Structural Break Analysis Of The Brazilian General Government Net Debt From 1998 To 2022

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Abstract
Public Debt Has Increased Substantially In Emerging And Developing Markets (Emdes) Since The 2009 Global Crisis. The Accumulation Of Public Debt Following The Subprime Financial And Economic Crisis Has Acted As A Buffer To The Negative Impacts On The Economy; In Addition, Covid-19, An Increase In Public Debt Was Further Justified Due To The Nature Of The Crisis. Therefore, It Is Considered An Acceptable Outcome. However, Once The Health Crisis Moves Away From Its Worst Period And The Recovery Begins, Keeping Debt At High Levels In The Medium Term Makes The Economy Vulnerable. In Brazil, The Fiscal Situation After 2014 Changed Its Trajectory. It Was Possible To Observe An Increase In Expenditure And A Reduction In Revenue, Accompanied By An Increase In The Public Debt. To Contain The Trend Mentioned Above, In 2016, The Constitutional Amendment To The Spending Ceiling (Ec 95/2016) Was Approved, Which Defines The Freezing Of Primary Federal Spending For 20 Years To Achieve Fiscal Adjustment And Consolidation. In This Sense, This Article Aims To Carry Out An Econometric Analysis And Investigate Whether, Based On Data On The General Government Net Debt, There Was A Structural Break In The Brazilian Public Debt In The Period From 1998 To 2022 To Provide The Literature And Open Space For A Debate Between The Need For Public Investment In The Country And The Importance Of Sustainable Debt Control.
Keywords: Public Debt; Fiscal Adjustment; Government Spending; Structural Change.

I.   Introduction

Public debt, current public spending, and social welfare are relevant topics extensively discussed in academia. Uncontrolled public debt (unsustainable, i.e., when the debt value exceeds the present value of all future primary surpluses) creates an environment of uncertainty for investors regarding the government's solvency capacity, contributing to an increase in country risk and causing an uptick in interest rates, thereby further augmenting the debt. Moreover, considering that the concept of development has not been surpassed and that economic and social disparities stem from historically deep-rooted inequalities (FRANKE and VIEIRA, 2021), the interaction between these economic variables and their implications for the economy vis-à-vis social needs is highly relevant and demands attention (SAMWEL 2016).

Brazilian debt has consistently represented a large proportion of GDP. However, since 2014, primary expenses have surpassed primary revenues, leading to a growing fiscal deficit and exacerbating the increasing public debt trend. Compounding this context, taxes in the country are concentrated and predominantly borne by the less affluent population due to a significant portion of the burden falling on indirect taxes tied to the consumption of goods and services. This further accentuates social inequality and contributes to the country's poverty rates (DE ALENCAR, 2020).

In recent years, the treatment of Brazilian public debt has become closely intertwined with the analysis of public spending. The premise is that controlling expenses contribute to sustainable levels of indebtedness. Therefore, to address the primary deficits observed since 2014 (TESOURO NACIONAL, 2017), Constitutional

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Amendment 95/2016 was approved, establishing a ceiling for government spending as part of the fiscal consolidation strategy.

However, a discussion arises: Is it feasible to comply with the "Spending Ceiling" when the Union has experienced significant growth in mandatory expenses in recent years? Given this reality, discretionary expenses, such as investments, have been curtailed due to fiscal restrictions. Consequently, concerns arise regarding investment expenditures and the potential for exceeding the spending ceiling. Arguments suggest that public infrastructure investment can improve the fiscal situation by promoting economic growth and increasing revenue (DE ALENCAR, 2020) without necessarily raising the already high tax burden.

When contextualizing the discussion within historical perspectives, it is evident that emerging countries like Brazil often exhibit high levels of public debt. These levels have demonstrated a tendency for further growth following the 2009 international crisis and the COVID-19 pandemic. The necessary spending to address the pandemic had to be executed by creating an emergency budget known as the "War Budget." This allowed for managing the crisis beyond the budgetary framework proposed by the spending ceiling. Failure to do so would have prevented using Union resources for this purpose, given that it did not align with discretionary spending categories.

On the other hand, in 2022, the current government proposed a controversial point called the "amendment to the rapporteur" (PR9) as part of the Budget Guidelines Law (LDO). This amendment allows for spending of approximately R$19 billion for parliamentary earmarks outside the spending ceiling. Scholars who strive to find viable means of reconciling sustainable debt control and public investment view this political development with concern.

To contribute to the discussion and analysis of the debt and its structure, this article's main objective was to examine whether any changes occurred in its patterns by applying the algorithm proposed by ZEILEIS et al. (2003). This algorithm utilizes linear regressions to identify structural breaks in the time series using a standard linear regression model. The aim was to observe whether the series of Net General Government Debt from January 1998 to September 2022 exhibited any structural breaks. This analysis seeks to determine if any political, economic, or historical factors explain the presence or absence of such breaks, thereby supporting existing literature and contributing to the reconciliatory debate between public spending and sustainable debt.

This work follows the following structure: the first section analyzes the discussions surrounding public debt, highlighting its definition, importance, and implications. This section is divided into two parts: the first part provides an analysis of government spending, its impact on debt, and the ramifications of Constitutional Amendment 95/2016; the second part presents the current Brazilian context "post-COVID-19" and during an election year. The second part explains the methodology used to verify the structural breaks. The third section presents the results obtained from the application of the structural break tests. Finally, the last section provides the conclusions.

## II.   Discussions on the Brazilian Public Debt

Different groups, including economists, politicians, and academics, have discussed and examined Brazil's governmental debt. The topics of discussion center on its scope, viability, effects on the economy, and potential controls. The magnitude of Brazil's public debt to its Gross Domestic Product (GDP) is one of the primary issues. The debt has grown significantly over time, reaching massive levels. This doubts the government's capacity to fulfill its financial obligations and the debt's long-term viability. The effect of government debt on the economy is a different topic of dispute. Increased interest rates due to excessive debt can harm consumer spending, private investment, and economic growth. Moreover, uncertainty Discussions on the Brazilian Public Debt.

