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ARTÍCULO

THE COORDINATION OF MONETARY AND FISCAL POLICIES IN BRAZIL AND THE NEW MACROECONOMIC MATRIX

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Pereira Freitas, R. J., & Gomes da Silva, C. (2025). The coordination of monetary and fiscal policies in Brazil and the New Macroeconomic Matrix. *Cuadernos de Economía, 44*(95), 823-856.

This article aims to analyse Brazil's economic performance, particularly focusing on the coordination between monetary and fiscal policies from 2003Q1 to 2020Q4, with a special emphasis on the period known as the "New Macroeconomic Matrix" (NMM), from 2011Q1 to 2018Q2. To this end, the study employs a DSGE model, examining observed variables such as the nominal interest rate, the GDP, CPI inflation, and primary surplus. The main empirical results indicate a lack of coordination between monetary and fiscal policies. For instance: i) During the NMM period, increases in the Selic interest rate were not able to mitigate eco-

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nomic activity, at the beginning of a cycle, indicating that other forces (mainly fiscal policy) were acting in the opposite direction; and ii) A decline in Fiscal Results and an increase in Government Spending also indicate a discoordination of economic policies during the NMM period.

Keywords: DSGE model; economic performance; fiscal policy; monetary policy; New Macroeconomic Matrix.
JEL: C68, E52, E62.

Pereira Freitas, R. J., & Gomes da Silva, C. (2025). La coordinación de las políticas monetaria y fiscal en Brasil y la nueva matriz macroeconómica. *Cuadernos de Economía, 44*(95), 823-856.

Este artículo tiene como objetivo analizar el desempeño económico de Brasil, enfocándose particularmente en la coordinación entre las políticas monetaria y fiscal desde el primer trimestre de 2003 hasta el cuarto trimestre de 2020, con especial énfasis en el período conocido como la "Nueva Matriz Macroeconómica" (NMM), desde el primer trimestre de 2011 hasta el segundo trimestre de 2018. Para ello, el estudio emplea un modelo DSGE, examinando variables observadas como la tasa de interés nominal, el producto interno bruto (PIB), la inflación del índice de precios al consumidor (IPC) y el superávit primario. Los principales resultados empíricos indican una falta de coordinación entre las políticas monetaria y fiscal. Por ejemplo: 1) Durante el período NMM, los aumentos en la tasa de interés Selic no lograron mitigar la actividad económica al inicio de un ciclo, lo que indica que otras fuerzas (principalmente la política fiscal) actuaban en la dirección opuesta y 2) Una disminución en los resultados fiscales y un aumento en el gasto público también indican una descoordinación de las políticas económicas durante el período NMM.

Palabras clave: modelo DSGE; resultados económicos; política fiscal; política monetaria; Nueva Matriz Macroeconómica.
JEL: C68, E52, E62.

INTRODUCTION

The Brazilian economy has faced several challenges in the last two decades, especially regarding its monetary and fiscal policies stance even thirty years after the "Real Plan" was adopted, in 1994. The Brazilian economic agents still see, in the rear-view mirror, the turbulent periods of high inflation. As a result, the Brazilian monetary and fiscal authorities must deal with this scenario when they try to coordinate their monetary and fiscal policies, actions and decisions.

In fact, after the adoption of the Inflation Targeting System, in 1999, the Brazilian economic authorities implicitly adopted the so-called "Macroeconomic Tripod", which consisted of three important approaches: a primary surplus target, a floating exchange rate, and an inflation target. This was an effort to coordinate monetary and fiscal policy decisions from the start. To reach the "Macroeconomic Tripod's" goal, the country started to implement various fiscal rules, starting with the Fiscal Responsibility Law, in 2000, and worked hard with its fiscal policies to generate positive fiscal results.

Over the last twenty years or so, the Brazilian economy has been hit by some downturns worth mentioning. There is no doubt that these economic cycles have been challenging, especially regarding the performance of economic activity and inflation. Several of them are related to external shocks and international crises, such as the 2008-2009 global financial crisis and the 2020 Covid-19 outbreak. However, the 2014 recession is more related to domestic problems, especially political instabilities and erratic economic decisions made before 2014, which became known as the "New Macroeconomic Matrix" (NMM) period.

Even with this inconsistent performance of the Brazilian economy, from a methodological standpoint, Dynamic Stochastic General Equilibrium (DSGE) models are useful for a thorough macroeconomic analysis of the country's economy. For instance, in their stochastic part, they can account for the important downturns faced by the Brazilian economy over the last years. As will be detailed in the literature reviews, central bank DSGE models are very useful for monetary authorities, but also for academic purposes, as researchers can replicate the models and try to simulate nuances and specific periods and variables not considered previously. The Brazilian SAMBA Model (Stochastic Analytical Model with a Bayesian Approach) can be used in the same way. Therefore, its adaptation is useful to explore the peculiarities of macroeconomic policies in the last two decades, especially during the deep recession faced by the country's economy, during the NMM period. This approach allows for a more detailed assessment of the effectiveness of these policies in a context of intense economic transformations and substantial challenges. In this way, this study captures insights that contribute to the understanding and formulation of policies in similar situations of instability. It is not easy to coordinate monetary and fiscal policies in this scenario of a myriad of domestic and external shocks.

This article seeks to evaluate Brazil's economic performance, focusing on the coordination between monetary and fiscal policies from 2003Q1 to 2020Q4, with particular emphasis on the NMM period from 2011Q1 to 2018Q2. The study utilises a DSGE model to analyse observed variables such as the nominal interest rate, the GDP, CPI inflation, and primary surplus. The main empirical findings reveal a lack of coordination between monetary and fiscal policies. For instance, during the NMM period, increases in the Selic interest rate failed to mitigate economic activity at the start of a cycle, suggesting that other forces, mainly fiscal policy, were working in the opposite direction. Additionally, a decline in Fiscal Results combined with increased Government Spending further highlights the discoordination of economic policies during the NMM period.

In addition to this introduction, the paper is organised into six additional sections. The second section reviews the relevant literature. The third section describes the Brazilian economy over the last two decades. Sections four and five present the macroeconomic model and the econometric methodology adopted, respectively. The sixth section discusses the results, and the last section concludes.

THE LITERATURE: A BRIEF REVIEW

The advent of research on the efficient behaviour of monetary authorities in the pursuit of credibility, such as the investigations related to i) rules versus discretion (Kydland & Prescott, 1977); ii) reputation (Barro & Gordon 1983a, 1983b); and iii) delegation (Rogoff, 1985), led to the development of a monetary policy institutional framework used by several central banks around the world.

Credible monetary policy actions call for a central bank reaction function, such as a Taylor Rule (Taylor, 1993). Interest rate rules should be credible enough to anchor the expectations of economic agents and, consequently, neutralise the time inconsistency of optimal plans. However, over the years, it became clear that neglecting the fiscal side of the economy would not yield optimal results in terms of social welfare. The advent of monetary rules was linked to the increasing importance given to fiscal policy as a crucial factor in achieving monetary policy objectives. This means that both monetary and fiscal rules would not be successful without an efficient coordination process between them.

Coordination between monetary and fiscal policies, as approached by Sargent and Wallace (1981) in their discussion related to monetary and fiscal dominance, and by authors such as Leeper (1991), Sims (1994), Woodford (1995, 2003), Cochrane (2001), among others, leading to the emergence of the Fiscal Theory of the Price Level.

With the theoretical advancement of research on the subject, the New Keynesian approach additionally emerges to articulate the role of optimal coordination between monetary and fiscal policies under the same objective function. This means that both policy rules would respect the same intertemporal government

budget constraint, as discussed in Bénassy (2003), Benigno and Woodford (2003), Muscatelli *et al.* (2004), Schmitt-Grohé and Uribe (2004, 2007), Persson *et al.* (2006) and Çebi (2012).

This discussion has also advanced in the quest for a better understanding of the interaction between monetary and fiscal policies in Brazil. Hillbrecht (2001) argues that the adoption of an efficient inflation targeting regime is necessarily linked to the joint coordination of monetary and fiscal policies. Mendonça (2003) views the coordination between monetary and fiscal policies in Brazil as a better framework for achieving Brazilian macroeconomic objectives. Afonso *et al.* (2016) analyse the origins and evolution of monetary and fiscal institutions in Brazil, with a focus on the framework for inflation control in the country. The conclusion is that along with the implementation of the "Real Plan", other institutional reforms were also decisive in the process of monetary stabilisation of the Brazilian economy.

Barros and Lima (2018) use DSGE models to analyse the impacts of fiscal stimulus on Brazilian macroeconomic variables from 1999 to 2017. These authors find evidence of an active monetary policy in Brazil, but one that undergoes significant transformations over time. Melo and Gomes da Silva (2019) examine the interaction between monetary and fiscal policies in Brazil ranging from 2003 to 2017 using the GMM System. They find evidence of a countercyclical monetary policy, but full coordination between monetary and fiscal policies is not fully assured.

