Macroeconomic and political determinants of the brazilian basic interest rate

Determinantes macroeconômicos e políticos da taxa básica de juros brasileira

Determinantes macroeconómicos y políticos de la tasa básica de interés brasileña

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Fábio Macedo Cavalcante
Master in Economics
Institution: Instituto Brasileiro de Ensino, Desenvolvimento e Pesquisa (IDP)
Address: Bela Vista, São Paulo, Brasil
E-mail: fmcavalcante1971@gmail.com

Sérgio Ricardo de Brito Gadelha
PhD in Economics
Institution: Instituto Brasileiro de Ensino, Desenvolvimento e Pesquisa (IDP)
Address: Bela Vista, São Paulo, Brasil
E-mail: sergio.gadelha@idp.edu.br

Mathias Schneid Tessmann
PhD in Economics
Institution: Instituto Brasileiro de Ensino, Desenvolvimento e Pesquisa (IDP)
Address: Bela Vista, São Paulo, Brasil
E-mail: mathias.tessmann@idp.edu.br

Bruno Saboya de Aragão
PhD in Administration
Institution: Instituto Brasileiro de Ensino, Desenvolvimento e Pesquisa (IDP)
Address: Bela Vista, São Paulo, Brasil
E-mail: bruno.aragao@idp.edu.br

ABSTRACT
This paper aims to investigate the formation of benchmark interest rates by understanding the factors that may influence the target set by the Brazilian Monetary Council for the Selic rate. To achieve this, data from 2003 to 2024 are analyzed to estimate a Taylor rule for Brazil through an autoregressive distributed lag (ARDL) model. The results suggest that the management of Brazilian monetary policy adheres to the principles of the Taylor

rule and has been influenced by structural changes. Extreme events, such as the Subprime crisis and COVID-19, may have impacted the decisions of the monetary authority, while the 2016 impeachment and different presidential administrations did not show statistically significant effects. These findings contribute to the scientific literature on interest rate formation by providing empirical evidence for Brazil and offer valuable insights for policymakers and other economic agents who consider monetary policy in their decision-making processes.

Keywords: Taylor's rule, Interest Rates, Selic, Brazilian Monetary Policy, JEL Classification: E520, E580, E430.

RESUMO
Este trabalho busca investigar a formação das taxas básicas de juros ao compreender os fatores que podem influenciar a meta definida pelo conselho monetário brasileiro para a taxa Selic. Para isso, são considerados informações de 2003 a 2024 para estimar uma regra de Taylor para o Brasil através de um modelo autorregressivo de defasagens distribuídas. Os resultados indicam que a gestão da política monetária brasileira é feita seguindo os princípios da regra de Taylor e que sofreu influências de mudanças estruturais. Eventos extremos como a crise do Subprime e o Covid-19 podem ter influenciado as decisões da autoridade monetária, enquanto o impeachment de 2016 e as diferentes administrações presidenciais não se mostraram estatisticamente significativos. Esses achados são úteis para a literatura científica que investiga a formação das taxas de juros ao trazer evidências empíricas para o Brasil, assim como aos policymakers e demais agentes econômicos que consideram a política monetária em suas decisões.

Palavras-chave: Regra de Taylor, Taxas de Juros, Selic, Política Monetária Brasileira. Classificação JEL: E520, E580, E430.

RESUMEN
Este trabajo tiene como objetivo investigar la formación de las tasas de interés de referencia mediante la comprensión de los factores que pueden influir en la meta establecida por el Consejo Monetario Brasileño para la tasa Selic. Para lograrlo, se analizan datos de 2003 a 2024 para estimar una regla de Taylor para Brasil a través de un modelo de rezago distribuido autorregresivo (ARDL). Los resultados sugieren que la gestión de la política monetaria brasileña se adhiere a los principios de la regla de Taylor y ha sido influenciada por cambios estructurales. Eventos extremos, como la crisis de las hipotecas subprime y el COVID-19, pueden haber impactado las decisiones de la autoridad monetaria, mientras que el impeachment de 2016 y diferentes administraciones presidenciales no mostraron efectos estadísticamente significativos. Estos hallazgos contribuyen a la literatura científica sobre la formación de las tasas de interés al proporcionar evidencia empírica para Brasil y ofrecen información valiosa para los responsables de las políticas y otros agentes económicos que consideran la política monetaria en sus procesos de toma de decisiones.

Palabras clave: Regla de Taylor, Tasas de interés, Selic, Política monetaria brasileña, Clasificación JEL: E520, E580, E430.

1 INTRODUCTION

Monetary policy plays a crucial role in the economic stability of a country. In Brazil, the Selic rate (Special System for Settlement and Custody) is the primary tool used by the Central Bank to control inflation and influence economic activity. It serves as the benchmark interest rate for the Brazilian economy, guiding the interest rates charged by banks on loans and financing, and thereby directly affecting consumption, investments, and aggregate demand. As such, the Selic rate is fundamental to maintaining economic stability, being utilized to keep inflation within the targets set by the National Monetary Council (CMN).

The Selic rate is periodically adjusted by the Central Bank's Monetary Policy Committee (Copom), which meets every 45 days to assess economic conditions and set the interest rate. During these meetings, various factors are considered, such as inflation, economic growth, labor market conditions, and both national and international economic and political events. The complexity of this process reflects the need for deep and ongoing analysis of the determinants of the Selic rate.

Understanding the determinants of the Selic rate and how it responds to different economic and political factors is fundamental to formulating effective policies. The Selic rate could be influenced not only by variations in inflation but also by other macroeconomic indicators, such as the level of economic activity, and by specific events that may impact the Brazilian economy. These include financial crises, significant political changes, and external shocks, which can cause market volatility and economic uncertainty.

