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Asymmetric and Nonlinear Foreign Debt–Inflation Nexus in Brazil: Evidence from NARDL and Markov Regime Switching Approaches

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Abstract: This paper augments the sparse literature on the inflationary impact of foreign debt in Brazil while addressing methodological caveats in previous studies. We depart from the linearity assumption and employ two nonlinear techniques: the nonlinear autoregressive distributed lag (NARDL) model and a Markov Switching Regression (MSR) to investigate the connection between foreign debt and inflation within a multivariate framework. The analyses consider the presence of structural breaks via assessing variable stationarity using the Zivot and Andrew unit root test and incorporating a residual-based cointegration test proposed by Gregory and Hansen. Additionally, we apply a multiple structural breakpoints test by Bai and Perron to determine the presence of structural breaks in the impact of foreign debt on inflation. Our findings robustly indicate that the domestic money supply has a statistically significant positive effect, while the nominal effective exchange rate has a negative effect on inflation in both the short and long run. The NARDL model reveals that only positive changes in foreign debt have a statistically significant negative effect on inflation in the short run, whereas both positive and negative foreign debt changes significantly affect inflation in the long run. The results from the MSR model are generally consistent with those of the NARDL model.

Keywords: asymmetry; Brazil; foreign debt; inflation; nonlinearity

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1. Introduction

Developing economies usually need help accumulating capital and financing their increasing public expenditures. This leads them to rely on foreign borrowing to fund their development needs and address their budget deficits and trade imbalances (Aimola and Odhiambo 2020). On the opposite view, foreign debt could create an acute debt overhang issue, and if the foreign debt becomes unsustainable, it can cause economic uncertainty and instability. There is substantial empirical evidence that high levels of foreign debt can lead to inflation and solvency issues, which pose significant risks to a country's financial stability and vulnerability to foreign shocks. Moreover, borrowing to plug budget deficits can impact inflation by monetizing foreign debt (Reinhart and Rogoff 2013; Mweni et al. 2016).

Statistics reveal that Brazil has increasingly relied on foreign borrowing to finance its rising developmental needs. However, it is crucial to acknowledge that this reliance on foreign debt could adversely affect macroeconomic indicators, including inflation. The increasing levels of foreign debt and inflation in Latin America have prompted questions about the nature of their relationship.

There is considerable literature that examines the effect of foreign debt on inflation in several countries, using a variety of econometric methodologies and covering different periods, with inconclusive findings.[1] A common feature among most empirical studies is that they assume that inflation responds symmetrically to changes in foreign debt. The mixed findings regarding the inflationary effect of foreign debt might be due to the failure of previous studies to consider the potential asymmetry in the inflationary effect of foreign debt, which the current study aims to overcome.

Meanwhile, although the relationship between foreign debt and inflation has garnered growing attention, very few studies have examined this nexus in Brazil, and the existing ones were published quite a long time ago. Instead, the focus has been on the linkage between Brazil's foreign debt and economic growth rather than inflation (e.g., Koyuncu Çakmak and Demirhan 2020; Afonso et al. 2020).

The main objective of this study is to unmask the nature of the relationship between foreign debt and inflation in Brazil over the period 1980 to 2020 within a multivariate framework while addressing methodological caveats in previous related studies. In particular, this study contributes to the sparse literature on the inflationary effect of foreign debt in Brazil along several dimensions. Firstly, it departs from the conventional linearity and symmetry assumptions and utilizes nonlinear and asymmetric methodologies, such as the nonlinear autoregressive distributed lag (NARDL) model and the Markov Switching Regression (MSR). Methodologically, we also address concerns regarding the presence of structural breaks when checking stationarity and cointegration between the variables. Secondly, to date, we are not aware of any study that investigates the asymmetric and nonlinear nexus between foreign debt and inflation in Brazil, as well as the potential regime shifts in regard to this relationship, and the current study aims to fill this gap in the literature.

The current study's findings based on linear models suggest no significant foreign debt effect on inflation; nonetheless, nonlinear models counter this, revealing a substantial negative effect for both positive and negative foreign debt shocks on inflation. Our findings also robustly indicate that the domestic money supply has a positive effect, while the nominal effective exchange rate has a negative effect on inflation. The results also revealed the existence of structural breaks in the examined variables and their underlying relationships.

These findings underscore the necessity of considering asymmetries and structural breaks for a comprehensive understanding of how foreign debt influences inflation in Brazil. We expect these findings to offer valuable insights for policymakers in Brazil, potentially aiding in devising more effective strategies for managing inflation and foreign debt levels.

The remaining structure of the paper is set as follows: Section 2 provides an overview of Brazil's foreign debt and inflation rate trends over the past four decades. Section 3 reviews the related theoretical and empirical literature. Section 4 presents the econometric methodology. Section 5 summarizes the empirical results, which are then discussed in Section 6.

2. Evolution of the Foreign Debt and Inflation Rate in Brazil over the Period 1980 to 2020

Figure 1 displays the evolution of Brazil's foreign debt and inflation rates from 1980 to 2020. The figure suggests a dynamic and fluctuating relationship between foreign debt stocks (% of GNI) and the inflation rate in Brazil from 1980 to 2020.[2]

The figure also illustrates the correlation between these two variables and how their relationship has changed over the past four decades. Specifically, the data show a fluctuating trend in foreign debt stocks and inflation rates with an apparent structural break. This structural change in the trends can be easily visualized by dividing the study period into two sub-periods: the 1980s to mid-1990s sub-period (Figure 1a) and the mid-1990s to 2020 sub-period (Figure 1b).

The figure clearly illustrates a structural break in these three series around 1995. This notable structural break serves as the primary rationale for dividing the study into two distinct periods, with the year 1995 serving as the demarcation point that distinguishes the two segments depicted in Figure 1.

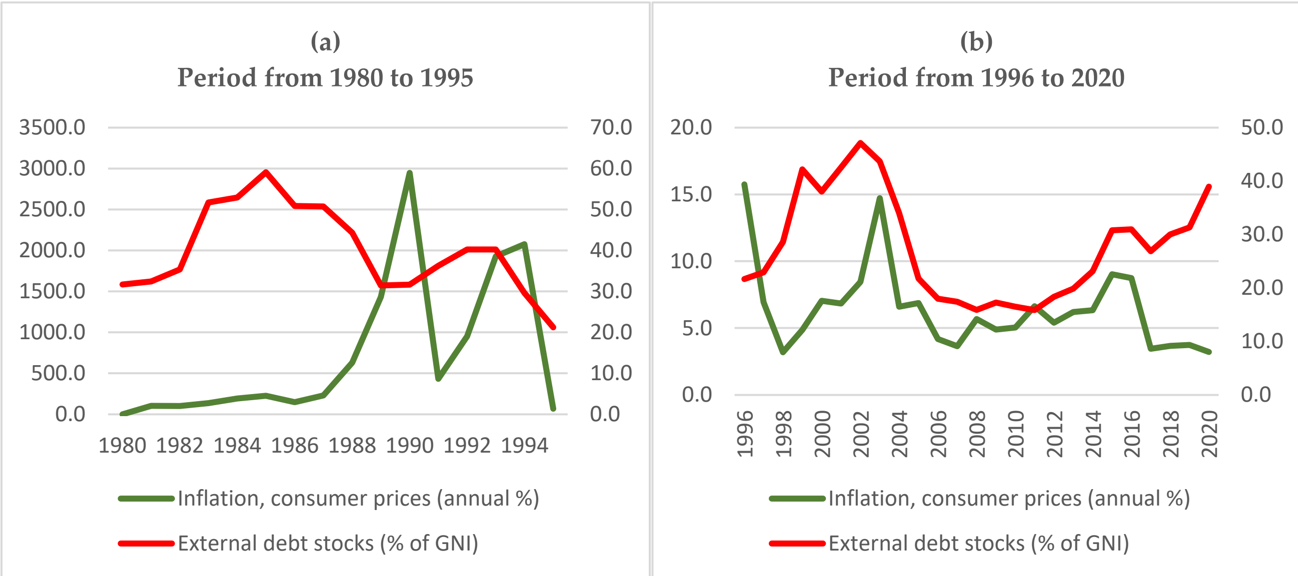

Figure 1. Brazil's external debt and inflation rate during the period (1980–2020). Source: Authors' compilation based on data from (WDI).