De Paula *et al.* (2015) analyse the contagion of the 2008 international financial crisis and the Eurozone crisis from 2011 to 2012 in Brazil, as well as the potential coordination between economic policies. The conclusion is that policy coordination was more harmonious during the first crisis, whereas it was not assured during the second one. Carvalho *et al.* (2016) estimate the fiscal costs, both direct and indirect, of positive interest rate shocks in the Brazilian economy. To do so, the authors employ Vector Autoregressive (VAR) models using data spanning from 2003 to 2013. The findings indicate that given the perception of a significant stock of international reserves, fiscal costs arise from a more restrictive fiscal policy through the exchange rate transmission channel. Moreover, it is suggested that effective policy coordination is necessary, rather than merely a slower accumulation of international reserves. Lastly, Fialho and Portugal (2005) analyse the existence of a monetary or fiscal dominance regime in Brazil. The methodology employed is based on VAR models, focusing on the period after the implementation of the "Real Plan". The conclusion is that there was coordination between monetary and fiscal policies in the country during the examined period. However, this coordination was sustained by a substitution between the respective policies, with the monetary regime being predominant for most of the period.

In the Latin American context, Sánchez *et al.* (2018) analysed the impact of fiscal and monetary policies on inflation and public debt in Mexico, from 1981 to 2016, using a Markov-switching DSGE model. They argued that if monetary dominance

had prevailed throughout the entire period, the average inflation rate would have been 13.2%, lower than the observed rate. Conversely, complete fiscal dominance would have resulted in an average inflation rate of 42% and an average debt level five times higher than observed.

As for the central banks' DSGE, they have been highly used around the globe. This is the case of the Canadian Central Bank ToTEM III Model (Terms-of-Trade Economic Model), the Swedish RAMSES II Model, the Norwegian NEMO (Norwegian Economy Model), the Chilean XMAS (The Extended Model for Analysis and Simulations), the Colombian PATACON (Policy Analysis Tool Applied to Colombian Needs), New Zealand's NZSIM DSGE model and the Brazilian SAMBA (Stochastic Analytical Model with a Bayesian Approach).

These models are very useful for central bankers, but also academic researchers. For instance, Cateau *et al.* (2009) make use of the Canadian ToTEM to evaluate welfare gains of moving from an inflation targeting regime to price-level targeting under imperfect credibility. The authors find that the welfare gains enter the presence of persisting imperfect credibility. After 13 years the gain turns into a loss.

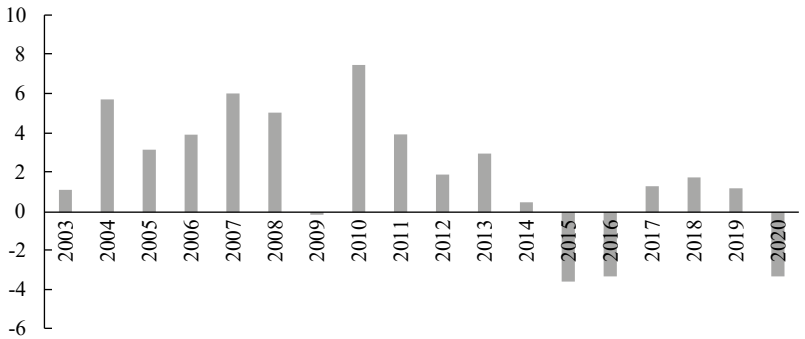
Adolfson *et al.* (2011) make use of Riksbank's open-economy DSGE RAMSES model to build optimal policy projections. The authors also use the model to "assess the recent Great Recession in the world economy and how its impact on the economic development in Sweden depends on the conduct of monetary policy". Adolfson *et al.* (2014) also use the RAMSES model, but now to evaluate the trade-off of inflation stabilisation and alternative measures of the Swedish output gap. The main result shows that "the trade-off between stabilising CPI inflation and the output gap strongly depends on which concept of potential output in the output gap between output and potential output is used in the loss function".

Kamber *et al.* (2016) estimate New Zealand's NZSIM DSGE model, for the period covering most of the country's Inflation Targeting era. The authors find that foreign shocks account for more than a third of New Zealand's GDP growth and that a "model with "adaptive" expectations is preferred by the data relative to the version of the model with "rational" expectations".

The Brazilian economy over the last two decades

The Brazilian economy experienced reasonable economic growth in the early 2000s. The annual GDP increased by 5.7% in 2004 and 3.20% in 2005 (figure 1), and the country's CPI inflation rate was experiencing a declining trend (figure 2).

Figure 1.
GDP (% per year)



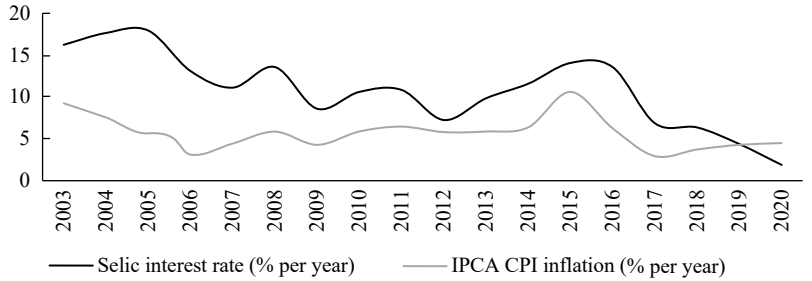
Source: Brazilian Institute of Geography and Statistics.

The 2008/2009 global financial crisis in 2008 had clear consequences for the country's economic activity, with a -0.13% decline in the GDP in 2009. Several countercyclical measures were adopted, between 2008 and 2010, such as tax relief measures, economic stimulus initiatives, credit incentives, and a reduction of the benchmark interest rate (Secretaria de Política Econômica [SPE], 2010).

Although the economic initiatives of the period were wide-ranging, coordination between monetary and fiscal policies proved challenging. During the 2008 global financial crisis and in subsequent years, the Brazilian government adopted a series of expansionary fiscal measures, while the Central Bank of Brazil tried to control inflation and stabilise the exchange rate. These actions sometimes operated in opposite directions, reflecting a lack of strategic alignment by policymakers. For example, while the federal government increased public spending, which in turn meant higher public debt (figure 3), the Central Bank had to deal with the resulting inflationary pressures by increasing interest rates (Melo & Gomes da Silva, 2019).

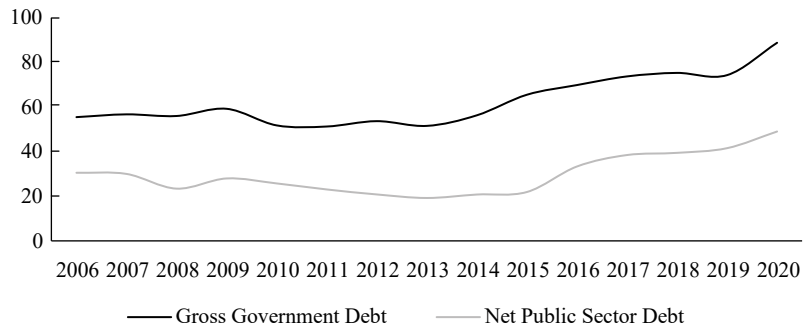
Certainly, actions had to be taken, as many countries did. However, the exacerbation of certain measures can be considered one of the origins of the period known as the "New Macroeconomic Matrix". This mismatch between fiscal and monetary policies was one of the reasons why the economic recovery after the 2008 crisis was inconsistent, leading to fluctuations in GDP growth and inflation in the following years. Following a rapid recovery from the 2008 financial crisis, the GDP experienced a significant increase, reaching a growth rate of 7.5% per year in 2010 (Gomes da Silva & Fishlow, 2021).

Figure 2.
Selic interest rate (% per year) and IPCA CPI inflation (% per year)



Sources: Central Bank of Brazil and Brazilian Institute of Geography and Statistics.

Figure 3.
Public debt (% of GDP)



Source: Central Bank of Brazil.

Faced with growing budgetary problems, the government began to employ "fiscal maneuvers" and creative accounting to comply with the country's Fiscal Responsibility Law. However, these actions were taken to the Court, which decided that they were irregular. The National Treasury had to issue more public debt to solve the legal problem, which led to a sharp increase in the series (figure 3).

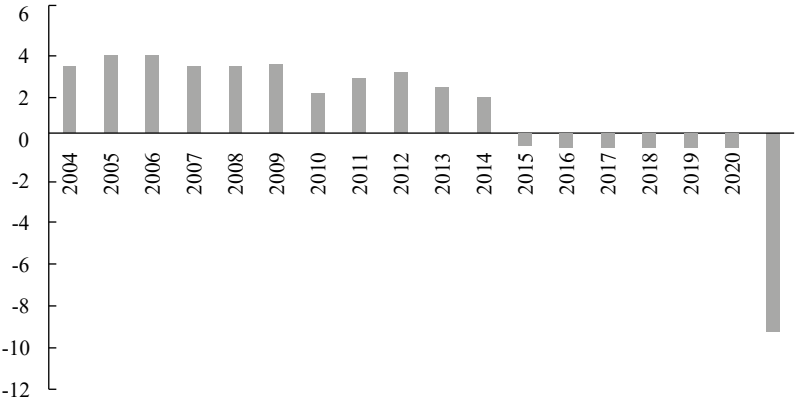
In 2016, political instabilities, which led to the impeachment of the President, had profound repercussions on economic stability and contributed to the recession process already in place due to other external and internal factors. All of these contributed to an increased perception of risk among economic agents. Besides, the "Operation Car Wash" corruption investigation intensified the distrust of economic agents.

