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The Role of Monetary and Fiscal Policies in Brazilian Hysteresis

O papel das políticas monetária e fiscal na histerese brasileira

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Abstract: This paper uses a Vector Error Correction (VEC) model and Impulse Response Functions (IRFs) to identify macroeconomic shocks affecting real GDP and their implications for policymakers. The analysis reveals economic hysteresis in Brazil, with variables like the real exchange rate and net public sector debt exerting persistent effects on GDP. This underscores the importance of addressing structural factors. Fiscal adjustments emerge as vital for fostering confidence, supporting aggregate demand and highlighting the non-neutrality of fiscal policy. Structural limitations in the monetary transmission mechanism suggest that conventional monetary policy alone may be insufficient to achieve full employment, growth and financial stability.

Keywords: Fiscal Policy; Monetary Policy; Hysteresis.
JEL Classification: C32; E23; E58.

Resumo: Este artigo utiliza um modelo VEC e IRFs para identificar choques macroeconômicos que afetam o PIB real e suas implicações para os formuladores de políticas públicas. A análise evidencia a presença de histerese econômica no Brasil, com variáveis como a taxa de câmbio real e a dívida líquida do setor público apresentando efeitos persistentes sobre o PIB. Isso ressalta a importância de abordar fatores estruturais. Ajustes fiscais mostram-se fundamentais para fortalecer a confiança, sustentar a demanda agregada e destacar a não neutralidade da política fiscal. Além disso, limitações estruturais no mecanismo de transmissão monetária sugerem que a política monetária convencional, por si só, pode ser insuficiente para alcançar pleno emprego, crescimento econômico e estabilidade financeira.

Palavras-chave: Política Fiscal; Política Monetária; Histerese.
Classificação JEL: C32; E23; E58.

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1. Introduction

A critical issue in evaluating policy effectiveness is distinguishing between short- and long-term effects. In the former case, a policy exerts a transitory effect on the outcome, while in the latter, it generates a permanent effect. Three major advances in multivariate time-series analysis have enabled empirical differentiation between short- and long-term effects when equal-interval time-series data are available. First, unit root tests in time series, as proposed by Dickey, Bell and Miller (1986), assess the presence of permanent versus transitory movements in individual time-series data. Second, the existence of long-term relationships can be investigated using cointegration methods (Engle and Granger, 1987). Third, the VEC model facilitates the analysis of short- and long-run relationships between variables, as demonstrated by Johansen (1988). Accordingly, this paper aims to identify the role of monetary and fiscal policies in Brazil, analyzing the responses of real GDP to macroeconomic shocks and assessing their implications for policymakers using a VEC model through IRFs.

The VEC model is a full information maximum likelihood estimation model, which allows for testing for cointegration in a whole system of equations in one step without requiring a specific variable to be normalized and explicitly accounts for long-term equilibrium relationships between variables (Maysami and Koh, 2000). Our analysis of the IRFs derived from the VEC model sheds light on the manifestation of economic hysteresis in the Brazilian context. Variables such as the real exchange rate and net public sector debt exhibit sustained effects on GDP, emphasizing the need for policymakers to address the structural underpinnings of these relationships. In this sense, fiscal adjustments can enhance confidence in economic stability supporting aggregate demand, thus fiscal policy cannot be considered neutral. Regarding monetary policy, we find structural limitations in the monetary transmission mechanism, which align with Summers' (2014) argument that it may be impossible for an economy to achieve full employment, satisfactory growth and financial stability through conventional monetary policy.

Friedman (1969) had already argued that monetary policy could not permanently influence the levels of real output, asserting its long-term neutrality. Following the framework introduced by Sargent and Wallace (1981), if fiscal policy dominates monetary policy, i.e., the government has a greater influence on overall economic conditions, the monetary authority becomes even less powerful. In this sense, monetary policy becomes subordinate to fiscal policy, generating macroeconomic imbalance. The monetary authority loses control of inflation due to fiscal policy, a phenomenon originally described by Sargent and Wallace (1981) as fiscal dominance. Blanchard (2004) later expanded this discussion, further emphasizing the risks of fiscal dominance for macroeconomic stability. According to Leeper (1991), under a fiscal dominance regime, fiscal policy is active, forcing monetary policy to be passive and adapt to fiscal needs, thereby undermining its ability to stabilize inflation.

Indeed, according to Sim (2022), in the presence of hysteresis, monetary policy responses to demand shocks should be asymmetric. Besides, the author also shows that if

the hysteresis mechanism is present, a fiscal multiplier can exceed 1, i.e., fiscal policy is a highly effective tool. Hysteresis is the perpetuation of an economic activity long after its initial cause has disappeared, suggesting that the effects persist beyond the short term and exhibit nonlinear dynamics (Richards and Green, 2003). This, as elucidated by Meloni, Romaniello and Stirati (2021), acknowledges the possibility that a cyclical decline in economic activity can have effects on macroeconomic variables. Thus, hysteresis has persistent implications for macroeconomic adjustment and policy.

In the presence of hysteresis, the costs of cyclical shocks or inaction by policymakers are much greater because of the permanent scars they can leave on the economy. This means that, on one hand, in recessions, aggressive and quick action becomes the ideal policy. On the other hand, in expansions, the cost of acting too early for fear of inflationary pressure can also reduce potential growth. In this sense, hysteresis is the worst counter-reformation we could have. Following Keynes (1936), a possible solution to this problem would be through monetary and fiscal policy together. Accordingly, this article will be divided into four sections besides this introduction. The next section will present a theoretical review about macroeconomic policy; moving forward, the third one will describe the methodology approach; the fourth section will discuss the results and finally we will present the concluding remarks.