The importance of studying the Selic rate lies in its broad influence on the economy. A high Selic rate tends to restrict consumption and investment, leading to slower economic growth but helping to curb inflation. Conversely, a low Selic rate may stimulate the economy by making credit more accessible, but it risks increasing inflationary pressures. Therefore, monetary policy and decisions related to the Selic rate are central topics for economists, policymakers, and investors.

Thus, this paper seeks to estimate a Taylor Rule for Brazil covering the period from 2003 to 2024 through an autoregressive distributed lag model (ARDL) and, by ordinary least squares, to test whether extreme events—such as the Subprime crisis, the 2016 presidential impeachment, and COVID-19—different presidential administrations, and the economic activity index have influenced the management of monetary policy.

The results indicate that the Brazilian Monetary Council follows the fundamentals of the Taylor Rule to set the Selic target, the benchmark interest rate in Brazil. Extreme events, such as the Subprime crisis and COVID-19, may have influenced the decisions of the monetary authority, while the 2016 impeachment, different presidential administrations, and the economic activity index did not show statistically significant effects.

These findings contribute to the understanding of the macroeconomic and political aspects that may influence benchmark interest rates, and the analysis of these issues is essential to understanding how monetary policy can be adjusted to better respond to the economic challenges faced by Brazil.

In addition to this introduction, the paper is divided into four sections. The second section presents a brief theoretical framework on the topic, the third section outlines the database and methodology employed, the fourth section presents and discusses the results, and finally, the fifth section concludes.

2 LITERATURE REVIEW

The literature on monetary policy and the determinants of interest rates is vast and multifaceted, encompassing a rich intersection between theory and empirical evidence. At the core of this literature is the "Taylor Rule," introduced by Taylor (1993), which represents a milestone in the formulation of systematic monetary policies. The Taylor Rule formalizes the monetary policy response to fundamental economic variations, proposing that central banks adjust nominal interest rates in response to deviations of inflation from its target and fluctuations in output around its potential level.

In the Brazilian context, Carvalho et al. (2016) conducted a thorough empirical analysis of the SELIC rate's response to fundamental economic variables, utilizing advanced econometric methodologies to identify and quantify these relationships. The study focuses on the relevance of critical factors such as current inflation, the output gap, and market inflation expectations. These elements are crucial for formulating an effective monetary policy that aims at both price stability and sustainable economic growth.

The econometric analysis by Carvalho et al. (2016) employs time series techniques, such as the Vector Autoregression (VAR) model, and incorporates Granger causality tests to examine the dynamic interactions between the SELIC rate and macroeconomic variables. The results indicate that Brazilian monetary policy, implemented by the Central Bank, follows a pattern that can be interpreted in light of the Taylor Rule. Specifically, the Central Bank adjusts the SELIC rate in response to deviations of inflation from its financial target and the output gap, reflecting a reactive and predictive approach to mitigating inflationary pressures and stabilizing the economy.

Furthermore, the study reveals specific nuances of the Brazilian economy, highlighting the high sensitivity of the SELIC rate to financial market expectations. This sensitivity suggests that the Central Bank of Brazil adopts a proactive stance, anticipating inflationary movements through market expectations analysis and adjusting monetary policy preemptively. This characteristic is particularly relevant in the context of emerging economies, where sound financial policy and effective expectation management play a vital role in anchoring inflation and maintaining economic stability.

Carvalho et al. (2016) also explore the persistence of the SELIC rate, using cointegration models to assess the long-term stability of relationships between interest rates and macroeconomic variables. The findings suggest significant inertia in Brazilian monetary policy, with gradual adjustments in the SELIC rate in response to changes in economic conditions, helping to avoid abrupt shocks in financial and real markets.

These studies reinforce the view that well-calibrated monetary policy is essential for economic stabilization, providing a more predictable macroeconomic environment conducive to sustainable growth. The ability of the Central Bank to adjust the SELIC rate in an informed and strategic manner, as indicated by empirical analyses, is crucial for the efficient conduct of monetary policy in Brazil. This not only strengthens the oversight of the monetary authority but also contributes to the confidence of economic agents, facilitating a favorable environment for long-term economic development.

However, the approach of Carvalho et al. (2016) is not without criticism. Some authors highlight limitations in the econometric models employed, such as the VAR model, which can be sensitive to model specification, variable selection, and the number of lags included. Cerqueira and Paula (2018) argue that these models may not fully capture the complexities and dynamics of the Brazilian economy, leading to potentially biased results.

Another frequent criticism concerns the issue of endogeneity in macroeconomic variables. Silva and Peres (2019) suggest that failing to properly address endogeneity can compromise the robustness of the results, as variables such as inflation and the output gap are influenced by other economic policies and shocks.

Moreover, critics point out that Carvalho et al. (2016) may underestimate the impact of external shocks, such as fluctuations in commodity prices and international capital flows, which play a significant role in the Brazilian economy. Ramos and Junior (2020) emphasize that these external factors may influence the SELIC rate in ways that are not fully captured by the proposed model.

Finally, the direct application of the Taylor Rule to the Brazilian context is questioned by some economists. The structure of the Brazilian economy, characterized by greater volatility and different transmission mechanisms of monetary policy, may require a more flexible and adapted approach than that suggested by the Taylor Rule. This implies the need to consider a broader range of economic and financial indicators when formulating policy decisions.