As demonstrated in Figure 1a, in the initial period spanning from the 1980s to the mid-1990s (the first period), Brazil's foreign debt as a percentage of GNI exhibited fluctuations within the range of 30% to 60%. During this same period, the country grappled with elevated inflation rates ranging from 100% to over 2900%. Notably, 1989 marked a significant turning point as Brazil experienced a dramatic surge in its annual inflation rate, reaching an unprecedented 1430.7%. This event signaled the onset of hyperinflation, leading to severe economic instability and a substantial devaluation of the Brazilian currency, the Cruzeiro.[3] By 1990, inflation had peaked at an alarming 2947.7%, the highest point recorded throughout the study period.

Concurrently, 1989 represented a pivotal year in Brazil's political evolution, as the nation held its first direct presidential elections in nearly three decades, ultimately electing a democratic government (Bethell 2000). Therefore, 1989 is a radical turning point, impacting Brazil's economic and political domains.

The 1980s is known as the "lost decade" due to the economic instability and debt crisis experienced by many Latin American countries, including Brazil. Brazil's version of the "lost decade" was characterized by economic stagnation, hyperinflation, and a significant burden of foreign debt (Grinberg 2008; Valença 1998).

The high foreign debt in Brazil posed a significant challenge in repaying loans, which, in turn, led to reduced investment and growth, resulting in elevated inflation rates. During this period, a clear positive correlation between foreign debt and inflation emerged, signifying that high levels of foreign debt were linked to soaring inflation. The economic crisis in Brazil during the 1980s and early 1990s was primarily driven by the simultaneous issues of high inflation and foreign debt, coupled with a lack of fiscal discipline. The government's implementation of multiple economic stabilization plans aimed to address these challenges, but these efforts were largely ineffective in quelling hyperinflation.

The second period commenced with Brazil adopting the Real Plan in 1994. This initiative was designed to stabilize the economy and control inflation, and it included the introduction of a new currency, the Brazilian real (BRL), in the same year (Barata 2019).

The program achieved partial success, leading to a substantial reduction in inflation, decreasing from 2076% in 1994 to 3.2% in 2020, as depicted in (Figure 1b). However, the percentage of foreign debt to GNI remained a crucial variable during this period, with fluctuations ranging from 16% to 47% of GNI. On the other hand, Brazil managed to lower its inflation rates from the mid-1990s until the end of the study period, resulting in a more stable economy and bringing some relief to the country. The relationship between foreign debt and inflation following the implementation of the Real Plan became less straightforward, with some years showing a positive correlation between the two variables while others showed no clear relationship. For instance, in 2015 and 2016, there was an increase in foreign debt as a percentage of GNI, but inflation remained stable. Similarly, in 2017 and 2018, foreign debt as a percentage of GNI rose again, but inflation remained low. In 2019 and 2020, foreign debt as a percentage of GNI continued to rise while inflation rates experienced a slight decline.

During the second period, the implementation of the Real Plan marked a relative success in curbing inflation and achieving economic stability in Brazil. It ushered in a period of stability and attracted higher levels of foreign investment. Concurrently, Brazil initiated a phase of economic openness to international trade, which significantly fueled its economic growth. Notably, the increased export of agricultural products and other commodities played a pivotal role in boosting the nation's economy.

Overall, the time series data indicate a positive correlation between foreign debt and inflation in Brazil. High foreign debt has previously been associated with high inflation rates and economic instability. However, this relationship has become less definitive in recent years. It is worth noting that other factors, such as government policies, economic growth, and international trade, also influence inflation rates. Therefore, the relationship between foreign debt and inflation in Brazil is complex.

3. Theoretical and Empirical Literature

Theoretically, there are several pathways through which debt can influence inflation. The first is through an increase in government deficits and debts, which can raise a country's overall wealth if bondholders of the new debt rule out the possibility of using future taxes to cover the deficit. In this non-Ricardian context, a rise in the nation's wealth increases the demand for goods and services, leading to higher prices. The second channel is the crowding-out effect, whereby an increase in government budget deficit and the associated increase in public debt raises interest rates, depressing private domestic investment, reducing the country's future productive capacity, decreasing aggregate supply, and driving up prices. Finally, the monetization of debt can be the third channel, where an increase in government debt may lead to an increase in seigniorage, allowing the government to balance its budget. This can increase the amount of printed money, propping up demand and increasing prices (Barth et al. 1987; Davig and Leeper 2007).

Earlier studies, such as those by Catão and Terrones (2005), Bajo-Rubio et al. (2006), and Lin and Chu (2013), provide evidence that inflation is not uniquely a monetary issue but also a fiscal concern due to large fiscal deficits and excessive public debt. Thus, coordinating monetary and fiscal policy is crucial in controlling inflation, and fiscal policy is increasingly recognized as an essential factor in determining inflation.

The Fiscal Theory of the Price Level, which asserts that debt plays a pivotal role in determining the price level, has been a subject of extensive debate and has spurred a substantial body of literature, such as studies by Cochrane (2005), Gordon and Leeper (2002), Cochrane (2001) and Sims (1994). Additionally, some studies suggest that an active monetary policy with a passive fiscal policy can stabilize prices. An independent central bank with a clear inflation target and the ability to adjust interest rates can effectively stabilize the economy and control inflation. These studies argue that the effects of debt management policy on the economy can be offset by changes in other policies, such as monetary policy (Assadi 2015; Davig and Leeper 2007, 2009; Leeper 1991).

Regarding empirical research, we observed that the bulk of the empirical literature predominantly focuses on examining the connection between inflation and public debt rather than foreign debt, such as the work of Aimola and Odhiambo (2022) in Gambia, Aimola and Odhiambo (2021a) in Ghana, Aimola and Odhiambo (2021b) in Nigeria, Van Bon (2015) across various developing countries, and the comprehensive study by Reinhart and Rogoff (2010) which covers 44 countries. Recently, a growing number of studies have probed the intricate relationship between foreign debt and inflation using a variety of econometric methodologies and covering different countries and periods, with inconclusive findings. Notably, research conducted by Enongene and Etape (2023) in Cameroon, Sharaf and Shahen (2023) in Sudan, Gathendu (2021) in Kenya, Uganda, and Tanzania, and the collective work of Arisa (2020) and Mweni et al. (2016) in Kenya, have explored this nuanced association. While a positive relationship between foreign debt and inflation is supported by some studies (e.g., Choong et al. 2010; Mweni et al. 2016; Arisa 2020), others indicate a negative relationship (e.g., Karakaplan 2009; Sharaf and Shahen 2023), and a third category of studies asserts no discernible relationship (e.g., Essien et al. 2016; Aimola and Odhiambo 2021b). These empirical studies share a common feature where they assume that inflation responds symmetrically to changes in foreign debt. However, recent evidence suggests that the effect of foreign debt on inflation could be asymmetric. The findings of some recent studies seem to support the asymmetric hypothesis, which indicates that positive foreign debt shocks could have a different effect on inflation than negative debt shocks (see, for example, Enongene and Etape 2023; Sharaf and Shahen 2023; Aimola and Odhiambo 2022).

