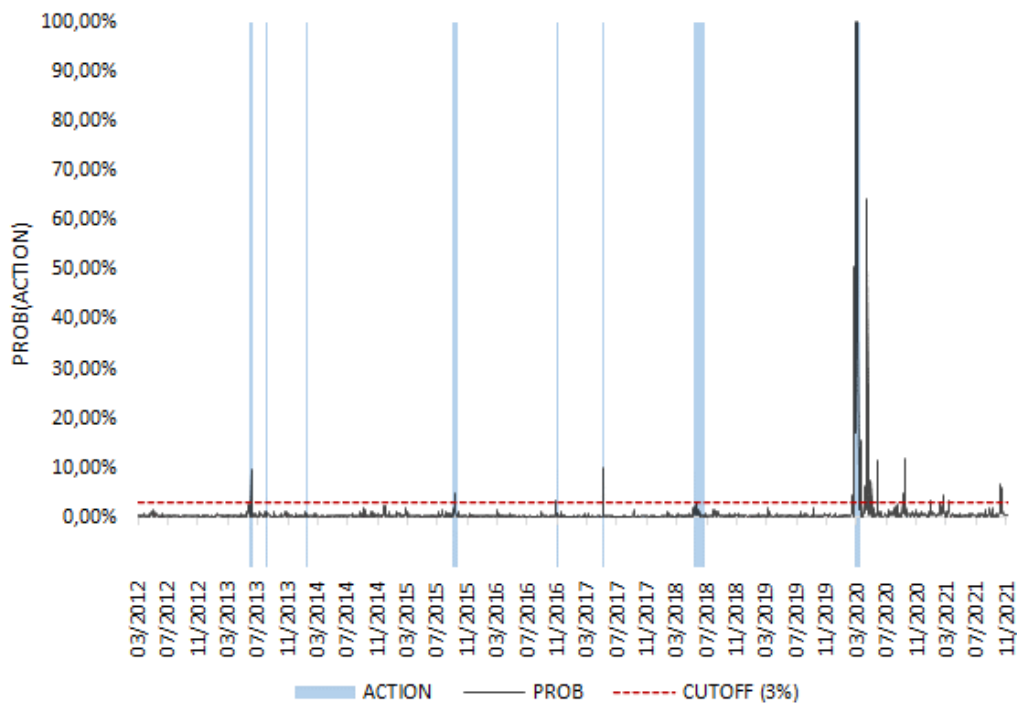
**Table 3 – Chosen Model (cut-off - 3,0%)**

		Estimated					Estimated (%)		
		0	1	Total			0	1	Total
Observed	0	1197	233	1430	Observed	0	81,3	15,8	97,1
	1	8	34	42		1	0,5	2,3	2,9
	Total	1205	267	1472		Total	81,9	18,1	100,0

Source: authors.

The graph below shows the BNT's probability of action (black line), as well as the dates of operations (blue bar) and the historical cutoff (red dashed line). In a simple reading, whenever the indicator of probability of action exceeds the historical cutoff, there is a relevant probability that the BNT will adopt extraordinary actions. As can be seen from the visual analysis, most of the BNT's actions coincide with the estimated indications.