In 2016, the Brazilian National Congress passed a new fiscal rule, called "Spending Ceiling Law", with the main objective of limiting the trajectory of public spending for at least a decade. The expectation was that, in parallel, a

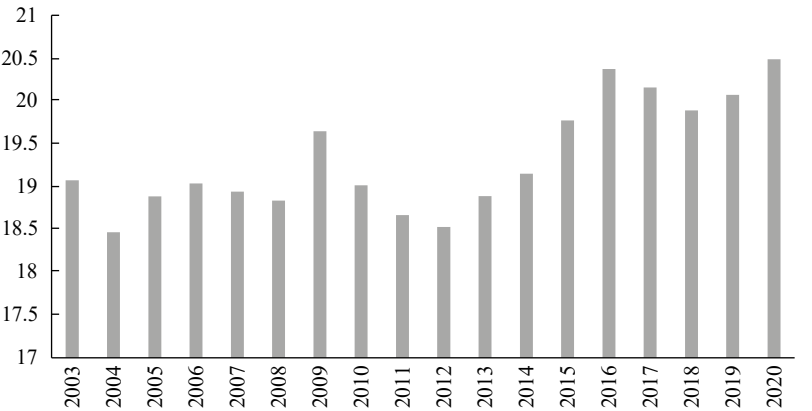
pension reform would also be approved, but this did not happen at that time. The pension reform was approved only after the inauguration of a new government, in 2019. In fact, the new government's promise was a new model of economic development, primarily based on economic reforms. Regarding monetary policy, the objective was to anchor inflation expectations to their effective values. This intention coincided with the growing concern for the spending ceiling as the guiding principle for fiscal policy (Giambiagi & Tinoco, 2021).

Like the rest of the world, Brazil experienced a significant decline in economic activity, due to the coronavirus pandemic outbreak in early 2020, leading to

Figure 4.
Primary result (% of GDP, 12-month basis) and government consumption (% of GDP)



a) Primary Result (% of GDP, 12-month basis)



b) Government Consumption (% of GDP)
Source: Central Bank of Brazil.

another year of economic recession (figure 1). As part of the response to the crisis, the fiscal solution involved the approval of a new budget, which allowed the government to increase the public deficit (figure 4) without committing any fiscal wrongdoing. The reopening of the economy after a few months and the disbursement of emergency financial aid to families provided some relief to economic activity but also had a considerable inflationary impact (figure 2).

Finally, to illustrate the correlation between the main variables in this study, a Granger Causality Test (with 2 lags) was applied to give us a hint of a precedence between the variables of interest (Table 1). The main results show precedence (Granger Causality) from the Brazilian Primary Result to inflation and the GDP, but not in the opposite direction from inflation. There is also Granger Causality from inflation to the GDP and interest rate, but not in the opposite direction.

Table 1.
Pairwise Granger causality tests (Null hypothesis: No Granger causality - 2 lags)

Null Hypothesis	Prob.	Null Hypothesis	Prob.
Primary Result → Inflation	0.0521*	Inflation → Primary Result	0.0841
Primary Result → GDP	0.0011*	GDP → Primary Result	0.0287*
Primary Result → Interest Rate	0.1497	Interest Rate → Primary Result	0.3937
Inflation → GDP	0.0046*	GDP → Inflation	0.9254
Inflation → Interest Rate	3.E-05*	Interest Rate → Inflation	0.3126
Interest Rate → GDP	0.0268*	GDP → Interest Rate	0.0692

Notes: "→" means does not Granger Cause; "*" means rejection of the null hypothesis.

Therefore, it seems that some type of coordination between monetary and fiscal policy is necessary as there is a connection between the main macroeconomic variables related to monetary and fiscal conditions in Brazil.

New Keynesian DSGE model

As mentioned previously, our research is based on the equations of the Brazilian Central Bank's DSGE SAMBA model [see Gouvea *et al.* (2008) and Castro *et al.* (2011, 2015) for a complete description of the model]. The article's contribution is on the specification and estimation of the parameters related to the model's monetary and fiscal policy rules. Also, the paper will emphasise the NMM, allowing for the incorporation of an important analysis of a highly critical economic scenario in Brazil.

The main log-linearised equations of the model are [see MMB (2021) for a basic script]: i) GDP equation; ii) CPI equation; iii) a monetary rule; iv) a fiscal rule; and v) an equation for government consumption.

The GDP equation is represented by:

$$y_t = s_C C_t + s_I I_t + s_G G_t + s_X X_t - s_M M_t \tag{1}$$

where y_t: GDP; s_C: private consumption parameter $(s_C = 0.62)$; C_t: private consumption; s_I: investment parameter $(s_I = 0.17)$; I_t: investment; s_G: government consumption parameter $(s_G = 0.20)$; G_t: government consumption, s_X: exports parameter $(s_X = 0.13)$; X_t: exports, s_M: imports parameter $(s_M = 0.12)$, and M_t: imports.

The CPI inflation equation is represented by:

$$\pi_t = \omega A \pi_t^A + (1 - \omega A)\pi_t^F \tag{2}$$

where π_t: CPI inflation; ωA: administered prices parameter $(\omega A = 0.30)$; π_t^A: inflation rate (administered prices), and π_t^F: inflation rate (free prices).

The monetary policy rule is represented by the following Taylor Rule:

$$i_t = (i_{t-1})^{\gamma i} \left[\left(i_t^n \frac{\pi_t}{\pi_t^*} \right)^{\gamma\pi} \left(y_t - y_t^n \right)^{\gamma y} \right]^{1-\gamma i} + \epsilon_t^i \tag{3}$$

where i_t: nominal interest rate; i_{t-1}: lagged nominal interest rate; γi: interest rate smoothing parameter $(\gamma i = 0.60)$; i_t^n: natural interest rate; π_t: CPI inflation; π_t^*: inflation target; $\gamma\pi$: inflation rate parameter $(\gamma\pi = 2.00)$; y_t: GDP; y_t^n: potential GDP, γy: GDP parameter $(\gamma y = 0.25)$, and ϵ_t^i captures monetary shocks.

The fiscal rule is given by the following equation for the primary surplus:

$$S_t^y = \overline{S}^y + \phi_S \left(S_{t-1}^y - \overline{S}^y \right) + \phi_{\overline{S}} \left(\overline{S}_t^y - \overline{S}^y \right) + S_G Z_t^G \tag{4}$$

where S_t^y: primary surplus/GDP; $\overline{S}^y$: long-run primary deficit/GDP; ϕ_S: primary surplus parameter $(\phi_S = 0.40)$; S_{t-1}^y: lagged primary surplus/GDP, $\phi_{\overline{S}}$: primary surplus/GDP target parameter; $\overline{S}_t^y$: primary surplus/GDP target; S_G: steady-state government consumption; and Z_t^G captures shocks to the primary surplus/GDP, which result from government consumption.

The government consumption equation is given by:

$$G_t = \gamma_G G_{t-1} + (1 - \gamma_G) \cdot \left(\gamma_S S_{t-1}^* \right) - \gamma_B B_{t-1}^y + \epsilon_t^G \tag{5}$$

where G_t: government consumption; γ_G: government consumption smoothing parameter $(\gamma_G = 0.50)$; G_{t-1}: lagged government consumption; γ_S: primary surplus

parameter $(\gamma_S = 0.40)$; S^*_{t-1}: lagged deviation of the primary surplus from its target; γ_B: public debt parameter $(\gamma_B = 0.05)$, B^y_{t-1}: lagged public debt/GDP, and ϵ^G_t captures fiscal shocks.

Finally, the law of motion for public debt is given by:

$$B^y_{t-1} = i_t \left(\frac{B^y_t}{\Pi^y_T} \frac{y_{t-1}}{y_t} - S^y_t \right) \tag{6}$$

where B^y_{t+1}: leading public debt/GDP; i_t: the nominal interest rate; B^y_t: public debt/GDP; Π^y_t: gross GDP deflator inflation, y_{t-1}: lagged GDP; y_t is the GDP, and S^y_t is the primary surplus/GDP. Appendix C summarizes the key equations of the model.

Data and Econometric Approach

The methodological approach to be implemented is based on New Keynesian DSGE models with a Bayesian approach, commonly used by researchers and central banks. These models work with micro foundations, allowing for a broader range of analyses with a more in-depth economic theory framework. In this methodology, parameter values can be either calibrated or estimated, enabling a more reliable relationship regarding the results of a particular economic policy adopted.

Concerning Bayesian estimations, their use has advanced in macroeconomic analysis due to the advantage of allowing the use of a prior distribution that brings additional information to the estimation process. Prior distributions are assigned to structural parameters and are updated by likelihood functions. Then, posteriors are generated using Bayesian simulation techniques, such as the commonly used Metropolis-Hastings algorithm (Metropolis *et al.,* 1953, An & Schorfheide, 2007).