2. Macroeconomic Policy

According to Setterfield (2009) policy-oriented macroeconomics includes three main components: a description of the income generation process, the inflationary process, and how monetary policy is conducted. In this sense, policymakers' monetary policy would be the appropriate instrument to control inflation and economic cycles, while fiscal policy should only be concerned with the possibility of balancing government deficits. The emphasis on fiscal discipline was associated with the concern that high nominal deficits were behind macroeconomic instability, leading to inflation and balance of payments problems. This approach has led several countries to adopt a primary surplus fiscal target, along with floating exchange rates and inflation targeting, forming a macroeconomic tripod. Brazil embraced this framework in 1999. Thus, Brazilian fiscal and monetary policies can be associated with high rigidity, essentially conservative in nature.

Therefore, Brazil adopted fiscal rule regimes to maintain stability and minimize public spending, ensuring the adjustment of public accounts. Following Kopits and Symansky (1998), a fiscal rule is a permanent constraint on fiscal policy aimed at promoting fiscal sustainability. Brazil has several fiscal rules, but they can basically be divided into three: the golden rule (the government can only issue debt to make investment), the primary result law (works to stabilize debt) and the spending ceiling (limits government spending in accordance with inflation). All of them limit the states' action and destabilize the economy, since they advocate for pro-cyclical fiscal policy. According to Tavares, Tavares and Moura (2008), the establishment of a law requiring the government to announce and meet an annual primary surplus target significantly changed the

preparation and execution of the public budget. Moreover, Brazil's fiscal performance began to improve even before the implementation of fiscal rules and remained strong following their adoption (Berganza, 2012).

However, these rules do not provide adequate flexibility to accommodate large, unexpected shocks, nor can they help to avoid the pro-cyclicality of fiscal policies. Then, in times of crisis, when it becomes necessary to intensively use fiscal policy to stimulate aggregate demand and prevent the deepening of the crisis, policymakers choose to adopt countercyclical policies. With the 2008 global financial crisis, Brazil faced a conflict between strict fiscal targets in the short term and the need for a rapid response in terms of economic policy to avoid the crisis, as pointed out by Dweck and Teixeira (2017). Currently, with the COVID-19 pandemic, the same problem has arisen. With the global economy recovering from pandemic and exceptional government measures largely ending, fiscal policy shifted towards tightening to address debt vulnerabilities (IMF, 2023). In this sense, monetary policy regained preference over fiscal policy.

Monetary policy acts so that the real interest rate behaves in a certain way depending on macroeconomic variables such as inflation and output. This means that it must have a nominal anchor to prevent nominal variables from rising or falling without limit. Thus, the central bank follows a real interest rate rule. The need to establish clear rules for conducting monetary policy in countries that have adopted the inflation targeting regime, with the aim of enhancing the credibility of monetary authorities, has led to the development of institutional frameworks seeking alignment with various models such as the Taylor Rule (Taylor, 1993) and analyses of ideal rules for interest rates presented in Woodford (2001) and Clarida, Galí and Gertler (1998, 1999, 2000, 2001). Credibility in these rules has become crucial for anchoring the expectations of economic agents and addressing the issue of dynamic inconsistency.

In the Brazilian case, monetary policy emphasizes price stability over other macroeconomic objectives. According to Mankiw (2020), monetary policy plays a circumscribed role: its primary responsibility is to avoid creating inflationary pressures and to limit inflation growth to levels desired by the central bank, emphasizing price stability as its main objective. This focus often comes at the expense of other macroeconomic goals, such as achieving full employment. In 1999, due to the collapse of the exchange rate regime and the need for an anchor to stabilize agents' expectations, the Central Bank of Brazil adopted the inflation targeting regime as the guiding principle of monetary policy. Thus, the Brazilian monetary policy can be associated with high rigidity or an essentially conservative character, whose main symptom would be a high basic interest rate (Modenesi and Martins, 2019). According to Feijó, Araújo and Bresser-Pereira (2022), such characterization keeps the economy with low growth and low investment rates and has resulted in stagnation and contributes to perpetuating cost pressures on prices.

As Leeper (1991) points out, equilibrium policies can be framed in two ways: one based on a monetary policy rule — where the interest rate responds to inflation — and another based on a fiscal policy rule — where taxes adjust to fluctuations in public debt. When monetary policy is active and fiscal policy is passive, fiscal disturbances do not

influence equilibrium prices, interest rates or real balances. This scenario is referred to as monetary dominance. Conversely, when fiscal policy is active and monetary policy is passive, monetary policy follows the lead of fiscal policy, a situation known as fiscal dominance. According to de Mendonça, Moreira and Sachsida (2017), both Brazilian monetary and fiscal policies were active after 2015. This implies that while monetary policy prioritizes the inflation target, fiscal policy fails to prioritize achieving a primary surplus consistent with the sustainability of public debt.

Thus, the combination of an active monetary policy focused on controlling inflation and a fiscal policy that did not prioritize achieving a primary surplus resulted in increased public debt and inflationary pressures. The active fiscal policy, misaligned with the sustainability of public debt, led to inadequate management of budgetary constraints. This lack of fiscal discipline undermined efforts to control inflation, as the rising public debt and associated expectations of higher future inflation counteracted the objective of the monetary authority. As a result, the inflation rate remains high, even with an active monetary stance, since fiscal policy has also adopted an active position instead of seeking a balanced budget, creating an explosive situation. In this regard, understanding how monetary and fiscal policies affect economic growth is crucial. Therefore, the next section will present the model developed in this article to analyze the impact of monetary and fiscal policies on the Brazilian business cycle.