**Chart 6 – Probability of Extraordinary Actions**

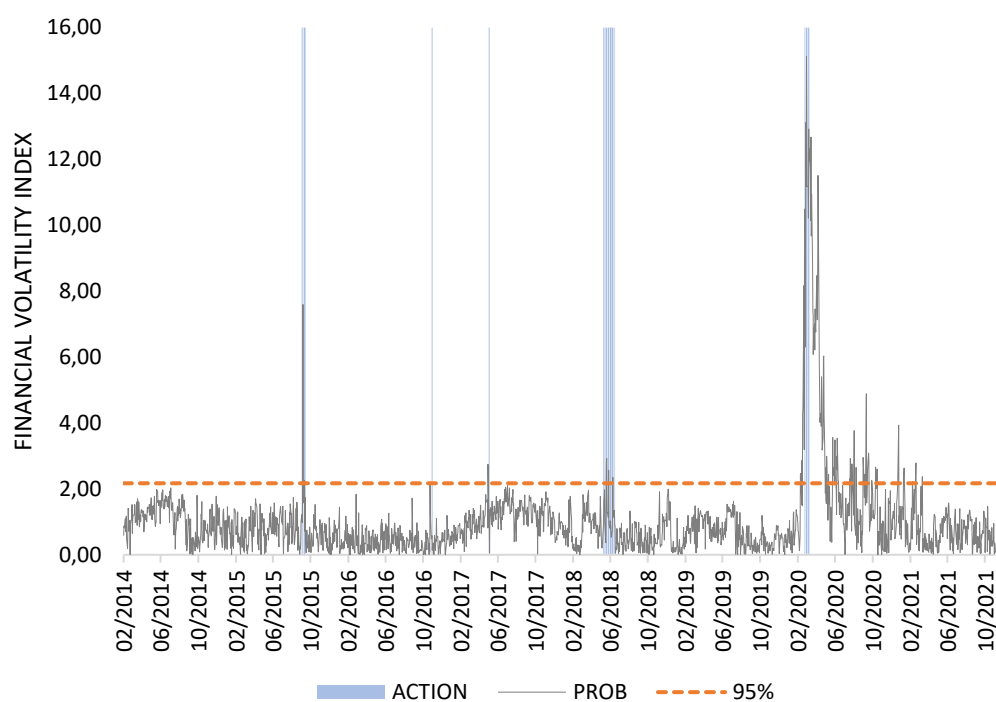


Source: authors.

The second method that we used also considers the group of 11 variables whose common behavior corresponds to the conditions of the financial market, in this case the extraction of the main components was considered to construct a financial volatility index. With this, it was possible to propose a metric for evaluating stressful situations in the financial market. Adopting variations above two standard deviations

(percentil of 95%) as an ad hoc criterion of high volatility, 70 moments were indicated during the period of analysis. During this period, the BNT performed special operations 44 times, and all actions, with the exception of those that took place in 2014, were located at least in the same week as the financial volatility index stress indication with 10 actions coinciding exactly with the indicated day by the index. Chart 7 shows the financial volatility index.

**Chart 7 – Volatility Index**



Source: authors.

Obtaining indications that the actions of the BNT remained within moments of volatility was an expected result. However, these indications are insufficient to determine the form of action, whether in instruments, time or intensity. In other words, the tool is able to indicate only one vector of the set of information that involves a debt manager's reaction.

It is also important to note that, although peaks in the financial volatility index indicate moments of stress or the precedence of a crisis, the action of economic authorities can mitigate abrupt movements in asset prices, whether government bonds or foreign currency. In other words, an event of extreme volatility may not have occurred as a result of the action of the economic authorities, despite the construction of an adverse scenario.

## Concluding Remarks

The approach to evaluate extraordinary actions of the public debt manager must encompass not only aspects that are intrinsic to debt management but also those related to the country's macroeconomics, public finances and institutional structure. In this sense, some tools have been consolidated as strategic among debt managers, with liability management operations being used for different purposes, such as supporting the government bond market in stressful situations.

In Brazil, this perception is present, and the National Treasury has acted several times over the last few years with the purpose of contributing to the good functioning of the public securities market. Therefore, we sought to understand the tools and contexts that gave rise to the extraordinary actions of the BNT, as well as the construction of the underlying factors that supported them. In this sense, an attempt was made to highlight the role played by the official credit policy and the institutional arrangement of the relationship between the National Treasury and the BCB over the last few years as a source of financing for the TSA and for the liquidity reserve.

The results of the quantitative analysis showed that important indicators of financial market volatility are relevant for forecasting the actions of the BNT in the public bond market. The models tested showed a high predictive capacity of the BNT's actions and were robust to different sets of independent variables and statistical tests. Furthermore, the analysis of principal components confirms the perception that moments of financial volatility were important for the decision to act of the public debt authority. The construction of an *ad hoc* metric of extreme volatility moments based on the financial volatility index also confirms the debt manager's performance system.

