

**INTERACTION OF ECONOMIC POLICIES AND FISCAL STIMULATIONS IN  
BRAZIL: EVIDENCE FROM THE 2000-2019 PERIOD****Mario Augusto Gouvêa de Almeida**

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**ABSTRACT**

This article aims at identifying economic policy interactions and measuring fiscal multipliers, within a framework of Markovian regime switching, in addition to drawing their relationship with the evolution of Brazil's recent economic crisis, based on quarterly data from the 2000:Q1 to 2019:Q4 period. Among the main results found, we highlight: i) the alternation of regimes, as observed in Leeper (2011), to be the practice: for Brazil, we pointed out eight successive alternations of regimes with prevalence of monetary dominance; ii) shocks on government consumption have different multiplier effects on output and consumption, depending on the monetary and fiscal policy regime; iii) for regimes in which monetary policy is passive, the multiplier effect on the product varies from 1.3% to 1.5% and on consumption from 0.50% and 0.30%, while the effect on inflation ranges from 2.4% to 3.2%; iv) for regimes with an active monetary policy, the effect on the product is 0.65%, with a negative effect on consumption by -0.35% and impacts on inflation by 0.8%; and v) the dynamics of interactions between monetary and fiscal policies were deeply related to macroeconomic imbalances in Brazil, yet, it does not seem feasible that this has been the determining factor in the economic dynamics of the Brazilian economy in recent years.

**Keywords: DSGE, fiscal multipliers, macroeconomic coordination.**

## 1.1 INTRODUCTION

The discussion around the use of countercyclical policies, notably concerning the adoption of an active fiscal policy, has been resumed since the 2008 U.S. financial crisis, as a way to minimize the contagion on world economic activity. An example of the reinstatement of the discussion is found in the *2009 World Economic Outlook, Crisis and Recovery*, in which the International Monetary Fund (IMF, 2009, p. 103) signaled to economies that: “Countercyclical monetary policy can help shorten recessions, but its effectiveness is limited in financial crises. By contrast, expansionary fiscal policy seems particularly effective in shortening recessions associated with financial crises and boosting recoveries.” The same study also pointed out that the effectiveness of such policies was a decreasing function of the level of public debt.

Aligned with the global economic context, economic policy in Brazil faced the crisis by adopting a policy of monetary and fiscal stimuli since 2008. Among the actions of monetary policy, there are measures taken to increase the liquidity of the market in both domestic and foreign currencies, i.e., reduction of compulsory deposits and foreign exchange swap auctions (BCB, 2009). In turn, amongst the actions of fiscal policy, a series of expansionary measures were also adopted, including loans to the National Development Bank (BNDES) and the expansion of its credit capacity, new tax relief measures and increased budgetary expenses, such as subsidies to face policies to encourage civil construction, among others. In addition, there was also an increase in credit to the entities of the federation through the flexibility of the State and Municipal Tax Adjustment Program (PAF), as defined in Law No. 9,496 of 1997 (MF, 2009).

At first, economic policy actions implemented in Brazil were successful, which is reflected in a GDP growth rate of 7.5% per year in 2010. However, as Tinoco et al. (2018) observed, despite the gradual overcoming of the 2008 crisis, which motivated the first loans to BNDES, the *modus operandi* remained the same in the following years. In fact, from the 2010 economic recovery on, economic policy measures, especially fiscal policy, could no longer be regarded as countercyclical. Nevertheless, National Treasury’s loans to BNDES were extended until 2014, reaching the amount of R\$ 416 billion<sup>1</sup>, as a means to enable the expansion of

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<sup>1</sup> The amounts are: R\$ 22.5 billion (2008), R\$ 105.0 billion (2009), R\$ 82.4 billion (2010), R\$ 50.2 billion (2011), R\$ 55.0 billion (2012), R\$ 41.0 billion (2013) and R\$ 60.0 billion (2014), according to Tinoco et al. (2018).

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investment programs such as the Growth Acceleration Program (PAC), Investment Support Program (PSI) and the *Minha Casa Minha Vida* Program (MCMV).

Despite the strong fiscal stimulus, the economy started to slow down and, since 2014, the country has plunged into the biggest economic crisis in its history, with a fall in economic activity, a sharp deterioration in fiscal indicators, and escalating inflation. The rapid weakening of the fiscal fundamentals of the economy, especially in relation to the debt stock, combined with the increase in inflation, has raised the discussion about the effectiveness of the policies adopted in Brazil, which even questioned whether the country was experiencing a fiscal dominance regime.

According to the classification in Leeper (1991), monetary and fiscal policies can be classified as active or passive, depending on the directions given by the authorities. In this case, the interaction of policies can assume different combinations depending on the inclination of the reaction functions in relation to inflation and debt, either assuming a behavior of monetary or fiscal dominance. Traditionally, the New Keynesian analysis model has conducted its analyses by assuming conditions that analyze possible dominance regimes in separate studies. However, according to Davig and Leeper (2006), there is no reason to assume that these regimes are fixed; actually, what seems to be more likely is that they evolve in alternation.

In fact, according to Cevik et al. (2014), recent studies that focus on fiscal policy and monetary policy rules indicate that fiscal and monetary policy regimes are not fixed over time and, therefore, fiscal and monetary equations must be estimated in a stochastic structure, like the one in Favero and Monacelli (2005), Davig and Leeper (2006 and 2011), Afonso et al. (2011), Doi et al. (2012) and Dewatcher and Toffano (2011). Still, according to Cevik et al. (2014), these studies generally adopt a two-state Markov regime-switching model to examine active and passive fiscal and monetary regimes.

Such literature has grown a lot in Brazil and we can mention Tanner and Ramos (2003), Fialho and Portugal (2005), Moreira, Souza and Almeida (2007), Ornellas and Portugal (2011) and Alves and Moura (2018) as examples, although many of the results are still divergent, depending on the methodology and periods considered. Yet, many studies have the limitation of not allowing the analysis of regime changes, or they assume it in an *ad hoc* manner, not based on evidence presented by some methodology, as in the case of a Markov regime-switching model. Anyway, as pointed out by Nunes and Portugal (2009), “the lack of coordination between these policies in Brazil, has often been pointed out as the reason for macroeconomic imbalances”.

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The objective of this essay aims at filling this gap, namely, the identification of economic policy interactions and the measurement of fiscal multipliers, within a framework of Markovian regime switching, relating them to the evolution of Brazil's recent economic crisis, with quarterly data from the 2000:Q1 to 2019:Q4 period. In order to do so, we first used Krolzig's (1997) methodology to estimate policy rules in a Markov-switching vector autoregressive (MS-VAR) context, and then studied policy interactions in a Dynamic stochastic general equilibrium model (DSGE), with Markovian regime switching, according to Davig and Leeper (2011).

As contributions of this essay, we believe that the combination of an MS-VAR approach for estimating policy rules with the use of a DSGE model, as proposed by Davig and Leeper (2011), can provide a valuable instrument for investigating the coordination of economic policies. In relation to Frascaroli, Oliveira and Almeida (2019), we point out that the update of data until 2019:Q4 and the inclusion of fiscal multipliers conditioned to the possible interactions of monetary and fiscal policies bring new evidence to Brazil and contribute to the discussion on the most recent developments of the current economic crisis.

Among the main results found, we highlight: i) the alternation of regimes, as observed in Leeper (2011), to be the practice: for Brazil, we pointed out eight successive alternations of regimes, with prevalence of monetary dominance; ii) shocks on government consumption have different multiplier effects on output and consumption, depending on the monetary and fiscal policy regime; iii) for regimes in which monetary policy is passive, the multiplier effect on the product varies from 1.3% to 1.5% and on consumption from 0.50% to 0.30%, while the effect on the inflation ranges from 2.4% to 3.2%; iv) for regimes with an active monetary policy, the effect on the product is 0.65%, with a negative effect on consumption by -0.35% and impacts on inflation by 0.8%; and v) the dynamics of interactions between monetary and fiscal policies were deeply related to macroeconomic imbalances in Brazil. However, it does not seem feasible that this has been the determining factor in the economic dynamics of the Brazilian economy in recent years.

This article is divided into four subsections, in addition to this brief introduction. In subsection 1.2, we present a literature review and the main results for Brazil. In subsection 1.3, we estimate the fiscal and monetary policy rules, identifying the regimes in force for the country in the period. In subsection 1.4, we introduce the estimated coefficients for the policy rules in the dynamic general equilibrium model (DSGE), according to Davig and Leeper (2006 and 2011), to obtain the impulse and response functions (FIR) for the economy aggregates in the

case of a shock in public spending. Also, in this subsection, we calculate the multipliers on product, consumption, and impacts on inflation. Finally, we present the conclusions of the article.

## 1.2 INTERACTION OF ECONOMIC POLICIES AND EMPIRICAL EVIDENCE FOR BRAZIL

The discussion on macroeconomic dynamics has been based on an approach that disregards the results that the interactions between different orientations for fiscal and monetary policy can achieve. According to Davig and Leeper (2006), traditional New Keynesian models have based their analyses of policies by adopting assumptions that allow monetary and fiscal rules to be studied separately. However, a growing line of research has emphasized that such assumptions can have questionable results by disregarding such interactions and, in this sense, more recent works, particularly those related to the Fiscal Theory of Price Level (TFNP), emphasize that the assumptions about how monetary and fiscal policies interact can be relevant.

Originally, the debate over coordination between fiscal and monetary policy was stimulated by the seminal work of Sargent and Wallace (1981), who described two possible scenarios of interaction between both economic policies that result in two forms of political dominance, namely monetary and fiscal dominance. Later studies of TFNP include Leeper (1991), Woodford (1996), Cochrane (1999) and Loyo (1999). According to Leeper and Leith (2016), the TFNP approach can be considered as a complement to the traditional New Keynesian theory in the sense that it includes the traditional case as one of the possible results.

Seeking TFNP's economic intuition, Walsh (2017) points out that fiscal and monetary policies are intertwined by the government's budget constraint, so that monetary policy decisions have an impact on fiscal policy and vice versa. Davig and Leeper (2006) make the previous statement clearer, using a transversal condition on the government's budget constraint to obtain the following equilibrium equation, called by Cochrane (2001) the debt pricing equation:

$$\frac{M_{t-1} + (1+r_{t-1})B_{t-1}}{P_t} = E_t \sum_{T=t}^{\infty} [q_{t,T} (\tau_t - G_t + \frac{r_t}{1+r_t} \frac{M_T}{P_T})] \quad (1)$$

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where  $M_T/P_T$  represents the real money stock,  $B_{t-1}$  the nominal value of the debt in the period  $t - 1$  and  $P_t$  the price level; and  $(\tau_t - G_t)$  is the primary surplus/deficit. In addition, the discount factor has the following definition  $q_{q,T} = (1 + r_{T-1})/(P_T/P_t)$ .

In an intuitive way, the equilibrium condition in equation (1) means that the fiscal authority defines the path of future surpluses through a fiscal rule and the nominal debt of the past period is predetermined. Assuming that the fiscal rule is given by a deficit trajectory, the price level in period  $t$  must be adjusted to ensure that the real value of the nominal debt equals the present value of the expected flows of primary surplus or seigniorage income.

Leeper (1991)'s classification has been used in TFNP, demonstrating that depending on the political guidelines of the monetary and fiscal authorities, different monetary and fiscal regimes can be found. Such policy guidelines can be defined as active or passive policy rules. A tax authority is said to be passive when it is not concerned with debt and is free to define its budget. On the contrary, if the tax authority is committed to debt sustainability, it defines its surplus path by looking to the maintenance of the debt balance path. In turn, a monetary authority is active when it is free to adjust the interest rate in order to stabilize inflation.

According to Leeper and Leith (2016), when the monetary authority is active (AM) and the fiscal authority is passive (PF), there is a regime of monetary dominance (AM/PF). In the opposite case, in which the fiscal policy is active (AF) and the monetary policy is passive (PM), there is a regime of fiscal dominance (PM/AF). Still under the classification of Leeper (1991), there would be two other policy combinations, active monetary and active fiscal (AM/AF), which implies explosive trajectories for inflation and both passive (PM/PF), which results in an undetermined balance.