Public debt, a stock variable, is directly related to the government's financing needs. When expenses exceed revenues, the government must seek alternative ways to finance its spending. To cover the deficit, public debt securities (such as LFT, LTN, NTN-F, NTN-B Principal, and NTN-B) are issued and traded in the open market. Each issued security represents an increase in the debt stock.

In addition to being a source of government financing, having a well-established securities market is crucial for the stability of the financial and macroeconomic systems. The open market operations are a fundamental instrument of the monetary policy conducted daily by the Central Bank. Public debt is also seen to make investments and fund social expenditures, contributing to the country's growth and reducing inequalities.

Debt is one of the variables observed in analyzing country risk. Therefore, for confidence and investment purposes, it is crucial to keep the debt stable and under control (TESOURO NACIONAL, 2017). To achieve this control, fiscal rules are implemented as part of the fiscal consolidation strategy. These rules are variables that optimize fiscal management based on sound finances. The fiscal rules include the resulting rule, the debt rule, the revenue rule, and the expenditure rule. The expenditure rule has been increasingly adopted by countries, including Brazil. This choice can be justified by the difficulty in expanding the tax base and increasing revenues, leading to a focus on expenditure containment.

After Brazil's fiscal situation became unstable in 2014 (SARAIVA et al., 2017; TESOURO NACIONAL, 2017), there was a need to address this situation by controlling the country's expenditures, as mentioned earlier. In this regard, Constitutional Amendment 95/2016, establishing a spending ceiling, was adopted to contain the growth of debt and restore Brazil's fiscal situation. Graph 1 below illustrates the deterioration of the country's accounts, showing the increasing trajectory of expenses and a slight reduction in revenues as a percentage of GDP between 2004 and 2019. Starting in 2020, there was a significant increase in expenses due to the COVID-19 crisis, with the government implementing an emergency budget to mitigate its effects.

Graph 1 - Primary revenues and expenses of the central government (as a % of GDP)
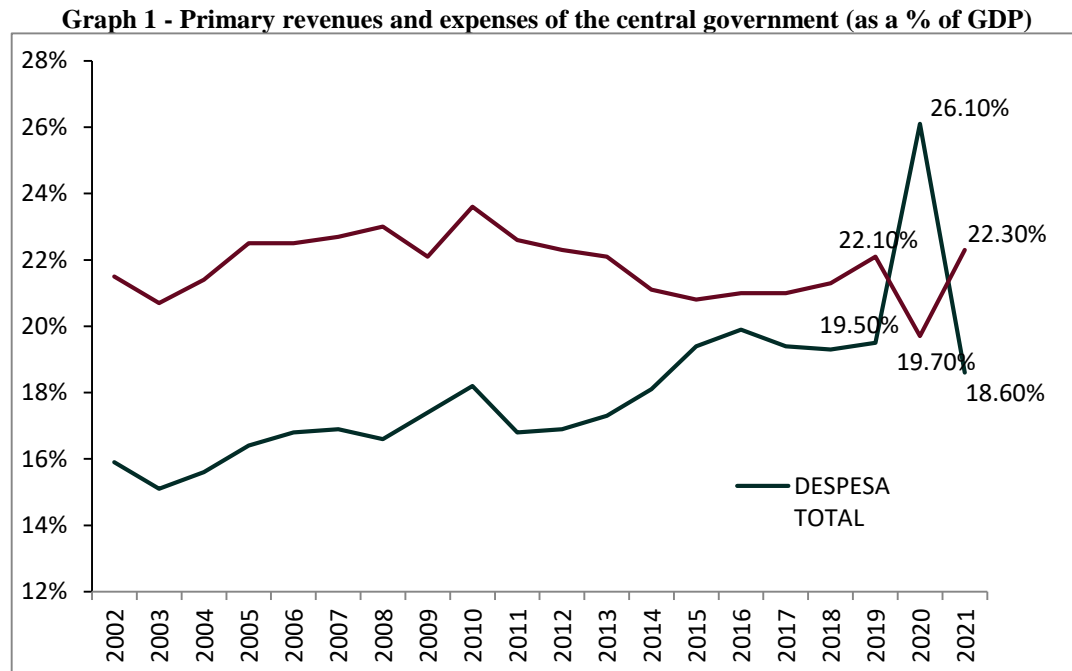
Source: Own elaboration based on data from the National Treasury

As a result, the increasing debt stock as a percentage of GDP can be observed in Graph 2. This aspect can be explained by the growth of expenses and the lack of corresponding revenue growth. According to an academic study published by Resende (2021), the increasing stock of Brazilian public debt as a proportion of Gross Domestic Product (GDP) can be attributed to the growth of government expenditures and the lack of revenue tracking. The researcher analyzed Brazil's fiscal data and found a significant increase in government spending during the examined period. However, this expenditure expansion was not accompanied by balanced revenue growth, resulting in persistent fiscal deficits. Consequently, the government had to increasingly resort to issuing debt securities to finance its expenses, leading to the growth of the debt stock relative to the size of the economy. The author emphasizes the role of money issuance and public debt as instruments used by the Brazilian government to tackle the economic crisis that occurred in 2020. The author explores the conventions adopted during this period, including the relaxation of fiscal rules and the need for financing through the issuance of debt securities. The study analyzes the impact of these measures on the Brazilian economy and presents reflections on the challenges and limitations faced by the country.