Our specific model will use a data set to estimate the parameters of interest for monetary and fiscal policy rules, and this will help to analyse the propagation and relative importance of structural shocks through Impulse Response Functions. Specifically, the emphasis will be on how important economic variables respond to interest rates and government consumption shocks. Therefore, the procedure will involve investigating the log-linearised macroeconomic model, with a focus on the estimated parameters of the monetary and fiscal rules.

For quarterly data ranging from 2003Q1 to 2020Q4, for the complete model, and from 2011Q1 to 2018Q2, for the specific NMM period, the following variables will be used:

- Selic interest rate (i_t): quarterly interest rate, deviation from its mean, seasonally adjusted. Source: Central Bank of Brazil.
- GDP (y_t): quarterly GDP log index, first difference, seasonally adjusted. Source: Brazilian Institute of Geography and Statistics.

- CPI inflation (π_t): quarterly accumulated IPCA, deviation from its mean, seasonally adjusted. Source: Brazilian Institute of Geography and Statistics.
- Primary Surplus $\left(S_t^y\right)$: Public sector financing requirement (% GDP) with primary surplus, excluding currency devaluation, as a percentage of the GDP, from its mean, accumulated over twelve months, obtained quarterly, with the numeric sign reversed, seasonally adjusted. Source: Central Bank of Brazil.

As mentioned previously, we will only estimate the Taylor Rule and the Fiscal Rule. The other parameters of the model will be calibrated (Table 2), following Castro *et al.* (2015):

Table 2.
Main calibrated parameters

Symbol	Parameter	Value
S_G	Government consumption (% of GDP)	0.20
S_X	Export of goods and services (% of GDP)	0.13
S_M	Import of goods and services (% of GDP)	0.12
ωA	Administered price inflation	0.30
χ_A	Free price inflation	0.80
υ_1^A	Real effective exchange rate	0.05
S^{B*}	Country risk index: EMBI Brazil	1.014
ρ_M^*	World demand for imports	0.50
$\Pi\, t^*$	World inflation (FED)	1.0064
R^*	World nominal interest rate (FED)	1.0074

Source: Castro *et al.* (2015).

This study is based on the Metropolis-Hastings algorithm, with 100,000 probabilistic responses. In addition, specifications are defined for the density distributions of the structural parameters to ensure that the estimated models are dynamically stable, with non-negativity constraints. Table 3 reports the Bayesian estimation results of the priors and posteriors related to both rules (equations 3 and 4). The observed data plays a significant role in helping improve the estimations, particularly those related to the primary surplus, which show priors and posteriors that are almost symmetrical. As in Sánchez *et al.* (2018), our CPI inflation parameters were greater than one in both cases analysed, which is an indication of monetary dominance. In this context, it is argued that the coordination between monetary and fiscal policies in Brazil became more complex during the NMM period. Although monetary dominance was present, it became more fragile and difficult to achieve, indicating a weaker form of monetary dominance.

Graphical representations of these priors and posteriors can be found in Appendices A and B.

Table 3.
Parameters: Monetary rule and fiscal policy rule

Parameter	Distribution	Prior mean	NMM		2003-2020		Post SD
			Post mean	Prior SD	Post mean	Prior SD	
i) Monetary rule							
Interest rate smoothing	Beta	0.60	0.7899	0.0641	0.8109	0.0329	0.15
CPI inflation	Normal	2.00	2.3086	0.2500	1.9587	0.2389	0.35
GDP	Gamma	0.25	0.3301	0.112	0.7179	0.1457	0.10
ii) Fiscal rule							
Primary surplus	Beta	0.40	0.3987	0.0507	0.3959	0.052	0.05
Public debt	Inverse Gamma	0.05	0.0475	0.0115	0.0909	0.0186	0.15

Note. 90% confidence interval.
Source: Data obtained from the performed estimations.

RESULTS

Figures 5 and 6 depict the Impulse Response Functions related to the model's Bayesian estimations of the proposed monetary and fiscal rules, considering the whole sample, from 2003Q1 to 2020Q4, and the specific NMM, from 2011Q1 to 2018Q2. For each graph, the vertical axis represents the magnitude of the response, and the horizontal axis indicates the quarterly period. The 100 basis-point monetary policy and fiscal shocks are equivalent to 0.25% per quarter, and the responses to these disturbances come from the GDP, IPCA CPI inflation, primary surplus, investment, private consumption, government consumption (specifically for interest rate shocks), and the interest rate (specifically for government consumption shocks).

Figure 5 reports the response of selected variables to a positive interest rate shock. The solid line refers to the NMM period (2011Q1 -2018Q2), while the dashed line refers to the whole period analysed (2003Q1 - 2020Q4). For the whole period, the initial positive response of the GDP to an interest rate positive shock is in negative territory all the way through (chart 'a'), indicating a typical reaction in which higher interest rates slow down economic activity by increasing borrowing costs and reducing consumption and investment. Specifically, in the NMM period, there is an initial positive response, possibly indicating that other forces were trying to expand economic activity. The divergent responses during these periods could be reflective of different macroeconomic conditions, policy environments, and external factors. The NMM period was marked by aggressive macroeconomic policies that might have temporarily mitigated the typical negative impacts of higher interest rates, leading to a lack of coordination between monetary and fiscal policies (figure 5, chart 'a').

Figure 5 (chart 'b') shows the inflation responses based on interest rate perturbations. For the whole period, from 2003 to 2020, a restrictive monetary policy

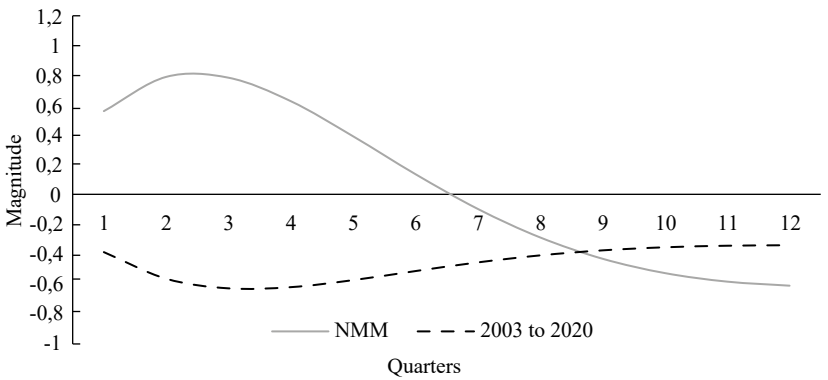
was able to control inflation (dashed line). Nevertheless, the responses related to the NMM period (solid line) show the result of a more volatile economic environment where monetary policy adjustments were more immediately reflected in price movements.

As for the responses of the primary surplus to a positive interest rate shock (figure 5, chart 'c') the pattern is similar, with a rapid decline of both lines, but more prominent in the NMM period. In fact, fiscal policy after 2011 may have been less austerity-oriented or more focused on fiscal stimuli and this graph shows some lack of coordination between monetary and fiscal policy in the whole period, but mainly during the NMM period. On one side, the Central Bank of Brazil tried to use its Taylor Rule to control economic activity and inflation, but the Federal Government responded with more government spending, trying to boost aggregate demand. Again, this is another example of uncoordinated economic policies.

This divergent pattern is even clearer shown by figure 5 (chart 'd'), which shows the responses of government spending based on disturbances coming from the interest rate. The NMM period is marked by a continuous and significant increase in government consumption (solid line), as the main fiscal policy instrument to stimulate the domestic economy. On the other hand, when one looks at a broader range, from 2003 to 2020, it seems that a fiscal consolidation process was more prominent and more in line with one of the pillars of the Macroeconomic Tripod, related to positive fiscal results (figure 5, chart 'd').