Although there is a consensus on dominance relations and their consequences within the New Keynesian approach, the development of the literature ended up assuming fixed dominance positions, exploring the analyses of one or another regime with a preponderance for the case of monetary dominance. However, as Davig and Leeper (2006) argue, perhaps the least plausible assumption is to assume that the political regime is fixed. Still, as pointed out by Cevik et al. (2014), monetary and fiscal policy rules show dramatic changes between wartime and peacetime. In addition, local and global financial crises can cause substantial changes in fiscal and monetary policy rules.

Even more categorical about the need to analyze macroeconomics under the possibility of regime changes, Davig and Leeper (2006) state that the fiscal theory of price levels is always operational. Fiscal shocks always affect aggregate demand, even when the rules in force at a

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given time suggest the prevalence of Ricardian<sup>2</sup> equivalence. In this sense, Davig, Leeper and Chung (2004) analytically show that in an environment of regime change, there is a unique limited balance. In this balance, fiscal theory is always at work, as long as agents believe that there is a positive probability of changing to a regime with active fiscal policy. Thus, a cut in current taxes, financed by government bonds, does not generate an expectation that future taxes will increase in proportion to the increase in debt. Tax cuts make families feel richer, given initial prices and interest rates, and they realize they can increase their consumption. With nominal rigidities, the expansion of demand ends up expanding the product and inflation.

From this theoretical benchmark, it is relevant to observe what the evidence is for Brazil. In this sense, the identification of the prevailing regime in Brazil presents results that vary according to the period of analysis and the methodological approach used. Tanner and Ramos (2003), from an empirical<sup>3</sup> approach, and estimating in different subperiods, observed that between 1995 and 1997, the prevailing regime was of monetary dominance; yet, the results differ when the estimation is performed considering the entire sample. Fialho and Portugal (2005) estimate an MS-VAR model for Brazil in the post-Plano Real period (between 1995 and 2003) and suggest that the prevailing regime was of monetary dominance.

Moreira, Souza and Almeida (2007), based on Leeper (1991)'s structural approach model, with data from 1995 to 2006, found that the predominant regime would be that of fiscal dominance. In turn, Ornellas and Portugal (2011), with data for the period between 1999 and 2009, pointed to a low degree of fiscal dominance in Brazil. However, these latter works have the limitation of not allowing the study of regime change.

Nunes and Portugal (2009), considering a structural approach with regime change for the period after inflation targets, found results that vary according to the period studied. For the full period, a regime of monetary dominance was identified, yet, for the period from 2000:Q1 to 2002:Q4, a regime was found in which both policies were active, a result that is very close to that obtained in this essay for the aforementioned period, according to the results in subsection 4.3.

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<sup>2</sup> Ricardian Equivalence Theory argues that an increase in public spending through debt generation and tax cuts has no effect on total demand and interest rates. The debt will postpone taxes for the future, causing families (taxpayers) to anticipate this increase and react in the present by raising private savings, smoothing their consumption over time (BARRO, 1989).

<sup>3</sup> Studies that seek to assess the interaction between fiscal and monetary policies can be methodologically distinguished as empirical and structural studies. The empirical studies aim to subject the time series to econometric tests and, from these tests, analyze the behavior of the debt and the government's response to debt shocks. In turn, the structural approach seeks to identify the behavior of the fiscal and monetary authorities through microfounded models.

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Alves and Moura (2018) found that the fiscal regime models are favored for the period between 1999 and 2010, and that monetary regime is preferred in the period from 2010 to 2017. Nonetheless, a limitation in their study is that the selection of subsamples are made *ad hoc* by the researchers, and not based on evidence presented by any methodology, as it is the case in a Markov regime-switching model.

Frascaroli, Oliveira and Almeida (2019), using data from the 2000:Q1 to 2016:Q4 period, in an approach similar to the one in this essay, pointed out that, for the Euro Zone and Brazil, there are different impacts on macroeconomic aggregates depending on the prevailing monetary and fiscal policy regime for the period. They also emphasized that both the Euro Zone and Brazil need continuous policy coordination, particularly to make better use of fiscal instruments and make more accommodating public debt decisions.

In relation to Frascaroli, Oliveira and Almeida (2019), we point out that the update of data until 2019:Q4 and the inclusion of fiscal multipliers conditioned to the possible interactions of monetary and fiscal policies bring new evidence to Brazil and contributes to the discussion on the most recent developments of the current economic crisis.

### 1.3 REGIME CHANGES AND SPECIFICATION OF FISCAL AND MONETARY POLICIES

In this subsection, we will deal with the specification of the policy rules that will be used to solve the DSGE model, discussed in subsection 1.4. By estimating the coefficients of these rules, in a context of a Markovian regime switching, we can obtain the probability of a policy being in a certain state. In our context, in an active or passive state for the monetary and fiscal policy rules.

Thus, this subsection is divided into four parts. In the first part, we describe the functional forms for the policy rules and the meaning of the signs of the coefficients from Leeper (1991). In the second part, we present the main characteristics of the data used for the estimations. In the third part, we explain the general characteristics of the Markov-switching vector autoregressive model (MS-VAR). Finally, the results of the estimates are presented and discussed against the economic history of Brazil.



**1.3.1 FISCAL AND MONETARY POLICY RULES**

Following the works of Davig and Leeper (2011) and Cevik et al. (2014), fiscal and monetary policy rules may assume different coefficients depending on the regime in which the system is found. In this sense, the specification of the monetary policy rule follows a standard specification by Taylor (1993), according to Davig and Leeper (2011):

$$r_t = \alpha_0 + \alpha_\pi(S_t^M)\pi_t + \alpha_y(S_t^M)y_t + \sigma_r^2\varepsilon_t^r \quad (2)$$

where  $\varepsilon_t^r \sim N(0, 1)$ ;  $S_t^M$  indicates the monetary policy regime;  $r_t$  the basic interest rate;  $\pi_t$  is the inflation rate and  $y_t$  is the output gap. For  $\alpha_\pi > 1$  and  $\alpha_y > 0$ , the interest rate is adjusted according to the Taylor rule in order to stabilize inflation and output.

Unlike in monetary policy, there is no standard specification for fiscal policy<sup>4</sup>. In this essay, we keep following the work of Cevik et al. (2014) and Davig and Leeper (2011), who use net revenue, as follows:

$$\tau_t = \gamma_0 + \gamma_b(S_t^F)b_{t-1} + \gamma_y(S_t^F)y_t + \gamma_g(S_t^F)g_t + \sigma_\tau^2\varepsilon_t^\tau \quad (3)$$

where  $\tau_t$  is the government's net primary revenue as a proportion of GDP;  $S_t^F$  indicates the fiscal policy regime;  $b_{t-1}$  the debt/GDP ratio in  $(t - 1)$ ;  $y_t$  the output gap;  $g_t$  the primary government expenditure as a proportion of GDP, and  $\varepsilon_t^\tau \sim N(0, 1)$ . As a rule, from Leeper (1991), it can be assumed that for values of  $\gamma_b > 0$ , fiscal policy is passive; on the contrary, if  $\gamma_b < 0$ , fiscal policy is active.

Still on the coefficients of the reaction functions, Leeper (1991), in an article entitled *Equilibria under 'active' and 'passive' monetary and fiscal policies*, describes that, starting from a general equilibrium model that not only models the private behavior of families and firms, but also includes both the behavior of the monetary authority and that of the fiscal authority, it is possible to identify regions of balance in which the parameters of the policy rules are decisive for this balance. This is done in such a way, that the solution of the model will determine the

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<sup>4</sup> Fialho and Portugal (2005) use the primary result as a dependent variable on the fiscal rule. Other examples can be found in Taylor (2000) and Moura (2015).

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limits of the parametric interval in which a policy is considered active or passive. In the context of the model used by Leeper (1991), this parametric interval was defined based on the parameters of the policy functions ( $\alpha_\pi$  and  $\gamma_b$ ) and on the intertemporal discount rate, thus establishing four possible regions:

- i. Region I (AM/PF): active monetary policy (AM) and passive fiscal policy (PF) when  $\alpha_\pi\beta > 1$  and  $\gamma_b > \beta^{-1} - 1$ . In this case, the monetary authority adjusts the interest rate in a greater proportion than the shock over inflation, acting independently and overlooking the impact on fiscal debt. In turn, fiscal policy respects the government's intertemporal restriction by adjusting revenues to increase debt. According to Davig and Leeper (2006), this position would be consistent with a Ricardian view of the economy;
- ii. Region II (PM/AF): passive monetary policy (PM) and active fiscal policy (AF) when  $\alpha_\pi\beta < 1$  and  $\gamma_b > \beta^{-1} - 1$ . The tax authority independently determines its budget and the monetary authority adheres to restrictions imposed by the fiscal policy, allowing the money stock to be used in response to shocks on the fiscal deficit. Following Davig and Leeper (2006), this behavior would be compatible with the view of the fiscal theory of price level (TFNP);
- iii. Region III (PM/PF): passive monetary policy (PM) and passive fiscal policy (PF) when  $\alpha_\pi\beta < 1$  and  $\gamma_b > \beta^{-1} - 1$ . Both monetary and fiscal policies are passive and, in this case, the model is undetermined;
- iv. Region IV (AM/AF): active monetary policy and active fiscal policy when  $\alpha_\pi\beta > 1$  and  $\gamma_b > \beta^{-1} - 1$ . In this case, the policy combination causes an explosive trajectory for the price level.

In summary, for the determination of fiscal and monetary policy rules as active or passive, we will consider the definition proposed in Leeper (1991) when analyzing the results of the estimates in subsection 4.3.4<sup>5</sup>.

### 1.3.2 DATA SOURCE

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<sup>5</sup> Davig and Leeper (2011) end up adopting the general rule, that is, active monetary policy if  $\alpha_\pi > 1$  and passive fiscal policy if  $\gamma_b > 0$ .

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The following variables were used to estimate both fiscal and monetary policy rules: (i) Total Net Revenue; ii) Total Expenses; iii) Central Government Net Debt (DLGC); iv) Output Gap; v) Nominal Interest Rate - Selic rate; and vi) Inflation Rate measured by the National Broad Consumer Price Index (IPCA).

The monetary variables that were used are from the Central Bank (BCB) and the data used to estimate the fiscal rules was obtained from the National Treasury Office (STN). The period under analysis comprises 1998:Q1 to 2019:Q4, yet, considering the introduction of an inflation targeting system in Brazil in June 1999, we decided to limit the estimates of this essay to the period after 2000:Q1. In order to obtain the output gap, the Hodrick-Prescott (HP) filter, developed by Hodrick and Prescott (1997), was applied to the monthly series of a 12-month aggregated Gross Domestic Product (GDP). For the inflation series, we adopted the 12-month aggregated IPCA index with quarterly frequency. This same parameter was applied to the Selic interest rate.

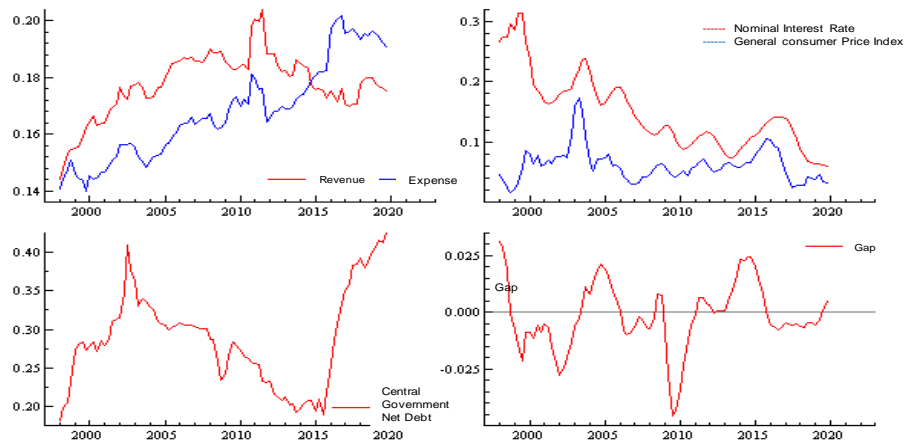
In turn, fiscal variables are represented as a proportion of GDP. The time series obtained with the STN were aggregated into 12-month sets and divided by the 12-month aggregated GDP on a quarterly basis. With this procedure, we tried to avoid the seasonal effect that is present in the original series. For symmetry purposes, the same treatment was given to the Central Government Net Debt series, with data sourced from the BCB. In Figure 9, we depict the variables' trajectories used to estimate reaction functions of the monetary and fiscal policies in this essay.