Therefore, the results suggest a performance of the BNT associated with volatility peaks over time, based on criteria and indicators that reflect the financial situation of the public bond market. Furthermore, they indicate that the selected model and the financial volatility index can be used to monitor the government bond market and to support the formulation of strategic actions aimed at improving the functionality of the government bond market.

However, it is worth noting that the use of indicators or mechanical metrics represents only one dimension in the light of the broad spectrum related to the BNT's actions and the financing process. The relationship between debt management and fiscal, exchange and monetary policy, as well as the interaction with different market participants, are essential conditions for decision making, and financial indicators should not be the only variable analyzed. Advancing the understanding of metrics that help in diagnosing public bond market conditions and that can help the debt manager in the decision-making process must be a constant exercise.

In the case of extraordinary actions, the interaction between analytical techniques and the debt manager's experience, as well as the idiosyncratic institutions of each country, is fundamental for debt management. The manager's technical tools and experience are, therefore, complementary and not substitutive.

Quoting Bolder and Deeley (2011), it could be said that economic-financial indicators are available tools that should be used together (not as a substitute for) of the manager's judgment. Thus, indicators are necessary because intuition cannot be fully trusted. However, intuition is necessary because indicators cannot be fully trusted. It is the controlled interaction between these two elements that contributes to a good debt management policy.

Finally, it should be emphasized that the actions of the National Treasury must be primarily focused on the development and preservation of a competitive and efficient public bond market, with the maintenance of the debt manager's reputation being necessary to decide whether or not to act at times of uncertainty or information asymmetry, since their actions have the potential to change the behavior of market participants and, consequently, the process of price formation of government bonds.

## Annex I

**Table 4 – Debt Management Objectives by Country**

	Cost and Risk Minimization in the Long Term	Cash Flow Optimization	Secondary Market Efficiency	Diversification of the Investor Base	Economic Coordination
Brazil	X		X		
Colombia	X				
Denmark	X		X		
Finland	X				
Ireland	X				
Jamaica	X				
Japan	X				
Mexico	X		X	X	
New Zealand	X			X	
Poland	X				
Portugal	X		X		
UK	X	X			
Turkey	X		X		X

Source: authors

## Annex II - Description of Indicators

The indicators analyzed to support decision making regarding the execution of extraordinary auctions of public debt securities of this National Treasury Secretariat were grouped into 5 categories, namely:

- 1) **Volatility indicators:** The occurrence of volatility at abnormal levels that are not explained by structural factors;
- 2) **Indicators of lack of liquidity:** The lack of liquidity in the markets makes it impossible to close positions and increases the risk of agents;
- 3) **Indicators of Absence of Price References:** Make it hard or impossible to carry out negotiations in the secondary market;
- 4) **Risk sentiment indicators:** Seek to show an atypical detachment between real and nominal interest rate curves;
- 5) **Asset repricing indicators:** They seek to identify whether the market is going through a period of transitory volatility or whether the price of assets undergoes a process of change in level.

Below is a brief description of the indicators.

## **1) Volatility Indicators**

Moments of uncertainty and/or risk aversion in the markets tend to be accompanied by an increase in asset price volatility, which in turn can impact the correct functioning of markets and even generate problems for public debt management. The indicators selected to indicate financial market volatility are:

### **1.1 DI Amplitude**

The DI amplitude indicator is calculated from the maximum and minimum trading rates of DI contracts throughout the day, and measures the percentage of the rate variation of such contracts in basis points in relation to the average of the maximum and minimum rates, the final indicator is obtained in this way:

$$\text{AmpDI\%} = (\text{Tx.max\%} - \text{Tx.min\%}) / [(\text{Tx.max\%} + \text{Tx.min\%})/2]$$

Where:

AmpDI% = DI Amplitude as a percentage of the average of the maximum and minimum rates

Tx.max% = Maximum DI rate traded throughout the day

Tx.min% = Minimum DI rate traded throughout the day

For the elaboration of this indicator, the maturity of January 2021 was initially chosen due to its great liquidity. It is understood that in times of stress, the market will show an increase in volatility, which may be reflected in greater intraday variation in the rates traded in DI contracts. Trading data is registered by the Stock Exchange - B3, and obtained from the Bloomberg platform.