Table 1 briefly reviews the empirical studies exploring the intricate connections between foreign debt and inflation, employing various research methodologies like ARDL bounds testing, NARDL, vector autoregression models, and regression analyses. The amalgamation of these methodologies has yielded a spectrum of results, showcasing varied conclusions, encompassing positive, negative, and inconclusive relationships. This diversity underscores the complexity of economic interactions. Additionally, these studies encompass multiple countries and timeframes, enriching our comprehension of how foreign debt and inflation interplay across different economic contexts. This breadth emphasizes the influence of contextual factors, emphasizing the need to consider diverse scenarios when formulating policies or theories related to foreign debt and its impact on inflation.

Table 1 shows that there is a significant research gap regarding the foreign debt–inflation nexus in Brazil. In particular, very few studies have investigated this relationship in Brazil, often within a comparative framework involving multiple countries, and these studies were published quite some time ago. Instead, the focus was on the linkage between Brazil's foreign debt and economic growth rather than inflation (e.g., Koyuncu Çakmak and Demirhan 2020; Afonso et al. 2020). Among the few studies that examined the connection between inflation and foreign debt in Brazil, Cardoso and Fishlow (1990) focused on the mid-1980s period. At that time, Brazil had a foreign debt of more than one-third of the country's GDP and was also facing high inflation rates. The authors argue that inflation and foreign debt are related problems with the same underlying issue. The study showed that shifting from foreign to domestic deficit finance has increased real interest rates and inflation. In another study, Koluri and Giannaros (1987) tested the monetarist view that deficits and money growth are the leading causes of inflation in Mexico and Brazil. The study findings indicate that the federal budget deficit has not significantly contributed to money growth in Brazil and Mexico. However, there is evidence of a direct impact of deficit spending on inflation in Mexico.

Moreover, the research supports the idea that changes in money supply directly affect the inflation rate in both countries. Foreign debt is a significant factor in money growth in both countries, with a possible indirect effect on inflation. The study suggests that expansionary fiscal policy can lead to inflation by impacting the central bank's monetary policy. However, the results should be interpreted cautiously due to sample size limitations. The study by Farhan and Younes (2021) is the most up-to-date research on the foreign debt–inflation nexus in Brazil. The study found that an increase in foreign debt leads to a rise in inflation rates, a persistent issue affecting the Brazilian economy and many other Latin American countries.

Table 1. A brief review of related Empirical studies.

Study	Study Period	Country/Region	Methodology	Public Debt/ Foreign Debt	Relationship in General
(Enongene and Etape 2023)	(1980–2020)	Cameroon	NARDL	Foreign debt	Positive (In the long run)
(Sharaf and Shahen 2023)	(1970–2020)	Sudan	ARDL bounds testing approach	Foreign debt	No relationship (In the long run)
			NARDL		Negative (In the long run)
(Aimola and Odhiambo 2022)	(1978–2019)	Gambia	NARDL	Public debt	Positive
(Aimola and Odhiambo 2021a)	(1983–2018)	Ghana	ARDL bounds testing approach	Public debt	Positive
(Aimola and Odhiambo 2021b)	(1983–2018)	Nigeria	ARDL	Public debt	No relationship (In the short and long run)
(Gathendu 2021)	(1988–2018)	Kenya, Uganda and Tanzania	VECM	Foreign debt	Positive
(Arisa 2020)	(1993–2018)	Kenya	Vector auto regression model Diagnostic tests	Foreign debt	Positive
(Mweni et al. 2016)	(1972–2012)	Kenya	Regression model	Foreign debt	Positive
(Essien et al. 2016)	(1970–2014)	Nigeria	Vector Autoregressive model Granger causality test Impulse response Variance decomposition of various innovations	Foreign debt	No relationship
(Van Bon 2015)	(1990–2014)	Developing Countries	GMM Arellano-Bond	Public debt	Positive
(Choong et al. 2010)	(1970–2006)	Malaysia	Cointegration test	Foreign debt	Positive
(Reinhart and Rogoff 2010)	200 years	44 countries	Examination of pertinent statistical data	Public debt	Positive (Emerging countries)
(Karakaplan 2009)	44 years	121 countries	GMM technique	Public debt	Negative (Advanced countries)
(Kwon et al. 2009)	(1963–2004)	Some developing and developed countries	Vector autoregression model	Public debt	Positive (Developing countries) - Specially indebted developing countries
(Janssen et al. 2002)	Past 300 years	U.K.		Public debt	No relationship
(Taghavi 2000)	(1970–1997)	Large European economies	Hybrid cointegration analysis Vector autoregressive model	Public debt	Positive (In most cases in the long run)

In summary, although the relationship between foreign debt and inflation has garnered growing attention, very few studies have examined this nexus in Brazil, and the existing ones were published quite a long time ago and suffer from several methodological caveats. In particular, these studies failed to consider the potential asymmetry in the inflationary effect of foreign debt, as well as the potential regime shifts in regard to this relationship that may result from the presence of structural breaks, and the current study aims to overcome these methodological limitations.

Consequently, a research gap exists concerning the specific relationship between foreign debt and inflation in Brazil. Further research is essential to establish a comprehensive and widely applicable understanding of how foreign debt influences inflation within the Brazilian context. Addressing this gap requires a detailed examination of the potential mechanisms through which foreign debt affects inflation, necessitating a more nuanced analysis of the dynamic nature of this relationship. Our ongoing research aims to bridge this gap by emphasizing the importance of considering structural changes and accounting for nonlinearities and asymmetry. This approach is crucial in unveiling the dynamic and multifaceted nature of the interplay between foreign debt and inflation in Brazil.

4. Data and Methods

We use annual time series data from 1980 to 2020 on the consumer price index (CPI), the foreign debt stock as a % of gross national income (Xdebt), the nominal effective exchange rate (NEER), and the broad domestic money supply (M). The period under investigation is dictated by data availability. The CPI, Xdebt, and M data are obtained from the World Development Indicators. Data on the NEER come from Bruegel's database Darvas (2021). All the variables are measured in natural logarithmic form.

To estimate the impact of foreign debt, within a multivariate framework, on the price level, we use the model in Equation (1).

$$\mathrm{CPI_t} = \theta_0 + \theta_1\,\mathrm{Xdebt_t} + \theta_2\mathrm{M_t} + \theta_3\mathrm{NEER_t} + \varepsilon_t \tag{1}$$

We first check the stationarity of the variables under investigation. The ARDL bounds test of cointegration validity requires that none of the series be integrated of order more than one. The order of integration of the variables is checked using the Augmented Dickey–Fuller (ADF) unit root test and the Zivot and Andrews (2002) unit root test, allowing for an endogenously determined structural break in both the intercept and the trend. After checking the stationarity property of the data, we check the nonlinearity of the variables by employing the Broock, Dechert, and Scheinkman (BDS) test developed by Broock et al. (1996). The results of the BDS test will be used to validate the use of the NARDL approach. We also use a residual-based cointegration test proposed by Gregory and Hansen (1996) that allows for a structural break in the cointegration vector. We then will incorporate a time dummy variable to represent the structural break when estimating the VECM to estimate the short- and long-run elasticities of the price level to the examined factors. Lastly, we estimate foreign debt's symmetric and asymmetric short-run and long-run impact on inflation using linear and nonlinear ARDL models and then conduct a Markov Switching regression (MSR) as a robustness check.