If we look at the trajectories of macroeconomic variables within the monetary framework, the economy could not reach its full GDP potential in the following periods: (i) between 2000 and 2003, a period scarred by the 1999 extreme currency depreciation and the 2002/2003 government transition period; ii) in 2009, due to the 2008 U.S. crisis; and iii) from 2015 and on, a period marked by the recent economic crisis. It is worth mentioning the long period between 2010 and 2015 when GDP was above potential, which, in part, may have pressured the upward trend in inflation in the same period.

The interest rate, in general, is adjusted to follow the shocks on inflation, being consistent with an inflation-targeting regime. However, it is interesting to note some relevant aspects in the analysis. The first aspect refers to the 2002-2003 crisis, in which the average growth rate of the interest rate was lower than the average growth rate of the inflation rate, evidencing that even though the Central Bank responded to inflation with an increase of the interest rate, it was an unproportioned response. The second aspect refers to the period between

2013 and 2014, which saw the lowest rate in the time series up to that moment, in a context of a positive output gap. In addition, more recently, the downward trend of the Selic rate since 2017, which drove the economy to a new lowest level within the series.

**Figure 1:** Variables for estimating fiscal and monetary policy rules.



Source: i) The series of revenues and expenses were obtained from STN, according to the National Treasury Result (RTN) report; ii) Total Net Revenue refers to Total Revenue minus Revenue-sharing Transfers; iii) Debt - total - federal govt. and Central Bank - net - R\$ (million) - BCB; iv) Interest rate - Over/Selic - (% per month.); and v) 12-month aggregated Gross Domestic Product (GDP) - Current values. BCB estimate.

Concerning fiscal variables, we observe that revenues and expenses showed an upward trend in relation to GDP until 2011. Expenses and revenues went from 14% and 15% of GDP in 2000 to around 17% and 19% respectively, in the end of 2007. This behavior was influenced by a moment of favorable international context, which contributed significantly to the increase in revenues, reaching more than 20% of GDP between mid-2010 and 2011. However, from 2011 on, government policies for revenue and spending took on dangerously opposite directions, with increasing expenses and falling revenues.

Regarding the behavior of the Central Government Net Debt (DLGC), there are three distinct periods. The first one corresponds to the start of the series until 2003, with its peak exceeding 40% of the GDP after the 2002-2003 government transition. The second one, from 2003 to 2015, with a constant downward trend throughout the period. The third one started in 2015, when debt bounces back in a growth trajectory, resulting in budget deficits and the latest cycle of rising interest rates.

### 1.3.3 MARKOV-SWITCHING VECTOR AUTOREGRESSIVE MODELS (MS-VAR)

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According to Krolzig (1997), MS-VAR models can be considered as generalizations of the VAR ( $p$ ) models in which parameters vary over time, yet, the process can be invariant when it is conditioned to an unobservable variable ( $s_t$ ), which indicates the prevailing regime at a specific moment. The general idea behind this class of regime-switching model is that the process generating the time series of a  $K$ -dimensional  $\{y_t\}$  vector depends on an unobservable regime variable ( $s_t$ )  $\in \{1, \dots, M\}$ , which represents the probability of being in a given state and, in our context, corresponds to the estimated policies rules' regimes, as follows:

$$p(y_t|Y_{t-1}, X_t, s_t) = \begin{cases} f(y_t|Y_{t-1}, X_t; \theta_1) & \text{se } s_t = 1 \\ \vdots \\ f(y_t|Y_{t-1}, X_t; \theta_M) & \text{se } s_t = M, \end{cases} \quad (4)$$

where  $Y_{t-1} = \{y_{t-j}\}_{j=0}^{\infty}$  denotes the history of  $y_t$  and  $X_t$  as strongly exogenous variables;  $\theta_m$  is the parameter vector associated with the  $m$  regime.

The most general form of a MS-VAR process is given by:

$$y_t = v(s_t) + A_1(s_t)y_{t-1} + \dots + A_p(s_t)y_{t-p} + u_t, \quad u_t|s_t \sim NID(0, \Sigma(s_t)), \quad (5)$$

where sample values  $y_0, \dots, y_{1-p}$  are fixed. Parameter-change functions  $v(s_t), A_1(s_t), \dots, A_p(s_t)$ , and  $\Sigma(s_t)$  describe how dependent on the performed regime ( $s_t$ ) these parameters are, for example:

$$v(s_t) = \begin{cases} v_1 & \text{se } s_t = 1 \\ \vdots \\ v_M & \text{se } s_t = M. \end{cases} \quad (6)$$

Note that the description of the data generation process is not completely defined in equations (4) and (5). In these cases, we must adopt a proposal for the evolution of the regimes, which, in the context of this essay, would be how a given monetary or fiscal policy transitions from an active to a passive regime and vice versa. The distinguishing characteristic of the Markov regime-switching model is the assumption that the unobservable realization of the regime ( $s_t$ )  $\in \{1, \dots, M\}$  is governed by a stochastic Markov process with a discrete time and a discrete state, which is defined by the transition probabilities, as follows:

$$P_{ij} = Pr(s_{t+1} = j | s_t = i), \sum_{j=1}^m 1 \forall i, j \in \{1, 2, \dots, m\} \quad (7)$$

where  $P_{ij}$  represents the probability that, being in regime  $i$ , at time  $t + 1$  there will be a change to regime  $j$ . The transition probabilities can also be represented in matrix form to better present the probability transitions adjacent to each regime:

$$T = \begin{bmatrix} p_{11} & 1 - p_{22} \\ 1 - p_{11} & p_{22} \end{bmatrix}, \quad (8)$$

where  $p_{11}$  represents the probability of, being in regime 1, there will be no change, and  $1 - p_{22}$  represents the probability of, being in regime 1, there will be a transition to regime 2. The rationale is analogous to the second line of the matrix.

It is particularly important in this section to realize that regimes 1 and 2 here described refer to active and passive regimes, respectively, regarding fiscal and monetary policies. Thus, equations (2) and (3) develop according to the transition probability matrix  $T^M$ , in the case of monetary policy and  $T^F$ , in the case of fiscal policy, as described below:

$$T^M = \begin{bmatrix} P_{1,1} & P_{2,1} \\ P_{1,2} & P_{2,2} \end{bmatrix} \quad \text{e} \quad T^F = \begin{bmatrix} P_{1,1} & P_{2,1} \\ P_{1,2} & P_{2,2} \end{bmatrix}. \quad (9)$$

Basically, these transition matrices provide information on the probability that the economy will migrate from one regime to another, i.e.,  $P_{1,1}$  represents the probability that a given policy is in regime 1 (active) and remains in the same regime. In turn,  $P_{1,2}$  represents the probability of being in regime 1 (active) and migrating to regime 2 (passive). Likewise,  $P_{2,2}$  represents the probability that a given policy is in regime 2 (passive) and remains there, while  $P_{2,1}$  depicts the probability of being on regime 2 (passive) and migrating to regime 1 (active).

Still according to Davig and Leeper (2006 and 2011), the joint probability transition matrix for fiscal and monetary policy can be calculated as:

$$T = T^M \otimes T^F. \quad (10)$$

The dating of the regimes is performed by means of an algorithm that filters and attenuates the probabilities of the regime. Generally, Hamilton's algorithm (1989) is used as a filtering method, but there are other filters, such as the Kalman filter. In order to estimate model parameters, we use the Expectation-Maximization (EM) algorithm, originally described by Dempster, Laird and Rubin (1977). It starts with estimates of the unobserved regimes and

iteratively produces a new joint probability distribution, which increases the likelihood of having observed data. These two steps are referred to as expectation and maximization. This algorithm has many desirable properties as indicated in Hamilton (1990).

#### 1.3.4 ESTIMATE RESULTS

Monetary and fiscal policies rules, as seen in equations (1) and (2) were estimated from two sets of variables: (i) monetary: interest rate, inflation, and output gap; and (ii) fiscal: revenue, public debt, output gap, and government spending. In order to justify the Markovian regression approach, a Likelihood-Ratio linearity test (*Likelihood-ratio test – LR*)<sup>6</sup> must be performed first. In this sense, according to Table 1, results reject the null hypothesis of linearity, indicating that estimating policy rules using a Markov regime-switching model is preferable.

**Table 1:** Linearity testing for policy rules.

	<i>Distribution</i>	<i>Test statistics</i>	<i>p-value</i>	<i>Davies p-value</i>
<i>Monetary Rule ( <math>r_t</math> )</i>	$\chi^2(4)$	58,38	0,000	0,000
<i>Fiscal Rule ( <math>\tau_t</math> )</i>	$\chi^2(4)$	77,73	0,000	0,000

Source: Elaborated by the authors with estimate results. (1)  $H_0$ : the model is linear.

Maximum likelihood estimates for the monetary policy reaction function are shown in Table 2. In sight of Leeper (1991)'s classification for the inflation parameter's result, we observe that the regime 1 monetary policy has a  $\alpha_\pi = 1,85$  coefficient, therefore determining that it is a clearly active monetary policy regime. For regime 2, it can be considered as a passive monetary policy regime, given that  $\alpha_\pi = 0,88$ . In both cases, the coefficients were significant at 99%. It appears that the other coefficients associated with the GDP gap were negative, although statistically insignificant for regime 1, which suggests consistency with the inflation targeting system.

Comparing with the literature, we observed similar results for the inflation parameter ( $\alpha_\pi$ ) estimated for Brazil, as seen in Carvalho and Valli (2010), Silva and Portugal (2010),

<sup>6</sup> The LR test statistic can be expressed as  $LR = 2[\ln L(\lambda) - \ln L(\lambda_r)]$  where  $L(\lambda)$  is the logarithmic probability value for the Markov regime-switching model and  $L(\lambda_r)$  is the log-likelihood value for the linear model. The LR test has a  $\chi^2$  distribution with r degrees of freedom, where r is the number of restrictions. However, a problem arises when testing regime-switching models against linear models. This is because the transition probabilities in the regime-switching models are not identified in the linear model and, therefore, the LR test does not follow standard distribution 2. In order to overcome this problem, Davies (1987) suggests calculating the p-values of the upper limit.

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Nunes and Portugal (2009), and Barbosa and Soares (2006). Still, Vereda and Cavalcanti (2011) use values between 1.5 and 3.0.

Likewise, regarding the monetary rule, the results of the fiscal policy rule are described in Table 3. As a rule, tax policy is assumed to be passive if  $\gamma_b > 0$ . However, according to Leeper (1991), in the context of the DSGE model proposed in his work, he observed that for a fiscal policy to be considered passive, the debt reaction coefficient should be  $\gamma_b > \beta^{-1} - 1$ . In this case, the limit value for the coefficient is  $\gamma_b = 0,0152$ , observing an intertemporal discount rate of  $\beta = 0,985$ .

In the case of regime 1, we observed a  $\gamma_b = 0,019$ , slightly higher than the limit, when considering the condition in Leeper (1991). Thus, regarding the parameters of public debt, it is clear that both regimes are passive. In this case, we are assuming that the passive fiscal policy can assume two states, so that we will have a less passive fiscal policy (PF-) for regime 1, which is closer to an active fiscal policy, and a more passive fiscal policy (PF+) for regime 2.

**Table 2:** Monetary Policy Rule Estimates.

<i>Coefficients</i>	<i>Active (1)</i>	<i>Passive (2)</i>
	$s_t^{M=1}$	$s_t^{M=2}$
$\alpha_0$	0,0550*** (0,0104)	0,0550*** (0,0104)
$\alpha_\pi$	1,8524*** (0,1523)	0,8811*** (0,1291)
$\alpha_y$	-0,2071 (0,3600)	-0,4918*** (0,1363)
$\sigma_r^2$	0,0221*** (0,0021)	0,0221*** (0,0021)

Log-Likelihood: 178.39

Number of observations: 80

Number of parameters: 8

Source: Elaborated by the authors with estimate results. Notes: i) Robust standard deviations in brackets; and ii) \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1

Regarding the parameters associated with the output gap, it is observed that both are positive and statistically different from zero. Likewise, there is positive and significant action by the tax authority regarding variations in expenses.

In Markovian regime-switching models, transition probability estimates are essential to capture regime change. According to Table 4, estimates showed that regimes are persistent, since the values found for the probability of remaining in one of the two regimes are high, with average values close to 1.