These criticisms highlight the importance of a holistic and adaptive approach when studying monetary policy in Brazil, considering the complexities and particularities of the Brazilian economy. Contemporary literature continues to explore variations and extensions of the Taylor Rule, seeking to more accurately capture the dynamic interactions and specific challenges faced by emerging economies.

The literature on monetary policy also widely explores how specific economic and political events can significantly affect central bank decisions. Events such as financial crises, pandemics, and political crises introduce exogenous shocks that can significantly alter the economic landscape and the conduct of monetary policy.

Studies on the subprime crisis, such as Borio (2008), investigate the mechanisms through which pre-crisis financial policies, particularly prolonged periods of low interest rates, led to the accumulation of systemic financial risks, culminating in the global financial crisis of 2007-2008. Borio argues that favorable economic conditions can create incentives for excessive risk-taking and investment bubbles.

The response of central banks to the crisis, which included aggressive interest rate cuts and large-scale asset purchase programs, exemplifies the use of unconventional policy measures in extreme situations to restore financial and macroeconomic stability. These episodes underline the need for monetary policy to be sufficiently flexible to respond to rapidly changing market conditions and systemic risks.

The COVID-19 pandemic presented an unprecedented challenge to the global economy, resulting in simultaneous supply and demand shocks. Gopinath (2020) details the magnitude of these shocks and the appropriate policy responses to mitigate their adverse effects. Central banks, including the Central Bank of Brazil, implemented historic interest rate cuts, expanded liquidity programs, and adopted quantitative easing measures to support the financial system and economic recovery. These actions highlight the importance of agile and adaptive policy in extreme crisis situations, capable of providing immediate economic support and stabilizing long-term expectations.

In the Brazilian context, political crises, such as the impeachment of Dilma Rousseff in 2016, had significant economic repercussions. The associated political instability and uncertainty directly affect economic agents' expectations, the exchange rate, country risk, and overall economic activity. Detailed studies of this period demonstrate how the Central Bank of Brazil adjusted its monetary policy to mitigate the negative impacts of these crises. For example, when facing increased risk perception and

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currency depreciation, the Central Bank may need to balance its decisions between controlling inflation and sustaining economic activity, illustrating the complexity of monetary policy in a volatile political environment.

Moreover, contemporary literature investigates the interaction between political and economic events and their influence on the effectiveness of monetary policy. Central bank credibility and independence, as well as clear and consistent policy communication, are crucial determinants of a central bank's ability to respond effectively in times of crisis. In emerging economies like Brazil, where political and economic volatility is more pronounced, these dynamics are even more critical. Research indicates that transparency in communicating monetary policy strategies can anchor inflation expectations and reduce market uncertainty, even during periods of political instability.

These studies highlight the need for adaptive and resilient monetary policy, capable of responding promptly to exogenous shocks. The ability of central banks to adjust their policies quickly and effectively is essential to maintaining macroeconomic stability and fostering the confidence of economic agents. The literature on the effects of economic and political events on monetary policy underscores the complexity of such interactions and the importance of a robust analytical framework to understand and anticipate potential responses in times of crisis.

Persistence in monetary policy is a recurring and widely debated theme in the economic literature. Classic studies such as Clarida et al. (1998) discuss inertia in interest rate decisions, emphasizing that central banks tend to adjust interest rates gradually, avoiding abrupt changes that could destabilize market expectations. This inertia can be explained by the preference of monetary policymakers to maintain a predictable and stable environment, minimizing economic volatility.

In the Brazilian context, evidence suggests that the SELIC rate exhibits significant persistence over time. Carvalho et al. (2016) used cointegration models to analyze the long-term stability of relationships between the SELIC rate and macroeconomic variations, finding significant inertia in the monetary policy decisions of the Central Bank of Brazil. This behavior may reflect a deliberate strategy by the Central Bank to avoid abrupt shocks in financial markets and the real economy, maintaining a predictable trajectory for interest rates.

Despite the advantages associated with persistence in monetary policy, various authors criticize this approach for several reasons. For example, Alesina and Stella (2010) argue that high persistence may limit central banks' ability to respond effectively to unexpected economic shocks. In crisis situations, a more agile and aggressive response may be necessary to stabilize the economy, and excessive inertia may delay the implementation of corrective measures.

Blinder (1999) also criticizes persistence, suggesting that it may reflect a conservative behavior by monetary policymakers. According to Blinder, in some cases, central banks may become averse to change, maintaining suboptimal policies for prolonged periods due to fear of making policy mistakes. This can result in a slow monetary policy response to new information and changing economic conditions.

In the Brazilian context, the critique that persistence may be detrimental is relevant, especially considering the high volatility of the economy. Silva and Peres (2019) point out that inertia in the SELIC rate may hinder the Central Bank's response to external shocks, such as fluctuations in commodity prices or international capital flows. The ability to quickly adjust interest rates in response to such shocks is crucial for maintaining economic stability.

Additionally, Ramos and Junior (2020) emphasize that persistence in monetary policy may be associated with reputational issues. If the market perceives that the Central Bank is reluctant to adjust monetary policy, there may be an increase in uncertainty and a reduction in the effectiveness of policy innovations. To avoid this issue, it is essential for the Central Bank to maintain clear and transparent communication about its goals and strategies, reinforcing its credibility and responsiveness.

To summarize, while persistence in monetary policy offers benefits in terms of predictability and stability, it is also crucial to consider the criticisms and limitations highlighted in the literature. Adapting monetary policies to current and future economic conditions, without compromising long-term stability, represents a constant challenge for central banks, particularly in emerging economies such as Brazil. Consequently, this work contributes to the scientific literature on interest rates by providing empirical evidence relevant to the Brazilian context.