Foreign debt's symmetric (linear) effect on the price level is examined using the ARDL model presented in Equation (2).

$$\begin{gathered}\Delta\,\mathrm{CPI_t} = \alpha_0 + \textstyle\sum_{i=1}^{p}\lambda_{1i}\Delta\mathrm{CPI_{t-i}} + \sum_{i=1}^{q}\lambda_{2i}\Delta\mathrm{Xdebt_{t-i}} + \sum_{i=1}^{r}\lambda_{3i}\Delta\mathrm{M_{t-i}} + \\ \textstyle\sum_{i=1}^{s}\lambda_{4i}\Delta\mathrm{NEER_{t-1}} + \varphi_1\,\mathrm{CPI_{t-1}} + \varphi_2\,\mathrm{Xdebt_{t-1}} + \varphi_3\,\mathrm{M_{t-1}} + \varphi_4\mathrm{NEER_{t-1}} + \varepsilon_t\end{gathered} \tag{2}$$

where Δ is a first difference operator, p, q, r, s are the optimal lag length based on the Schwarz Information Criterion (SIC).

The short-run coefficients are estimated by presenting the ARDL model in an error correction form, as shown in Equation (3).

$$\begin{gathered}\Delta\,\mathrm{CPI_t} = \tau_0 + \textstyle\sum_{i=1}^{p}\tau_{1i}\Delta\mathrm{CPI_{t-i}} + \sum_{i=1}^{q}\tau_{2i}\Delta\mathrm{Xdebt_{t-i}} + \sum_{i=1}^{r}\tau_{3i}\Delta\mathrm{M_{t-i}} + \\ \textstyle\sum_{i=1}^{s}\tau_{4i}\Delta\mathrm{NEER_{t-1}} + \varnothing\mathrm{ECT_{t-1}} + \varepsilon_t\end{gathered} \tag{3}$$

We use the NARDL model of Shin et al. (2014) to investigate the asymmetric impact of foreign debt on inflation. The intuition of this model is that it decomposes the foreign debt changes into negative changes $\left(\mathrm{Xdebt_t^-} = \sum_{i=1}^{t}\Delta\mathrm{Xdebt_t^-} = \sum_{i=1}^{t}\min(\mathrm{Xdebt_i},\,0)\right)$ and positive changes $\left(\mathrm{Xdebt_t^+} = \sum_{i=1}^{t}\Delta\mathrm{Xdebt_t^+} = \sum_{i=1}^{t}\max(\mathrm{Xdebt_i},\,0)\right)$. $\mathrm{Xdebt_t^-}$ and $\mathrm{Xdebt_t^+}$ are the partial sums of the negative and positive changes in the foreign debt, respectively.

Equation (4) presents the NARDL formulation of the model in Equation (1). It is used to uncover an asymmetric equilibrium relationship between foreign debt and inflation within a multivariate setting by incorporating the other covariates, NEER and M.

$$\begin{aligned}\Delta\, \mathrm{CPI_t} = \ & \varphi_0 + \sum_{i=1}^{p} \omega_{1i}\Delta \mathrm{CPI_{t-i}} + \sum_{i=1}^{q} \omega_{2i}\Delta \mathrm{M_{t-i}} + \sum_{i=1}^{r} \omega_{3i}\Delta \mathrm{NEER_{t-1}} + \sum_{i=1}^{s} \omega_{4i}\Delta \mathrm{Xdebt^{+}_{t-i}} + \sum_{i=1}^{v} \omega_{5i}\Delta \mathrm{Xdebt^{-}_{t-i}} + \\ & \vartheta_1\, \mathrm{CPI_{t-1}} + \vartheta_2 \mathrm{M_{t-i}} + \vartheta_3 \mathrm{NEER_{t-i}}\ \vartheta_4 \mathrm{Xdebt^{+}_{t-1}} + \vartheta_5 \mathrm{Xdebt^{-}_{t-1}} + \varepsilon_t\end{aligned} \tag{4}$$

Equation (5) shows the error correction representation of the NARDL model in Equation (4) and is used to estimate the short-run asymmetric effect of foreign debt on inflation.

$$\begin{aligned}\Delta\, \mathrm{CPI_t} = \ & \varphi_1 + \sum_{i=1}^{p} \eta_{1i}\Delta \mathrm{CPI_{t-i}} + \sum_{i=1}^{q} \eta_{2i}\Delta \mathrm{M_{t-i}} + \sum_{i=1}^{r} \eta_{3i}\Delta \mathrm{NEER_{t-1}} + \sum_{i=1}^{s} \eta_{4i}\Delta \mathrm{Xdebt^{+}_{t-i}} + \sum_{i=1}^{v} \eta_{5i}\Delta \mathrm{Xdebt^{-}_{t-i}} \\ & + \varnothing \mathrm{ECT_{t-1}} + \varepsilon_t\end{aligned} \tag{5}$$

In Equations (3) and (5), the error correction term coefficient measures the speed of recovery from short-run disequilibrium in the aftermath of a shock to the long-run equilibrium path. Dynamic stability requires $\varnothing$ to have a negative sign and is less than unity.

We also run a multiple structural breakpoints test of Bai and Perron (1998) to check the presence of structural breaks in the impact of NEER, M, and foreign debt on the CPI. Equation (6) presents a multiple structural breakpoints linear model with T periods and m structural breaks.

$$\mathrm{CPI_t} = \gamma_i \mathrm{Xdebt_t} + \varphi_i\, \mathrm{NEER_t} + \psi_i\, \mathrm{M_t} + \mathrm{u_t} \tag{6}$$

In which γ_i, φ_i and ψ_i are the regime-dependant coefficients for $i = 1, \ldots, m+1$, and u_t is the error term. The number of statistically significant structural breaks, m, is determined endogenously by a sequential algorithm as proposed by Bai and Perron (1998).

Finally, we estimate a nonlinear Markov Switching Regression (MSR) as a robustness check to determine if there is a regime shift in the impact of foreign debt on inflation.

5. Empirical Results

Results of the ADF unit root test, presented in Table 2, show that CPI, M, and NEER are stationary at level in one of the versions of the test and non-stationary in the other versions.

Table 2. Results of the ADF unit root test.

		CPI	M	NEER	Xdebt
		At Level			
With Constant	T-Statistic	−2.5749	−3.2326 **	−2.5877	−2.3552
	Prob.	(0.1067)	(0.0259)	(0.1041)	(0.1607)
With Constant and Trend	T-Statistic	−1.8663	−2.5808	−1.9279	−2.6338
	Prob.	(0.6526)	(0.2906)	(0.6210)	(0.2684)
Without Constant and Trend	T-Statistic	−2.3888 **	−0.3375	−2.6546 ***	−0.0677
	Prob.	(0.0181)	(0.5567)	(0.0093)	(0.6539)
		At First Difference			
With Constant	T-Statistic	−1.7557	−1.2856	−1.8892	−3.9091 ***
	Prob.	(0.3962)	(0.6260)	(0.3338)	(0.0046)
With Constant and Trend	T-Statistic	−2.4705	−2.2844	−2.5496	−3.8752 **
	Prob.	(0.3401)	(0.4316)	(0.3042)	(0.0228)
Without Constant and Trend	T-Statistic	−1.5565	−1.1474	−1.6111	−3.9602 ***
	Prob.	(0.1111)	(0.2242)	(0.1001)	(0.0002)

, * indicate rejection of the null hypothesis (series is non-stationary) at the 5%, and 1% significance level, respectively. Lag length is based on SIC. *p*-values are in parenthesis.

Foreign debt is non-stationary at level across the three versions of the ADF test. The ADF also shows that foreign debt is the only stationary variable at first difference. One shortcoming of the conventional ADF unit root test is its failure to allow for existing structural breaks in the series, which causes a bias in conducting the unit root test. Results of the Andrew–Zivot unit root test of the variables at level and first difference are presented in Table 3.

Table 3. Results of Andrew–Zivot unit root test.