3. Econometric Approach, Model and Data

This section presents the methodology applied to investigate the complex interactions among macroeconomic variables using the VEC model. VEC fits a type of vector autoregression in which some of the variables are cointegrated by using Johansen's (1995) maximum likelihood method. Besides, VEC models are used to model the stationary relationships between multiple time series that contain unit roots. The unit root approach is used to model hysteresis and involves postulating the existence of unit or zero roots in systems of linear difference or differential equations (Setterfield, 2008). In this sense, this modeling approach is particularly relevant for the analysis of economic hysteresis due to its ability to capture long-term relationships among non-stationary variables. Hysteresis reflects the persistent effects of economic shocks even after their initial causes have dissipated, making the VEC model especially suitable as it incorporates error correction terms that adjust short-term deviations toward long-run equilibria. This feature is particularly valuable in studies focusing on variables such as economic growth, interest rates and public debt, which often exhibit dynamic relationships and cointegration.

Moreover, the VEC model provides a more robust framework for interpreting the effects of economic policies by uncovering the mechanisms through which such shocks influence the economic system in a persistent manner. This capability is critical for understanding and addressing phenomena like secular stagnation and other hysteresis-related challenges. This model — a restricted form of the Vector Autoregression (VAR)

model — incorporates cointegration among variables and is represented mathematically as follows:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \mu_t \quad (1)$$

where Δ is the first difference, y_t is an $n \times 1$ vector of endogenous variables, Π is an $n \times n$ cointegration matrix, y_{t-1} is an $n \times 1$ vector of lagged endogenous variables, Γ_i are $n \times n$ matrices of short-term parameters related to lagged first differences, y_{t-i} are the lagged endogenous variables at $t - i$ and μ_t is a vector $n \times 1$ of error terms with zero mean and constant variance.

The first term, Πy_{t-1}, incorporates long-term relationships among the variables and adjusts the system back to equilibrium when misaligned. While the matrix Π captures the cointegration among the variables, if the system is out of equilibrium, y_{t-1} adjusts the dynamics to bring the variables back toward the long-term relationship. This approach allows us to address how deviations from this equilibrium are corrected. The second term, $\Gamma_i \Delta y_{t-i}$, allows the model to capture short-run fluctuations or transitory effects that do not necessarily affect the long-term relationships among the variables. Thus, the VEC model explicitly accounts for both short-term dynamics and long-term relationships, through cointegration vectors[1], making it a powerful tool for analyzing systems of variables that are non-stationary but cointegrated.

The simplest method to estimate a VEC is a two-step procedure. First, estimate the cointegrating relationship and generate the lagged residual series resulting from it. By testing stationarity and cointegration, the VEC is designed to handle non-stationary variables, provided they share a long-term equilibrium relationship. In the second step, the VEC model is estimated by regressing the first differences of the variables on their lagged first differences, including the error correction term to capture deviations from the long-term equilibrium. The appropriate number of lags is determined using various selection criteria, such as the Akaike Information Criterion (AIC) or Schwarz Bayesian Criterion (SC), ensuring the robustness and reliability of the model. Rather than fully differencing the variables, the VEC model incorporates error correction terms that adjust short-term deviations back toward the long-term equilibrium. Thus, the VEC models have been estimated with relatively few restrictions on parameters, offering greater flexibility in capturing short-term dynamics and long-term relationships among the variables.

3.1. Data

To achieve the objectives outlined in this article, a monthly dataset spanning the period from 2006M12 to 2024M09 was utilized. This timeframe was specifically chosen due to the revision of the debt calculation methodology in 2006, which ensures

[1] For further discussion, see Johansen (1991), Hamilton (1994) and Stock and Watson (2001).

consistency in the treatment of key fiscal indicators. Such methodological uniformity is essential for preserving the integrity of econometric analysis. Accordingly, to maintain econometric parsimony, we avoided combining different statistical methodologies, thereby enhancing the consistency of the results. The dataset includes carefully selected variables, deemed essential for analyzing Brazil's macroeconomic dynamics, sourced from reliable databases, as detailed in Table 1.

Table 1: Variables

Variable	Description	Source
Real GDP	IBC-Br, base year 2012	Central Bank of Brazil
Broad money supply	Sum of currency in circulation and demand deposits, savings deposits, certificates of deposit with a maturity of less than two years and money market funds (% of GDP).	Central Bank of Brazil
Real exchange rate	Real exchange rate between Brazil and the United States, base year 2010	Institute of Applied Economic Research (IPEA - Brazil)
General government gross debt	General government gross debt (% of GDP)	Central Bank of Brazil
Net public sector debt	Net public sector debt (% of GDP)	Central Bank of Brazil
Primary surplus	Public sector borrowing requirement with primary result and without exchange rate devaluation (% of GDP), accumulated over twelve months, with result with inverted numerical sign	Central Bank of Brazil

Source: Elaborated by the authors.

In Macroeconomic Theory, GDP is made up of four main components: consumption, investment, public spending and net exports (exports minus imports) [see Romer (2018)]. In this sense, the output is an assertive measure for capturing a country's levels of economic activity, since the variable represents the total value of goods and services produced in an economy. By analyzing the contribution of the different components of GDP, it is possible to understand overall economic health, including the role of investments, public spending, and foreign trade.

In addition to GDP, which serves as the central measure of economic activity by capturing the aggregate value of goods and services within the economy, other variables were included in this study to provide a more comprehensive analysis of economic dynamics. Broad money supply, for instance, complements GDP by reflecting the economy's liquidity conditions, which are essential for assessing how monetary policy influences growth and economic stability. Its composition, encompassing currency in circulation, demand deposits, savings accounts and short-term instruments, allows for the capture of both direct and indirect effects of money supply on economic activity. Similarly,

the real exchange rate enriches the analysis by incorporating the international dimension of economic growth, measuring external competitiveness and the impacts of economic policies on trade and capital flows.