3 METHOD

Specifically, the traditional version of the Taylor Rule (1993, p. 200) can be expressed in a special manner as follows:

$$i_t = r^* + \pi_t + \alpha(\pi_t - \pi^*) + \beta(y_t - y^*) + \varepsilon_t \quad (1)$$

In the equation, i_t denotes the short-term nominal interest rate (i.e., the basic nominal interest rate); r^* is the neutral real interest rate (i.e., the equilibrium real interest rate or natural rate of interest); π_t represents the current inflation rate; π^* is the inflation target; y_t is the actual output and y^* is the potential output (i.e., the economy's productive capacity), such that the term $y_t^c = (y_t - y^*)$ represents the output gap (the deviation of actual output from potential output). The parameters α e β capture the interest rate's sensitivity to variations in inflation and the output gap, respectively. Furthermore, α e β are the response coefficients to inflation and the output gap. The term ε_t represents a policy shock, independent and identically distributed, following a normal distribution with zero mean and constant variance: $\varepsilon_t \sim i.i.dN(0, \sigma^2)$.

Equation (1) demonstrates that the interest rate reacts to deviations in the inflation rate from its target, as well as to deviations of actual output from potential output. In other words, it implies an increase (decrease) in the interest rate when inflation is above (below) the target, and similarly, indicates that in the case of a positive (negative) difference between GDP growth and its perceived potential, there should be an increase (decline) in the interest rate to curb the growth of output or demand, aligning it with the full capacity of the economy or the level of full employment of production factors.

This arrangement provides a systematic framework for the conduct of monetary policy, promoting transparency and predictability in the actions of central banks. The applicability of the Taylor Rule has been extensively tested and adapted across various macroeconomic contexts, demonstrating its robustness in economic stabilization. Empirical studies corroborate that the implementation of a similar rule can mitigate macroeconomic volatilities and anchor inflation expectations, contributing to a more stable economic environment.

However, it is crucial to consider the limitations and allowable adaptations of the Taylor Rule to the specific context of each economy. Issues such as nominal tension, central bank additions, and the dynamics of economic agents' expectations are factors that may require adjustments in the practical application of the rule. Thus, contemporary literature continues to explore variations and extensions of the Taylor Rule, including nonlinear rules and responses to other economic variables such as the exchange rate and overall financial conditions, to better capture the complexities of the global economic environment.

Given that the Brazilian economy is affected by structural changes in both national and international economic conditions, it is intended to estimate the following modified Taylor Rule:

$$i_t = r^* + \tau_t + \pi_t + \alpha(\pi_t - \pi^*) + \beta(y_t - y^*) + \delta D_t + \varepsilon_t \quad (2)$$

In which τ_t represents the deterministic trend, and D_t denotes a vector of dummy variables associated with structural breaks that have influenced the behavior of the variables under analysis during the period considered in this study.

Equation (2) will be estimated using an Autoregressive Distributed Lag (ARDL) model. However, the estimation of the Taylor Rule was preceded by a rigorous stationarity analysis through unit root tests. The modified Dickey-Fuller (ADF^{GLS}) and Phillips-Perron ($\overline{MZ}_{\alpha}^{GLS}$) tests, proposed by Elliot, Rottemberg, and Stock (1996) and Ng and Perron (2001), are applied to verify the time series' stationarity. These tests overcome the issues of low statistical power and size distortions found in traditional tests by Dickey and Fuller (1979, 1981), Said and Dickey (1984), and Phillips and Perron (1988).

Modifications to the standard unit root test by Dickey and Fuller (1979, 1981) and Said and Dickey (1984) are based on two central aspects: extracting trends in time series using Ordinary Least Squares (OLS) is inefficient, and the importance of appropriately selecting the order of lag in the augmented term to better approximate the true data-generating process.

In the first case, Elliot, Rottemberg, and Stock (1996) propose using Generalized Least Squares (GLS) to extract the stochastic trend of the series. The standard procedure is employed to estimate the ADF^GLS statistic as the t-statistic to test the null hypothesis of a unit root against the alternative hypothesis that the series is stationary. Regarding the second aspect, Ng and Perron (2001) demonstrate that the Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) tend to select low values for the lag when there is a large negative root (close to -1) in the series' moving average polynomial. This leads to distortions and motivated the development of the Modified Akaike Information Criterion (MAIC) for selecting the autoregressive lag to minimize distortions caused by inappropriate lag selection.

Ng and Perron (2001) suggest that the same modifications be applied to the traditional Phillips and Perron (1988) test, resulting in the $\overline{MZ}_{\alpha}^{GLS}$ test. Through simulations, Ng and Perron (2001) show that the combined application of GLS to extract the deterministic trend and the MAIC lag selection criterion produce tests with greater power and fewer statistical size distortions compared to traditional ADF and PP tests. The critical values for the ADF^{GLS} and $\overline{MZ}_{\alpha}^{GLS}$statistics are reported in Ng and Perron (2001).

However, even the modified ADF^{GLS} and $\overline{MZ}_{\alpha}^{GLS}$ tests have low power in the presence of structural breaks, becoming biased towards not rejecting the null hypothesis of a unit root, even when the series is stationary. Perron's (1989) pioneering work illustrates the importance of including a structural break in traditional unit root tests. Three models of structural break were considered: Model A, known as the crash model, allows a change in level at one period; Model B allows for a break in the trend of the time series; Model C, known as the changing growth path model, includes a change in both level and trend during one period.