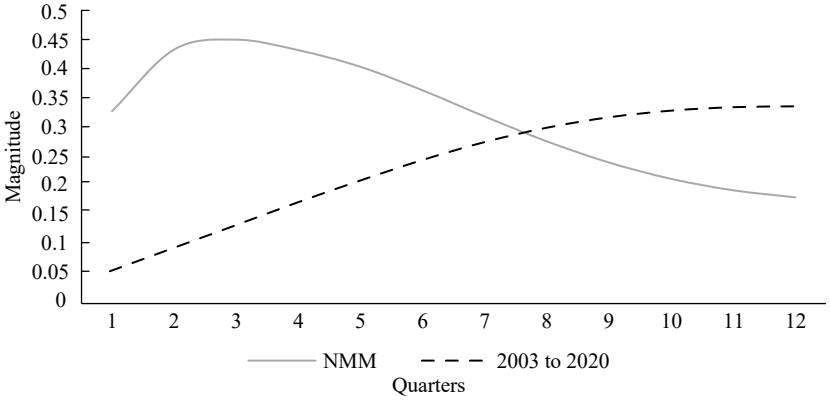
Figure 5.
Impulse response functions: interest rate positive shocks

a) Real GDP

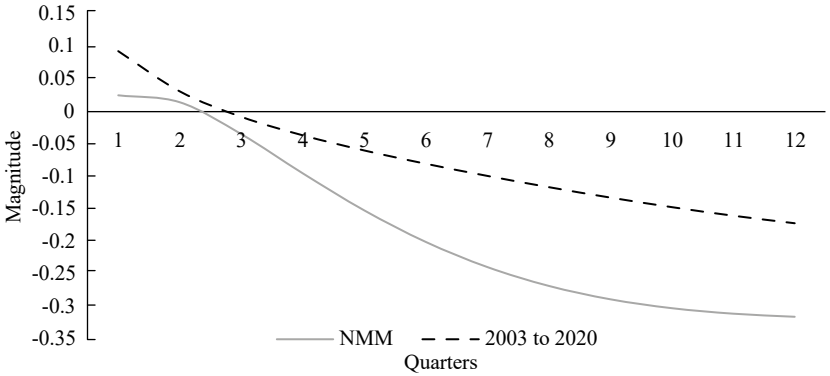


b) IPCA CPI inflation

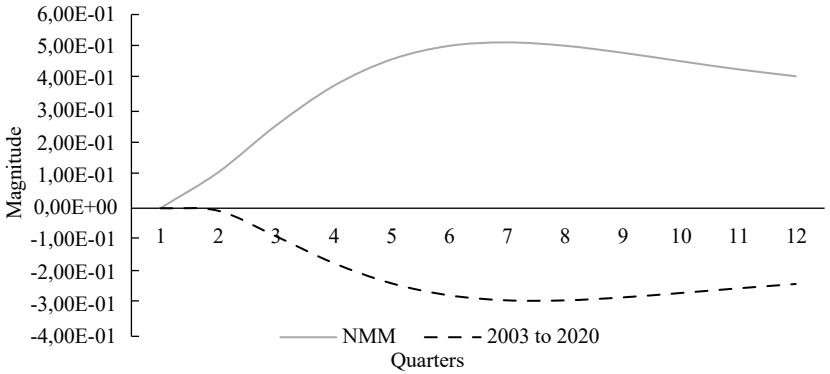
(*continued*)



c) Primary surplus



d) Government consumption



e) Investment

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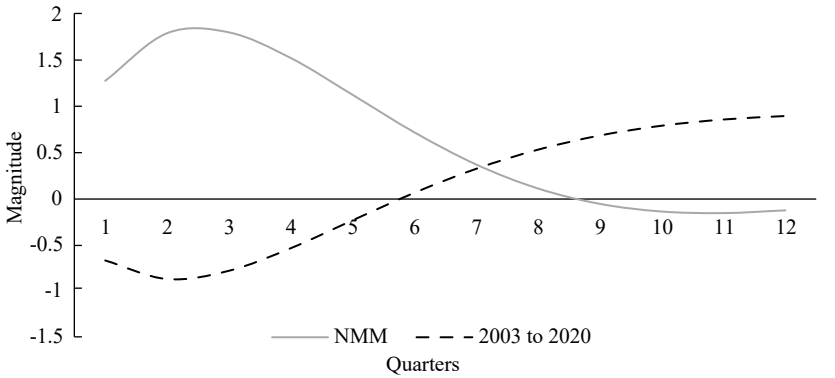
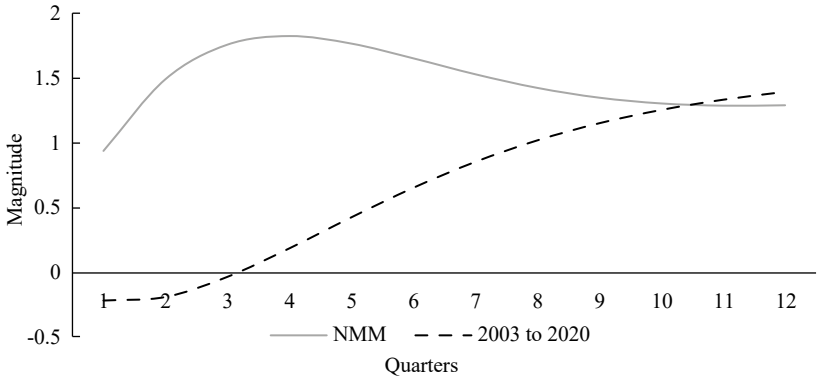


f) Private consumption



Notes. i) Dashed line: whole period (2003Q1 - 2020Q4); Solid line: NMM period (2011Q1 -2018Q2); ii) 90% confidence interval. Source: Graphs generated from the conducted estimates.

Investment and private consumption (figure 5, charts 'e' and 'f') show a similar pattern when the whole period response (dashed line) is compared to the NMM period response (solid line). Even though the initial response is negative for the whole period (dashed line) the final result is in positive territory. As expected, from 2003 to 2020, investment and private consumption show an initial negative reaction to interest rate increases, i.e., to a more restrictive monetary policy. In other words, interest rates discourage investment, due to a higher cost of capital, for instance, and discourage consumption, due to higher credit cost. However, as time goes by, investment and consumption pick up. On the other hand, in the NMM period (solid line) both responses were always in positive territory, showing that monetary policy was not able to control consumption and curb investments, not even at the beginning. In other words, the main monetary policy instrument, the interest rate, seemed to be impotent (figure 5, charts 'e' and 'f').

These initial findings depicted in figure 5 illustrate some predictable responses to interest rate shocks over a broader period but reveal an intensified complexity during the NMM period. This shows that the dynamics of monetary and fiscal policies can be significantly influenced by the volatile economic and political environment, in which the confidence of economic agents is crucial to shaping macroeconomic outcomes (figure 5).

To go further into the analysis of the coordination of monetary and fiscal policies in Brazil, it is important to look at the response of important macroeconomic variables in the face of positive shocks to government consumption, within the framework of a DSGE macroeconomic model (figure 6). As the Brazilian economic history is marked by varied scenarios in the implementation of fiscal policy, accurately modelling a single fiscal rule that reflects economic reality in different periods is a significant challenge. For example, the adoption of a ceiling on federal expenditures marked an important change in the country's fiscal structure and may affect the parameters of a specific fiscal rule. Considering that our analysis focuses on two periods, we adopted a generalised approach that uses shocks to government consumption as a proxy for fiscal shocks. This method is also employed by other researchers, such as Castro *et al.* (2015), and ensures that the model, despite its generalisation, remains balanced and understandable, providing valuable information on the monetary-fiscal policies interaction in Brazil.

Figure 6 (chart 'a') depicts the GDP responses to a positive government consumption disturbance. No matter what period of analysis we focus on, the result is clear: government spending seems not to have been effective in promoting GDP growth in Brazil. However, when responses are compared, the NMM period (solid line) shows a less negative response, indicating a change in the use of fiscal policy, characterised by a greater state intervention in the economy. This could be interpreted as an attempt to stimulate the economy through government spending, although the long-term effectiveness of this strategy is debated among economists. As for the whole period, from 2003 to 2020, on the other hand, the decrease in economic activity was more intense (figure 6, chart "a").

Figure 6 (chart "b") shows the inflation responses based on government spending disturbances. Both lines show that an expansionary fiscal policy leads to an inflationary process. For the whole period, from 2003 to 2020, there is a much sharper and faster response of inflation to the shock, indicating a significantly greater sensitivity of inflation to fiscal stimuli in this period. For the NMM, the response is softer, but still positive. Therefore, in any period the inflation response reflects fiscal stimuli that would lead to higher inflation, tighter monetary policy in the future, or a reaction to perceived fiscal deterioration, increasing uncertainties about macroeconomic stability (figure 6, chart "b").

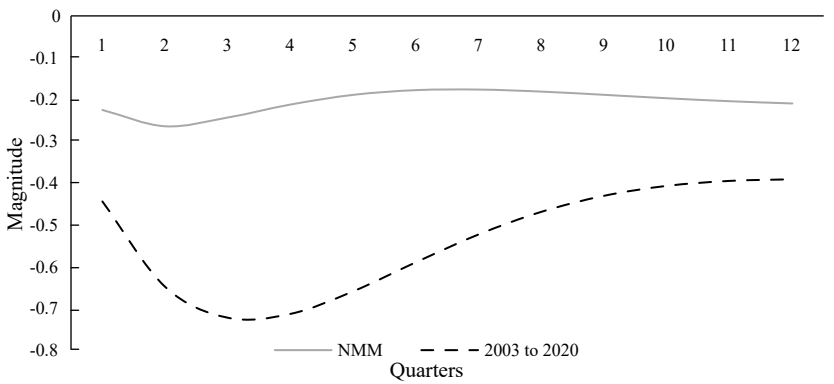
As for the responses of the primary surplus to a positive government spending perturbation (figure 6, chart "c") there is a certain similarity in the pattern related to both periods analysed, with a rapid decline of both lines, but more prominent for

the whole period. The dynamics of the responses shows that during the NMM, the primary surplus starts at higher levels and gradually declines over time, getting into negative territory after 9 quarters. This indicates a deterioration in public accounts, reflecting a more expansionary fiscal policy aimed at stimulating the economy through greater public spending, despite the consequences for fiscal sustainability. On the other hand, in the period from 2003 to 2020, the primary surplus starts at a lower level and shows a downward trend but begins to show deficits as early as the third quarter. This trajectory suggests that, even before the implementation of the NMM period, Brazil was already facing fiscal challenges that worsened with the economic crisis and subsequent fiscal adjustments (figure 6, chart "c").