Unit Root Test of Variables in Level							
CPI		**M**		**Xdebt**		**NEER**	
T-Statistic	Time break	T-Statistic	Time break	T-Statistic	Time break	T-Statistic	Time break
−6.38 ***	1992	−7.89 ***	1992	−4.03	2005	−6.43 ***	1992
Unit root tests of variables in first difference							
−9.41 ***	1995	−8.02 ***	1995	−5.41 **	1995	−10.91 ***	1995

, * imply rejection of the null hypothesis of a unit root with a structural break at the 5%, and 1% significance level, respectively.

The test shows that, but for foreign debt, all of the variables (CPI, M, NEER) are stationary at level at the 1% significance level. More importantly, at their first difference, all the variables become stationary, with one structural break in 1995 for CPI, M, and NEER and in 2003 for foreign debt. The Andrew–Zivot unit root test results align with the time series plots in Figure 2, which also reveals the existence of a structural break in the consumer price index, money supply, and the nominal effective exchange rate series around 1995.

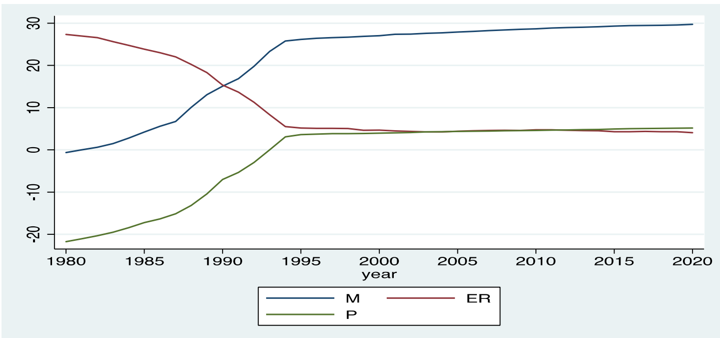

Figure 2. Evolution of the consumer price index, money supply and the nominal effective exchange rate over 1980–2020. Source: Authors' compilation based on data from (WDI).

Results of the BDS test, displayed in Table 4, confirm nonlinearity patterns in the data of the variables, which allow us to proceed with the nonlinear (asymmetric) NARDL approach. According to the BDS test, the null hypothesis that data in a time series are independently and identically distributed (iid) is rejected for all the variables.

Results of the Gregory–Hansen test for cointegration with regime shifts are shown in Table 5. According to this test, the ADF and Zt statistics both exceed their asymptotic critical values at the 5% significance level, confirming cointegration between the price level and the other variables with an identified structural break in 1999.

The Schwarz Information Criterion selected an ARDL (1, 2, 1, 0) and a NARDL (1, 2, 1, 1, 0) model. Results of the cointegration bounds test for both the symmetric and asymmetric ARDL models, presented in Table 6, show both a linear and a nonlinear cointegration between CPI, M, NEER, and Xdebt since the F- and t- statistics are greater than their upper critical bounds at the 5% significance level.

Table 4. Results of the BDS Test.

BDS Test for CPI				
Dimension	**BDS Statistic**	**Std. Error**	**z-Statistic**	**Prob.**
2	0.2075	0.0141	14.7009	0.0000
3	0.3512	0.0226	15.5192	0.0000
4	0.4487	0.0271	16.5064	0.0000
5	0.5122	0.0285	17.9120	0.0000
6	0.5531	0.0278	19.8635	0.0000
BDS Test for M				
Dimension	**BDS Statistic**	**Std. Error**	**z-Statistic**	**Prob.**
2	0.2073	0.0139	14.8805	0.0000
3	0.3508	0.0224	15.6316	0.0000
4	0.4489	0.0270	16.5707	0.0000
5	0.5149	0.0286	17.9803	0.0000
6	0.5570	0.0280	19.8791	0.0000
BDS Test for NEER				
Dimension	**BDS Statistic**	**Std. Error**	**z-Statistic**	**Prob.**
2	0.2075	0.0141	14.7009	0.0000
3	0.3512	0.0226	15.5192	0.0000
4	0.4487	0.0271	16.5064	0.0000
5	0.5122	0.0285	17.9120	0.0000
6	0.5531	0.0278	19.8635	0.0000
BDS Test for Foreign Debt				
Dimension	**BDS Statistic**	**Std. Error**	**z-Statistic**	**Prob.**
2	0.1135	0.0077	14.6836	0.0000
3	0.1800	0.0124	14.4366	0.0000
4	0.2023	0.0150	13.4327	0.0000
5	0.2031	0.0159	12.7570	0.0000
6	0.1868	0.0155	11.9930	0.0000

Table 5. Results of the Gregory–Hansen Test for cointegration with regime shifts.

Testing Procedure	**Test Statistic**	**Breakpoint**	**Date**	**Asymptotic Critical Values**		
				1%	5%	10%
ADF	−6.77	21	2000	−5.77	−5.28	−5.02
Zt	−5.60	20	1999	−5.77	−5.28	−5.02
Za	−33.20	20	1999	−63.64	−5.58	−48.65

Source: Authors' estimation. The optimal lag length is automatically chosen based on Bayesian criterion.

Table 7 shows the results of the estimated ARDL and NARDL models. The results of the ARDL model show that current and lagged values of the domestic money supply have a statistically significant positive impact on inflation in the short run.

The NARDL model results show that the current value of the domestic money supply has a positive effect, though not statistically significant, on the inflation rate, while the lagged value of the money supply positively affects inflation in the short run. Results of both the ARDL and NARDL models reveal that the nominal effective exchange rate has a statistically significant negative impact on inflation in the short run. This means a nominal appreciation of the Brazilian real lowers the inflation rate. The estimated time dummy variable coefficient is positive and statistically significant, which confirms the importance of controlling for the structural break in the time series.

Table 6. Results of the symmetric and asymmetric cointegration bounds test.

				95% Critical Bounds	
Dependent Variable	**Explanatory Variables**	**Specification**	**F-Statistic**	**I(0)**	**I(1)**
Δ(CPI)	M, NEER, Xdebt	**ARDL (1, 2, 1, 0)**	12.54 ***	2.45	3.63
			T-Statistic	I(0)	I(1)
			−5.46 ***	−1.95	−3.33
Δ(CPI)	M, NEER, $Xdebt_t^+$, $Xdebt_t^-$	**NARDL (1, 2, 1, 1, 0)**	F-statistic	I(0)	I(1)
			8.69 ***	2.26	3.48
			T-Statistic	I(0)	I(1)
			−3.65 **	−1.95	−3.60

, * indicate statistical significance at the 5%, 10% level, respectively. The lower and upper bound critical values are obtained from Pesaran et al. (2001).

Table 7. Estimated short and long-run coefficients of the symmetric and asymmetric ARDL models.

	ARDL (1, 2, 1, 0)		**NARDL (1, 2, 1, 1, 0)**	
	Coefficient	**Std. Error**	**Coefficient**	**Std. Error**
Short-run coefficients				
ΔM	0.0850 **	0.0366	0.0360	0.0356
ΔM_{t-1}	0.1139 ***	0.0331	0.0922 ***	0.0319
ΔNEER	−0.8884 ***	0.0570	−0.9943 ***	0.0592
D_{95}	0.0334 *	0.0203	0.2019 ***	0.0330
$\Delta Xdebt^+$			−0.7451 ***	0.1365
ECT_{t-1}	−0.4804 ***	0.0647		
Long-run coefficients				
M	0.3279 ***	0.0164	0.2505 ***	0.0329
NEER	−0.6946 ***	0.0182	−0.7500 ***	0.0104
Xdebt	−0.5223***	0.1213		
$Xdebt^+$			−0.5701 ***	0.1926
$Xdebt^-$			−0.6761 ***	0.2182
Diagnostic checks				
Breusch–Godfrey Serial Correlation LM Test	$\chi^2(2) = 0.15$ *p* value (0.92)		$\chi^2(2) = 2.40$ *p* value (0.30)	
Heteroskedasticity Test: Breusch–Pagan–Godfrey	$\chi^2(8) = 2.18$ *p* value (0.21)		$\chi^2(10) = 2.39$ *p* value (0.77)	
Ramsey RESET Test	F (1,30) = 1.02 *p* value (0.33)		F (1,28) = 0.66 *p* value (0.15)	
Normality	Jarque-Bera = 1.48 *p* value (0.47)		Jarque-Bera = 1.45 *p* value (0.48)	
	R^2 = 0.99 Adjusted R^2 = 0.99		R^2 = 0.99 Adjusted R^2 = 0.99	

*, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively. Lag length is based on SIC.