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Subsequent research adopted an endogenous procedure to determine the breakpoint from the data. In this context, Vogelsang and Perron (1998) developed a unit root test with endogenously estimated breakpoint, based on Perron's (1989) Models A, B, and C, and the Innovation Outlier (IO) and Additive Outlier (AO) methods. The AO model allows for a sudden change in the mean (crash model), while the IO model allows for more gradual changes. Thus, both models are used to verify the stationarity hypothesis: break in intercept, break in intercept and trend, both at level and in first difference.

In turn, Saikkonen and Lütkepohl (2002) and Lanne, Saikkonen, and Lütkepohl (2002, 2003) propose that structural breaks may occur over a number of periods and exhibit a smooth transition to a new level. Therefore, a level shift function is added to the deterministic term of the data-generating process. The deterministic terms are extracted by Generalized Least Squares (GLS), followed by an ADF test applied to the adjusted series. Critical values for the test are tabulated by Lanne, Saikkonen, and Lütkepohl (2002).

The monthly data considered for equation's (2) estimation are obtained from the Central Bank of Brazil (BCB) and the Brazilian Institute of Geography and Statistics (IBGE), covering the period from January 2003 to February 2024. The following variables were considered:

Nominal Interest Rate (i_t) represents the nominal interest rate set by the central bank at time t. It serves as the primary monetary policy tool used to control inflation and influence economic activity.

Equilibrium Real Interest Rate (r^*): the real interest rate that would prevail when the economy is at its potential level, i.e., when inflation is on target and output is at its full employment level. It is a theoretical variable, typically estimated using economic models.

Inflation Rate in Period t (π_t): the observed inflation rate during the period t. It measures the general increase in prices of goods and services in the economy.

Inflation Target (π^*): the inflation target set by the central bank. The central bank adjusts the interest rate to align the observed inflation (π_t) with the inflation target (π^*).

Inflation Response Component ($\alpha(\pi_t - \pi^*)$): this component reflects the central bank's response to deviations between the observed inflation and the inflation target. The parameter α indicates the interest rate's sensitivity to changes in inflation relative to the target.

Real Gross Domestic Product in Period (y_t): level of economic activity or real GDP during period t. It is a measure of the total output of goods and services in the economy.

Potential Output (y^*): level of GDP that the economy can sustain over the long term without generating inflationary pressures. It represents the maximum productive capacity of the economy at full employment.

Output Gap Response Component ($\beta(y_t - y^*)$): reflects the central bank's response to the divergence between actual GDP and potential GDP. The parameter β indicates the interest rate's sensitivity to variations in the output gap.

Error Term or Exogenous Shock ($\boldsymbol{\varepsilon_t}$): exogenous shocks or factors not captured by other terms in the equation, which can affect the nominal interest rate during period t.

4 RESULTS

Table 1 presents the results of the unit root tests applied to the time series considered in the study, both without and with structural breaks.

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Table 1. Unit Root Tests Results (1997 to 2023)

Variables	Model	No Structural Break			Endogenous Structural Break (unknown break date)					
					Vogelsang e Perron (1998)			Saikkonen e Lütkepohl (2002)		
		ADF^{GLS}	$\overline{MZ}_t^{GLS}$	*Lags*	**Model Tipe**	**Break Date**	**Test's Statistics**	**Model Tipe**	**Break Date**	**Test's Statistics**
$-y_t^c$	C	-5,51[(a)]	-5,30[(a)]	2	*Inovational Outlier*	2003:06	-7,53[(a)] (0 *lag*)	*Rational shift*	2003:06	-5,42 [(a)] (2 *lags*)
$-y_t^c$	C,T	-5,46[(a)]	-5,26[(a)]	2	*Inovational Outlier*	2003:08	-7,54[(a)] (0 *lag*)	*Rational shift*	2003:06	-5,16 [(a)] (2 *lags*)
$-y_t^c$	T	-	-	-	*Inovational Outlier*	2023:12	-7,56[(a)] (0 *lag*)	*Rational shift*	-	-
$\tilde{\pi}_t$	C	0,04	0,07	0	*Inovational Outlier*	2016:06	-7,34[(a)] (0 *lag*)	*Rational shift*	2004:01	-4,09[(a)] (0 *lag*)
$\tilde{\pi}_t$	C,T	-0,69	-0,66	0	*Inovational Outlier*	2016:06	-7,44[(a)] (0 *lag*)	*Rational shift*	2004:01	-1,17 (0 *lag*)
$\tilde{\pi}_t$	T	-	-	-	*Inovational Outlier*	2024:01	-6,07[(a)] (0 *lag*)	*Rational shift*	-	-
i_t	C,T	-0,93	-0,79	13	*Additive Outlier*	2023:12	-5,85[(a)] (2 *lags*)	*Rational shift*	2004:03	-5,65 [(a)] (2 *lags*)
i_t	C	-2,63[(c)]	-3,33[(b)]	13	*Additive Outlier*	2023:12	-5,85[(a)] (2 *lags*)	*Rational shift*	2004:03	-5,02 [(a)] (2 *lags*)
i_t	C,T	-	-	-	*Additive Outlier*	2023:08	-6,08[(a)] (2 *lags*)	*Rational shift*	-	-

Source: Prepared by the authors. Econometric softwares used: EViews and JMulTi.

Nota: 1 – "Lags" refers to the number of time delays. Model types: "C" stands for constant; "T" stands for deterministic trend. Maximum initial count of 15 lags. Note that (a), (b), and (c) indicate that the estimated coefficients are statistically significant or reject the null hypothesis at statistical significance levels of 1%, 5%, and 10%, respectively. Monthly observations included: 254 (sample: January 2003 to February 2024).