In the realm of fiscal policy, variables such as gross and net public debts offer complementary perspectives. While gross debt reflects the total obligations of the public sector, net debt adjusts this value by accounting for available financial assets, providing a more accurate view of the government's fiscal capacity. The primary surplus, in turn, captures fiscal stance by measuring the difference between revenues and expenditures, excluding interest costs, making it crucial for understanding how the government manages its accounts in relation to economic growth. Thus, the inclusion of these variables complements the analysis of GDP, enabling a deeper exploration of how the interplay among liquidity, external competitiveness, and fiscal sustainability shapes economic cycles and the persistence of their effects, as observed in hysteresis.

Finally, the variables used in this study were carefully analyzed for the presence of seasonality, and those requiring seasonal adjustments were deseasonalized using the Census X-13 method (US Census Bureau, 2017). This method, widely recognized for its robustness and accuracy, was selected to ensure that predictable short-term fluctuations were appropriately removed while preserving the structural economic dynamics relevant to the analysis. In the econometric context of this study, deseasonalization is a critical step to prevent distortions in unit root and cointegration tests, which are essential for identifying long-term relationships among variables. The application of the Census X-13 method ensured the consistency of the adjusted data, enabling a more accurate analysis of the underlying economic interactions.

It is worth noting that variables such as the real exchange rate, which do not exhibit intrinsic seasonality, were kept in their original form, while variables displaying predictable seasonal patterns, such as the money supply or fiscal indicators, were properly adjusted. This meticulous approach ensured that the results accurately captured the effects of monetary and fiscal policies in the context of the economic hysteresis dynamics analyzed.

This careful preparation of the data is further reinforced by the results presented in Table 2, which summarizes the outcomes of the Augmented Dickey-Fuller (ADF) test. The findings confirm that all variables exhibit a unit root in levels but become stationary after first differencing, indicating they are I(1). This classification is essential for the application of the VEC model, which relies on I(1) variables to investigate long-term equilibrium relationships through cointegration.

Furthermore, the I(1) nature of these variables signals the persistence of shocks, a characteristic closely tied to economic hysteresis, where temporary disruptions can lead to lasting impacts. Following these results, the next step involves determining the appropriate number of lags for the model, a critical step to accurately capture the short-term dynamics and ensure reliable tests for cointegration and further model estimation.

Table 2: ADF Stationarity Test of the Variables

Variable	Critical Value at 5%	t-statistic at 5% (level)	t-statistic at 5% (first diff.)	Inference
Real GDP	-2.875	-2.108 (0.242)	-11.621** (0.000)	I(1)
Broad money supply	-2.875	-0.434 (0.900)	-6.894** (0.000)	I(1)
Real exchange rate	-2.875	-1.268 (0.645)	-11.949** (0.000)	I(1)
General government gross debt	-2.875	-0.989 (0.757)	-4.568** (0.000)	I(1)
Net public sector debt	-2.875	0.505 (0.987)	-7.334** (0.000)	I(1)
Primary surplus	-2.875	-2.640 (0.087)	-5.450** (0.000)	I(1)

Notes: ** denotes statistical significance at the 5% level. Values in brackets represent p-values. All tests were conducted using only the intercept.
Sources: Central Bank of Brazil and IPEA – Brazil.

3.2. Model

The results of the residual serial correlation Lagrange Multiplier (LM) tests indicate no significant evidence of autocorrelation in the residuals at lags 1, 2 or 3, as all p-values are above the 5% significance level. This suggests that the chosen number of lags adequately captures the temporal dependencies in the data and ensures the model's residuals are independent. While information criteria such as AIC or SC suggest fewer lags for the model, these criteria balance model fit with parsimony and may sometimes underestimate the number of lags needed to address issues like autocorrelation. The LM test, however, provides a direct diagnostic for autocorrelation, a critical assumption for valid inference in VEC models. Since autocorrelation persisted with fewer lags in preliminary tests, the lags suggested by the LM test were adopted to eliminate residual correlation and ensure the robustness of the model. This approach prioritizes the diagnostic quality of the residuals over strict adherence to parsimony, ensuring more reliable and interpretable results (Table 3).

Table 4 presents the results of the unrestricted cointegration rank test, offering key insights into the relationships among the analyzed variables. The trace statistics confirm the presence of at least one significant cointegrating vector at the 5% level, establishing a long-term equilibrium relationship between the variables. This addresses a critical concern in time series econometrics raised by Granger and Newbold (1974), who cautioned against the dangers of spurious regression when dealing with non-stationary data without proper adjustment.

Table 3: Residual Serial Correlation LM Tests

Lag	Likelihood ratio expansion statistic	Degree of freedom	Prob
1	38.788	36	0.345
2	42.770	36	0.203
3	37.855	36	0.385

Source: Calculations based on the model equations.

By confirming cointegration, Johansen's (1991) method ensures the suitability of the VEC model, as it accounts for both long-term equilibrium and short-term dynamics among the variables. This comprehensive approach is crucial for capturing complex economic interactions and avoiding erroneous conclusions. These findings provide a solid foundation for constructing a model that not only yields reliable parameter estimates but also enhances explanatory depth and predictive accuracy. The identification of cointegrating relationships validates the econometric framework, ensuring that subsequent results contribute meaningfully to the academic literature and guide policy or decision-making with rigorous methodological support.

Table 4: Unrestricted Cointegration Rank Test

Null hypothesis	Eigenvalue	Trace statistic	Critical value at 5%	P-value
None ($r = 0$)*	0.367	162.802	95.754	0.000
At most 1 ($r \leq 1$)	0.102	65.896	69.819	0.099
At most 2 ($r \leq 2$)	0.085	43.023	47.856	0.132
At most 3 ($r \leq 3$)	0.061	24.101	29.797	0.196
At most 4 ($r \leq 4$)	0.049	10.805	15.495	0.224
At most 5 ($r \leq 5$)	0.000	0.079	3.841	0.778

Note: The hypothesis $r = 0$ indicates no cointegrating vectors.
Source: Calculations based on the model equations.