### **1.2 VIX**

The VIX volatility indicator was created by the Chicago Board Options Exchange (CBOE) and is an indicator of the volatility of stock options traded on the Standard & Poor's 500 (S&P 500), the main composite US stock market index. For five hundred assets listed on the New York Stock Exchange (NYSE) or NASDAQ. The VIX represents the market's expectation for share price volatility over the next 30 days, and can be a good gauge of the level of stress in the global market, given that in times of crisis share price volatility tends to increase.

### **1.3 Implied volatility of exchange options**

The implied volatility indicator for exchange options (FX vol) prospectively measures the uncertainty of the future exchange rate that is embedded in the trading of US dollar options on the BM&F. Implied volatility is an undetermined variable in the

Black-Scholes option pricing model and as it cannot be observed, it must be calculated using the other inputs of the model, namely:

- Option market price; Target share price; Exercise price; Time to maturity; and Risk-free interest rate.

With the option's current price, the Black-Scholes formula can be solved by obtaining the implied volatility value.

The FX vol index is published daily in the BM&F's daily bulletin, with reference to the trading of options that took place in the trading session immediately prior to the disclosure date. Its historical series can be obtained from the Bloomberg platform.

## **2) Absence of Liquidity Indicators**

Lack of liquidity is another good metric to check moments of great risk aversion in the financial market, as the lack of reference prices, caused by high volatility, can make agents feel insecure about doing business, taking away liquidity from the market. In moments like this, the performance of this National Treasury Secretariat, offering extraordinary auctions and acting in the purchase and sale of selected securities, can help the market to return to its normal operation by increasing liquidity. The indicators selected for checking market liquidity are:

### **2.1 Daily Volume of Reference DI Contracts**

The daily contract volume indicator of the reference DI is constructed from the sum of the total intraday volume of a specific DI contract maturity. Initially, we chose to follow the January 2023, January 2025, January 2027 and January 2029 maturities due to their liquidity. However, for the regression we used a series consisting of the trading volume of the January 2017 DI ranging from 01/01/2013 to 8/25/2014 and the January 2021 DI ranging from 8/25/2014 to 12/07/2018 .

The trading data of DI contracts are registered by the Stock Exchange - B3, and obtained from the Bloomberg platform.

### **2.2 Total Daily Volume of Public Securities**

The total daily volume of government bonds indicator seeks to have an overview of liquidity in the secondary market for government bonds, and monitors the aggregate daily trading volume of each category of government bonds (Letra Financeira do Tesouro - LFT, Letras do Tesouro Nacional - LTN , Notas do Tesouro Nacional série B - NTN-B and Notas do Tesouro Nacional série F - NTN-F). NTN-F were further subdivided into two categories, the first covering the volume of the NTN-F market as a whole and the second the volume of maturities 01/2025, 01/2027 and 01/2029. Data on government securities trading are registered in the Special System for Settlement and Custody - SELIC, and obtained from the Bloomberg platform.

## **3) Absence of Price Reference Indicators**

During times of turmoil, it is very common for markets to lose the relative price reference for financial assets, whether due to the drop in liquidity of these assets or other factors, which can generate a vicious cycle, further reducing market liquidity and making it difficult to return to a balanced situation. In times like this, a performance by this STN offering extraordinary auctions, and acting on the buying and selling points of selected securities, can help the market to return to its normal operation by providing different players with a fair buy and sell spread. The indicator selected for checking the absence of a price reference is:

### **3.1 Public Securities Spread (Purchase Rate - Sell Rate)**

The government bond spread indicator measures the relationship between the spread and the reference rate for buying and selling the bond, as follows:

$$\text{Spread\%} = (\text{Rate.purchase\%} - \text{Rate.sale\%}) / [(\text{Rate.purchase\%} + \text{Rate.sale\%})/2]$$

Where:

Spread% = Spread in percentage of the average of the reference rates for the purchase and sale of the security.