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For monetary policy, the transition probabilities are given by matrix  $T^M$ . In this case, the probability of remaining in the active monetary policy regime is 91.32%. Consequently, being in the active regime, the probability of moving to the passive monetary policy regime is 8.68%. In turn, being in a passive regime, the probability of staying in this same regime is 96.332%, while the probability of going to the active regime is 3.67%. The transition probabilities between fiscal policy regimes are found in transition matrix  $T^F$ . Likewise, as an analogy of the analysis of the monetary rule, the probability of remaining in a less passive fiscal policy regime (PF-) is 97.67%, while the probability of remaining in a more passive fiscal policy regime (PF +) is 97.22 %.

**Table 3:** Fiscal Policy Rule Estimates.

<i>Coefficients</i>	<i>Passive (-)</i>	<i>Passive (+)</i>
	$s_t^M=1$	$s_t^M=2$
$\gamma_0$	0,1520*** (0,0061)	0,1520*** (0,0061)
$\gamma_b$	0,01878* (0,0074)	0,0682*** (0,0095)
$\gamma_y$	0,11433*** (0,0527)	0,1561** (0,0698)
$\gamma_g$	0,1033*** (0,0341)	0,1033*** (0,0341)
$\sigma_r^2$	0,0044*** (0,0005)	0,0044*** (0,0005)

Log-Likelihood: 312,78

Number of observations: 80

Number of parameters: 9

Source: Elaborated by the authors with estimate results. Notes: i) Robust standard deviations in parentheses; and ii) \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1

The smoothed transition probabilities in Figure 2 show a clear picture of the timing of monetary policy regime changes, with regimes alternating from active to passive during the period. The intervals in which monetary policy is considered active are: i) from 2000:Q1 to 2002:Q3; ii) from 2003:Q4 to 2007:Q4; and iii) from 2017:Q1 to 2017:Q4. On the other hand, the intervals in which monetary policy is considered passive are: i) from 2002:Q4 to 2003:Q3; ii) from 2008:Q1 to 2016:Q4; and from 2018:Q1 to 2019:Q4.

**Table 4:** Probability transition matrices between regimes.

Monetary Regime Transitions $T^M$	Fiscal Regime Transitions	$T^F$
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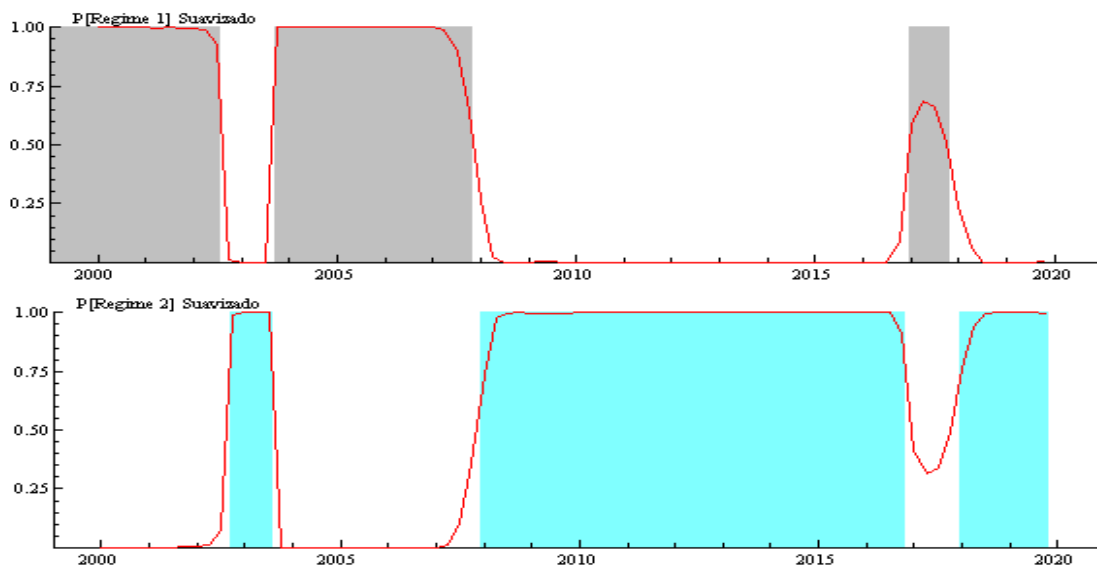
$$T^M = \begin{bmatrix} 0,9132 & 0,0367 \\ 0,0868 & 0,9633 \end{bmatrix}$$

$$T^F = \begin{bmatrix} 0,9767 & 0,0278 \\ 0,0233 & 0,9722 \end{bmatrix}$$

Source: Elaborated by the authors with estimate results.

The transition between fiscal policy regimes can be seen in Figure 3. Although our estimates point to a passive behavior throughout the period, following the classification proposed in this article, we consider that the fiscal policy was less passive (PF-) in: i) from 2000:Q1 to 2005:Q2; and ii) from 2014:Q4 to 2019:Q4. In turn, the interval from 2005:Q3 to 2014:Q3 was considered to be more passive (PF+).

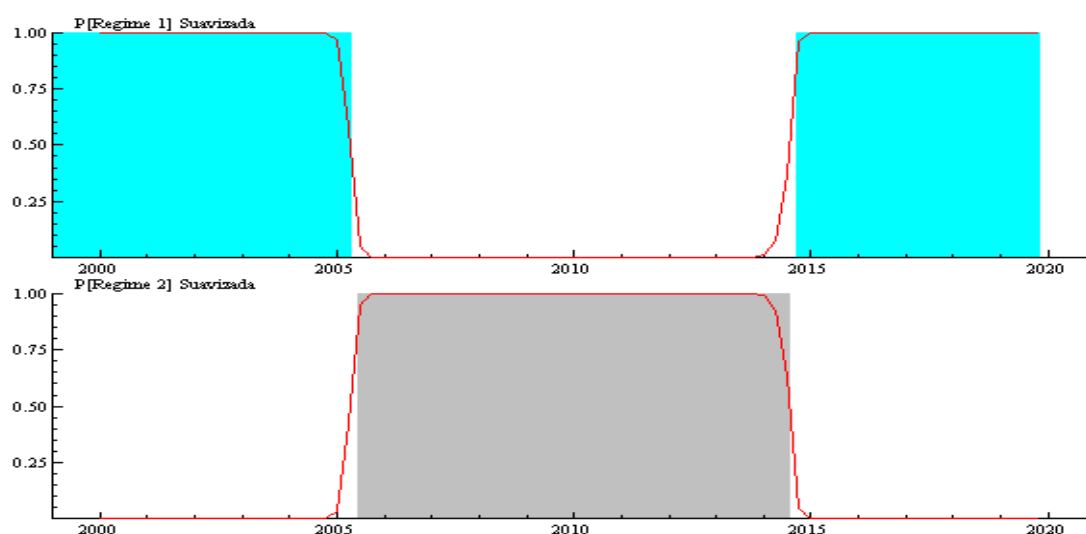
**Figure 2:** Probabilities of Monetary Policy Regimes.



Source: Estimation results.

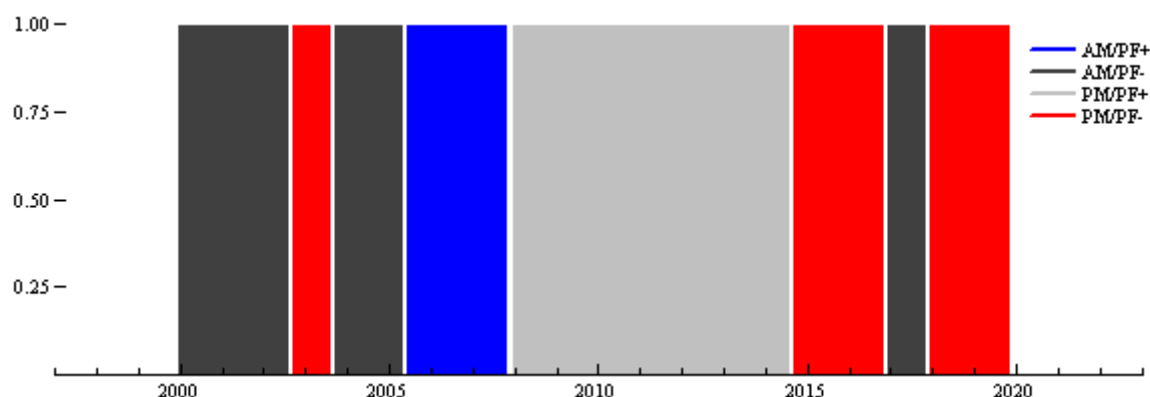
As a means to investigate the policy mix as well as the monetary and fiscal policy interactions, we calculated the joint transition matrix according to Equation (9), providing possible policy interactions and using the terminology of Leeper (1991) in the sample provided in this essay. In Figure 4, information about the interactions of the studied policies is summarized.

**Figure 3:** Probabilities of Fiscal Policy Regimes.



Source: Estimation results.

**Figure 4:** Estimated Interactions for Monetary and Fiscal Policy Regimes.



Source: Elaborated by the authors with estimate results.

With the purpose of evaluating the results found, it is worth doing a quick rereading of the main economic facts regarding the management of fiscal and monetary policies as a way of contextualizing our estimates.

Having started during the administration of President Fernando Henrique Cardoso (FHC) after the 1999 currency depreciation, the monetary policy in place responded aggressively to inflation in the first years of the inflation targeting system, which was pressured by the exchange rate depreciation because of exchange pass-through activity, as pointed out in Amaury et al. (2016). On the fiscal side, the agreement made with the International Monetary Fund (IMF), which required targets for primary surpluses, the creation of the Fiscal Responsibility Law, among other measures, was decisive for the conduction of a passive fiscal

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policy, aiming at debt sustainability. In this context, the dating of the regimes, as shown in Figure 4, seems coherent, pointing to an initial period of monetary dominance (AM/PF +).

In turn, the increase in the Selic rate ended up putting pressure on public debt, which at that time was strongly tied to post-fixed rates. This fact may have raised questions concerning fiscal sustainability, especially in view of the government transition in 2002 and the escalation of uncertainties regarding the continuity of the macroeconomic tripod by the new administration, something that would justify the first switch to a passive monetary policy regime in 2002. Blanchard (2004) even argues that Brazil experienced a period of fiscal dominance (PM/AF), during which the increase in interest rate in response to the inflation increase would lead to a higher probability of default on debt. The rise in country risk would in turn put pressure on the exchange rate and price levels again, creating a vicious circle. This context is, in a way, consistent with our classification (PM/PF-). On the monetary side, in Figure 2, we note that the probability that the monetary regime was passive is significantly higher during this period. From the point of view of the tax regime, represented here as (PF-), it is way too close to the limit to be considered as an active regime (AF).

From 2003 onwards, the economic orientation of former President Luiz Inácio da Silva (Lula) not only followed the fiscal adjustment initiated by the previous administration, but also even deepened it, increasing and fulfilling the primary surplus targets. Still, there was a growing concern in the debt management area of the National Treasury regarding the reduction of installments indexed to exchange rates and post-fixed interest rates, which in the previous period were determinant factors for the sudden increase in public debt that occurred in 2002. From a monetary standpoint, inflation, as well as interest rates, began to fall gradually, further corroborating for the improvement of the fiscal framework and allowing the economic authorities to abandon fiscal dominance. In fact, Figure 2 shows that the estimated model captured this change, in a way that from 2004 on, the probability of being in a regime of monetary dominance is close to one. Thus, it seems very reasonable to assume that the country experienced a period of monetary dominance (AM/PF) between 2003 and 2008.

From a fiscal policy standpoint, there is a turning point in 2005, moving from a less passive (PF-) posture to a more passive (PF +) one. There are some remarks to be made here. A recurring view is that President Lula's second term was marked by a more flexible fiscal policy, adopting policy proposals that went against an orthodox view. According to Arantes and Lopreato (2017), there was a greater concern at that time about policies aimed to reduce poverty and inequality, such as increasing the minimum wage and spending on Bolsa Família

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under the argument that such policies could be carried out without generating fiscal imbalances, since they would finance themselves through economic growth.

When we look at this context in the light of the first and second essays of this thesis, our results suggest that the sharp rise in international commodity prices had both direct and indirect effects on income and decisively contributed to the strong revenue increase and the good performance of the economy in the period. Although there is a continuous increase in spending as a percentage of the GDP, a faster revenue growth rate was decisive for the downward trend in debt in the period, as seen in Figure 1.