Since VEC models have an underlying VAR, then we can estimate IRFs after estimating a VEC. VEC models introduce unique considerations regarding the decomposition used to analyze the innovation vector and the ordering of variables, particularly in the context of IRFs. While the Cholesky decomposition remains commonly employed due to its simplicity and ability to capture dynamic effects, the ordering of variables remains critical, as it can influence the interpretation of systemic effects within the model. In the VEC framework, variables with higher Granger causality are typically placed earlier in the order, as they are considered more endogenous, while those with lower Granger causality, reflecting greater exogeneity, are placed later.

To determine the relative degree of exogeneity and guide the ordering of variables, the Wald test for block exogeneity was applied. In the context of VEC models, this test assesses the importance of lagged endogenous variables in explaining the variation of the

dependent variable in each equation, incorporating the long-term equilibrium relationships defined by cointegration. The statistic from the test quantifies the influence of other lagged endogenous variables on a given equation, allowing for a consistent classification of variables. Higher Wald statistics indicate greater endogeneity and suggest that the variable plays a more central role in the system, while lower values signify greater exogeneity.

Table 5: Wald Tests for Block Exogeneity

Order	Variable	χ^2	Prob
1	Real exchange rate	87.488	0.000
2	Primary surplus	74.474	0.000
3	Broad money supply	36.826	0.000
4	Real GDP	35.194	0.000
5	General government gross debt	34.655	0.000
6	Net public sector debt	26.134	0.003

Note: 60 degrees of freedom.
Source: Calculations based on the model equations and Hamilton (1994).

By leveraging these results, the variables were ordered systematically based on their degree of exogeneity (Table 5), ensuring that the generated IRFs accurately reflect the dynamic interactions and long-term equilibrium relationships among the variables. This method not only ensures consistency in the interpretation of results but also aligns with the theoretical framework of the VEC model, which integrates both short-term dynamics and long-term adjustments. Thus, the Wald test provides a robust basis for the variable ordering, crucial for analyzing the systemic effects captured in the model.

Finally, the normality of residuals, while often emphasized in econometric analyses, is not a strict requirement in the context of this study due to the sufficient sample size and the theoretical foundations provided by the Central Limit Theorem (CLT). According to the CLT, as the sample size grows, the distribution of the estimates approaches normality regardless of the underlying distribution of the residuals[2]. With a sample of 214 observations, the asymptotic properties of the model ensure the reliability of parameter estimates and inferential statistics, even in the presence of deviations from normality. This theoretical guarantee reduces the practical necessity of adhering to the normality assumption in residual diagnostics. While such tests provide insights into the distributional properties of the data, their significance diminishes when the sample size allows for convergence to normality. Therefore, in this context, the focus shifts toward ensuring other critical assumptions, such as the absence of autocorrelation and homoscedasticity, which have a more direct impact on the robustness of the model's results. By leveraging the CLT, this analysis ensures that inferential outcomes remain valid, rendering the strict testing of residual normality less critical to the study's conclusions.

[2] For further discussion, refer to Hamilton (1994).

4. Results

This section provides a detailed analysis of the results from the VEC model estimation, covering critical aspects such as heteroskedasticity (Table 6), Granger causality and IRFs. These components are examined to analyze the dynamic interactions among variables, offering deeper insights into the model's structure and implications. Table 6 presents the results of the Breusch-Pagan test for heteroskedasticity, conducted to ensure the validity of the model's residuals. The results show no significant evidence of heteroskedasticity, as both the LM statistic ($p = 0.325$) and the F-statistic ($p = 0.327$) fail to reject the null hypothesis of homoskedasticity. These findings support the assumption of constant residual variance, a critical condition for ensuring reliable inference in econometric modeling.

Table 6: Breusch-Pagan Test for Heteroskedasticity

Statistic	Value	Interpretation
LM statistic	0.970	Tests if residual variance depends on regressors
LM test p-value	0.325	Fails to reject the null hypothesis of homoscedasticity (p>0.05)
F-statistic	0.970	Alternative formulation of the test statistic
F-test p-value	0.327	Fails to reject the null hypothesis of homoscedasticity (p>0.05)

Source: Calculations based on the model equations and Breusch and Pagan (1979).

Table 7 provides important observations into the dynamic relationships among selected economic variables and their relevance to the study of economic hysteresis. The findings indicate that real GDP Granger-causes the real exchange rate, as the null hypothesis of no Granger causality is rejected ($p = 0.022$). It is important to note that Granger causality does not imply causality in the strict sense of the word but rather reflects temporal precedence, where one variable provides information useful for predicting another. In this case, fluctuations in GDP, such as those caused by economic shocks, preceded changes in the real exchange rate, highlighting potential long-term effects of the output variations on external competitiveness and exchange rate dynamics.

Additionally, while the relationship from GDP to the primary surplus is not statistically significant at the 5% level, it points to a marginally significant association that warrants further exploration, as fiscal variables often adjust in response to economic output. No evidence of Granger causality is found between GDP and broad money supply ($p = 0.107$) or between general government gross debt and GDP ($p = 0.561$), suggesting that these relationships may not exhibit predictive temporal dynamics over the tested horizon. However, net public sector debt significantly Granger-causes GDP ($p = 0.000$), underscoring the critical role of fiscal debt dynamics in influencing economic output. These findings align with the broader literature on hysteresis, suggesting that fiscal and exchange rate dynamics can play a role in reinforcing persistent effects of economic shocks,

particularly through interactions between GDP and variables like the real exchange rate and public sector debt.