Graph 2 - Gross Debt of the Central Government (% of GDP)
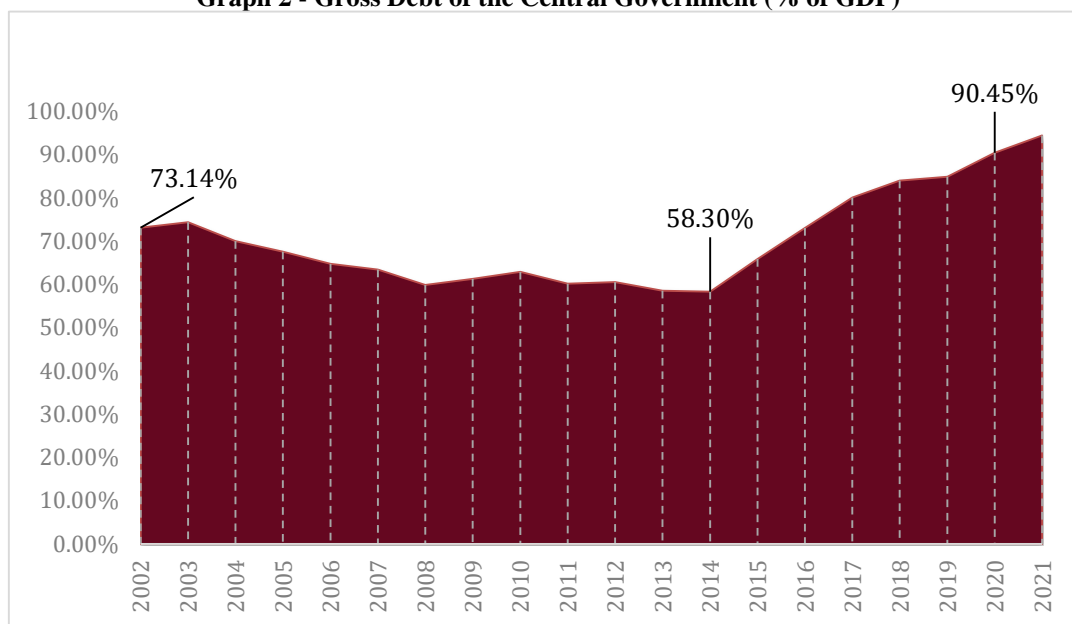
Source: Own elaboration based on data from the National Treasury

Different ideas and solutions have been discussed in this context to address the public debt in Brazil. Some of them entail tighter regulation of public spending, improved public financial management, and the execution of structural reforms to enhance the ability of the government to raise money. The necessity of encouraging an environment that fosters economic growth is often discussed because it can increase tax revenues for the government and lessen its reliance on borrowing. The complexity and breadth of the debates surrounding Brazil's national debt must be noted. There are various viewpoints and strategies that reflect the diversity of beliefs and interests. As a result, finding efficient and long-lasting solutions necessitates in-depth research and extensive yet constructive discussion among the many parties.

How government expenses and their control are central aspects adopted to maintain fiscal stability, as well as the level of debt, it is necessary to discuss this macroeconomic variable and the measures taken regarding it, presented in subsection.

Public Expenditure and Constitutional Amendment 95/2016 of the Expenditure Ceiling

As mentioned above, Brazil's fiscal situation has been the subject of constant discussions in recent years due to the increasing public expenditures not covered by tax revenues, leading to an unsustainable debt trajectory. Similar to other emerging countries, Brazil's fiscal fragility hinders the implementation of economic policies (ARAÚJO, 2019), adding to the uncertainties generated.

GIAMBIAGI and HORTA (2019) argue that curbing the "deficit bias" of the public sector and the need for economic policies to have credibility are two reasons fiscal variables were created. Therefore, debates about public debt and how to control it are crucial for Brazil's fiscal stability. As SARAIVA et al. (2017) pointed out, primary results and GDP growth observed from 2000 onwards contributed to a declining trajectory of the Net Public Sector Debt/GDP ratio.

However, according to the authors, this trend lost strength from 2011 onwards, and in 2014, the scenario reversed, with deficits in primary results and a decrease in GDP. Thus, adopting new mechanisms to control Brazil's fiscal situation became necessary.

In this regard, Constitutional Amendment 95/2016 was established to contain this trajectory and bring the country to a stable fiscal balance. However, opinions are divided regarding its effectiveness in curbing expenditures and public debt. Especially during election years, when the Annual Budget Guidelines Law and the Annual Budget Law for the first year of the elected president's term are approved, political motivations often lead to budget allocations for electoral purposes, including the distribution of the so-called "relator's amendment" (PR9 of the 2022 LDO), which involves the use of expenditures without transparency and equality among parliamentarians allegedly used for vote influence[4].

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[4] Congress approves LDO without forcing the execution of rapporteur amendments.
Available:https://www.camara.leg.br/noticias/896847-congresso-aprova-ldo-sem-obrigar-execucao-de-emendas-de-relator/

According to the World Bank report (2017)[5], adopting the expenditure ceiling is a fundamental measure for restoring Brazil's fiscal balance, as it limits federal primary expenditures. The report also highlights one of the significant challenges in implementing what the amendment proposes: the rigidity of mandatory expenditures, which constitute the most significant portion of government spending, such as public servant salaries and income transfers to parts of society. This problem becomes more significant when considering the real growth mandated by law (e.g., increased pension expenses resulting from the minimum wage increase), that some of these mandatory expenditures may undergo during the duration of the amendment (SCHYMURA, 2017).

According to GIAMBIAGI (2020), one alternative to maintaining the expenditure ceiling, considering the rigidity of mandatory accounts and their growth (as observed by the author between 2016 and 2021), is to cut discretionary expenses. These expenses refer to flexible expenditures that the government can decide how much, when, and in which sector to allocate. By analyzing the evolution of such expenses from 2016 to 2021 and observing their behavior in previous periods, the author concludes that in the year of the adoption of Constitutional Amendment 95/2016, there was a "margin of maneuver" that could be cut from the budget and contribute to the effectiveness of the amendment. However, over the years, this margin has been decreasing. It is still recommended to have some level of expense for the proper functioning of public sectors.

As a result, there have been several criticisms of the measure mentioned above. MARIANO (2017) argues that the expenditure ceiling does not consider the economic and demographic changes that may occur during the 20-year period in which the constitutional amendment will be in effect. This aspect will significantly affect investments and the provision of public services, particularly social ones.

Besides ensuring the maintenance of well-being through income transfer policies and investments, government spending covers required payments by the executive branch. While reducing these expenditures contributes to the country's fiscal stability, limiting them raises questions about the country's structural growth and the reduction of existing social inequalities. This highlights, once again, the trade-off between these issues.

Brazilian context: COVID-19 Crisis and Budgetary Guidelines Law[6]

To understand the context of Brazil's escalating debt, we will examine the historical process that encompasses the COVID-19 crisis, government spending policies, their adherence to the constitutional limits of Constitutional Amendment 95/2016, and the spending prospects outlined in the Budget Guidelines Law (LDO).