Regarding the interest rate responses, from shocks coming from government spending (figure 6, chart 'd'), the analysis of the whole period, from 2003 to 2020 (dashed line), shows a declining interest rate response, meaning that fiscal policy was more coordinated with monetary policy. In other words, government spending perturbations were not so strong and did not cause inflation, leaving space for a decrease in interest rates. On the hand, the NMM period (solid line) is characterised by a continuous and gradual increasing interest rate response. This increase can be interpreted as a response by the Central Bank of Brazil to the fiscal expansion resulting from increased government consumption, trying to control inflationary pressures that a fiscal policy could generate. In other words, a clear lack of coordination between monetary and fiscal policies (figure 6, chart 'd').

Figure 6.
Impulse response functions: Government consumption positive shocks

a) Real GDP



b) IPCA CPI inflation

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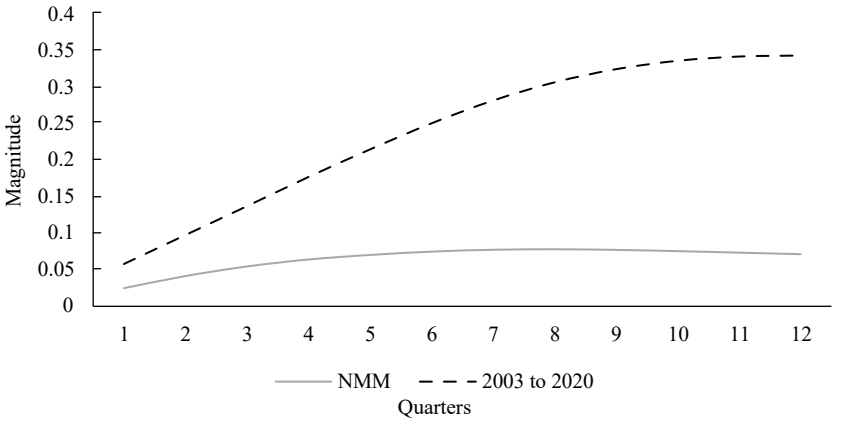
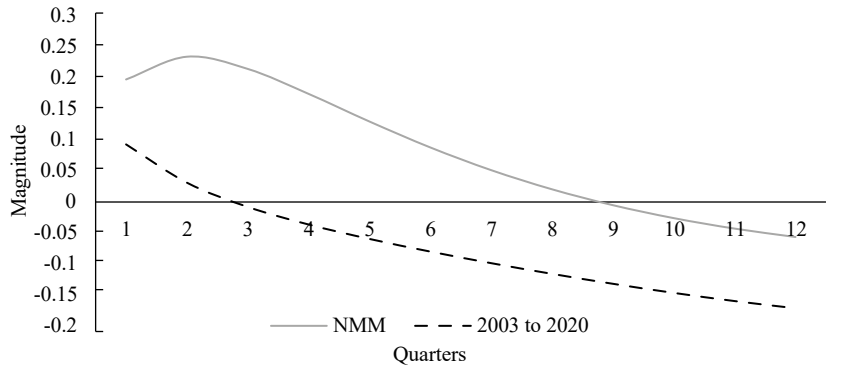
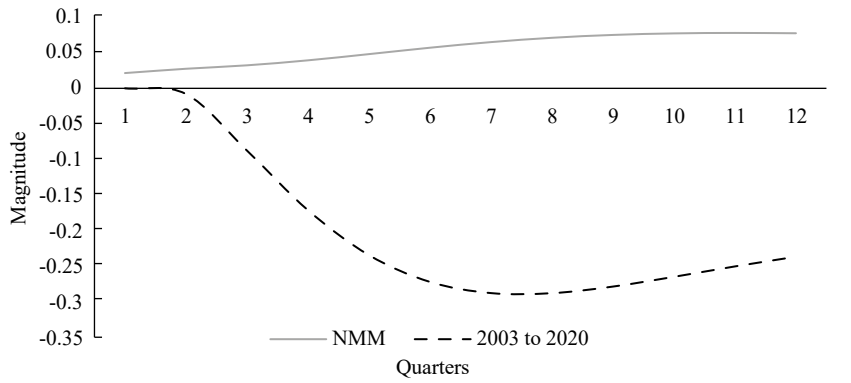


c) Primary surplus

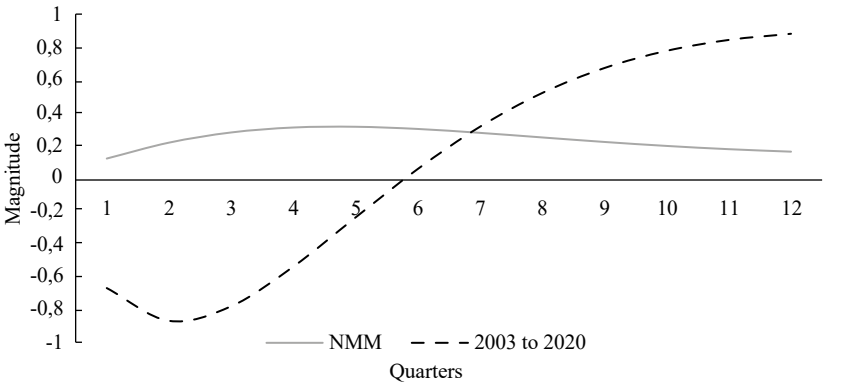


d) Selic nominal interest

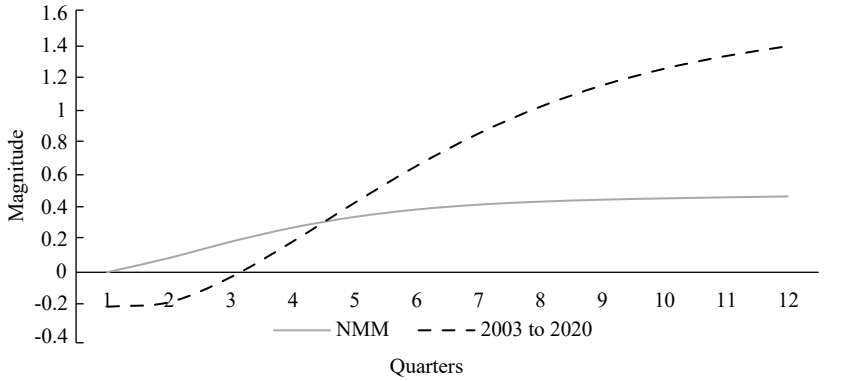


e) Investment

(*Continued*)



f) Private consumption



Notes. i) Dashed line: whole period (2003Q1 - 2020Q4); Solid line: NMM period (2011Q1 -2018Q2); ii) 90% confidence interval. Source: Graphs generated from the conducted estimates.

As in figure 5, investment and private consumption show similar responses, based on shocks coming from government consumption (figure 6, charts 'e' and 'f'). For the whole period (dashed line) both initial responses are negative, and the final response is in positive territory. It means that an expansionary fiscal policy is deleterious to investment and privation consumption, at the beginning of the cycle, with a gradual recovery over time. The initial negative reaction might reflect a high political and economic uncertainty. The subsequent recovery in investment suggests companies and economic agents are adapting to a new economic environment. For the NMM period (solid line), private consumption and investment responses are in positive territory. This behaviour may indicate that the measures adopted during the period, possibly including policies to stimulate consumption through easy credit, subsidies, and fiscal expansion, had a positive impact on private consumption. As for investment in the NMM period (solid line), despite being

in positive territory, the final response shows a declining trend, meaning that even with a series of expansionary policies, investment may have been perceived as risky by economic agents and enterprises, discouraging investment due to instability and negative expectations.

CONCLUDING REMARKS

This article aimed to analyse Brazil's economic performance, particularly focusing on the coordination between monetary and fiscal policies from 2003Q1 to 2020Q4, with special emphasis on the "New Macroeconomic Matrix" period, from 2011Q1 to 2018Q2. To this end, the study employed a DSGE model, examining observed variables such as the nominal interest rate, the GDP, CPI inflation, and primary surplus. This paper provides a detailed assessment of the effectiveness of these policies during a period of intense economic transformations and substantial challenges.

The results shown in figures 5 and 6 illustrate a clear dichotomy in the responses of economic variables to monetary and fiscal policies between the periods of the NMM and from 2003 to 2020. During the NMM period, there was a trend towards positive initial responses to fiscal and monetary stimulus policies, possibly reflecting a greater tolerance for inflation and an economic policy environment aimed at stimulating domestic demand. These policies included direct intervention in the markets, stimulus to consumption and investment, resulting in a moderate appreciation of the currency and gradual increases in interest rates to contain inflationary pressures. In contrast, the period from 2003 to 2020 is characterised by a more conservative and reactive approach to market conditions, with initially negative responses to the government's consumption shock, reflecting a policy more focused on fiscal sustainability and economic stability.