It is interesting to note that in December 2008, the government signed Law 11,887, creating the Sovereign Fund of Brazil with the application of surplus budgetary resources of about 0.5% of the GDP. In other words, even though the 2008 financial crisis was tough on the global economy, at that time, fiscal policy management still seemed to be strongly impacted by the earnings made by Brazil in terms of the trade during that period.

From a monetary policy management standpoint, the 2008 U.S. financial crisis seems to be the turning point. In fact, Figure 2 shows that the estimated model captured this change, in a way that from 2008 onwards, the probability of being in a passive monetary policy regime is close to one.

Aligned with the global economic context, economic authorities in Brazil faced the crisis by adopting a monetary and fiscal stimuli policy from 2008 onwards. Amid the monetary policy actions, they implemented measures to increase market liquidity of both domestic and foreign currencies, i.e., reduction of compulsory deposits and foreign exchange swap auctions (BCB, 2009). In turn, amidst fiscal policy actions, a series of expansionary measures were also adopted, including loans to the National Development Bank (BNDES) and the expansion of its credit capacity, new tax relief measures, and increased budgetary expenses, such as subsidies to fund the civil construction stimulation policy, among others (MF, 2009). In addition, there was also an increase in credit to entities of the federation through the flexibility of the State and Municipal Tax Adjustment Program (PAF), as defined in Law No. 9,496 of 1997 (MF, 2009).

We must highlight that many of these fiscal policy economic measures were conceived in such a way as to minimize the impact on net debt; for example, BNDES' loan operations increased the Federal Public Debt (DPF) by placing new bonds on the market, while, in turn, National Treasury received a credit from the BNDES at the same face value. At first, the effect on net debt was null, but over the years, the difference between the indexes of DPF and these loan contracts would provoke, with some delay, a rise in net debt. At this point, it is important

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to draw attention to the methodology used. Since the indicator used for debt was DLGC, many of the expansionary fiscal measures of the period went unnoticed. It is not by chance that many studies began using this period's series of gross debt for their analysis on fiscal policy management.

During the first term of President Dilma Vana Roussef (Dilma), despite the continuation of the expansionary fiscal policy measures, which became known as the New Macroeconomic Matrix, there was a strong deceleration in economic activity at the end of her first term. This led to a reduction in tax collection and, consequently, to a worse fiscal situation, as pointed out by Arantes and Lopreato (2017).

Despite the succession of political events and the continuity of an expansionary fiscal agenda in a scenario of evident fiscal deterioration, a relevant fact for this essay can be drawn from Resende (2017). He highlights that, from the end of 2014 onwards, along the discussion on the need for fiscal adjustment, the debate on fiscal dominance is resumed, in view of the interdependence of fiscal and monetary policies and the recurrent fiscal imbalances. In fact, considering that they appear in the data presented in this study in a context of passive monetary policy and with a switch for a less passive fiscal policy in 2014:Q3, it seems reasonable to assume that, in fact, the country has moved closer to a new period of fiscal dominance.

By the end of 2016, already under President Michel Miguel Elias Temer's (Temer) administration, there is a new switch to monetary policy and, as it can be seen in Figure 2, the probability of dominance substantially increases during 2017. However, as of 2018, our model points to a new reversal towards a monetary policy, which is in line with the cycle of unprecedented downfalls in interest rates, with significant downfall in real interest rates.

#### 1.4 DYNAMIC IMPACT OF GOVERNMENT SPENDING: EVIDENCE FOR BRAZIL

In this subsection, policy rules specified and estimated in subsection 1.3 are studied under a New Keynesian<sup>7</sup> framework. More specifically, we insert these policy rules into a Dynamic Stochastic General Equilibrium model (DSGE) and simulate the impacts on

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<sup>7</sup> The New Keynesian approach has its great instrument of analysis in DSGE models. DSGE modeling (from Dynamic Stochastic General Equilibrium) is an application of general equilibrium theory, which seeks to explain aggregate economic phenomena - such as economic growth, economic cycles, and monetary and fiscal policy effects - using as base macroeconomic models derived from microeconomic principles. As its name implies, DSGE models are dynamic - that is, they study how the economy evolves over time - and stochastic, because they use random shocks (such as changes in technology, prices, government spending, etc.) to analyze the impacts on a simulated economic system.

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macroeconomic aggregates in a scenario of shocks in government spending. The difference between the approach used in this essay and traditional DSGE approaches is that, in the MS-DSGE approach, impacts on macroeconomic aggregates can be completely different, depending on the economic policy mix that is in place at the moment.

Regarding the general characteristics of the DSGE model, steady-state conditions and solution methods, we emphasize that our methodology rigorously follows the model developed by Davig and Leeper (2006 and 2011). In this sense, subsections 1.4.1 and 1.4.2 simply reproduce the mentioned references so as to facilitate the analysis of results that are presented in subsection 1.4.3. This article does not aim to explore innovations for the model, but rather to discuss the mechanisms by which shocks in government spending may have different effects on macroeconomic aggregates, depending on the interactions between monetary and fiscal policies that were estimated for Brazil.

This subsection is divided into four parts. In the first part, we continue with the presentation of the DSGE model, in which households and goods-producing firms are working in monopolistic competition with respect to final goods in an environment that assumes fixed capital stock and elastic labor supply. We assume a government as the fiscal authority which taxes consumers, makes expenditures, consumes goods, issues debts and that is the monetary authority responsible for currency supply. In the second and third parts, subsections 1.4.2 and 1.4.3, there is a description of the methodology used to calculate the impulse response functions, as well as for the calculation of fiscal multipliers. Finally, in the fourth part, we analyze the impact of shocks on government spending on macroeconomic aggregates, fiscal multipliers, and the impact on inflation, assuming different scenarios for macroeconomic coordination.

#### 1.4.1 MARKOV REGIME-SWITCHING DYNAMIC STOCHASTIC GENERAL EQUILIBRIUM MODEL (MS-DSGE)<sup>8</sup>

##### 1.4.1.1 HOUSEHOLDS

The behavior of households is modeled by assuming a representative family that lives infinitely and seeks to maximize its intertemporal utility. In this way, this representative family

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<sup>8</sup> The applied methodology follows the model used by Davig and Leeper (2006 and 2011) In this sense, the equations described here were based on a work from the respective authors, entitled *Monetary-Fiscal Policy Interactions and Fiscal Stimulus*. It should also be noted that for the simulations to be presented in subsection 4.4.4, Dynare programming provided by the authors was used at: <http://php.indiana.edu/~eleeper/#Papers>.

selects  $\{C_t, N_t, M_t, B_t\}$ , where  $C_t$  is a consumption basket,  $N_t$  the total number of hours worked,  $M_t/P_t$  the real currency stock and  $B_t$  the allocation in nominal securities within a period, in order to maximize the following utility function:

$$E_t \sum_{i=0}^{\infty} \beta^i \left[ \frac{C_{t+i}^{1-\sigma}}{1-\sigma} - \chi \frac{N_{t+i}^{1+\eta}}{1+\eta} + \delta \frac{(M_{t-i}/P_{t+i})^{1-k}}{1-k} \right], \quad (11)$$

with  $0 < \beta < 1$ ,  $\sigma > 0$ ,  $\eta > 0$ ,  $\kappa > 0$ ,  $\chi > 0$  and  $\delta > 0$  respectively representing the intertemporal discount rate, the elasticity of intertemporal substitution in consumption, the elasticity of labor supply, the interest elasticity of real money demand, the equilibrium labor supply, and, finally, the monetary base velocity. Also,  $E_t$  is the expectation operator and consumption basket  $C_t$  consists of different goods,  $c_{jt}$ , which are aggregated by using an aggregator developed by Dixit and Stiglitz (1977), as follows:

$$C_t = \left[ \int_0^1 c_{jt}^{\frac{\theta-1}{\theta}} dj \right]^{\frac{\theta}{\theta-1}}, \quad (12)$$

where  $\theta$  is the elasticity of substitution among diverse goods, with  $\theta > 1$ . The issue for families is to choose each  $c_{jt}$  asset that will minimize total spending, generating the demand functions for each asset  $j$ :

$$c_{jt} = \left( \frac{p_{jt}}{P_t} \right)^{-\theta} C_t, \quad (13)$$

with  $P_t \equiv \left[ \int_0^1 p_{jt}^{1-\theta} dj \right]^{\frac{1}{1-\theta}}$ . Households' budget restrictions are represented by:

$$C_t + \frac{M_t}{P_t} + \frac{B_t}{P_t} + \tau_t \leq \left( \frac{W_t}{P_t} \right) N_t + \frac{M_{t-1}}{P_t} + \frac{(1+r_{t-1}B_{t-1})}{P_t} + \Pi_t, \quad (14)$$

where  $\tau_t$  are lump-sum taxes/transfers,  $B_t$  government bonds for a period,  $W_t$  the nominal wage,  $1 + r_{t-1}$  the risk-free nominal interest rate between period  $t - 1$  and  $t$  and  $\Pi_t$  the profits of firms. This is done in such a way that the left side of equation (14) represents the destination of households' resources, while the right side is the source of the resources. Thus, the issue for households is to maximize (11) while being subject to (14), leading to:



$$\chi \frac{N_t^\eta}{C_t^{-\sigma}} = \frac{W_t}{P_t}. \quad (15)$$

$$1 = \beta(1 + r_t) \left( \frac{C_t}{C_{t+1}} \right)^\sigma \left( \frac{P_t}{P_{t+1}} \right). \quad (16)$$

$$\frac{M_t}{P_t} = \delta^k \left( \frac{r_t}{1+r_t} \right)^{-1/k} C_t^{\sigma/k}. \quad (17)$$

In an intuitive way, equation (15) represents the intertemporal decision and can be understood as a job offer condition, given the salary. In turn, equation (16) concerns the intertemporal consumption decision of families. While equation (17) gives us the relationship between real money demand, nominal interest rates, and aggregate consumption.

Government demand for consumer goods occurs to households in a similar way, leading to government demand that is equal to  $g_{jt} = \left( \frac{p_{jt}}{P_t} \right)^{-\theta} G_t$ , in which  $G_t = \left[ \int_0^1 g_{jt}^{\frac{\theta-1}{\theta}} dj \right]^{\frac{\theta}{\theta-1}}$ .

The necessary and sufficient conditions for the households' finances' optimization issue require that equations (15) to (17) are valid in each period and that the budget constraint is always met with equality. In addition, the current value of expected household consumption follows the cross-sectional condition described below:

$$\lim_{n \rightarrow \infty} E_t \left[ q_{q,T} \frac{A_T}{P_T} \right] = 0, \quad (18)$$

in which  $A_T = B_t + M_t$  e  $q_{q,T} = (1 + r_{T-1}) / (P_T / P_t)$ .