The COVID-19 health crisis in 2020 and 2021 left profound marks on economies worldwide, particularly impacting emerging countries (CAMPRA, et al 2021). The crisis deepened the fiscal dilemma that had been observed since the global financial crisis of 2008/2009, exacerbated by the complete shutdown of productive sectors in the economy in 2020, as well as the need to sustain livelihoods through income transfers and increased public health expenditures, pushing the debt levels to over 90% of GDP.

One of the debates during the COVID-19 pandemic revolved around the notion that the economy could not afford to come to a halt. Some sectors of society argued that the economic effects would be worse than those caused by COVID-19 (ALBER & DABOUR 2020). In contrast, others advocated for prioritizing human lives, aligning with the World Health Organization's (WHO) recommendations. The proposal to address the economic measures to mitigate the crisis was to be discussed after the pandemic subsided. In these circumstances, the legislative branch proposed and approved an emergency budget to combat the COVID-19 pandemic, known as the "War Budget," which authorized expenditures beyond the expenditure ceiling.

In the context of the Budget Guidelines Law (LDO), it establishes the budgetary goals and priorities of the executive government for the following year. It determines the amount of resources the government aims to save, sets rules, prohibitions, and limits for the branches of power, authorizes increased personnel expenses, regulates transfers to public and private entities, balances revenues and expenditures, and indicates priorities for financing by public banks. The National Congress approved the text of the 2023 Budget Guidelines Law with a highly controversial provision: the mandatory execution of what is known as rapporteur's amendments (RP9), which could amount to R$19 billion in spending "beyond the ceiling." Additionally, the government's proposed project foresees that the central government's public accounts (Treasury, Social Security, and Central Bank) will close in 2023 with a primary deficit of up to R$65.9 billion and establish a minimum wage of R$1,294 for the following year.

In 2023, the Executive expects the gross domestic product (GDP) to grow by 2.5%, the same percentage projected for 2024 and 2025. GDP represents the total wealth produced in the country. Regarding inflation, the National Consumer Price Index (IPCA) is estimated to be 3.3%, while the Selic rate (the Central Bank's benchmark interest rate) is set at 10% in the following year.

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[5] available: https://documents1.worldbank.org/curated/en/884871511196609355/pdf/121480-REVISED-PORTUGUESE-Brazil-Public-Expenditure-Review-Overview-Portuguese-Final-revised.pdf. Acesso em: 30 ago. 2022.
[6] Budget Guidelines Law for 2023. Bill No. 5 of 2022-CN.

For 2023, the projected total primary revenues amount to R$2.2 trillion. In 2024, the government's revenue is expected to reach R$2.36 trillion and R$2.52 trillion in 2025. Consultants indicate that the forecasted primary deficit of R$65.91 billion for 2023 would correspond to 0.63% of GDP, which is lower than the projected R$66.9 billion (0.69% of GDP) for 2022. The estimated loss for federal state-owned enterprises, excluding the Petrobras and Eletrobras groups, is R$3 billion.

According to the Executive, the spending limit for the federal government in 2023 is set at R$1.79 trillion, an increase of R$108 billion compared to 2022. This calculation takes into account an estimated 6.55% accumulated IPCA from January to December 2022, and the adjustment resulting from the difference between the IPCA projected in the 2022 Budget (10.18%) and the actual rate at the end of 2021 (10.06%), as clarified by the Budget Consultancy.

These trajectories of government expenditures emphasize the impossibility of making abrupt spending cuts in Brazil and reveal the country's vulnerability in controlling debt. They also shed light on political decisions regarding spending, such as RP9, which further restricts essential discretionary expenditures for the public sector's economy and social well-being.

Based on this explanation, we propose conducting an econometric analysis of the Brazilian public debt to contribute to the debate on fiscal rules that can be discussed and implemented to achieve sustainable debt levels while ensuring the well-being of civil society. By carefully examining the data, we can observe the behavior of Brazilian Net Debt in a time series from January 1998 to September 2022. Section 3, presented below, outlines the methodology for conducting a structural break analysis of the debt to determine if the observed phenomena in the series of years indicate any significant changes.

III.   Structural break model

In this section, we present the methodology used in this study to determine if there was a structural break in the public debt during the analyzed period, that is, if there was a sudden change in the data series. For this econometric analysis, time series data is utilized, which, after testing, shows whether there was a change in the trajectory of the object of interest (SHIKIDA et al., 2016). Generally, structural breaks are associated with significant events in a country's history, such as political and/or economic crises, epidemics, and wars.

The R package Strucchange, used in this article and produced by ZEILEIS et al. (2003), provides a robust statistical approach to identify and test structural changes in time series data.

The technique proposed in this article allows for detecting abrupt and significant changes in the relationship between explanatory variables and the response variable over time. These changes may indicate economic, political, or social events that have influenced the behavior of the data and require a differentiated analytical approach.

The Strucchange package facilitates the implementation of these structural change tests by providing various statistical methods, such as the Chow test, Andrews test, and parametric assumptions test, among others. These tools enable researchers and analysts to correctly identify and interpret structural changes in linear regression data, contributing to a more comprehensive understanding of the phenomena under study.

ZEILEIS et al. (2003) present ideas and methods for implementing generalized fluctuation tests and F tests comprehensively and flexibly that reflect the standard features of the testing procedures and offer facilities to display the results in various ways. These ideas have been realized in a package called strucchange in the R system for statistical computing, the GNU implementation of the R language.

The methodology proposed in this research was used in over 800 published articles in different areas. Wauchope et al. (2020) applied in ecology, Kurtz et al. (2021) and Ropkins and Tate (2021) in health. Bernabucci et al. (2014) applied this to livestock. They were used to study the effects of heat stress in Italian Holstein dairy cattle. Verbesselt et al. (2010) and De Jong (20121) used it to detect trends and changes in the time series of satellite images. Chakraborty and Joseph (2010) applied it in macroeconomics to the UK CPI inflation series. Jamali et al. (2015) in biology. The authors detected changes in vegetation trends using time series segmentation. Zhang et al. (2009) used the test and estimated the impact of extreme events on the price of crude oil: an event analysis method based on EMD. Bogdan et al. (2021) applied in finance; in the article in question, the authors investigated the Chicago Board Options Exchange Volatility Index ('VIX') response to the COVID-19 pandemic crisis in terms of information efficiency.