Table 7: Pairwise Granger Causality Tests for Relationships Involving Real GDP

Null hypothesis	F-statistic	Prob
Real GDP → Real exchange rate	3.904	0.022*
Real GDP → Primary surplus	2.834	0.061
Real GDP → Broad money supply	2.256	0.107
General government gross debt → Real GDP	0.580	0.561
Net public sector debt → Real GDP	8.769	0.000*

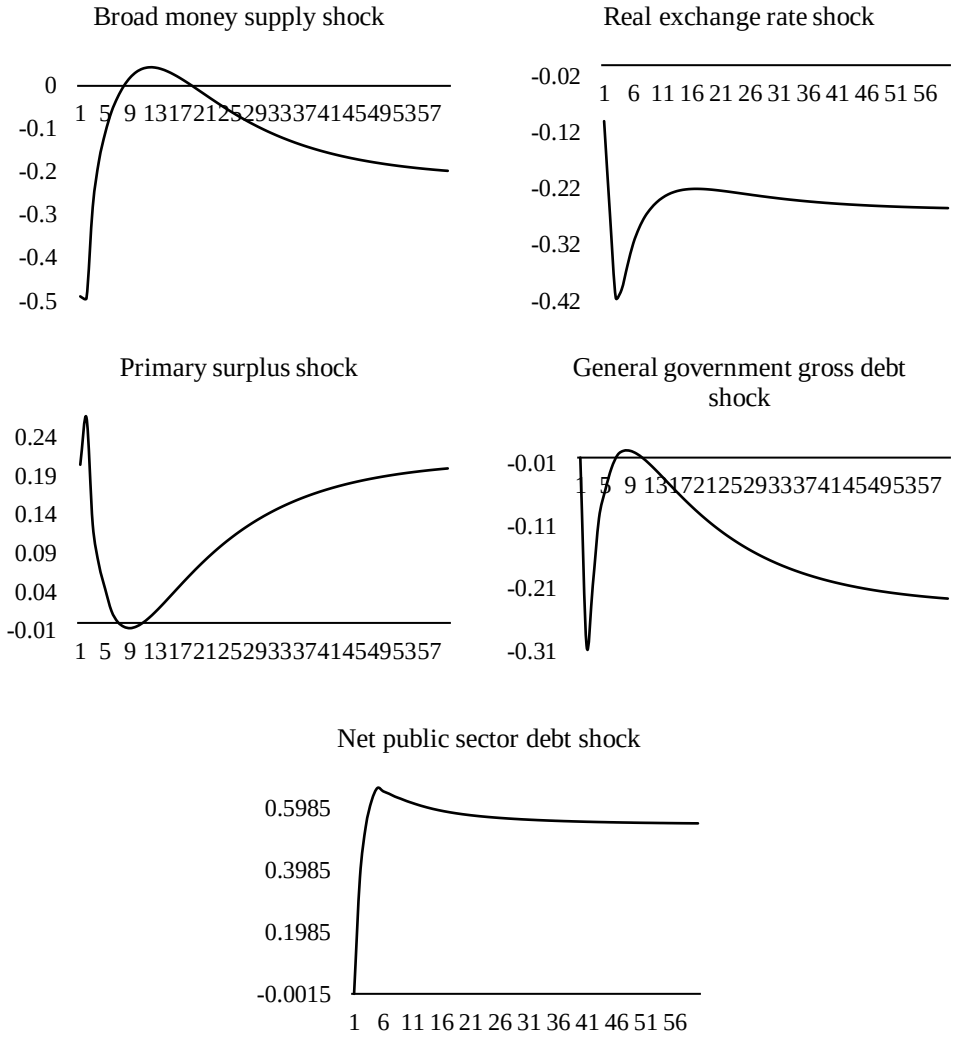
Notes: "→" means does not Granger Cause; "*" means rejection of the null hypothesis.
Calculation based on 2 lags.
Source: Elaborated by the authors.

Subsequently, the IRFs will be analyzed to compare the different responses of the economic activity level to positive shocks from selected macroeconomic variables, where the horizontal axis of each graph represents the period in months and the vertical axis represents the magnitude of the response of aggregate demand, in addition to the magnitude of the shock being a standard deviation. The aim of this initial analysis is to identify possible characteristics of economic hysteresis, which refers to the persistence of long-term effects after an initial disturbance in the economic system disappears [see Richards and Green (2003)]. By simulating a positive impulse, the aim is to assess the contribution of variables related to monetary and fiscal policies in Brazil to economic dynamics over time. In addition, the analysis covers the recent period of the coronavirus pandemic. The choice to evaluate these two fundamental policies aims to understand the possible permanence of significant impacts after a change in economic conditions. The persistence of these effects over time would corroborate hysteresis, even after the initial stimulus has dissipated. In this way, this analytical approach contributes to a deeper understanding of economic dynamics over time.

Figure 1 shows how real GDP responds to shocks from policy variables, notably: broad money supply, the real exchange rate, the primary surplus, general government gross debt and net public sector debt. A positive shock to the money supply initially generates a negative response in GDP, possibly due to liquidity adjustments or inflationary pressures. A temporary positive effect follows but then reverts to a prolonged negative trend. In this sense, a surprise expansion of the money supply could have long-lasting effects on productivity and output through channels such as business formation or exit (Benati and Lubik, 2021). This dynamic indicates structural inefficiencies in the monetary transmission mechanism, as well as Boivin, Kiley and Mishkin (2010) shown, highlighting that monetary policy alone may not effectively sustain long-term economic growth. The response to such shocks also demonstrates hysteresis, where the effects persist long after

the shock dissipates. This persistence underscores the importance of combining monetary and fiscal policies to address structural challenges and ensure stable economic growth.