Finally, for future research, it would be beneficial to explore the long-term impacts of these policy changes, especially how the structural changes implemented in recent years will affect Brazil's economic resilience and growth trajectory. In addition, examining the interaction between fiscal policy, monetary policy and other economic policies in a more interconnected global economy will provide deeper insights into the effectiveness of the country's macroeconomic dynamics.

ACKNOWLEDGMENTS

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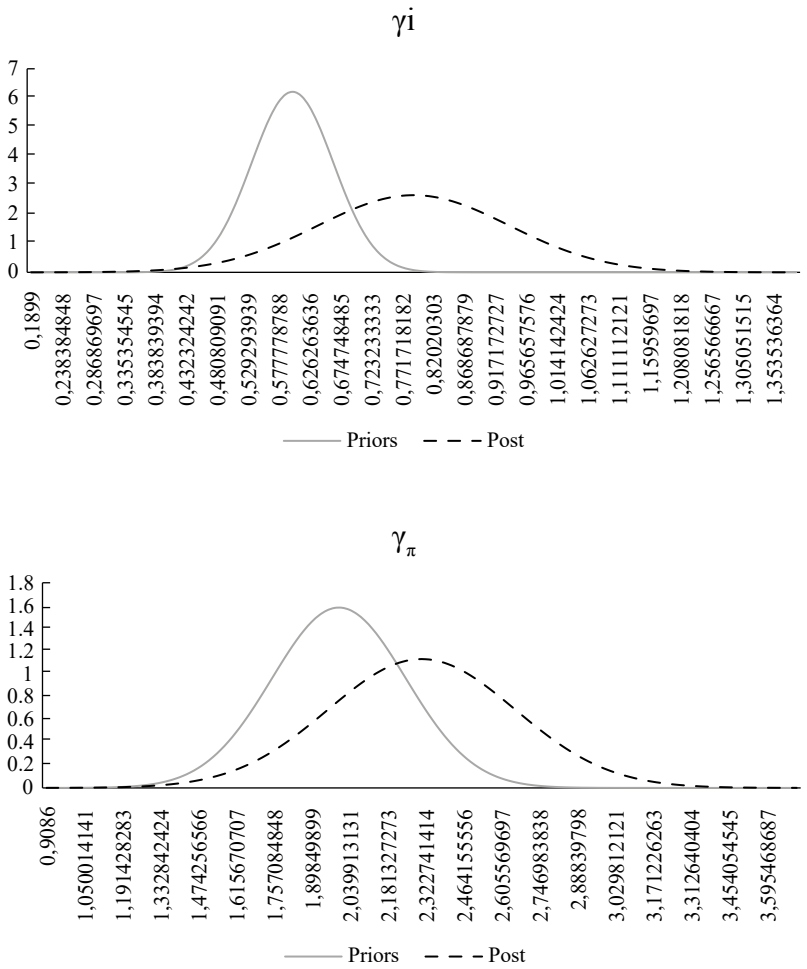
APPENDIX A

Figure 7.
Priors and posteriors of the parameters (NMM)



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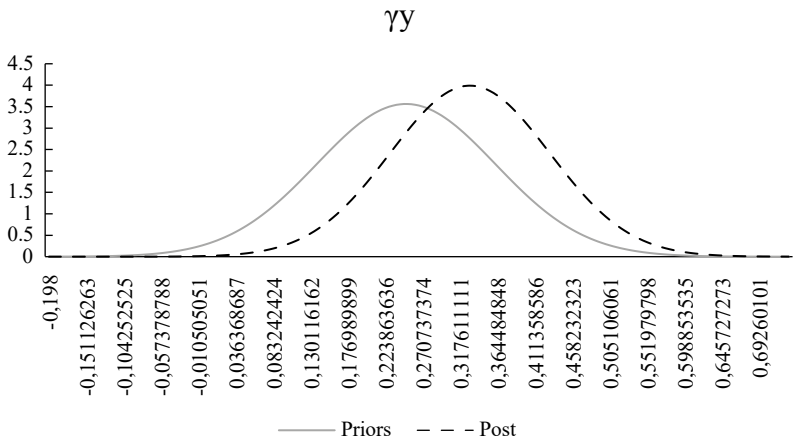
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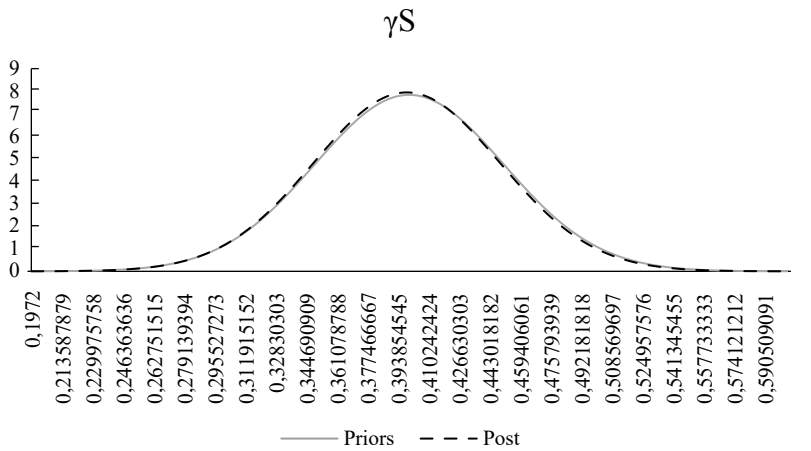
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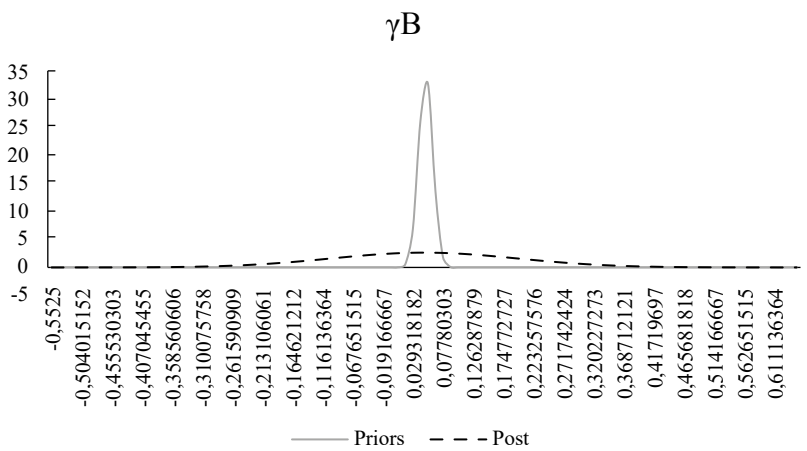
Priors
Post

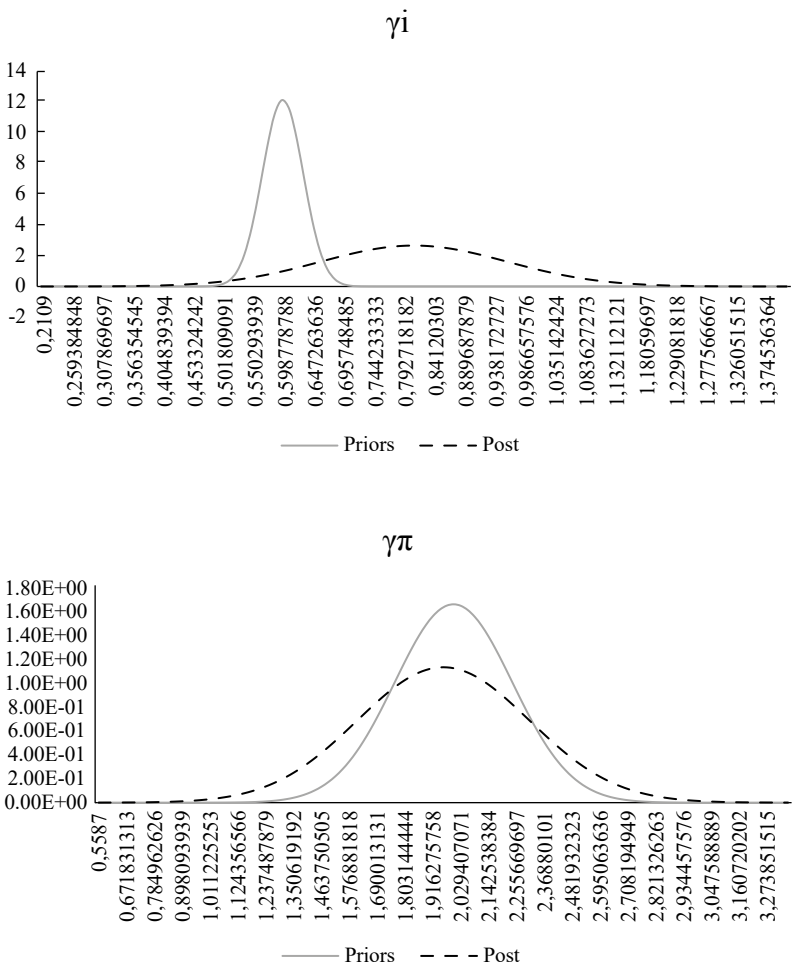
(*Continued*)