As for the impact of foreign debt in the short run, the symmetric ARDL model shows that foreign debt does not affect inflation in the short run. In contrast, the results of the NARDL model show that only positive changes in foreign debts have a negative and significant effect on inflation in the short run.

The estimated long-run coefficients of the symmetric ARDL model show that M, NEER, and Xdebt have a statistically significant long-term effect on inflation. According to the estimated long-run elasticity coefficients, a one percent increase in money supply raises the inflation rate by 0.32 percent. An increase in the nominal effective exchange rate (a nominal appreciation of the Brazilian real) by one percent lowers the inflation rate by 0.69 percent. Analogously, a one percent increase in foreign debt lowers the inflation rate by 0.52 percent.

The results of the NARDL model are generally similar in the long run. In particular, money supply has a statistically significant long-term positive effect on inflation. A rise in domestic money supply by 1% raises the inflation rate by 0.25 percent. Analogously, a 1% rise in the nominal effective exchange rate of the Brazilian real lowers inflation by 0.75% in the long run. Regarding the effect of foreign debt on inflation, the estimated long-run coefficients of the NARDL model reveal that positive and negative foreign debt changes have a significant impact on inflation at the 1% significance level. A 1% rise in foreign debt lowers inflation by 0.57% in the long run, while a 1% drop in foreign debt raises inflation by 0.68 percent. The dynamic asymmetric multiplier of the NARDL model presented in Figure 3 portrays this.[4] It is evident in Figure 3 that the dynamic asymmetric multiplier is statistically significant at the 5% significance level, where the asymmetry plot lies within the 95% confidence level as reflected by the upper and lower thin dashed red lines.

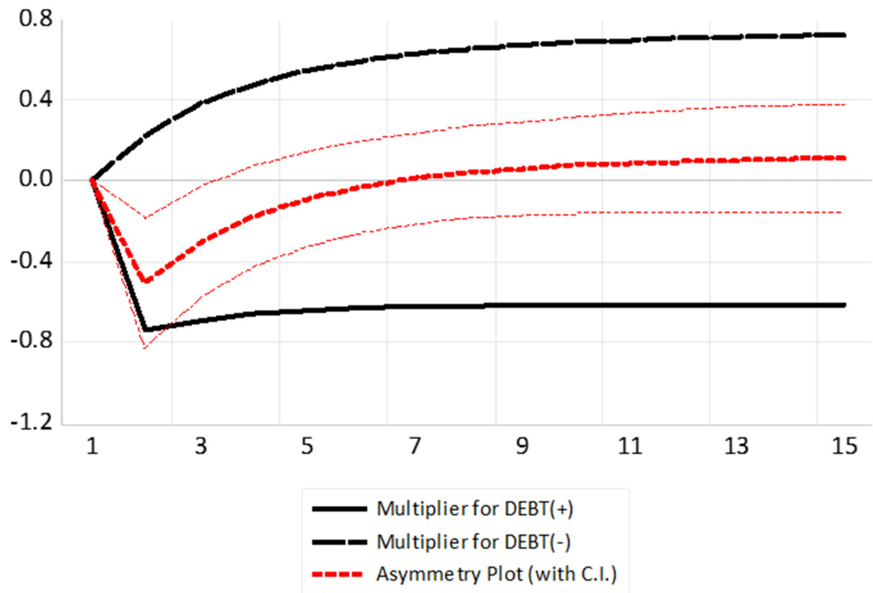

Figure 3. Dynamic asymmetric multiplier of the NARDL model.

The estimated coefficients of the error-correction term of both the symmetric and asymmetric ARDL models are both less than unity, are statistically significant, and have a negative sign. The ARDL error correction model shows a speedy restoration to long-run equilibrium, where 48% of the past period's disequilibrium is corrected in the current period. This implies that following a shock, restoring the long-run equilibrium between CPI, M, NEER, and foreign debt takes about two years. The NARDL error correction model shows a slower speed to restore equilibrium, where 33.5% of the past period's disequilibrium is corrected in the current period. This means that following a shock, it takes about three years for examined variables to restore their long-run equilibrium relationship.

We checked the soundness of the estimated symmetric and asymmetric ARDL models using a set of post-estimation diagnostic tests. The results of these tests indicate that the estimated ARDL and NARDL models are free from heteroskedasticity, serial correlation, specification errors, and non-normality of the residuals at the 5% significance level. Parameters stability diagnostics as reflected by the cumulative sum of recursive residuals (CUSUM) test and the cumulative sum of squares of recursive residuals (CUSUMSQ) test, displayed in Figures 4 and 5, reveal that the estimated coefficients of the ARDL and NARDL models are stable at the 5% significance level.

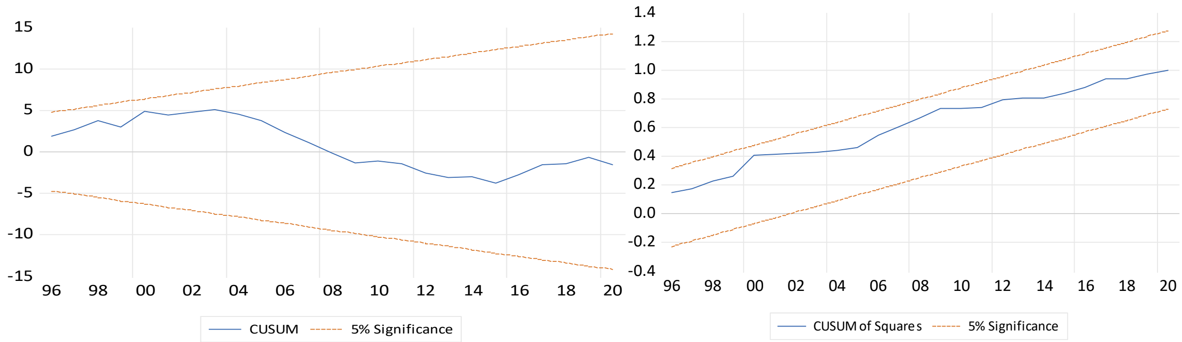

Figure 4. CUSUM and CUSUMSQ stability plots of the ARDL (1, 2, 1, 0) model.