Figure 1: Real GDP Responses to Shocks



Notes: 90% confidence interval. The horizontal axis represents the period in months and the vertical axis represents the magnitude of the response.
Source: Graphs generated from the performed estimates.

However, a shock in the real exchange rate elicits an immediate negative response in GDP, with the most significant impact occurring within the first quarter. The response gradually diminishes in magnitude but remains negative over the 20-quarter horizon. This prolonged adjustment suggests that exchange rate shocks have lasting effects on economic output, consistent with hysteresis theories. The inability of the economy to quickly realign export competitiveness or domestic demand could explain the persistence. This phenomenon has come to be called hysteresis in trade, as Blanchard and Summers (1986) pointed out. Besides, such a shock can also led to substantial losses of market position. The negative trajectory underscores how external price adjustments may exacerbate economic downturns if not accompanied by compensatory policy measures.

When analyzing the response of economic activity to shocks in the real exchange rate, the literature often highlights an inversion in the direction of the effect over time. Initially, an increase in the exchange rate is expected to boost GDP positively by enhancing export competitiveness. However, this response typically reverses, becoming negative as the economy adjusts, a pattern commonly observed in developing countries. This phenomenon, linked to the concept of Dutch disease as discussed by Bresser-Pereira (2010), suggests structural vulnerabilities, such as over-reliance on commodity exports and external exposure, that erode the initial gains. The divergence in this study, where the response is persistently negative, may reflect an economy unable to capitalize on the theoretical benefits of exchange rate depreciation. Factors such as a limited export base, reliance on imported inputs and inflationary pressures likely exacerbate the negative trajectory, highlighting the challenges of aligning empirical outcomes with theoretical expectations in the context of developing economies.

Regarding the fiscal policy, a shock to the primary surplus produces an initial positive response in GDP, peaking early but sustaining moderate persistence over the subsequent months. This result aligns with theories suggesting that fiscal adjustments, such as reducing deficits, can enhance confidence in economic stability, thus supporting aggregate demand (Alesina and Ardagna, 1998). However, the diminishing magnitude after the first year indicates that such effects are not indefinite and may require additional fiscal stimuli to sustain long-term growth. Indeed, according to Alesina and Perotti (1995), a fiscal adjustment cannot have long-lasting effects unless it tackles two expenditures — government employment and social programs — often regarded as untouchable by policymakers and their advisers.

For general government gross debt, the shock initially exerts a slightly negative influence on GDP. Such results align with concerns about fiscal sustainability and the crowding out effects. However, this impact diminishes rapidly, transitioning to a small positive response around the second quarter and stabilizing at low levels thereafter. This shift suggests that, while debt levels can create a short-term drag on economic activity, their long-term effects depend on the context of their use, such as investments in productive capacity. The net public sector debt demonstrates the most significant and persistent positive response among all variables. Following an initial lag, the positive impact on GDP peaks around the fifth month and gradually stabilizes over the subsequent months,

maintaining a high level of persistence even at the end of the 20-quarter horizon. This pattern underscores the central role of fiscal dynamics in influencing economic activity, particularly when debt is utilized effectively to stimulate demand or invest in growth-enhancing projects. The long-term persistence highlights how fiscal policies, if well-targeted, can have durable effects on economic output (Figure 1).

Across all shocks, the presence of persistence in GDP responses reinforces the relevance of hysteresis in economic dynamics. Variables such as the real exchange rate and net public sector debt exhibit sustained effects over the 20-quarter horizon, emphasizing the need for policymakers to address the structural underpinnings of these relationships. The varying magnitudes and directions of responses also highlight the complexity of managing economic shocks, where policy interventions must account for both immediate impacts and long-term adjustments. These findings align with the broader macroeconomic literature, illustrating how shocks in key variables can embed themselves in the economic trajectory, either reinforcing or mitigating the effects of past disturbances.

Thus, hysteresis could play a role in amplifying the persistence of the negative effects, where the initial adverse impacts of monetary expansion embed into the economy, reducing its ability to recover fully. This behavior aligns with Summers' (2014) argument that while monetary policy can have significant short-term effects, its ability to sustain long-term growth is constrained by diminishing returns and structural factors. Caldara and Herbst (2019) further emphasize that monetary policy is not neutral and can exhibit persistent effects, but the nature of these effects depends heavily on the broader macroeconomic and institutional context. These findings suggest that while monetary expansion may provide temporary boosts, the role of complementary policies, particularly fiscal measures and robust credit channels, is critical to ensuring sustained economic growth.

The presence of hysteresis in the observed responses can be attributed to various factors and mechanisms that influence economic dynamics over time. There are several elements that can contribute to the persistence of effects and patterns observed in the data. Firstly, inertia in prices and wages plays a significant role. Slow price adjustments by companies and wage adjustments by workers can result in longer responses to initial shocks. This phenomenon creates an inertia that maintains the effects of the shock for an extended period. The expectations of economic agents are also crucial to understanding hysteresis. If companies and consumers anticipate that a shock will have long-lasting effects, they will adjust their behavior to prolong these effects. Pessimistic expectations, for example, can lead to more conservative decisions in terms of spending and investment. Cumulative effects from certain monetary or fiscal shocks also contribute to hysteresis. Amplification of impacts over time can occur, resulting in a more persistent economic response. An initial drop in demand, for example, can trigger a series of events that feedback on each other, prolonging the adverse effects. Rigidity in the financial markets is another possible explanation.