#### 1.4.1.2 FIRMS

On the production side, it is assumed that there is a continuity of firms indexed by  $j \in [0,1]$  that produce goods using labor, so that the production function is given by:

$$y_{jt} = ZN_{jt}, \quad (19)$$

where  $Z$  is the homogeneous aggregate technology, which is common among firms and considered constant. Given the demands of consumers and the government, company  $j$  observes the following demand curve:

$$y_{jt} = \left(\frac{p_{jt}}{P_t}\right)^{-\theta} Y_t, \quad (20)$$

where  $Y_t$  is defined by households and government consumption as:

$$Y_t = C_t + G_t. \quad (21)$$

In market equilibrium, when demand and supply of goods are equal:

$$ZN_{jt} = \left(\frac{p_{jt}}{P_t}\right)^{-\theta} Y_t. \quad (22)$$

Since firms have a certain degree of market power, as originally developed by Calvo (1983), it is assumed that a fraction  $(1 - \varphi)$  of firms can adjust their prices in each period, while a fraction  $\varphi$  of firms cannot. If firms can adjust their prices in period  $t$ , they choose a new price,  $p_t^*$ , which maximizes the sum of expected profits, in such a way that the firm is maximized:

$$E_t \sum_{i=0}^{\infty} \varphi^i q_{t,t+i} \left[ \left(\frac{p_t^*}{P_{t+i}}\right)^{1-\theta} - \Psi_{t+i} \left(\frac{p_t^*}{P_{t+i}}\right)^{-\theta} \right] Y_{t+i}. \quad (23)$$

The actual profit stream for company  $j$  in period  $t$ ,  $\Pi_{jt} = (p_{jt}/P_t)^{1-\theta} Y_t - (W_t/P_t)N_{jt}$ , can be rewritten using (22).  $\Psi_t$  is the actual marginal cost, defined as:

$$\Psi_t = \frac{W_t}{ZP_t}. \quad (24)$$

When we maximize the firm's objective function, given by equation (23) and being subject to demand sequences (20), the most relevant condition to determine ideal price  $p_t^*$  can be written as:

$$\frac{p_t^*}{P_t} = \left(\frac{\theta}{\theta-1}\right) \frac{E_t \sum_{i=0}^{\infty} (\varphi\beta)^i (Y_{t+i} - G_{t+i})^{-\sigma} \left(\frac{P_{t+i}}{P_t}\right)^{\theta} \Psi_{t+i} Y_{t+i}}{E_t \sum_{i=0}^{\infty} (\varphi\beta)^i (Y_{t+i} - G_{t+i})^{-\sigma} \left(\frac{P_{t+i}}{P_t}\right)^{\theta-1} Y_{t+i}}. \quad (25)$$

Or even represented by:

$$\frac{p_t^*}{P_t} = \left( \frac{\theta}{\theta-1} \right) \frac{K_{1t}}{K_{2t}}, \quad (26)$$

where the numerator and denominator assume recursive representations, according to the following specifications:

$$K_{1t} = (Y_t - G_t)^{-\sigma} \Psi_t Y_t + \varphi \beta E_t K_{1t+1} \left( \frac{P_{t+1}}{P_t} \right)^\theta, \text{ and} \quad (27)$$

$$K_{2t} = (Y_t - G_t)^{-\sigma} Y_t + \varphi \beta E_t K_{2t+1} \left( \frac{P_{t+1}}{P_t} \right)^{\theta-1}. \quad (28)$$

Note that  $p_t^*$  does not depend on  $j$ , as all companies that optimize their prices at  $t$  choose the same price. This specification tries to capture the fact that a company chooses  $p_t^*$  before the actual realization of the currency's growth rate in  $t$ . In this sense,  $p_t^*$  influences the profits of company  $j$  while the company is not able to proceed with the new optimization. By solving equation (26) for  $p_t^*$  and replacing the result in the aggregate price index  $P_t^{1-\theta} = (1 - \varphi)(P_t^*)^{1-\theta} + \varphi (P_{t-1}^*)^{1-\theta}$ , we get:

$$\pi_t^{\theta-1} = \frac{1-\varphi}{\varphi} \left( \mu \frac{K_{1t}}{K_{2t}} \right)^{1-\theta}, \quad (29)$$

with  $\mu \equiv \theta / (\theta - 1)$  representing the desired markup, which is when a fraction  $\varphi$  of firms choose their price as a markup on the expected marginal cost. The aggregate supply of labor is obtained by the linear aggregation of individual labor as follows:

$$N_t = \int_0^1 N_{jt} dj, \quad (30)$$

The linear aggregation that the equilibrium condition of an individual market implies in  $ZN_t = \Delta_t Y_t$ , with  $\Delta_t$  as a measure to disperse relative prices, is:

$$\Delta_t = \int_0^1 \left( \frac{p_{jt}}{P_t} \right)^{-\theta} dj. \quad (31)$$

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Therefore, the aggregate production function is defined by:

$$Y_t = \frac{Z}{\Delta_t} N_t . \quad (32)$$

Aggregate profit ( $\Pi_t$ ) is defined as the sum of firms' individual profits:

$$\Pi_t = \int_0^1 \Pi_{jt} dj. \quad (33)$$

By integrating the profit of the firms and combining it with the budget restrictions of households and the government, we get the following resource restrictions:

$$\frac{Z}{\Delta_t} N_t = C_t + G_t, \quad (34)$$

From the definition of price dispersion and the aggregate price index, the dispersion of relative prices is represented as:

$$\Delta_t = (1 - \varphi) \left( \frac{p_t^*}{P_t} \right)^\theta + \varphi \pi_t^\theta \Delta_{t-1}, \quad (35)$$

with  $\pi_t = P_t/P_{t-1}$ .

#### 1.4.1.3 GOVERNMENT

In order to include the effects of fiscal policy in the analysis, we assume that the dynamics of government spending  $G_t$ , follows the process described below:

$$\log(G_t) = \log(\bar{G})(1 - \rho) + \rho \log(G_{t-1}) + \varepsilon_t, \quad (36)$$

where  $G_t$  is government spending,  $\bar{G}$  the steady state expenses,  $\rho$  the government spending correlation parameter and  $\varepsilon_t \sim$  i. i. d.  $(0, \sigma^2)$ .

Thus, the government's ideal alternative  $\{G_t, M_t, B_t, \tau_t\}$  should satisfy the flow of its budgetary profile.

$$G_t = \tau_t + \frac{M_{t+i} - M_{t+i-1}}{P_t} + \frac{B_t}{P_t} - \frac{(1-r_{t-1})B_{t-1}}{P_t}, \quad (37)$$

given  $(1 - r_{t-1})B_{t-1}$  and  $M_{-1} > 0$ .

Finally, debt level value, at steady state and conditioned to the regimes, is fixed to remain the same across different regimes. As Davig and Leeper (2011) point out, this is done by replacing fiscal policy rule (3) in the government budget constraint equation (37), setting the deterministic value of the output (output gap) in a steady state to one. Resolving the equation for the interception of the fiscal policy rule, we have:

$$\gamma_0(S_t^F) = G - m \left( \frac{\pi}{(1+\pi)} \right) - b \left( 1 + \gamma_b(S_t^F) - \frac{\beta^{-1}}{(1+\pi)} \right) \quad (38)$$

where  $S_t^F$  indicates the fiscal policy regime,  $m = \frac{M_t}{P_t}$  and  $b = \frac{B_t}{P_t}$ . Still, except for  $\gamma_0(S_t^F)$  and  $\gamma_b(S_t^F)$ , each variable is in their steady state value.

This same procedure is applied by replacing the monetary policy rule in the currency demand equation. Like debt, steady state inflation rate is adjusted to be the same across regimes.

#### 1.4.1.4 CALIBRATION AND CHARACTERISTICS OF THE MODEL SOLUTION

In this way, the complete model consists of the primary conditions that are necessary for optimization problems of households and firms, restrictions, policy specifications, price adjustment process, and transversality condition.

As a means to calibrate the model, we considered the parameters shown in Table 5. In addition to the references that were cited and the estimated parameters for fiscal and monetary policy rules according to subsection 1.3, values for public debt and the government's steady state expenses were obtained from the average of the series smoothed by an HP filter. We calculated the order 1 autocorrelation coefficient to use it as a correlation parameter for government spending. The steady state inflation rate applied was 4.5%, equal to the reference value in the inflation target system.

After calibrating DSGE, we used a numerical routine developed by Davig and Leeper (2006) to obtain the dynamic balance of the model by solving a system of first-order dynamic

non-linear difference equations. This routine uses a monotonic mapping method based on Coleman (1991).<sup>9</sup>

**Table 5:** Parameters used in the MS-DSGE model.

<i>Parameters</i>	<i>Description</i>	<i>Value</i>	<i>Source<sup>(1)</sup></i>
$\beta$	Intertemporal discount rate	0,985	VC (2010)
$\sigma$	Elasticity of intertemporal substitution in consumption	1,000	DL (2011)
$\eta$	Elasticity of labor supply in relation to wages	1,000	DL (2011)
$\kappa$	Interest elasticity of real money demand	2,300	BL (2014)
$\delta$	Money base velocity	6,060	BL (2014)
$\bar{\chi}$	Working time spent in steady state	0,200	DL (2011)
$\varphi$	Fraction of firms that cannot change prices	0,660	DL (2011)
$\mu$	Firms markup	1,150	DL (2011)
$\bar{G}$	Government spending / steady state GDP	0,168	E
$\bar{B}$	Public debt / steady state GDP	0,288	E
$\bar{\pi}$	Steady state inflation rate	0,045	IT
$\rho$	Government spending correlation parameter	0,850	E
<b><i>Monetary Policy Rule</i></b>			
$\alpha_{\pi 1}$	Inflation in regime 1	1,852	E
$\alpha_{\pi 2}$	Inflation in regime 2	0,881	E
$\alpha_{y 1}$	Output gap in regime 1	0,000	E
$\alpha_{y 2}$	Output gap in regime 2	-0,491	E
<b><i>Fiscal Policy Rule</i></b>			
$\gamma_{b 1}$	Debt in regime 1	0,019	E
$\gamma_{b 2}$	Debt in regime 2	0,068	E
$\gamma_{y 1}$	Output gap in regime 1	0,114	E
$\gamma_{y 2}$	Output gap in no regime 2	0,156	E

Source: Estimated data were obtained from BCB and STN. (1) Estimated = E; Davig and Leeper (2011) = DL (2011); Vereda and Cavalcanti (2010) = VC (2010); Barros and Lima (2014) = BL (2014); Inflation target = IT.

#### 1.4.2 IMPULSE RESPONSE FUNCTIONS

As previously mentioned, one of the goals of this essay is to understand the impact of fiscal stimulus through government spending on the economy, on each of the different regimes for

<sup>9</sup> The model is solved in its nonlinear form. The procedure is developed and described in Davig and Leeper (2006).

monetary and fiscal policies. Thus, after calibrating the DSGE model, we performed impulse response simulations.

As defined in Davig and Leeper (2006), for a shock on policies at time  $t$ , the initial response of endogenous variable  $k$  is:

$$\phi_t^k(\varepsilon_t^r, \varepsilon_t^\tau) = h^k(\overline{b^J}, \overline{w^J}, \overline{\Delta^J}, \varepsilon_t^r, \varepsilon_t^\tau, J) - h^k(\overline{b^J}, \overline{w^J}, \overline{\Delta^J}, 0, 0, J), \quad (36)$$

where  $h^k$  is the decision rule for endogenous variable  $k$  as a function of state variables  $\{b, w, \Delta\}$ , for regime  $J$  and the realizations of policy disturbances,  $\varepsilon_t^r$  e  $\varepsilon_t^\tau$ . In turn,  $\{\overline{b^J}, \overline{w^J}, \overline{\Delta^J}\}$  represents the average of the vector of state variables, in regime  $J$ . After an initial shock, the impact of policies disappears, and the value of variable  $k$  in period  $n > t$  is given by:

$$\phi_n^k(\varepsilon_t^r, \varepsilon_t^\tau) = h^k(b_{n-1}, w_{n-1}, \Delta_{n-1}, 0, 0, J) - h^k(\overline{b^J}, \overline{w^J}, \overline{\Delta^J}, 0, 0, J), \quad (37)$$

where  $\phi_n^k$  is a function of the initial shocks.

### 1.4.3 FISCAL MULTIPLIERS

Without wishing to step into the long discussion in the literature on this subject, in general, the traditional Keynesian approach admits that in view of the increase in government spending, household consumption increases due to a multiplier effect. On the other hand, if the economy observes the principle of Ricardian equivalence, then households would prefer to reduce their consumption, and an increase in government spending financed by public bonds, *ceteris paribus*, would induce households to decrease their present consumption with the expectation of an increased tax burden in a future period.

Looking at the work of Mankiw (2000), both effects could be valid. However, those effects would depend on the proportion of consumers in the economy, split into Ricardians and non-Ricardians<sup>10</sup>. Ricardian consumers optimize their maximization problems as postulated by the Ricardian equivalence principle, while other consumers would behave differently.

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<sup>10</sup> According to Afonso (2010), studies on this theme point out that in the European Union, the proportion of non-Ricardian families varies from 25% to 35%.

Nevertheless, economic policy decisions are expected to affect agents' expectations and, thus, influencing the trajectory of macroeconomic variables in relation to a steady state.

Within the methodology adopted in this essay, the effects of multipliers were calculated considering the different parameters estimated for the government's reaction functions. Under a regime of monetary dominance (AM/PF), the real interest rate rises in the face of an increase in the general price level, since the monetary authority raises the nominal interest rate above the increase in inflation. Therefore, private consumption decreases. Since fiscal policy is passive, the value of government spending tends to be steady, as do real interest rates and consumption. In a regime of fiscal dominance (PM/AF), household consumption increases. The monetary authority would just mildly react to raise nominal interest rates, due to an increase in the general price level. In this scenario, real interest rates decrease, thus, discouraging household savings.