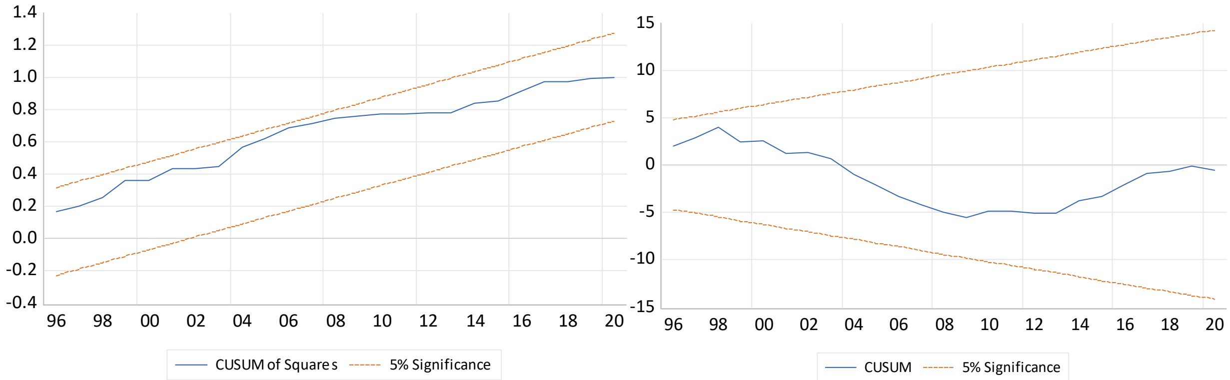

Figure 5. CUSUM and CUSUMSQ stability plots of the NARDL (1, 2, 1, 1, 0) model.[5]

The Bai–Perron multiple breakpoint test results, presented in Table 8, indicate the existence of two structural breaks in 1989 and 1997 in which the null hypothesis of a two-regime (one break) model is tested versus the alternative of a three-regime (two breaks) model and the null hypothesis is rejected at the 5% significance level.

Table 8. Bai–Perron multiple breakpoint test of L + 1 vs. L sequentially determined breaks.

Break Test	F-Statistic	Critical Value **
0 vs. 1 *	51.78	16.19
1 vs. 2 *	37.78	18.11
2 vs. 3	4.067	18.93
Break dates:		
	Sequential	Repartition
1	1991	1989
2	1997	1997

* Significant at the 0.05 level. ** Bai–Perron (Bai and Perron 2003) critical values.

The Bai and Perron multiple structural breakpoint test is implemented with a maximum of five breaks and a trimming parameter of 0.15 to test the null hypothesis of L + 1 versus L sequentially determined structural breaks.

Table 9 presents the results of the discrete threshold regression associated with the Bai–Perron multiple structural breaks estimation over 1980–2020.

Table 9. Discrete Threshold Regression.

Variable	Coefficient	Std. Error	T-Statistic	Prob.
		1980–1989		
M	0.4018 ***	0.0396	10.147	0.000
NEER	−0.6031 ***	0.0590	−10.211	0.000
XDEBT	0.3017 **	0.1261	2.3923	0.023
		1990–1997		
M	0.5560 ***	0.0580	9.5833	0.000
NEER	−0.3969 ***	0.0685	−5.7947	0.000
XDEBT	−0.9903 ***	0.1975	−5.0131	0.000
		1998–2020		
M	0.4009 ***	0.0320	12.507	0.000
NEER	−0.2014	0.1466	−1.3739	0.179
XDEBT	−0.0282	0.0846	−0.3333	0.741
		Non-Breaking Variables		
C	−5.8452 ***	1.6675	−3.5053	0.001

Break type: Bai–Perron tests of L + 1 vs. L sequentially determined breaks. **, *** indicate statistical significance at the 5% and 1% level, respectively.

The break model for the sub-period 1980–1989 shows that both the broad money supply and the foreign debt have a statistically significant positive effect on the CPI, while the NEER has a statistically significant negative effect. For the sub-period 1990–1997, the effect of money supply on CPI remains positive and significant, and the effect of the NEER is negative and statistically significant. However, foreign debt has a statistically significant negative impact on the CPI in that second sub-period. Notably, in the third sub-period, 1998–2020, the effect of foreign debt on CPI is negative, though not statistically significant. While money supply continues to have a statistically significant positive effect on CPI, the effect of the NEER is negative but not significant.

Table 10 presents the results of the Markov Switching Regression. The findings of Markov Switching Regression in the two regimes (regime 1 and regime 2) are generally similar. In particular, M and NEER negatively and statistically significantly impact the price level in both regimes.

Table 10. Markov Switching Regression (BFGS/Marquardt steps).

Variable	Coefficient	Std. Error	z-Statistic	Prob.
		Regime 1		
M	0.374 ***	0.064	5.836	0.000
NEER	−0.600 ***	0.078	−7.613	0.000
Xdebt	−0.202 *	0.122	−1.655	0.097
C	−2.762	2.439	−1.132	0.257
		Regime 2		
M	0.254 ***	0.035	7.220	0.000
NEER	−0.817 ***	0.047	−17.23	0.000
Xdebt	−0.066	0.153	−0.429	0.667
C	1.294	1.082	1.195	0.232

Table 10. *Cont.*

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Common				
LOG (SIGMA)	−2.286	0.155	−14.66	0.000
Probabilities Parameters				
P1-C	−0.591	0.723	−0.817	0.413
Mean dependent var	−1.703	S.D. dependent var		9.521
S.E. of regression	0.286	Sum squared resid		2.627
Durbin–Watson stat	0.432	Log likelihood		22.41
Akaike info criterion	−0.605	Schwarz criterion		−0.187
Hannan–Quinn criter.	−0.453			

*, *** indicate statistical significance at the 10% and 1% level, respectively.

However, although foreign debt has a negative impact on the CPI in both regimes, the impact is statistically significant in the first regime at a 10% significance level and not significant in the second regime.

6. Discussion

This study augments the existing literature investigating the relationship between foreign debt and inflation. It does so by examining this nexus in the context of Brazil, within a multivariate framework, from 1980 to 2020. In addressing methodological concerns in previous studies, our research diverges from conventional linear assumptions and employs two nonlinear approaches: the nonlinear autoregressive distributed lag (NARDL) model and a Markov Switching Regression (MSR). Additionally, the study considers the presence of structural breaks via utilizing the Zivot and Andrews (Z–A) unit root test and incorporates a residual-based cointegration test developed by Gregory and Hansen (G–H). Moreover, the study employs a multiple structural breakpoints test by Bai and Perron (B–P).

The merit of this study lies in recognizing the importance of incorporating structural breaks in time series analysis, which highlights the dynamic nature of economic relationships and emphasizes the necessity of addressing regime shifts. This significance stems from the limitation of the conventional unit root tests, which do not account for structural breaks in time series data, resulting in bias that weakens the ability to detect a false unit root null hypothesis. We employed the Z–A unit root test to address this issue, revealing that most variables exhibited stationarity at their levels with one structural break around 1995. This corresponds to the period following the introduction of the Real Plan in Brazil in 1994, an initiative aimed at stabilizing the economy and controlling inflation. Another contribution of our study concerning structural breaks is the utilization of the Gregory–Hansen test, which examines the presence of cointegration in the context of structural breaks, verifying its existence between the price level and other variables, with a structural break identified in 1999.

The results obtained from the linear ARDL model suggest that the influence of foreign debt on inflation in Brazil has no statistical significance. These findings are consistent with Sharaf and Shahen's (2023) study, which found no statistically significant effect of foreign debt on inflation in Sudan over the period from 1970 to 2020. Similarly, these findings align with the research conducted by Aimola and Odhiambo (2021b), focusing on the relationship between public debt and inflation in Nigeria, spanning from 1983 to 2018. The findings of another study conducted by Essien et al. (2016) corroborate and fortify the conclusions that utilizing the linear ARDL model in the analysis may not detect a statistically significant inflationary effect for foreign debt.

To consider the possible asymmetry in how foreign debt could affect inflation, we employed a nonlinear ARDL model. The rationale for using this nonlinear model is the recognition that the link between foreign debt and inflation might not exhibit symmetry and could depend on whether the foreign debt shock is in a positive or negative direction. The results of the NARDL model reveal that positive foreign debt shocks have a statistically significant negative impact on inflation in the short run. This relationship remains negative and significant in the long run as well. This finding contradicts the conventional belief that excessive foreign debt can lead to inflation through currency devaluation and increased import demand.