Rate.purchase% = Referral rate for purchase.

Rate.sale% = Referral rate for sale.

The reference rates for buying and selling are calculated through a daily survey carried out by Anbima with the main financial institutions.

For this study, it was decided to limit the maturity of the analyzed government bonds. The criteria for selecting the maturities to be monitored was liquidity in the secondary market, which at this time resulted in the following maturities: NTN-F 2023 and 2025.

## **4) Risk Feeling Indicators**

Risk sentiment indicators bring aggregate market data that may indicate moments of great stress in the global or local financial market. In this way, the risk spread charged to the private sector, the risk spread of Brazil against selected countries, among other data, are analyzed. The indicators selected for checking market risk sentiment are:

### **4.1 TED Spread**

The TED Spread measures the spread between the US government's 3-month Treasuries and the 3-month interbank rate of the international market (Libor) in US dollars, and aims to measure the difference in the cost of short-term financing in the States States and the Libor rate. Given that Treasuries are considered one of the least risky assets in the market, it is expected that, during times of stress, the spread charged by financial agents to finance banks will rise, in other words, the greater the



risk of liquidity or solvency banks, the greater the spread between Treasuries rates and Libor. This indicator is taken from Bloomberg data.

#### **4.2 Libor OIS**

Libor OIS measures the spread between the interbank rate on the international market (Libor) and the Overnight Indexed Swap rate (OIS), which measures the cost of exchanging a pre-fixed flow for a floating rate flow of the same period in the American market. Thus, the Libor OIS spread measures the difference in the cost of interbank loans in the international market, which have solvency risk, with the risk-free interest rate of the American market. Similar to the TED spread, it is expected that, during times of tension, the rate of remuneration charged by financial agents to finance banks will rise, in other words, the greater the liquidity or solvency risk of banks, the greater the spread between the free interest rate and the Libor. This indicator is taken from the Bloomberg database.

#### **4.3 CDS Brazil**

The Credit Default Swap - CDS is the premium charged to the investor by the seller to guarantee the payment of a specific issuer's bond, that is, it works as a kind of insurance, ensuring that the investor receives the amount owed to him by the issuer. CDS works as a measure of the issuer's credit risk.

The analysis of Brazil's CDS is a good indicator of the market's confidence in Brazil's ability to honor its commitments. It is expected that in times of great uncertainty, the premium charged for such protection will increase, raising the CDS.

For regression estimation purposes, it was used the the CDS variation rate compared to the previous day.

### **5) Asset repricing indicators**

#### **5.1 Exchange Regression x DXY**

The U.S. Dollar Index or DXY is a measure of the strength of the US dollar against a pre-defined basket of foreign currencies. The index rises when the dollar appreciates or “gains” strength against other currencies, and falls when the dollar devalues or “loses” strength. Its linear regression against the real can show whether the real is undergoing a devaluation/appreciation process that is not explained by the gain/loss of strength in the dollar.

The indicator is calculated from the difference between the effective exchange rate in reais and the rate predicted by the linear regression of the exchange rate in reais against the DXY index.

Such regression in turn is obtained through the excel "linear prediction" function, which performs a simple linear regression in order to predict future values and is calculated as follows:

$$a = y^* - bx^*$$

and:

$$b = \frac{\sum (x-x^*)(y-y^*)}{\sum (x-x^*)^2}$$

where  $x$  and  $y$  are the arithmetic means of the DXY and Real/Dollar series respectively.

## 5.2 Linear Regression FX x DI

The Linear Regression of exchange rate x DI interest rate is used to find out if changes in the exchange rate can be explained by changes in the level of the interest rate. Initially, the 10-year DI rate was chosen as reference because it is less affected by short-term changes in the SELIC rate.

The index is obtained from the difference between the effective exchange rate in reais and the rate predicted by the linear regression of the exchange rate in reais against the 10-year DI rate.