2 – The critical values for the ADF^{GLS} test (Elliot, Rothenberg, and Stock, 1996) are: (i) model with constant: -2.57 (1%), -1.94 (5%), and -1.62 (10%); (ii) model with constant and deterministic trend: -3.47 (1%), -2.91 (5%), and -2.60 (10%). Selection of the optimal number of lags through the modified Akaike Information Criterion.

3 – The asymptotic critical values for the $\overline{MZ}_\alpha^{GLS}$ test (Ng and Perron, 2001, Table 1) are: (i) model with constant: -2.58 (1%), -1.98 (5%), and -1.62 (10%); (ii) model with constant and deterministic trend: -3.42 (1%), -2.91 (5%), and -2.62 (10%). Spectral estimation method: AR GLS-detrended. Selection of the optimal number of lags through the modified Akaike Information Criterion.

4 – The critical values for the Vogelsang and Perron (1998) test are: (i) model with constant and deterministic trend/break in intercept: -5.35 (1%), -4.86 (5%), and -4.61 (10%); (ii) model with constant and deterministic trend/break in intercept and trend: -5.72 (1%), -5.17 (5%), and -4.89 (10%); (iii) model with constant and deterministic trend/break in trend: -5.07 (1%), -4.52 (5%), and -4.26 (10%). Types of break: innovational outlier and additive outlier. Structural break selection: minimized Dickey-Fuller t-statistic. Selection of the optimal number of lags: Schwarz Information Criterion.

5 – The critical values for the Saikkonen-Lütkepohl test (Lanne et al., 2002) are: (i) model with constant: -3.48 (1%), -2.88 (5%), and -2.58 (10%); (ii) model with constant and deterministic trend: -3.55 (1%), -3.03 (5%), and -2.76 (10%). Types of structural break: Rational Shift, Exponential Shift, and Impulse dummy.

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Unit root tests, such as the Augmented Dickey-Fuller (ADF) and Modified Z (MZ), were conducted with and without structural breaks. The results indicated that, even in the presence of breaks, the series remained stationary at level, i.e., integrated of order zero (I(0)). These findings suggest that the economic policies and identified shocks were absorbed by the series without altering their stationary nature, indicating a certain resilience of the time series to structural changes over the considered period. The following structural breaks were identified in the series:

June 2003: In 2003, Brazil underwent a market confidence crisis due to political uncertainty with the election of Luiz Inácio Lula da Silva. The market was concerned about possible changes in economic policies.

January 2004: The beginning of 2004 marked the implementation of stricter economic policies and fiscal adjustment, aiming to regain market confidence and stabilize the economy after the turbulence of 2003.

June 2016: In 2016, Brazil was in the midst of a deep economic crisis, resulting from a combination of factors, including economic recession, falling commodity prices, and political instability following the impeachment of President Dilma Rousseff.

December 2023: In 2023, Brazil may have experienced a significant event, such as a change in monetary policy or an external shock, that impacted economic variables.

January 2024: This could be related to a recent event, such as an abrupt change in inflation due to economic policies or changes in the international scenario, directly affecting inflation.

Table 2 presents the results for the estimation of the Taylor Rule in Brazil.

Table 2. Taylor's Rule results

	Dependent Variable:
	i_t
i_{t-1}	1.701631***
	(0.059483)
i_{t-2}	-0.487776***
	(0.112149)
i_{t-3}	-0.224473***
	(0.055616)
$\pi_t^{\sim}$	0.021025**
	(0.006826)
y_t^c	1.89E-06***

	(3.89E-07)
y^c_{t-1}	-2.35E-06***
	(5.33E-07)
y^c_{t-2}	1.60E-06***
	(4.62E-07)
r^*	0.142599***
	(0.029487)
τ_t	-0.000325***
	(0.000105)
D2003_10	-0.271618***
	(0.019773)
D2003_11	-0.223407***
	(0.025921)
D2003_12	-0.214516***
	(0.021938)
D2004_01	-0.379201***
	(0.019646)
D2004_03	0.432570***
	(0.022538)
D2004_04	-0.183242***
	(0.030227)
D2004_08	0.303910***
	(0.025307)
D2004_11	0.361754***
	(0.015738)
D2004_12	0.339727***
	(0.023661)
D2007_04	0.254917***
	(0.013765)
D2003_05	0.245024***
	(0.022716)
D2023_02	-0.217879***
	(0.015369)
R^2	0.999733
Adjusted R^2	0.999710
F-Statistic	43049.65***
Akaike info criteriun	-2.121070
Schwarz info criteriun	-1.826112
Hannan-Quinn info criteriun	-2.002372
Durbin Watson stat	2.195143
LM Test	6.640935***
White Test	0.863584
RESET Test	0.011188

Source: Prepared by the authors.

The results presented in Table 2 reveal that all variables considered in the Taylor Rule, including their lags selected through Akaike, Schwarz, and Hannan-Quinn criteria, are statistically significant in determining the Selic rate, the Brazilian benchmark interest rate. This finding strongly suggests that the monetary policy implemented in Brazil is aligned with the principles of the Taylor Rule.

The significance of the lagged variables evidences a clear persistence in the conduct of monetary policy, demonstrating that past decisions have a substantial impact on current decisions. This phenomenon of inertia is widely recognized in the economic literature as an effective strategy to mitigate abrupt fluctuations in both the financial market and the real economy. Previous studies, such as those by Clarida et al. (1998) and Blinder (1999), have also identified this trend, indicating that a gradualist approach to monetary policy can provide greater predictability and stability to the economic environment.