According to the algorithm proposed by ZEILEIS et al. (2003), we will work with a regression to capture potential breakpoints in the time series of the Brazilian public debt from 1998 to 2021.
For this purpose, we consider the following model:

$$y_i = x_i^\top \beta_i + u_i (i = 1, 2, \ldots, n) \qquad (1)$$

where i is the time index, y_i is the dependent variable, x_i is the vector of independent variables, β_i are the coefficients to be estimated for each x_i, and the term u_i represents the random component of the regression.

The model tests the following hypothesis:

$$H_0: \beta_i = \beta_0 (i = 1, 2, \ldots, n) \qquad (2)$$

The coefficients do not change over time since there are no structural breakpoints in the time series under the null hypothesis (H_0). The alternate theory contends that there is a structural breakpoint and that at least one coefficient changes with time.

In many applications, it is appropriate to suppose that there are m breakpoints, resulting in $m + 1$ unique segments in the time series, with the regression coefficients being constant within each segment but potentially varying between segments, according to ZEILEIS et al. (2003). SHIKIDA et al. (2016) suggest that we can adapt model (1) to include these $m + 1$ segments, which will β have different values:

$$y_i = x_i^\top \beta_j + u_i (i = i_{j-1} + 1, \ldots, i_j, \qquad j = 1, \ldots, m+1) \qquad (3)$$

Where j is the segment index, $T_{m,n} = \{i_1, \ldots, i_m\}$ denotes the set of structural breakpoint points $T_{m,n}$, also referred to as the m- Partition. $\{u_i\}$ } is a martingale difference sequence that is independent of x_i. By convention, $i_0 = 0$ e $i_{m+1} = n$.

According to SHIKIDA et al. (2016), there are three ways to test for structural breakpoints when estimating this model: the first is to see if the parameters changed over time (if a breakpoint occurred); the second is to determine when the breakpoint occurred; and the third is to determine the connection between the breakpoint and the unit root.

The most often employed tests to look into parameter instability, according to KLEIBER & ZEILEIS (2008), as quoted in SHIKIDA et al. (2016), fall into two categories: efp fluctuation testing and F-statistic-based tests.

According to ZEILEIS et al. (2003), the test is based on a sequence of F-statistics for a specific breakpoint at period i. The test utilizes the sub-samples (segments) obtained from the least squares estimated residuals. It compares them with the least squares estimated residuals from the overall sample using the F-statistic as shown in the equation below:

$$F_i = \frac{\hat{u}^\top \hat{u} - \hat{u}(i)^\top \hat{u}(i)}{\hat{u}(i)^\top \hat{u}(i)/(n - 2k)} \qquad (4)$$

The F-statistic is calculated for $i = n_h, \ldots, n - n_h (n_h \geq k)$. According to SHIKIDA et al. (2016), the null hypothesis is rejected if the function exceeds the respective critical values marked by a line on the resulting graph. We will explore this in more detail in the application of the model. In the test decisions, n_h will be a cutoff parameter that can be chosen by the test performer.

For the test that allows estimating a possible breakpoint given the model (3) of m-partition $n_1, \ldots, n_m$, the least squares estimate for can be β_j easily obtained (ZEILEIS et al. 2003). The sum of squared residuals is given by:

$$RSS(\hat{\imath}_1, \ldots, \hat{\imath}_m) = \sum_{j=1}^{m+1} rss(i_{j-1} + 1, i_j), \qquad (5)$$

where the result is the minimum residual sum of squares for segment j.
Detecting structural breaks involves finding the breakpoints that minimize the objective function:

$$(\hat{\imath}_1, \ldots, \hat{\imath}_m) = argmin(\hat{\imath}_1, \ldots, \hat{\imath}_m) RSS(i_1, \ldots, i_m) \qquad (6)$$

over all segments $(i_1, \ldots, i_m)$ with $i_j - i_{j-1} \geq n_h \geq k$.

IV. Results

The structural break tests described in section 3 were applied using the R-Project software to carry out the analysis suggested in this study, which tries to determine whether any changes have happened in the trajectory of the Brazilian public debt. The data series utilized was the Central Bank of Brazil's (BCB) Net Debt of the General Government in Current Values, which covered the period from January 1998 to September 2022. This series, in the words of the Central Bank, "corresponds to the net debt of the Federal Government, state governments, and municipal governments, with the public and private financial system, non-financial private

sector, and rest of the world." As seen in Figure 1, the chosen series shows a growing trajectory, which corroborates with what has been presented throughout the text.

Figure 1: Net Debt of the General Government (1998-2021) (in millions of R$)
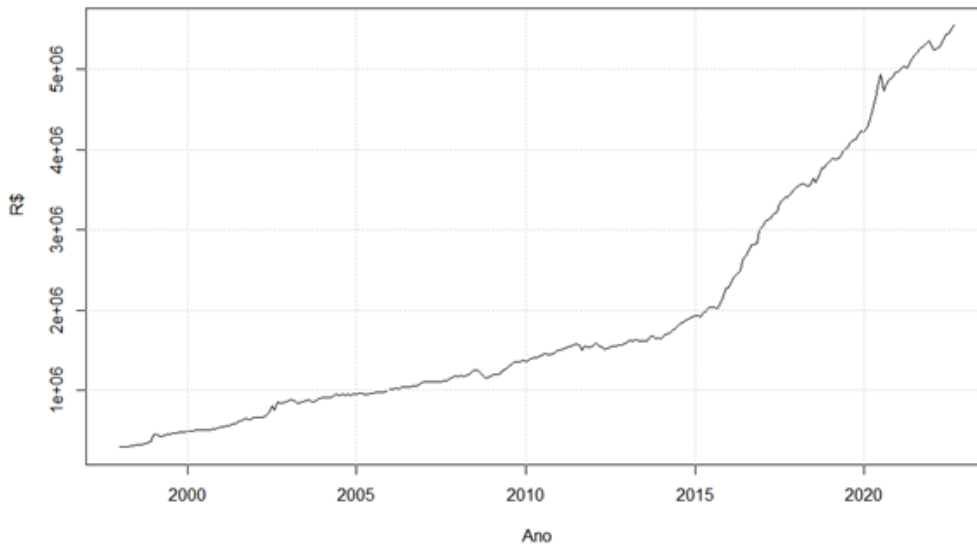
Source: Own elaboration based on data from BCB (Central Bank of Brazil)

Table 1 presents descriptive statistics for the series of 297 observations. The chosen periods were determined randomly based on visual inspection of the time series graph, rather than through econometric tests. The table reveals a high coefficient of variation, indicating a substantial dispersion around the mean for all periods except the most recent one.