Restrictions on access to credit can prevent the rapid recovery of affected companies and sectors. Indeed, this type of policy was used to complete the aggregate demand during

recessions, proving the importance of this type of channel to transmit monetary policy. In addition, changes in the confidence of economic agents triggered by initial shocks can lead to behavioral adjustments that persist over time. Hysteresis can also arise from sectoral and structural adjustments in the economy. Changes in economic policy, for example, can result in reallocations of production and employment that unfold over a prolonged period, contributing to persistent patterns in economic responses. In short, the combination of these factors creates a scenario in which the effects of shocks to the economy do not dissipate quickly but persist over time. Understanding these mechanisms is fundamental for policymakers, allowing them to implement more effective measures in the face of the temporal complexities of economic dynamics.

When analyzing economic responses to hysteresis, it is crucial to understand that this persistence does not necessarily imply continuous and unidirectional responses. Hysteresis is not strictly defined by a linear and continuous trajectory in positive or negative territory. On the contrary, the presence of fluctuations around zero aligns perfectly with the idea of hysteresis, where a complex dynamic of adjustments is observed. These oscillations may represent the resistance of the economic system to a complete reversion to initial levels, reflecting gradual adaptations over time. The mean trend associated with hysteresis emphasizes that, despite momentary variations in responses, there is a persistent overall direction. Past actions continuously influence present and future economic conditions, indicating inertia in the system and path dependence.

Therefore, understanding hysteresis involves recognizing a mean trend in responses, reflecting the enduring influence of past events on the economic course. Dutt (2023) approaches the concept of hysteresis refers to the property of systems which retain a memory of their time paths because different levels of the dependent variable can result from a particular level of the independent variable. It has also been defined as the phenomenon in which the effect persists after the changes that caused it to have been removed. The author still pointed out that the term “path dependence” is perhaps a little less vague, because it refers to what happened on a time path in the past. This characteristic is essential for interpreting the complex dynamics of the economic system and acknowledging resistance to instantaneous changes following a shock.

Besides, the persistence of the effects of fiscal policy shock proves that this type of policy cannot be considered neutral, as some strands of economic thought claim. Thus, if we continue with a framework of fiscal policy without any flexibility to adjust to the economic cycle, the policy’s effectiveness may be limited. Therefore, such a policy is crucial for combating such problems and should be regarded not only as a complementary instrument to monetary policy. The integrated analysis of these variables provides insights into economic dynamics, emphasizing the importance of considering the cumulative impact of past events on the current configuration of the economy. This understanding is crucial for formulating effective economic policies and strategies for mitigating persistent effects, acknowledging the complexity of interaction among various elements in the economy.

In short, the detailed analysis of the IRFs from the VEC model elucidates the occurrence of economic hysteresis in the Brazilian context. Across different shocks related

to policies, the responses of real GDP exhibit nonlinear dynamics, indicating that the effects are not confined to the immediate aftermath of the shocks but persist over time. These findings underscore the complexity of economic dynamics, influenced by factors such as inertia in prices and wages, expectations of economic agents, cumulative effects and structural adjustments. Understanding hysteresis is crucial for policymakers, as it implies that the economic system resists instant reversion to initial levels following shocks. This recognition informs the formulation of effective policies that consider the enduring influence of past events, facilitating a more nuanced and adaptive approach to economic management. Thus, the next section presents the concluding remarks.

Concluding Remarks

This paper undertook an analysis of monetary and fiscal policies to understand the fluctuations in the Brazilian business cycle. Using VEC models, the study focused on comparing IRFs for different macroeconomic variables, seeking to identify possible characteristics of economic hysteresis. When analyzing the responses of GDP to shocks in these variables, the presence of hysteresis was highlighted, indicating that the effects are not limited to the short term, but persist over time with non-linear dynamics.

Shocks to selected macroeconomic variables in this study reveal persistent and nonlinear dynamics in GDP, highlighting the structural complexities of the Brazilian economy. Changes in the real exchange rate trigger a sustained negative impact on GDP, reflecting challenges such as heavy reliance on imported inputs and limited export diversification. These factors intensify the long-term effects of external shocks, demonstrating the economy's limited capacity to absorb and adapt to such disturbances. Similarly, money supply shocks follow a complex trajectory, with an initial negative response giving way to a brief positive adjustment before reverting to a prolonged negative pattern. This behavior suggests inefficiencies in the monetary transmission mechanism, where short-term pressures, such as inflation or liquidity constraints, overshadow the potential benefits of monetary expansion. Fiscal variables, however, display more favorable dynamics, with targeted interventions showing potential for long-term growth. Positive shocks to the primary surplus produce early gains in GDP, though these effects diminish over time, reflecting the finite capacity of fiscal consolidation to sustain demand. Public debt, particularly net public sector debt, emerges as a critical driver, with significant and persistent positive impacts on GDP when managed to finance productive investments. This underlines the importance of fiscal policy as a strategic tool for economic resilience and growth.

The persistence of these dynamics underscores the presence of hysteresis, where the effects of shocks extend far beyond their initial impact. Structural factors such as price and wage rigidity, as well as the expectations of economic agents, amplify these prolonged adjustments, challenging the idea of neutrality in monetary and fiscal policies. Effective coordination between these policies is essential to mitigate adverse effects,

strengthen economic stability, and address the underlying structural limitations that sustain hysteresis over time.

Finally, an area of potential further exploration in this study would be the analysis of the impact of the policies mentioned on specific indicators of economic inequality, a crucial aspect often underestimated in macroeconomic research. Integrating measures of income and wealth distribution into VEC models could provide valuable insights into how monetary and fiscal policies affect different social strata. Understanding the effects of these policies on economic equity could not only improve the formulation of more inclusive policies, but also highlight possible trade-offs between macroeconomic stability and social justice. Examining the effects of these policies on the distribution of opportunities and resources could contribute significantly to a more holistic understanding of economic dynamics in Brazil, promoting a more comprehensive and equitable approach to the design of future economic policy strategies.

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