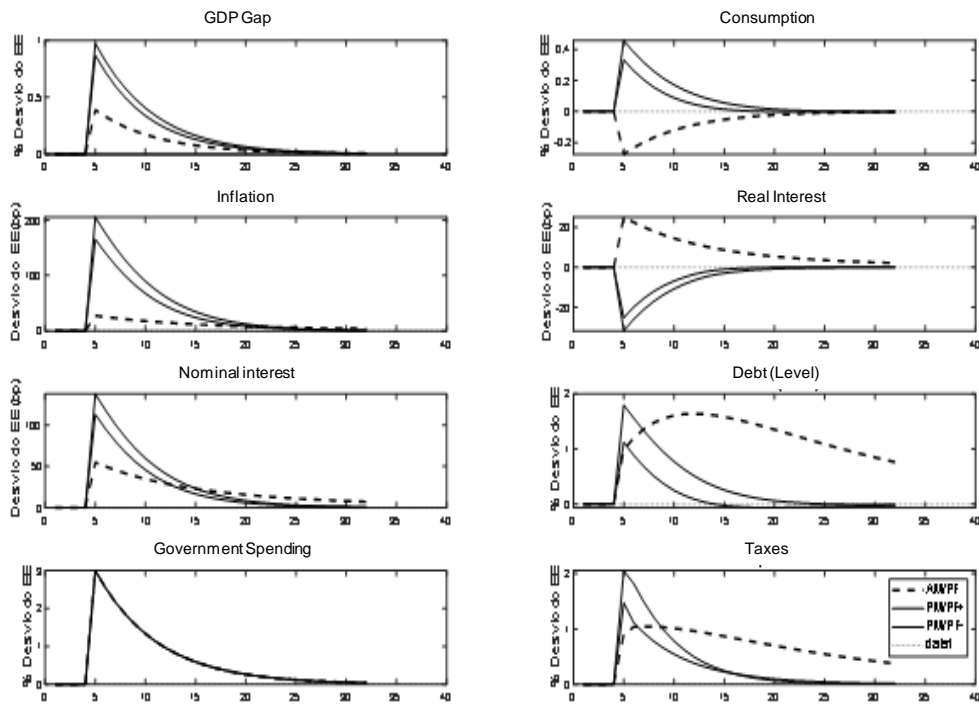
The government spending multiplier can be defined as an increase in output,  $k$  periods ahead of what was generated in period  $t$ , that is,  $\frac{\Delta Y_{t+k}}{G_t}$ , according to Blanchard and Perotti (2002). However, as pointed out by Mountford and Uhlig (2009) and followed by Davig and Leeper (2011), this definition fails to consider a couple of important issues. Firstly, the traditional definition may be biased, as it disregards the serial correlation of government spending and, consequently, the future impact of this public spending. If government spending is serially correlated, then changes in government spending may provide some indication of the future trajectory of government spending. Secondly, this definition has no intertemporal discount factor. In other words, an increase in output in the future would have the same importance and the same impact as if the increase in output generated by an increase in government spending occurred today. Thus, equation 38 presents the definition used in Davig and Leeper (2011) for calculating the present value of the government spending multiplier, that is, the increase in the present value of the output over the next  $k$  periods:

$$Present\ value\ of\ multiplier(k) = \frac{E_t \sum_{j=0}^{\infty} \prod_{i=0}^j (1+r_{t+i})^{-j} \Delta Y_{t+k}}{E_t \sum_{j=0}^{\infty} \prod_{i=0}^j (1+r_{t+i})^{-j} \Delta G_t}. \quad (38)$$

#### 1.4.4 ANALYSIS OF THE RESULTS OF THE MS-DSGE MODEL

**Figure 5:** Response to a government spending shock of 2 standard deviations (3%).





Source: Elaborated by the authors based on estimations results.

However, the monetary and fiscal policy regime plays a critical role in this approach by assuming different positions for the monetary and fiscal authorities, which will ultimately affect the determination of real interest rate, consumption, and inflation trajectories. These differences are illustrated in Figure 5, as a result of impulse response simulations of a shock of two standard deviations in government purchases, an approximate increase of 3% in the level of spending, which is conditional on each of the three stationary regimes.

Under an active monetary and passive fiscal policy (AM/PF+), the monetary authority responds aggressively to the rise in inflation, increasing the nominal interest rate by more than one by one (dashed lines) relative to the price level. As Figure 4 indicates, the monetary response persistently increases the real interest rate and decreases household consumption. As the spending shock dissipates, the real interest rate falls and consumption returns to a steady or equilibrium state. As inflation remains relatively moderate, seigniorage revenues play a small role in controlling debt dynamics, as shown in Figure 5. Fiscal policy reacts passively, increasing taxes and, consequently, raising the primary surplus, as the government issues debt bonds to fund the rising government spending. Nevertheless, revenues do not respond

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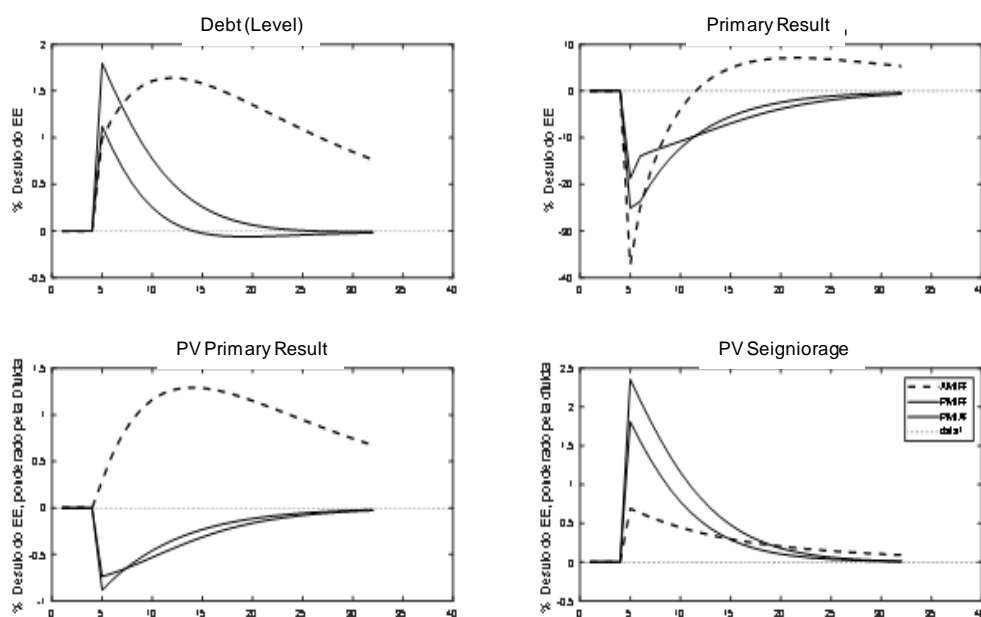
sufficiently to result in a monotonically declining debt, so, debt peaks in approximately 12 periods after the initial shock.

In turn, for policy interactions in which monetary policy is passive (PM/PF+ and PM/PF-) (solid lines), the increase in government purchases puts pressure on current and future demands, increasing inflation expectations. In this policy context, the monetary authority responds weakly to the increase in inflation, in a ratio that is less than one to one, causing a drop in the real interest rate. The trajectory of a lower real interest rate decreases the return on bonds, which stimulates present consumption of households in the intertemporal decision process. In this case, the increase in government purchases ends up expanding the output by more than one to one, expanding production above its potential level, with a consequent increase in the price level above the one seen in the AM/PF+ regime.

Looking to better understand the dynamics of debt, it is worth resorting to the condition of intertemporal debt equilibrium, which indicates that the present value of primary surpluses and seigniorage must be equal to the real value of government debt, stressing that this condition must be valid for any of the policy interactions. Thus, keeping everything constant apart from government spending, the equilibrium condition (1) implies that an increase in spending, financed by a new debt issue, reduces the present value of primary surpluses and creates an imbalance between the initial value of liabilities and the value that is expected from government revenue sources, that is, the variables on the right side of the equilibrium condition.

In order to restore equilibrium, several adjustments can occur. Firstly, the present value of taxes can increase exactly by the amount that the government spending has increased, which is the adjustment that occurs under a Ricardian regime. Secondly, the present value of seigniorage revenue can increase. Thirdly, the current price level may rise, thus, reassessing existing liabilities. In the regime change scenario, all these adjustments occur and the relative importance of each adjustment to regain the equilibrium condition (1) depends on the joint interaction process of monetary and fiscal policies.

Figure 6 decomposes debt dynamics into changes in the present value of primary surpluses and seigniorage, again conditioned by the monetary-fiscal regime. The upper left panel reports the debt paths under different regimes and the lower two panels report the responses to the present value of primary surpluses and seigniorage. The trajectories for primary surpluses and seigniorage are given in terms of percentage changes, which are then weighted by their share of the debt.

**Figure 6:** Response of fiscal variables to a shock in government spending of 2 standard deviations (3%).


Source: Elaborated by the authors based on estimations results.

Considering the AM/PF+ regime, the increase in debt is supported by an increase in primary surpluses and seigniorage (dashed lines). The increase in government spending puts negative pressure on the trajectory of primary surpluses, but the present value of primary surpluses increases because the passive fiscal policy raises taxes above the initial equilibrium level. Given that in this regime (AM/PF+) there is a characteristic strong reaction from the monetary authority, the real interest rate increases and therefore, a significant and persistent increase in taxes becomes necessary to increase the present value of the surplus trajectory.

In turn, in a passive monetary policy context (PM/PF+ and PM/PF-), a fiscal shock expands public debt to a greater extent than in the AM/PF+ regime since, in a monetary dominance regime, the fiscal authority will adjust the trajectory of primary surpluses to face debt sustainability. In both cases, the debt's return to a point of equilibrium is faster in the context of a passive monetary policy, as it allows inflation leaps that quickly stabilize debt, reducing its real value. Comparing the PM/PF+ and PM/PF- regimes against each other, the greater output response under passive monetary policy also positively impacts government tax revenues, since the fiscal policy rule responds positively to the output gap. Under the PM/PF+ regime, the tax response to the gap is greater than in PM/PF-, so that taxes see a larger relative

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increase, which in turn provides the scenario for a faster debt reduction than the one simulated in the PM/PF- regime.

The values of government spending multipliers on product and consumption, conditioned to the regimes of fiscal and monetary interactions, are presented in Table 6. The results reinforce the findings illustrated in the impulse-response functions. It appears that, in a regime where monetary policy is passive and fiscal policy is less passive (PM/PF-), the multiplier is higher, trailed by the PM/PF+ regime. In general, it is observed that for these regimes, the multiplier is greater than one, which implies that the consumption multiplier in these regimes is positive, unlike in a monetary dominance regime.

**Table 6:** Present value of Government spending multipliers (shock of 2 standard deviations).

<i>Regimes</i>	<i>5 Quarters</i>	<i>10 Quarters</i>	<i>25 Quarters</i>
<i>Multipliers on Output</i>			
AM/PF+	0.641	0.642	0.647
PM/PF+	1.38	1.33	1.28
PM/PF-	1.58	1.54	1.50
<i>Multipliers on Consumption</i>			
AM/PF	-0.359	-0.358	-0.353
PM/PF+	0.383	0.331	0.277
PM/PF-	0.577	0.545	0.497

Source: Elaborated by the authors based on estimations results.

Hence, considering the PM/PF- regime, a one-unit increase in government spending increases the output by 1.5 after 25 quarters, which is equivalent to a 0.50 multiplier in consumption. In turn, under the PM/PF+ regime, the increase in government spending increases the output by 1.28, generating a consumption multiplier equal to 0.28. Finally, in the AM/PF+ regime, the increase of one unit in long-term spending has a 0.65 multiplier effect on output, thus having a negative impact on private consumption by -0.35.

Regarding the impact on the general price level, Table 7 presents a direct relationship between multiplier and prices. In this sense, the PM/PF- regime is the one with the greatest increase in prices, while in the AM/PF+ regime, this increase is smaller, given the contractionary behavior of the monetary authority.

**Table 7:** Accumulated price change (%).

<i>Regimes</i>	<i>5 Quarters</i>	<i>10 Quarters</i>	<i>25 Quarters</i>
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AM/PF+	0.29171	0.48306	0.76851
PM/PF+	1.5229	2.1176	2.4276
PM/PF-	1.9316	2.7445	3.1964

Source: Elaborated by the authors based on estimations results.

#### 4.5 CONCLUSIONS

From the discussion on the estimation results of the monetary and fiscal policy rules, it seems to us that the estimated model fits the macroeconomic facts that have occurred since the implementation of the inflation targeting system in Brazil in 1999.