Such regression in turn is obtained through the excel "linear prediction" function, which performs a simple linear regression in order to predict future values and is calculated as follows:

$$a = y' - bx'$$

and:

$$b = \frac{\sum (x-x')(y-y')}{\sum (x-x')^2}$$

where  $x$  and  $y$  are the arithmetic means of the 10-year DI and Real/Dollar series respectively.

## Annex III – Linear Probability Model

According to Wooldridge (2010), when  $y$  is a binary variable that assumes the values 0 and 1, the probability of success is the same as the expected value  $P(y_{it} = 1|x_{it}) = E(y_{it}|x_{it})$ . Thus, the Linear Probability Model (LPM) for a binary variable can be specified as follows:

$$P(y_t = 1|x_t) = x_t\beta \quad t = 1, 2, \dots, T$$

Where  $x_t = (1, x_{t2}, \dots, x_{tk})$  is a 1 x K dimensional vector that can contain observable variables that change between periods  $t$ .  $\beta = (\beta_1, \beta_2, \dots, \beta_k)'$  is the K x 1 dimension vector of all parameters. Thus, the coefficient is given by  $\beta_k = \frac{\partial P(y_t=1|x_t)}{\partial x_{tk}}$ , if  $x_{tk}$  is not functionally related to other explanatory variables. Hence  $\beta_k$  is the change in the probability of success, given a change of one unit in  $x_{tk}$ .

## The Binary Response Models

In general, the conditional probability of a binary response model is described as follows:

$$P(y_t = 1|x_t) = \begin{cases} \Lambda(x_t\beta), & \text{logit} \\ \Phi(x_t\beta), & \text{probit} \\ F(x_t\beta), & \text{general cases} \end{cases}$$

where  $\Lambda(\cdot)$ ,  $\Phi(\cdot)$  e  $F(\cdot)$  represents the specified functions. To ensure that the probability results in values such that  $0 \leq p \leq 1$ , we normally specify the function as an accumulated density function (ADF). The most common functions are those that identify the models known as logit and probit. In the case of the *logit* model the FDA is given by a logistic distribution, while in the *probit* the FDA is given by a standard normal.

## The Maximum Likelihood Estimation

Following Wooldridge's (2010) approach and considering strictly exogenous explanatory variables, for each temporal unit called  $t$ , we can establish the vectors of independent and dependent variables, respectively,  $\{(y_t, x_t): t = 1, 2, \dots, T\}$ , as a random sample of temporal data.

The interest of the estimation lies in understanding the distribution of  $y_t$  given  $x_t$ . Let's accept that the vector  $x_t$  can contain any lag structure of its variables and that  $f_t(y_t|x_t; \beta)$  denote the specified probability density function for each period  $t$ .

## The Probit model

Assuming strict exogeneity,  $D(y_t|x_t)$ , and that for each  $t$  unit of there is a binary result of  $y$ , the model can be written in latent variable form:  $y_t^* = x_t\beta + u_t$  e  $y_t = 1[y_t^* > 0$  (or any critical value)], in which the vector  $x_t$  contains exogenous variables. The conditional density of  $y_t$  is given by  $f_t(y_t = 1|x_t; \beta) = [\Phi(x_t\beta)]^{y_t}[1 - \Phi(x_t\beta)]^{1-y_t}$ .

## The Logit Model

In the *logit* with unobserved effects we also assume that the probability is given by  $P(y_t = 1|x_t) = \Lambda(x_t\beta)$ , where  $\Lambda(\cdot)$  is the logistical function<sup>15</sup>. If we keep the full set of assumptions, given by strict exogeneity, conditional independence, and normality assumption, we arrive at the *logit* random effects model.

### Choosing the Binary Model

According to Cameron and Trivedi (2005), the choice between econometric methodologies has practical and theoretical implications. From a theoretical point of view, the appropriate model depends on the data generating process, which is unknown. Also theoretically, the LPM would not be chosen, as it violates the

---

<sup>15</sup>  $P(y_t = 1|x_t) = \frac{e^{x_t\beta}}{1+e^{x_t\beta}}$ .

probability limits. However, from an empirical point of view, there is little difference between the predicted probabilities in the three models.