Table 1 - Descriptive Statistics

Period	N. observations	Mean	Standard Deviation	Coef. Of Variation %
Jan 1998 a Dec 2002	60	528.230,23	150374,03	28,47%
Jan 2003 a Dec 2014	144	1.281.754,59	293198,86	22,87%
Jan 2015 a Dec 2019	60	3.119.910,47	725433,47	23,25%
Jan 2020 a Set 2022	33	5.041.625,72	343908,10	6,82%

Source: Own elaboration based on data from BCB (Central Bank of Brazil)

The outcomes of the tests that were run are shown below. The *strucchangeRcpp* package's "*breakpoints*" function analyzes and checks departures from stability in a conventional linear regression model (equations 1, 2, and 3). It is plausible to presume that there are m breakpoints in many cases where a relationship's coefficients change. To determine if m + 1 segments exist where the regression coefficients are constant or not, the test looks for such segments.

Bai (1994) laid the groundwork for estimating breakpoints in regression models for time series, while Bai (1997ab) and Bai & Perron (1998) expanded it for multiple breakpoints. The algorithm for simultaneous estimate of numerous breakpoints, as described in Bai & Perron (2003), is implemented via the "breakpoints" function.

Bai (1997b) provides the distribution function for the breakpoint confidence intervals. As previously indicated, Zeileis et al. (2003) discuss the fundamental concepts behind this approach. Given the number of breakpoints, the algorithm for determining the best breakpoints is based on dynamic programming. The Bellman's principle, which is the basic idea, states that the main computing work should go into calculating a triangular RSS matrix, which gives the residual sum of squares for a segment starting at observation i and ending at i' with i < i'.

The BIC, LWZ, and RSS selection criteria supported the decision on the number of breakpoints. Six breakpoints are reached when the information criterion, also known as the BIC selection criterion, in the test being done reaches its minimal value (Figure 2). Therefore, it is possible to determine the dates of the structural

breakpoints with m = 6 and h = 0.1. The BIC criterion's conclusions align with those of the LWZ criterion, a modified information criterion with harsher parameters.

Figure 2: Breakpoints and Sum of Squares of Residuals for Net Debt of the General Government (1998 - 2022)
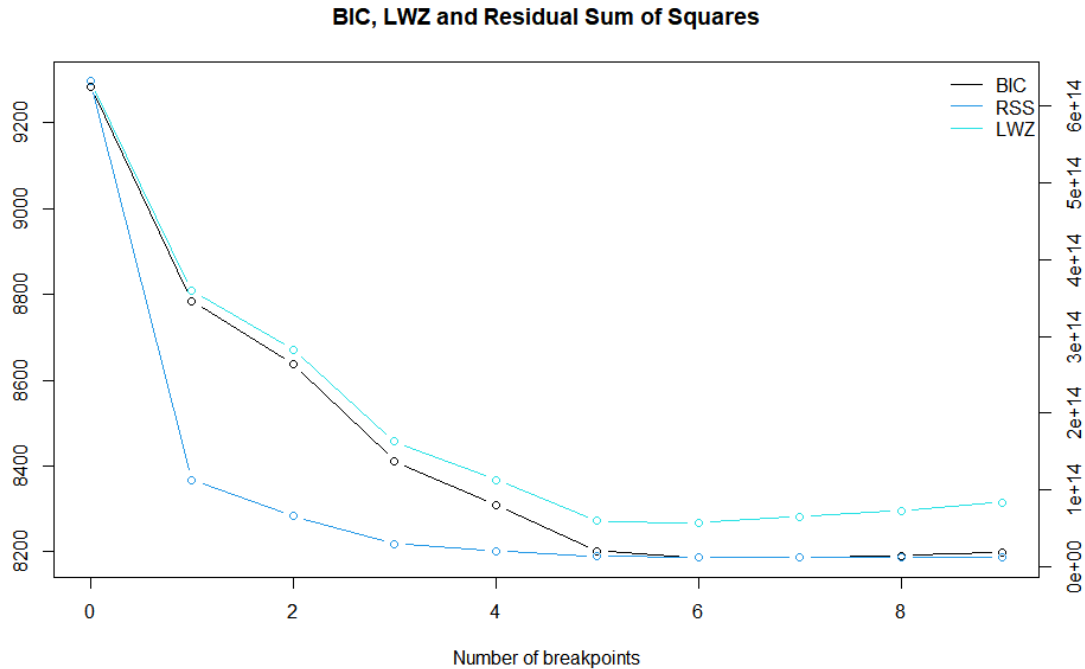
Source: Own elaboration based on data from BCB (Central Bank of Brazil)

The series of Net Debt of the General Government is shown in Figure 4 as a graph generated using the R-project software and divided into 7 (m+1) optimum segments. The structural breakpoints' dates are also mentioned. The size of the segments generally follows a pattern, except for the fifth segment, which is shorter than the others.