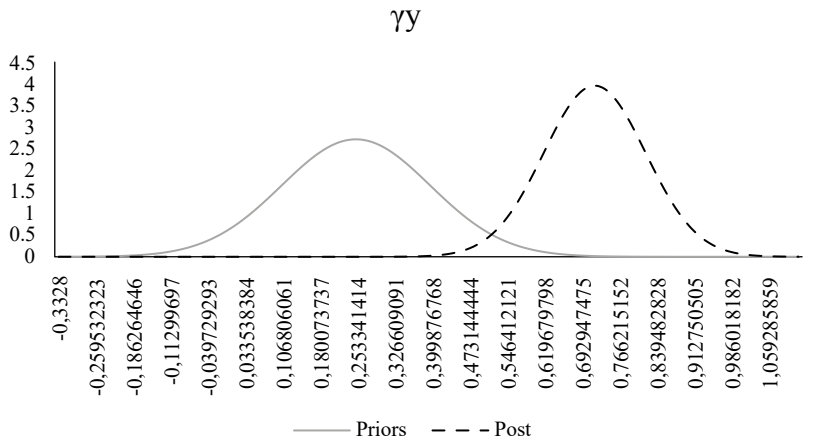
Notes. Normal probability distribution function based on 100 points. The solid line refers to the priors, while the dashed line refers to the posteriors. Source: Graphs generated from the conducted estimates.

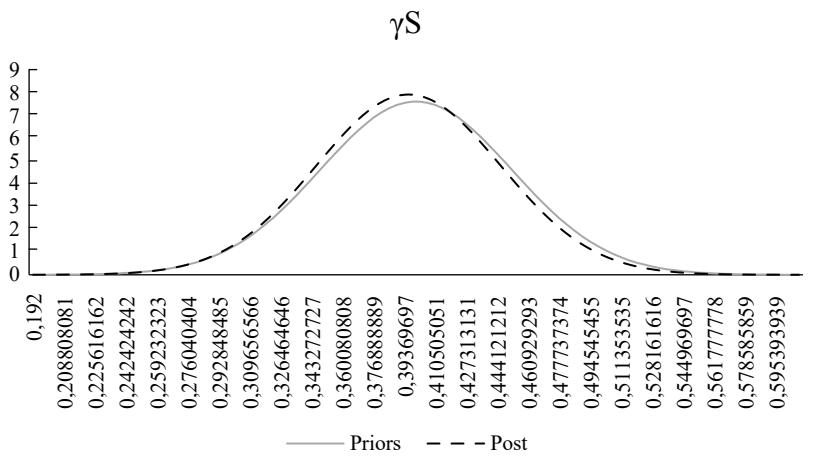
APPENDIX B

Figure 8.
Priors and posteriors of the parameters (2003 to 2020)

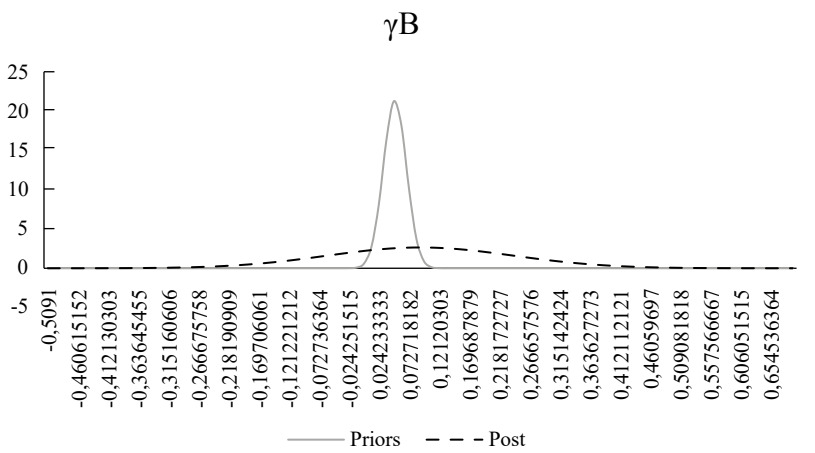


(*Continued*)


γy
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0,3328
-0,259532323
-0,186264646
-0,11299697
-0,039729293
0,033538384
0,106806061
0,180073737
0,253341414
0,326609091
0,399876768
0,473144444
0,546412121
0,619679798
0,692947475
0,766215152
0,839482828
0,912750505
0,986018182
1,059285859
Priors
Post


γS
9
8
7
6
5
4
3
2
1
0
0,192
0,208808081
0,225616162
0,242424242
0,259232323
0,276040404
0,292848485
0,309656566
0,326464646
0,343272727
0,360080808
0,376888889
0,3939697
0,410505051
0,427313131
0,444121212
0,460929293
0,477737374
0,494545455
0,511353535
0,528161616
0,544969697
0,561777778
0,578585859
0,595393939
Priors
Post

(*Continued*)



Notes. Normal probability distribution function based on 100 points. The solid line refers to the priors, while the dashed line refers to the posteriors. Source: Graphs generated from the conducted estimates.

APPENDIX C

Box 1.
DSGE model equations

i) Equation for GDP:

$$y_t = s_C C_t + s_I I_t + s_G G_t + s_X X_t - s_M M_t$$

where y_t represents GDP, s_C is a parameter related to private consumption $(s_C = 0.62)$, C_t represents private consumption, s_I is a parameter related to investment $(s_I = 0.17)$, I_t represents investment, s_G is a parameter related to government consumption $(s_G = 0.20)$, G_t represents government consumption, s_X is a parameter for exports $(s_X = 0.13)$, X_t represents exports, s_M is a parameter for imports $(s_M = 0.12)$, and M_t represents imports.

ii) Equation for CPI inflation:

$$\pi_t = \omega A \pi_t^A + (1 - \omega A)\pi_t^F$$

where π_t represents the CPI inflation, ωA is the parameter for administered prices $(\omega A = 0.30)$, π_t^A refers to the inflation rate of administered prices, and π_t^F represents the inflation rate of free prices.

iii) Taylor Rule:

$$i_t = (i_{t-1})^{\gamma i}\left[\left(i_t^n \frac{\pi_t}{\pi_t^*}\right)^{\gamma\pi}\left(y_t - y_t^n\right)^{\gamma y}\right]^{1-\gamma i} + \epsilon_t^i$$

where i_t is the nominal interest rate, i_{t-1} is the lagged nominal Selic interest rate, γi is the interest rate smoothing parameter $(\gamma i = 0.60)$, $i_t^n$is the natural interest rate, π_t is the CPI inflation, π_t^* is the inflation target, $\gamma\pi$ is the inflation rate parameter $(\gamma\pi = 2.00)$, y_t is the GDP, y_t^n is the potential GDP, γy is the GDP parameter $(\gamma y = 0.25)$, and ϵ_t^i captures monetary shocks.

iv) Fiscal rule:

$$S_t^y = \overline{S}^y + \phi_S\left(S_{t-1}^y - \overline{S}^y\right) + \phi_{\overline{S}}\left(\overline{S}_t^y - \overline{S}^y\right) + S_G Z_t^G$$

where S_t^y is the primary surplus/GDP, $\overline{S}^y$ is the long-term value of the primary deficit/GDP, ϕ_S is the primary surplus parameter $\left(\phi_S = 0.40\right)$, S_{t-1}^y is the lagged primary surplus/GDP, $\phi_{\overline{S}}$ is the parameter for the primary surplus/GDP target, $\overline{S}_t^y$ is the target for the primary surplus/GDP, S_G represents the steady-state government consumption, and Z_t^G captures shocks to the primary surplus/GDP, which result from government consumption.

v) Government consumption:

$$G_t = \gamma_G G_{t-1} + \left(1-\gamma_G\right)\cdot\left(\gamma_S S_{t-1}^*\right) - \gamma_B B_{t-1}^y + \epsilon_t^G$$

where G_t is government consumption, γ_G is the government consumption smoothing parameter $\left(\gamma_G = 0.50\right)$, G_{t-1} is the lagged government consumption value, γ_S is the primary surplus parameter $\left(\gamma_S = 0.40\right)$, S_{t-1}^* is the lagged deviation of the primary surplus from its target, γ_B is the public debt parameter $\left(\gamma_B = 0.05\right)$, B_{t-1}^y is the lagged public debt/GDP, and ϵ_t^G captures fiscal shocks.

vi) Law of motion of government debt:

$$B_{t-1}^y = i_t\left(\frac{B_t^y}{\Pi_T^y}\frac{y_{t-1}}{y_t} - S_t^y\right)$$

where B_{t+1}^y is the public debt/GDP in the subsequent period, i_t is the nominal interest rate, B_t^y is the public debt/GDP, Π_t^y is the gross GDP deflator inflation, y_{t-1} is the lagged GDP, y_t is the GDP, and S_t^y is the primary surplus/GDP.

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