Since 2000, it has been found that the Brazilian economy has continuously changed under eight different regimes, namely: i) AM/PF+ (2000:Q1-2002:Q3); ii) PM/PF- (2002:Q4-2003:Q3); iii) AM/PF- (2003:Q4-2005:Q2); iv) AM/PF+ (2005:Q3-2007:Q4); v) PM/PF+ (2008:Q1-2014:Q3); vi) PM/PF- (2014:Q4-2016:Q4); vii) AM/PF- (2017:Q1-2017:Q4); and viii) PM/PF- (2018:T1-2019:T4). In this sense, the position of Davig and Leeper (2006) that perhaps the least plausible assumption is to assume that the political regime is fixed, seems to us to be very reasonable. In our opinion, the alternation of regimes is part of the evolution of the game. As Davig, Leeper and Chung (2004) show, that characteristic has a unique limited equilibrium in which fiscal theory is always in operation.

From a monetary policy standpoint, the 2002-2003 government transition crisis stands out, during which the estimated probability of the monetary policy being passive was close to 100%, in a context of a vicious circle of interest, exchange rates, risk, and inflation, as observed by Blanchard (2004). In that context, the continued adoption of a regime that approached fiscal dominance, which we have classified as PM/PF- since 2003, or even PM/PF+, could have dangerously counterproductive results. Observing the impulse-response functions and the multipliers presented here, the maintenance of the PM/PF- regime could aggravate the process of an escalating inflation. The adoption of an active monetary policy agenda from 2003 onwards, while fiscal controls aimed at debt sustainability were put in place, provided the conditions for a switch to the monetary dominance regime, generating reflexes on the control of inflation. It is also worth remembering that, at that moment, as observed in the first essay, the period of rising commodity prices began.

From a fiscal policy standpoint, the prevalence of the passive regime is evident, although on gradations that bordered on an active policy as already mentioned. However,

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comparing the evolution of the government's debt (DLGC), as shown in Figure 1, with the probability curve of the fiscal policy regimes, according to Figure 3, we see that the period classified as PF+ coincides with the long declining period of DLGC, between 2005 and 2014. Nonetheless, from 2014 onwards, a period with large debt growth, it overlaps with the period in which fiscal policy became less passive (PF-).

When the 2008 financial crisis hit Brazil, a turning point in monetary policy appears, in which authorities were imbued with a feeling of properly facing the crisis that was mounting at the time. Expansionary measures aiming at the economy's liquidity configured a passive monetary policy (PM). However, despite the atypical year of 2009, economic policy actions implemented in Brazil were successful, which reflected in a 7.5% GDP growth rate in 2010. Therefore, under the sensitivity of fiscal management, revenue continued growing at an increasing pace and there was a continued drop in the debt indicator, which characterized the PF+ regime until 2014:Q3.

Although we have established that the turning point on fiscal policy happened in 2014:Q3, it is important to note that many of the fiscal measures were conceived with the intention of avoiding impact on net debt and, thereby, our estimates disregard this when working with the DLGC indicator. Combined with some atypical revenue growth measures, it could be likely that this turning point occurred a little earlier.

In any case, in 2011, government revenues entered a new downward trend, despite a wide range of programs aimed at stimulating the economy, especially in civil construction, with PAC, PSI and MCMV. Considering the PM/PF+ regime and the multipliers estimated in this essay, which consider all government spending as consumption and, therefore, tend to be underestimated by not separating the effects of investment on firms' productivity, we expected that an increase in government spending would have a multiplier effect on output and a positive effect on consumption; although with some negative impact on inflation. Interestingly, the effects on output have not been confirmed, while the effects on inflation have been materialized and inflation has gradually started to rise.

Regarding the growth dynamics of the Brazilian economy, Catela, Almeida and Silveira (2019) assessed the impacts that international commodity prices had on investment, notably on GFCF in machinery and equipment in Brazil. In this article, the authors found a positive relationship between international commodity prices and private investment in machinery and equipment, accounting for approximately 56% of the variation in investment in

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machinery and equipment. Thus, the multipliers described here require a careful interpretation, since they assume a closed economy situation.

Brazil's fiscal policy change in 2014:Q3 and the debate on fiscal dominance became more intense as the inflation was climbing again. Eventually, this has made pressure for the change in monetary policy in 2016:Q4. The more austere monetary policy that was adopted, reinstating a regime of monetary dominance, managed to put inflation back within the target.

Finally, as it can be seen in Figure 2, our model points to a new monetary policy switch starting in 2018, which coincides with a cycle of interest rate downfall that is unprecedented in the historical series, with a significant breakdown in real interest rates. At this moment, a question arises regarding the most recent developments of the current Brazilian crisis. Are we moving closer towards a fiscal dominance regime? Once again, it seems that the external context will define the evolution of the economy in Brazil.

Given the initial objective of the present essay, we can affirm that the dynamics of interactions between monetary and fiscal policies played a role in the macroeconomic imbalances that occurred in the entire period. There was an upward trend in inflation, especially for those periods in which the PM/PF- regime was in place, approaching a fiscal dominance regime. However, the switch to a monetary dominance posture managed to put inflation back under control. Thus, from a monetary and fiscal policy coordination standpoint, there seems to be no reason for such a great downfall in investment and economic growth. A more credible take is to credit external factors and the characteristics of the Brazilian productive sector for the recent crisis, as they strongly influenced the dynamics of Brazilian economy.

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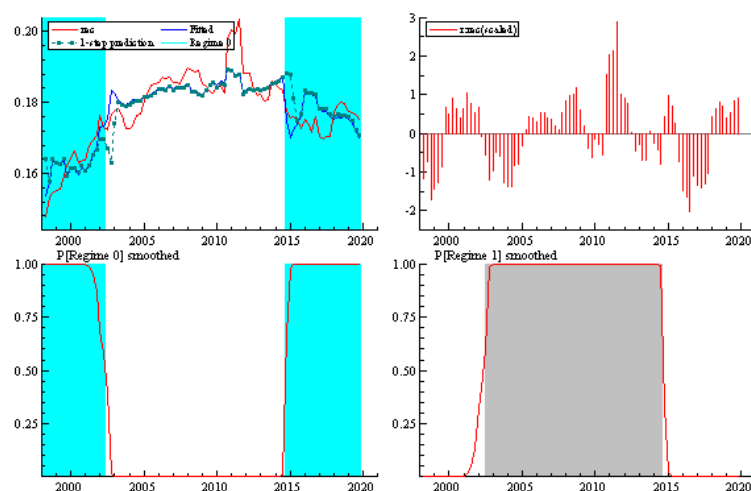
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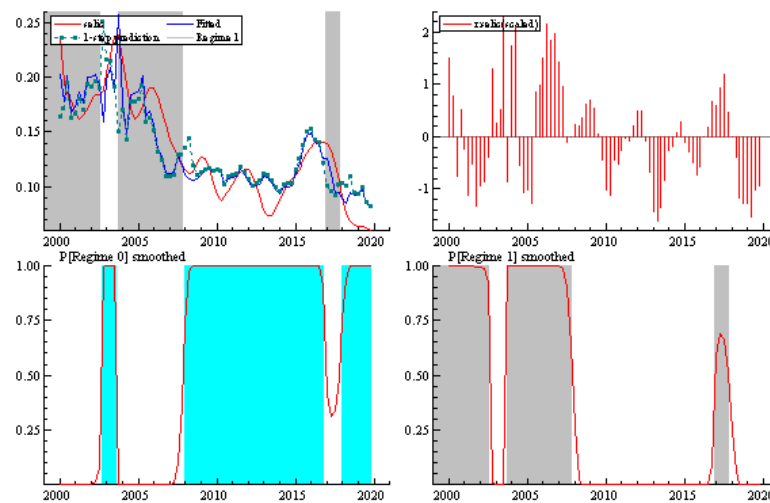
## APPENDIX

**Figure A.1:** Adjustment of the model for fiscal rule.



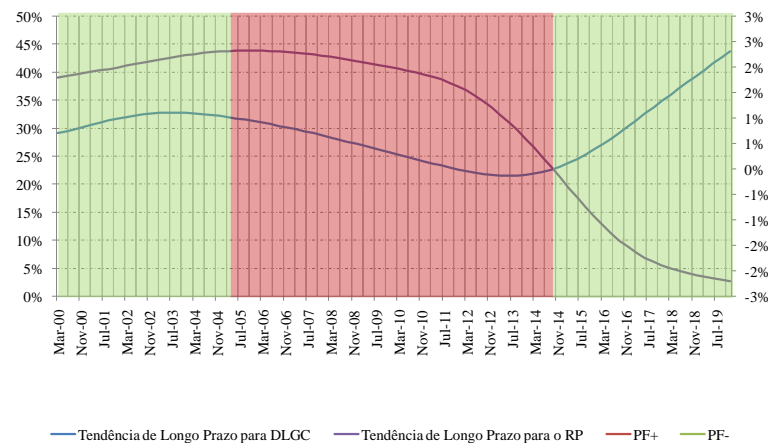
Source: Elaborated by the authors based on estimations results.

**Figure A.2:** Adjustment of the model for monetary rule.



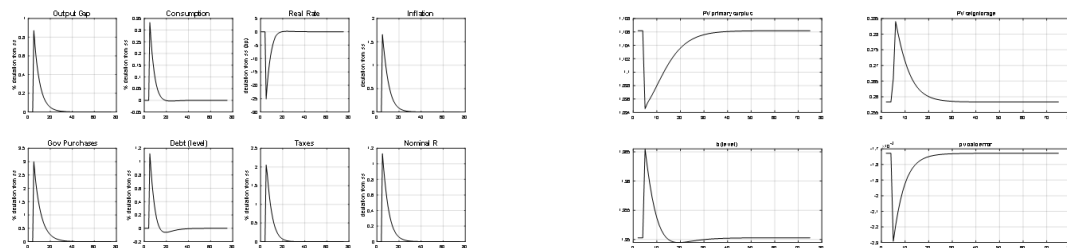
Source: Elaborated by the authors based on estimations results.

**Figure A.3:** Fiscal policy and DLGC regimes and primary outcome.



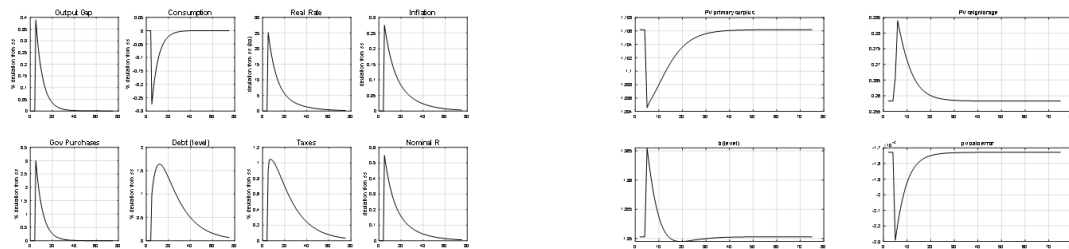
Source: Elaborated by the authors based on estimations results. Note: Long-term trends obtained through the HP filter.

**Figure A.4:** Impulse-response functions - AM/PF+ regime.



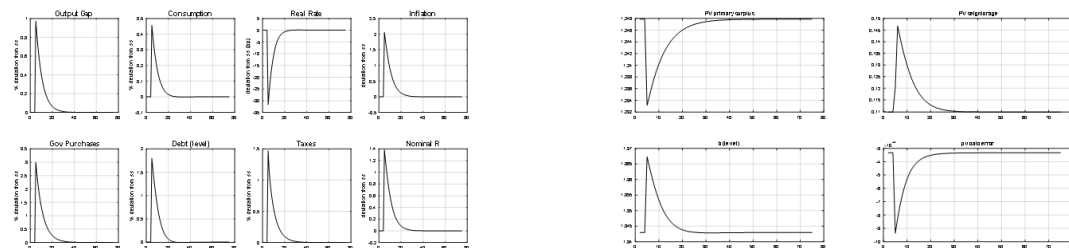
Source: Elaborated by the authors based on estimations results.

**Figure A.5:** Impulse-response functions - PM/PF+ regime.



Source: Elaborated by the authors based on estimations results.

**Figure A.6:** Impulse-response functions - PM/PF- regime.



Source: Elaborated by the authors based on estimations results.