Furthermore, the statistical relevance of the inflation variable underscores the crucial importance of inflation control in defining the Selic rate. This result corroborates the extensive literature advocating for a vigorous response by central banks to inflationary variations as a means of ensuring macroeconomic stability. Fundamental works, such as those by Taylor (1993), emphasize that a central bank should adjust interest rates proactively in response to deviations from the established inflation target. This principle is essential to avoid an inflationary spiral and ensure sustainable economic growth.

In summary, the findings reinforce the thesis that the Central Bank of Brazil adopts a well-founded and prudent monetary policy, guided by the principles of the Taylor Rule and the need for economic stability. The persistent and reactive approach to inflationary variations demonstrates a solid commitment to maintaining a stable and predictable economic environment, benefiting the Brazilian economy as a whole.

In addition to the analysis of Taylor's Rule, other estimations were conducted in order to achieve a deeper understanding about the Selic rate in Brazil. Table 3 presents the results of estimations from three additional models using Ordinary Least Squares (OLS) that aim to verify the influences of macroeconomic and political factors in determining interest rates.

Table 3. Additional Estimations results

	Dependent Variable:		
	ir_t^*		
	Model (1)	Model (2)	Model (3)
$\pi_t^{\sim}$	0.189***	0.310***	0.203***
	(0.032)	(0.130)	(0.031)
$ibcbr_t$	-0.0002	0.004	-0.003
	(0.003)	(0.011)	(0.003)
ir_{t-k}	0.955***	1.028***	0.940***
	(0.010)	(0.091)	(0.012)
$adm_1\pi_t^{\sim}$	-	-0.175	-
		(0.137)	-
$adm_2\pi_t^{\sim}$	-	-0.197	-
		(0.123)	
$adm_3\pi_t^{\sim}$	-	0.062	-
		(0.130)	
$adm_1 ibcbr_t$	-	0.010	-
		(0.008)	
$adm_2 ibcbr_t$	-	0.006	-
		(0.008)	
$adm_3 ibcbr_t$	-	0.010	-
		(0.008)	
$adm_1 ir_{t-1}$	-	-0.057	-
		(0.093)	
$adm_2 ir_{t-1}$	-	-0.026	-
		(0.083)	
$adm_3 ir_{t-1}$	-	-0.102	-
		(0.087)	
$covid$	-	-	-0.382**
			(0.152)
$subprime$	-	-	0.346***
			(0.130)
$impeachment$	-	-	0.059
			(0.132)
$Constant$	0.357	-1.500	0.926
	(0.518)	(1.083)	(0.565)
Observations	253	253	253
R²	0.991	0.992	0.992
Adjusted R²	0.991	0.992	0.992
Residual Standard Deviation	0.445 (df = 249)	0.421 (df = 240)	0.436 (df = 246)
F-statistics	9,384.091*** (df = 3;249)	2,625.101*** (df = 12;240)	4,906.951*** (df = 6;246)

Note: *p<0.1; **p<0.05; ***p<0.01

Source: Prepared by the authors.

The results from Table 3 indicate that the inflation gap and past Selic rates are statistically significant, suggesting that inflation and monetary policy persistence are primary determinants of the SELIC rate. The IBC-BR was not significant, implying that the economic activity index used may not adequately capture variations influencing the

SELIC rate. These findings align with existing literature. Taylor (1993) emphasizes the importance of adjusting interest rates in response to inflation deviations, while studies such as those by Blinder (1999) and Clarida et al. (1998) confirm inertia in monetary policy decisions. The insignificance of the IBC-BR may indicate the need to explore other economic activity indices that better reflect economic conditions in Brazil.

The model with interactions, considering presidential periods, was not statistically significant, suggesting that monetary policy did not vary between administrations. However, the inflation gap remains significant, reinforcing its importance in determining the SELIC rate. The absence of significance in interactions may suggest that, regardless of differences in presidential administrations, the Central Bank of Brazil maintains a consistent approach in responding to inflation variations, corroborating the notion that monetary policy is largely guided by price stability objectives (Taylor, 1993; Clarida et al., 1998).

The model with specific events showed mixed results. A dummy for COVID-19 was statistically significant with a negative sign, indicating a reduction in the SELIC rate during the pandemic. A dummy for the subprime crisis was significant and positive, reflecting an increase in the SELIC rate during this period.

These results align with expected responses to economic shocks. During the COVID-19 pandemic, the reduction in interest rates was a common response by many central banks to provide economic stimulus (Gopinath, 2020). Similarly, the increase in the SELIC rate during the subprime crisis reflects an attempt to control inflationary pressures and stabilize financial markets (Borio, 2008).

Thus, inflation and monetary policy inertia are crucial determinants of the SELIC rate in Brazil. While economic activity measured by the IBC-BR was not significant, other economic activity indices might provide additional insights. A consistent response from the Central Bank to inflation variations, regardless of presidential administrations, reflects a commitment to price stability. The impacts of specific economic events, such as the COVID-19 pandemic and the subprime crisis, demonstrate an adaptive capacity of monetary policy in times of crisis.

The findings regarding the inflation gap confirm the central importance of inflation in determining the SELIC rate, as proposed by the Taylor Rule (Taylor, 1993). According to the Taylor Rule, central banks adjust interest rates in response to deviations in inflation relative to the target and the output gap. The presence of a positive and highly significant coefficient for the gap suggests that the Central Bank of Brazil follows a similar approach, where inflation above the target results in increases in the SELIC rate to curb inflationary pressure.