Figure 3 - Net Debt of the General Government (in millions of R$) divided into 7 optimal segments.
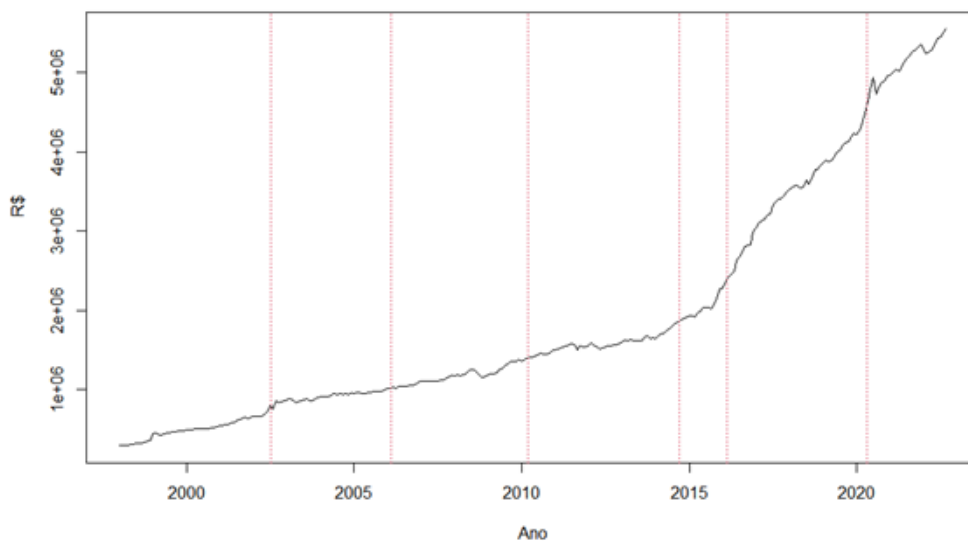
Source: Own elaboration based on data from BCB (Central Bank of Brazil)

Table 2 provides a more thorough description of the structural breakpoints, including the month, year, and 95% confidence intervals for each breakpoint. It is possible to better comprehend the debt's findings and trajectory by comparing the dates acquired from the econometric test with Brazil's political and economic history.

Table 2 - Breakpoints with Dates

Breakpoint	Date	95% Confidence Interval
1	5/2002	[4/2002, 6/2002]
2	10/2006	[8/2006, 11/2006]
3	2/2010	[1/ 2010, 3/ 2010]
4	7/2014	[3/2014, 8/2014]
5	12/2016	[11/2016, 1/2017]
6	3/2020	[2/2020, 4/2020]

Source: Own elaboration with data from R-project software.

As a result, it is determined that the data and testing indicate that structural breaches in the Brazilian public debt occurred in the years 2002, 2006, 2010, 2014, 2016, and 2020. This data may suggest that the containment of spending up to that time produced the first rupture, which occurred in 2002. The break is said to be explained by a process that began in 1999 when Brazil started to implement a floating currency rate and inflation goal since both policies were expensive. The debt figures started to decline starting in 2002, when there was a shift in the presidential administration, because of a decrease in these costs.

The Brazilian economy was in a recession, with low economic growth, high unemployment rates, and erratic financial markets. This poor economic climate may have had an impact on the public debt. Brazil's Gross Domestic Product (GDP) declined by 1.5% in the first quarter of 2002 compared to the previous quarter, indicating a significant slowdown in the country's economy. As a result, fewer customers paid taxes, which reduced government income.

In April 2002, there were 1,451,733 unemployed people in the metropolitan areas of Recife, Salvador, Belo Horizonte, Rio de Janeiro, So Paulo, and Porto Alegre, according to the Monthly Employment Survey (PME[7]) published by the Brazilian Institute of Geography and Statistics (IBGE). This represents a 17.2% increase from April 2001, when there were 1,202,179 unemployed people. According to the IBGE, the average unemployment rate in 2002 was 11.7%. Low consumption and reduced tax revenue are effects of a high unemployment rate, which reduces government revenues.

On the other hand, the National Treasury reports[8] that the total amount spent by the federal government from January through April 2022 was R$ 68.3 billion, up R$ 9.5 billion (16.1%) over the same time last year. The National Treasury noted in the July 2002 report that the total cost of the central government up to July had reached R$ 123.8 billion. A significant increase is seen compared to the total time up through April.

The second structural split might possibly be connected to the public debt's decline that has been seen since 2002. The Lula government paid off the nation's debt to the IMF after that year, which most likely explains the break in 2006. Prior to 2005, the country's public debt burden was still considerable. It is also important to remember that Brazil held presidential elections at the end of 2006. The election and potential political changes may have impacted investor confidence and financial market movements, which in turn may have impacted the national debt. Fiscal policies put in place at the period by the government, such as measures for economic stimulus or greater public spending, may have had an impact on the expansion of the debt. The public debt may have increased because of expansionary fiscal policy or an increase in government spending.

The second structural split could have something to do with the declining public debt trend since 2002. After that year, the Lula government paid off the nation's debt to the IMF, which most likely explains the break in 2006. Before 2005, the country's public debt burden was still considerable, and this likely caused the break in 2006. The fact that Brazil held presidential elections at the end of 2006 should also be noted. Investor confidence and financial market movements may have been impacted by the election and the prospect of political change, which would have affected the public debt. Fiscal policies put into effect at the period by the government, such as actions to stimulate the economy or higher public spending, may have impacted the growth of the debt.

Employment, credit, and commerce increased in 2010 along with a capitalization process that saw Petrobras raise about R$ 120.4 billion. Petrobras raised R$ 120.4 billion in the largest mega-share sale ever carried

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[7] https://www.ibge.gov.br/estatisticas/sociais/trabalho/9183-pesquisa-mensal-de-emprego-antiga-metodologia.html?edicao=20750

[8] https://www.gov.br/tesouronacional/pt-br/estatisticas-fiscais-e-planejamento/resultado-do-tesouro-nacional-rtn

out, funding the exploration of pre-salt assets, and securing a key place in the world financial market. Investors from various areas, including sovereign wealth funds from Asian and Middle Eastern nations, showed much interest in the Brazilian oil giant. According to the current currency rate, the capitalization was $70 billion.

The improvement in the economy can be used to explain how the debt series' coefficients changed that year. Brazilian Institute of Geography and Statistics (IBGE) data show that the country's GDP increased by 2.7% in the first quarter of 2010 compared to the same period in 2009. This outcome demonstrates a considerable increase in the nation's economic activity. The labor market did well throughout this time, with increased job openings and a decline in the unemployment rate. Over 657,000 new formal occupations were registered by the Cadastro Geral de Empregados e Desempregados (CAGED) during that time.