In the case of non-linear models, the predicted *probit* and *logit* probabilities tend to diverge more at the tails of the distributions, where the probabilities are close to 0 or 1, and are not as important when the interest lies in the marginal effects calculated on the sample and not in every individual. Additionally, the maximum likelihood properties can be used to obtain a model selection test. If we are satisfied with just choosing the model with the best fit, then just choose the model with the highest likelihood value.

## Annex IV – Stationarity tests

**Table 5 – Stationarity tests**

SERIES	CONST. and			STATUS
	CONSTANT	TREND	NONE	
AMPLITUDE_DI*	-9,42	-9,43	-2,95	Stationary
VOLUME_DI	-5,06	-5,06	-1,63	Stationary
SPREAD NTN-F*	-5,17	-10,88	-3,79	Stationary
CDS_BRAZIL*	-30,50	-30,52	-30,49	Stationary
EXCHANGE_REGRESSION	-14,12	-14,14	-14,14	Stationary
DXY_REGRESSION	-11,79	-11,79	-11,59	Stationary
IMPLICIT_VOL_EXCHANGE_RATE	-3,61	-3,63	-0,84	Stationary
VIX	-6,75	-6,74	-1,47	Stationary
<b>LIBOR OIS</b>	<b>-1,53</b>	<b>-1,13</b>	<b>-1,02</b>	<b>Non Stationary</b>
<b>TED SPREAD</b>	<b>-2,40</b>	<b>-2,23</b>	<b>-1,17</b>	<b>Non Stationary</b>

\* The AMPLITUDE\_DI, SPREAD NTN-F and CDS\_BRAZIL series used in the regression were constructed from non-stationary data. See Annex I for more details

**Table 6 – Stationarity test – 1º difference**

SERIES	CONST. and			STATUS
	CONSTANT	TREND	NONE	
AMPLITUDE_DI*	-	-	-	-
VOLUME_DI	-	-	-	-
SPREAD NTN-F*	-	-	-	-
CDS_BRAZIL*	-	-	-	-
EXCHANGE_REGRESSION	-	-	-	-
DXY_REGRESSION	-	-	-	-
IMPLICIT_VOL_EXCHANGE_RA	-	-	-	-
TE	-	-	-	-
VIX	-	-	-	-
LIBOR OIS	-12,31095	-12,31928	-12,30477	Stationary
TED SPREAD	-17,08874	-17,11308	-17,08928	Stationary

## Annex V –Econometric results

Table 8 – Estimation results

	PROBIT	LOGIT	MQO
C	-3.48****	-6.89***	-0.07***
	0.36	0.889	0.02
AMPLITUDE_DI(-3)	33.67***	63.98***	5.27***
	8.25	20.1	1.24
VOLUME_DI(-3)	1.64**	3.39	0.078
	0.82	2.11	0.07
CDS_BRAZIL(-3)	5.23**	11.85**	0.61**
	2.65	5.98	0.27
RESIDUE_EXCHANGE RATE_ - DXY(-3)	3.57***	6.62***	0.40***
	1.04	2.15	0.11
RESIDUE_EXCHANGE RATE – DI(-3)	-5.16***	-10.86***	-0.57***
	1.77	3.72	0.14
EXCHANGE RATE IMPLICITY VOL(-3)	0.01	0.04	0.00
	0.01	0.03	0.00
VIX(-3)	0.01	0.02	0.00
	0.02	0.04	0.00
SPREAD_LIBOR_OIS(-3)	5.80	19.64	0.19
	12.12	31.50	0.52
TED_SPREAD(-3)	-2.43	-4.94	-0.19
	5.76	12.30	0.29
Akaike	0.20	0.20	-0.88
Schwarz	0.24	0.24	-0.84
LL	-130.21	-132.02	644.37
H-L Statistic	11.01	7.10	-
LR Statistic	119.02	115.39	-
Obs with Dep=0	1394	1394	1394
Obs with Dep=1	42	42	42
Obs Total	1436	1436	1436

## Bibliography

BOLDER, D. J. The Canadian Debt-Strategy Model. Bank of Canada Review, 2008.