This finding is in line with studies such as those by Clarida, Galí, and Gertler (1998), which also found evidence that authorities vigorously monitor inflation variations. Blinder (1999) argues that responding to inflation variations is a common practice among central banks that adopt prudent monetary policies, seeking to maintain renewal and anchor inflation expectations. The literature emphasizes that a robust response to inflation is crucial to avoid a price spiral and ensure macroeconomic stability.

The persistence in the SELIC rate reflects the inertia observed in other monetary policy studies, such as Clarida et al. (1998) and Blinder (1999), which extensively discuss inertia in monetary policy decisions, as central banks adjust interest rates gradually. This behavior is often interpreted as a strategy to avoid destabilizing market expectations and to smooth the effects of changes in economic conditions. The scientific literature also suggests that inertia may be a response to economic uncertainties and the desire to avoid abrupt fluctuations in the economy.

Woodford (2003) argues that gradual changes in interest rates can help anchor expectations and provide a more predictable economic environment. In the Brazilian context, the significance of the SELIC rate's lag coefficient suggests that the Central Bank of Brazil adopts a cautious and predictive approach, adjusting interest rates in a manner that avoids abrupt shocks in the financial market and the real economy.

The impacts of specific events, such as the COVID-19 pandemic and the subprime crisis, are also in line with the literature on monetary policy responses to significant economic shocks. Gopinath (2020) details how central banks around the world, including the Central Bank of Brazil, aggressively reduced interest rates during the COVID-19 pandemic to mitigate adverse economic effects. Similarly, Borio (2008) examines the response of central banks during the subprime crisis, where interest rate increases were implemented to control inflationary pressures and stabilize financial markets. Likewise, Bernanke (2013) highlights the importance of a swift and effective response to economic shocks to ensure recovery and economic stability.

These findings demonstrate the adaptive capacity of Brazilian monetary policy in response to economic shocks and reinforce the importance of a flexible and informed approach to maintaining macroeconomic stability and promoting sustainable growth. Mishkin (2007) and Svensson (1997) also emphasize the need for a monetary policy that dynamically responds to economic challenges, suggesting that flexibility and adaptability are essential for long-term success.

The findings are consistent with the extensive literature on monetary policy and the Taylor Rule. The significant response to observed inflation is in line with studies by Taylor (1993), who proposes that central banks adjust interest rates in response to deviations from the inflation target. Clarida, Galí, and Gertler (1998) also found robust evidence that monetary policy is strongly influenced by inflation variations, reinforcing the idea of a vigorous response to avoid a price spiral and ensure macroeconomic stability.

The observed persistence in the SELIC rate, evidenced by the coefficients of the lagged variables, is widely supported by the literature. Blinder (1999) and Clarida et al. (1998) discuss inertia in monetary policy decisions as a common practice among central banks, a strategy aimed at minimizing economic volatility. Woodford (2003) argues that gradual changes in interest rates can help anchor expectations and provide a more predictable economic environment, something particularly crucial for emerging economies like Brazil. This gradualist approach is corroborated by Goodfriend (1991), who highlights the importance of avoiding abrupt adjustments to maintain market confidence.

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Literature substantiates the effectiveness of the observed strategies, highlighting the importance of a well-calibrated and adaptable monetary policy to shifting economic conditions. This alignment with both theory and international practice strengthens the validity of the findings and suggests that the Central Bank of Brazil is employing a prudent and effective approach in the conduct of monetary policy.

5 CONCLUSIONS AND IMPLICATIONS

This paper sought to investigate interest rates by estimating a Taylor Rule for Brazil from 2003 to 2024 using an autoregressive distributed lag model. The findings indicate that the Brazilian monetary authority adheres to the principles of the Taylor Rule. Moreover, extreme events such as the Subprime crisis and COVID-19 may have influenced the monetary authority's decisions, while the 2016 impeachment, different presidential administrations, and the economic activity index were not statistically significant.

As implications for public policy, several key areas can be outlined. The first relates to price stability, where the Central Bank would continue monitoring inflation to adjust the SELIC rate as needed, maintaining and strengthening inflation targets to help anchor market and public expectations.

The second focuses on consistent communication, aiming to mitigate observed inertia with an emphasis on transparency about targets, the reasons behind decisions, and future expectations to reduce uncertainty and improve monetary policy correction. Regular publication of reports on inflation expectations, economic analyses, and policy decisions helps align market expectations with the objectives of the Central Bank.

The third involves responding to specific events, where developing robust contingency plans to address specific economic events, such as financial crises and pandemics, would contribute to flexibility and readiness in adjusting policies in response to these external shocks, demonstrating the resilience of the Central Bank and the effectiveness of its approach.

Another point would be the implementation of ongoing analyses of the impacts of past events to enhance future responses, exploring and implementing innovations in monetary policy tools that could address new economic challenges, including the use of macroprudential policies to complement traditional monetary policies. Moreover, strengthening collaboration with other international monetary authorities could provide valuable insights and increase the effectiveness of responses to international shocks.

As suggestions for future research, other economic activity indices could be explored to assess their influence on the SELIC rate, such as industrial production indices and consumer confidence indices. Additionally, conducting studies focused on long-term analyses that consider structural changes in the Brazilian economy could provide further insights into the determinants of monetary policy.

Incorporating new variables, such as demographic factors and technological changes, might enrich the analysis, and finally, comparing Brazilian monetary policy with that of other emerging countries would offer useful perspectives on the effectiveness of the strategies employed and potential improvements.

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