The Brazilian trade balance showed a surplus in the first quarter of 2010, according to Funcex (Foundation Center for Foreign Trade Studies). Exports outpaced imports as a result of the rising worldwide demand for commodities and the strengthening of the Brazilian real. The nation's foreign reserves and financial status were boosted by this surplus. With $38.745 billion in exports and $38.857 billion in imports during this time period, there was a $111 million trade surplus.

Compared to the R$ 9.5 billion recorded in 2009, the Central Government's primary result for the first quarter of 2010 showed a surplus of R$ 8.2 billion. This change is due to an increase in the Treasury's surplus of R$ 822.7 million, an increase in the Social Security deficit of R$ 2.2 billion, and a decrease in the Central Bank's deficit of R$ 16.1 million. Compared to the first quarter of 2009, the Treasury's gross revenue increased by 16.5% (R$ 21.1 billion). The following variations mostly account for this rise: This increase is mainly explained by the following variations: i) a R$ 7.2 billion increment in Cofins (Contribution for the Financing of Social Security) and R$ 1.4 billion in PIS-Pasep (social contributions collected by companies, which are used for benefits to private and public sector workers); ii) an increase in the collection of CIDE-Combustíveis (Contribution of Intervention in the Economic Domain), IOF (federal tax applied to various financial operations), and IPI (Tax on Industrialized Products) due to compensations for R$ 1.0 billion and tax exemptions implemented in 2009, and changes in tax legislation; iii) growth in the collection of compensatory shares, dividends, and other revenues.

The fiscal situation did not continue to improve in 2014 as it had in prior years. There were already indications that economic growth was slowing, and the public accounts included many imbalances that would call for regressive policies and higher debt levels in the coming years. The recessive effects of the fiscal correction that was started in 2015 were amplified by a string of unfavorable shocks (changes in the international situation, the economic effects of the Lava Jato operation, political fragmentation, and loss of governance under Dilma's administration). In the same year, particularly in 2016, when a legislative coup delayed many economic stabilization measures and worsened the crisis, the outcome was a significant increase in public debt (BARBOSA, 2020). These pieces of evidence can explain the structural break in 2016.

The COVID-19 health crisis can be used to explain the collapse in 2020. Trade restrictions, company closures, higher unemployment rates, and a sharp fall in demand were all caused by the pandemic. The social segregation measures put in place to contain the virus impacted many economic sectors in Brazil, including business, services, tourism, and industry. This led to decreased tax revenue and increased government spending to address the crisis's repercussions, such as emergency help, business support programs, and public health investments.

According to data released by the National Treasury in March 2020, the primary result of the Central Government, at current prices, had a deficit of R$ 21.2 billion, compared to a deficit of R$ 21.1 billion in March 2019. Compared to March 2019, net revenue dropped by R$ 5.8 billion (-6.0%) while total expenses fell by R$ 6.4 billion (-5.4%). At current exchange rates, the Central Government's main result for the month after had a deficit of R$ 92.9 billion as opposed to a surplus of R$ 6.5 billion in April 2019. Net revenue fell by R$ 45.5 billion (-35.6%) in real terms, but total spending grew by R$ 54.1 billion (+44.7%) compared to April 2019. At current prices, the Central Government's main outcome in May 2020 had a deficit of R$ 126.6 billion. Net revenue fell by R$ 38.5 billion (-41.6%) while total expenses rose by R$ 73.1 billion (+68.0%) in real terms from May 2019 to May 2019.

As already stated in this paper, substantial expenditures had to be made to mitigate the pandemic's economic, social, and public health effects, resulting in the creation of the so-called emergency budget, which was not subject to the spending cap. As the pandemic still generates uncertainties worldwide, as it is not fully under control, it is not yet possible to affirm that the difficulties imposed by it have been overcome. However, slight improvements are observed in Brazil's economic activity level.

The results suggest a cautious approach to fiscal management in the country, considering that the debt has undergone six structural changes from 1998 to 2022. Strict fiscal adjustment policies, such as introducing the spending limit within the Constitution, may have been premature from a practical standpoint, as they proved unviable in each period, failing to contain changes in the debt stock trend after their implementation.

It is known that, although not a settled point among economists, many theorists argue that high public debt does not pose an absolute risk, particularly concerning the Public Sector. Due to seigniorage capacity, there

are no major risks of the country defaulting when issuing bonds in its currency. Certainly, we cannot disregard the risks arising from investment instability, country risk, and an increase in interest rates. Still, it is substantially the role of academics and scholars to bring about a more comprehensive reflection on which fiscal measures and rules can be more effective for social welfare.

V.   Conclusion

As an emerging country, Brazil still faces some challenges regarding its macroeconomic stability. In recent years, fiscal control has gained significant attention in the public debate.

When observing the increasing Debt and fiscal deficit from 2014 onwards, an attempt was made to contain this trend by implementing Constitutional Amendment 95/2016. This amendment establishes limits for federal public spending for 20 years, calculated based on primary expenses in 2016 and adjusted for inflation in subsequent years. This measure was adopted with sound finances and debt containment through expenditure reduction rather than revenue increase.

However, during the recent major health crisis, the need for spending and public investments became evident, raising concerns about the adopted measure's viability and sustainability. To carry out the necessary spending, it was necessary to create a budget "outside the limit." Additionally, budget guidelines have been approved, with potentially politically motivated expenditures in the billions, outside the limit, and lacking transparency. This notably hampers both debt control and necessary public investments.

Given these observations, there is a need for a quantitative econometric analysis of the Debt to enrich the literature on the subject and encourage robust studies aimed at reconciling Public Investment and Public Debt.

For this purpose, the algorithm proposed by ZEILEIS et al. (2003) was used, which employs linear regressions to identify points of a structural break in the time series. The results show six structural breaks in the Net Debt series, rejecting the null hypothesis of no variation in coefficients over time. In other words, the coefficients varied significantly, indicating a structural break.

This result prompts reflection on how to approach Brazil's fiscal situation by seeking to understand the specificities of Public Debt and its effects. It serves as a contribution to the field of study. This study unquestionably emphasizes the importance of controlling public Debt without forgetting the significance of public spending and investments for society.

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