BOLDER, D. J.; DEELEY, S. The Canadian debt-strategy model: An Overview of the Principal Elements. Bank of Canada Review, 2011.

BLOMMESTEIN, Hans, Mehmet Emre Elmadag, and Jacob Wellendorph Ejsing. 2012. "Buyback and Exchange Operations: Policies, Procedures and Practices amongst OECD Public Debt Managers." <https://ideas.repec.org/p/oec/dafaaf/5-en.html#biblio>.

BLOMMESTEIN, H. J. Overview of Risk Management Practices in OECD Countries. OECD Publishing, Paris, 2005.

BLOMMESTEIN, H. J. e TURNER, P. Interactions between sovereign debt management and monetary policy under fiscal dominance and financial instability, OECD Working Papers on Sovereign Borrowing and Public Debt Management 3, OECD Publishing, Paris, 2012.

CABRAL, R., LOPES, M. et al. A Benchmark for Public Debt: The Brazilian Case. Tesouro Nacional, Departamento de Planejamento Estratégico da Dívida Pública, Brasília, 2008.

CRUZ, P. and KOC, F. The liquidity buffer practices of public debt managers in OECD countries, OECD Working Papers on Sovereign Borrowing and Public Debt Management, 2018.

PEREIRA, F. M., PEDRAS, G. B. V. and Gragnani, J. A. Mercado secundário da Dívida Pública Federal. In: SILVA, Anderson; CARVALHO, Lena; MEDEIROS, Otavio de (Org.). Dívida pública: a experiência brasileira. Brasília: STN; Banco Mundial, 2009.

DEUS, G.P.; FLEURY, G. M. N; LEITE, G. L.; LIMA, O. C. S; MOTA, T. O; SILVA, G. B. Normalização da Política Monetária Americana e Seus Impactos na Curva de Juros Brasileira. XX Prêmio Tesouro Nacional, Tesouro Nacional, Brasília, 2015.

ESCOLANO, J. A Practical Guide to Public Debt Dynamics, Fiscal Sustainability and Cyclical Adjustment of Budgetary Aggregates. IMF Technical Notes and Manuals, 2010.

GRAGNANI, J. A.; PEDRAS, G. B. B.; PEREIRA, M. P. Mercado secundário da Dívida Pública Federal. In: SILVA, Anderson; CARVALHO, Lena; MEDEIROS, Otavio de (Org.). Dívida pública: a experiência brasileira. Brasília: STN; Banco Mundial, 2009.

GOODHART, C. A. E. The changing role of central banks, BIS Working Paper 326, Bank for International Settlements (BIS), Basel, Switzerland, 2010.

HOOGDUIN, L.; ÖZTÜRK, B. e WIERTS, P. Public debt managers behaviour: Interactions with macro policies, DNB Working Paper 273, Netherlands Central Bank, Research Department, 2010.

IMF. Guidelines for Public Debt Management of 2001, revised in 2014.

IMF e WB. Developing government bond markets: A handbook, International Monetary Fund (IMF), Washington, D.C., 2001a.

MENDES, M. A Lei 11.803/2008 e a relação financeira Tesouro Nacional e Banco Central. In: Bacha, E. (org.). A Crise Fiscal e Monetária Brasileira. Rio de Janeiro: Civilização Brasileira, 1º ed, 2016.

SECRETARIA DO TESOURO NACIONAL. Plano Anual de Financiamento: 2001 a 2019.

TESOURO NACIONAL. Plano Anual de Financiamento. Brasília, Tesouro Nacional, 2004-2019.

\_\_\_\_\_. Relatório Anual da Dívida. Brasília, Tesouro Nacional, 2004-2019.

WORLD BANK. Revised Guidelines for Public Debt Management. Washington, DC: World Bank, 2014.

WORLD BANK. Bond Buybacks and Exchanges. Background Note. Washington, DC: World Bank, 2015.