Nevertheless, these results coincide with the research conducted by Sharaf and Shahen (2023), demonstrating that debt negatively affects inflation in Sudan when the NARDL model technique is utilized. Likewise, Karakaplan (2009) also indicated that debt has a negative effect on inflation in certain advanced countries. Furthermore, these results are consistent with the study conducted by Bleaney (1996), which suggested that debt has a negative influence on inflation during particular periods.

The negative effect of foreign debt on inflation can be explained by various economic mechanisms, notably the rise of debt service costs associated with the mounting foreign debt. In response, governments may employ monetary strategies, such as tightening the money supply, to mitigate the inflationary impact. Additionally, the accumulation of foreign debt can influence exchange rates and, if managed effectively, contribute to inflation control. Fiscal measures, such as austerity, are also deployed to ensure the proper management of the debt burden while averting inflationary pressures. These outcomes underscore the active role of governments in mitigating the potential inflationary consequences of increasing foreign debt through a fusion of monetary and fiscal approaches.

The findings derived from the ARDL and NARDL models present contrasting perspectives regarding the influence of debt on inflation. Findings of the linear ARDL model imply an absence of a statistically significant long-term impact of foreign debt on inflation, aligning with studies such as Aimola and Odhiambo (2021b) and Essien et al. (2016) on Nigeria and Janssen et al. (2002) on U.K., whose findings also suggest no significant association between debt and inflation. Conversely, the NARDL model results reveal a statistically significant long-term relationship between foreign debt shocks and inflation. These NARDL findings align with several empirical studies emphasizing asymmetric effects in adjusting economic variables, particularly regarding critical elements like debt and inflation. Noteworthy research endeavors, including studies by Enongene and Etape (2023) on Cameroon, Sharaf and Shahen (2023) on Sudan, and Aimola and Odhiambo (2022) on the Gambia, further substantiate and bolster these conclusions and support the asymmetric hypothesis which indicates that positive foreign debt shocks could have a different effect on inflation than negative debt shocks.

Using the nonlinear ARDL approach often leads to distinct results compared to the linear models in these studies. For example, previous investigations using a linear ARDL approach did not reveal significant long-term impacts of foreign debt on inflation in Sudan until the study conducted by Sharaf and Shahen (2023), where the ARDL approach suggested an absence of a statistically significant impact from foreign debt on long-term inflation. In contrast, the findings from the NARDL model imply that positive and negative shocks in foreign debt wield a statistically significant influence on long-term inflation. Consequently, applying the nonlinear ARDL method in their research revealed the asymmetric effects of alterations in Sudan's foreign debt on inflation from 1970 to 2020, presenting critical supplementary insights in our research.

To sum up, the use of asymmetry analysis in the current study reveals a significant impact of foreign debt shocks on inflation, underscoring the importance of accounting for nonlinear dynamics. The research suggests that changes in foreign debt levels can gradually reduce inflationary effects over time. Furthermore, the study demonstrates that the relationship between foreign debt and inflation is nonlinear, indicating that the magnitude and direction of the shock can influence how foreign debt affects inflation. These conflicting results underscore the complexity and nuances in comprehending the intricate relationship between debt and inflation, emphasizing the necessity for more detailed analyses and considerations of multifaceted factors in future research.

On the other hand, the findings of both linear (symmetric) and nonlinear (asymmetric) ARDL models, for both short-term and long-term periods, concerning domestic money supply and nominal effective exchange rate, reveal that domestic money supply (M) has a significant positive effect on inflation, while the nominal effective exchange rate (NEER) has a statistically significant negative effect on inflation.

The results related to the impact of M on inflation align with the Quantity Theory of Money, a fundamental concept in monetary economics that suggests that an expansion of the money supply causes inflation. This correlation is supported by multiple empirical investigations, including studies conducted by Gharehgozli and Lee (2022), Helmy (2021) in Egypt, Abate (2020) in Ethiopia, and Benati (2021) across 27 countries. For instance, Gharehgozli and Lee (2022) illustrated that the lockdowns in 2020, coupled with expansive fiscal and monetary policies, triggered an unprecedented surge in the money supply. This excess of money supply subsequently contributed to the rise in the core inflation rate during and after COVID-19.

Similarly, the results for the NEER correspond to economic theory, suggesting that a stronger currency can reduce inflation by lowering import costs and enhancing the competitive position of local producers. These findings are also supported by empirical evidence, such as the studies conducted by Sharaf and Shahen (2023) and Baharumshah et al. (2017) in Sudan. Both studies employed a NARDL model and concluded that a stronger currency has a negative and statistically significant impact on inflation, implying that it can reduce inflationary pressures in Sudan. However, our findings contrast with those of Sharaf et al. (2023) in Jordan, who found that a nominal depreciation of the Jordanian Dinar led to increased short- and long-term inflation rates spanning from 1970 to 2020.

A distinctive aspect of our study, focusing on structural breaks, involves the application of the Bai–Perron multiple breakpoint test to identify such breaks in different periods. The test detected structural breaks in 1989 and 1997, revealing varying effects of the variables on the price level within distinct sub-periods. These structural breaks indicate significant relationship changes between the variables and the inflation during those years. As a result, these findings provide insight into shifts in economic conditions in Brazil during those specific periods. Notably, the economic landscape in Brazil showed marked differences in the distinct years of 1989 and 1997, which represented pivotal moments in the nation's economic history. In 1989, Brazil grappled with hyperinflation and underwent a significant political transition. Conversely, in 1997, the introduction of the Real Plan marked a shift towards relative economic stability and the initiation of trade liberalization in the country.

The current study is not free from limitations. One limitation is that the data used cover the period 1980–2020 annually, which might pose a challenge due to the relatively small sample size. Nonetheless, a sample size of about 40 observations is acceptable in empirical research. Also, it is worth mentioning that our use of annual data, instead of quarterly data, for instance, and the choice of the study period are dictated by data availability for all the variables included in the analysis.

7. Conclusions

This study investigated the relationship between foreign debt and inflation in Brazil from 1980 to 2020 while addressing the methodological limitations of earlier studies. Analyzing structural breaks and implementing nonlinear models uncovers pivotal insights into the nature of the foreign debt–inflation nexus. While linear models suggest no foreign debt impact on inflation, nonlinear models counter this, revealing a substantial negative effect from positive foreign debt shocks, thus disrupting established beliefs. These revelations underscore economic links' intricate and dynamic nature, stressing the importance of acknowledging regime shifts and asymmetry in economic analyses. Additionally, the research pinpoints significant years like 1989 and 1997 as pivotal economic milestones, emphasizing the Brazilian government's proactive role in managing foreign debt levels to stave off potential inflationary consequences. Ultimately, this study enriches our comprehension of the intricate interplay between foreign debt, inflation, and other economic factors, offering indispensable guidance for policymakers navigating economic transformations. In conclusion, these findings corroborate earlier research, illustrating the multifaceted impact of foreign debt on inflation. We expect these findings to aid policymakers in Brazil in designing more effective strategies for managing inflation and foreign debt levels by providing a better understanding of how the two variables are interrelated.

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Notes

1. Aimola and Odhiambo (2020) offer a systematic review of the related literature.
2. M denotes the broad domestic money supply; E.R. is the nominal effective exchange rate; P is the consumer price index. All these variables are expressed in natural logarithmic form.
3. The "cruzeiro" was Brazil's former currency before it was replaced by the Brazilian real (BRL) in 1994.
4. DEBT $(+)$ and DEBT $(-)$ are the partial sums of the positive and negative changes in the foreign debt, respectively.
5. CUSUM refers to the cumulative sum of recursive residuals, and CUSUMSQ is the cumulative sum of squares of recursive residuals.

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