TESOURONACIONAL

REVISTA
CADERNOS DE FINANÇAS PÚBLICAS

Edição Especial
Prêmio Tesouro Nacional 2022

XXVII PRÊMIO TESOURO
DE FINANÇAS PÚBLICAS 2022

Apoio:

BID
Banco Interamericano
de Desenvolvimento

Fiscal rules in different economic scenarios: An analysis of contractionary shocks on public accounts

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Abstract

This paper seeks to investigate the effect of the easing and introduction of escape mechanisms in public spending rules on fiscal variables. To this end, we used a Dynamic Stochastic General Equilibrium (DSGE) model with elements of an open economy, adjusted to reproduce the main characteristics of the Brazilian economy. The results show the ability of spending rules - of whatever type - to stabilize the level of public spending and smooth the growth of public debt in adverse periods, when compared to the model without any rules. In addition, the results indicate that the introduction of escape mechanisms is able to promote flexibility of fiscal rules in relation to the economic cycle without compromising the fiscal framework in terms of debt stabilization. Finally, simulations suggest superiority of debt rules over the alternative proposed in Constitutional Amendment No. 95/2016.

Keywords: Tax rules. DSGE. Uncertainty. Public Finance.

JEL: C02, C63, E62, H61

SUMÁRIO

1. Introduction

Since the 1990s, an increasing number of countries have adopted fiscal rules to stabilize debt, increase the credibility of fiscal policy, and increase the predictability of economic outcomes. In the 1980s the use of fiscal rules was limited almost exclusively to advanced economies, but since then emerging and low-income countries have become increasingly interested in using them. As pointed out by Davoodi et al. (2022), at the end of 2021 about 105 economies had at least one fiscal rule, with 66.34% of these countries represented by emerging economies, indicating an increase of 11 countries compared to 2015 and 96 countries compared to 1985 data.

Cangiano, Curristine, and Lazare (2013) define a fiscal rule as a durable constraint on fiscal policy given through numerical limits on budget aggregates. Numerical bounds on a given budget aggregate set limits on fiscal policy that cannot be changed frequently and provide operational guidance. For Kumar and Baldacci (2010) the elements that best express a fiscal rule are: numerical target for a long period of time with the goal of guiding fiscal policy; specify a summary operational fiscal indicator to which it applies; be simple so that it can be readily operationalized, communicated to the public, and monitored.

In 2016, Brazil started to adopt a new fiscal rule, defined based on Constitutional Amendment No. 95/2016 (EC 95), which imposed that public spending can only grow at the equivalent of the previous year's inflation rate. In this sense, we began to know the trajectory of public spending and economic agents began to condition their future prospects to this scenario, knowing that there is less expectation of an increase in the tax burden in the future to finance the lack of fiscal control in the present.

The adoption of a fiscal rule in Brazil has motivated the development of some studies focused on the analysis of the economic and social impacts of fiscal austerity policies. Works such as Benegas and Marinho (2017), Santos (2017), Saraiva et al. (2017), Cavalcanti et al. (2018a), Jesus, Besarria and Maia (2020a) and Nobrega, Besarria and Aragón (2022) have sought to address - for Brazil - the economic impacts of fiscal policy constraints through dynamic stochastic general equilibrium (DSGE) models.

Despite the advances noted in this literature and the advantages of adopting fiscal rules, there is still room for discussing improvements in these instruments. The Covid-19 pandemic, for example, has caused many countries to deviate from the established limits or to suspend rules to fund emergency measures (We discuss this in more detail in section 2, Table 3). This is a discussion that is likely to be at the center of the public finance debate in Brazil in the year 2023.

Among the fiscal results that can be credited to the adoption of EC 95 are: reduction in aggregate spending, readjustment of the headings as a result of the increase in pension spending and, as described by Giambiagi and Pires (2022), once the extraordinary sources of spending linked to the fight

against Covid disappear in 2020 and due to the recent strong inflation, in the 6 years between the base of 2016 - the year of the adoption of the ceiling - and 2022, the total expenditure will have suffered a significant cumulative real reduction of 4%, which means that, strictly speaking, in real terms, it is as if the ceiling had been "lowered" because of the difference in trajectory between the GDP deflator and the IPCA, even considering the change of indexing factor that occurred in the PEC approved in 2021.

On the other hand, the Brazilian fiscal rule does not capture drastic changes in the economic cycle which makes it "inflexible" and reduces the usability of fiscal policy as a countercyclical instrument, which has generated some criticism of the current fiscal framework in the face of periods of economic turbulence as it was during the height of the pandemic. In this sense, something that can be evaluated is the fiscal rule described by Wesselbaum (2019) for the United States (US) economy. The idea is to present a discussion on possible proposals for improvements to Brazilian fiscal rule, specifically for:

> *§ 1 Each of the limits referred to in the caption of this article will be equivalent II - for subsequent fiscal years, the value of the limit referring to the immediately preceding fiscal year, corrected by the variation of the Broad National Consumer Price Index - IPCA, published by the Brazilian Institute of Geography and Statistics, or another index that comes to replace it, for the twelve-month period ended in June of the previous fiscal year to which the budget law refers. BRAZIL (2016).*

Wesselbaum's (2019) proposal is to analyze the effects of uncertainty shocks on U.S. government spending by checking the differences arising in modeling fiscal policy with and without fiscal rules. The rule developed by the author indicates that government spending should vary according to changes in GDP and public debt. Besides the proposals to change the fiscal rule, it is also interesting to discuss the implementation of escape clauses or relaxation of the rule at atypical times. In this sense, it is interesting to learn about the experiences of countries that have already adopted this type of proposal and possible impacts on fiscal sustainability arising from their adoption.

From a practical point of view, it is possible to perform an empirical analysis from a DSGE model that considers characteristics of the Brazilian economy, being mainly based on the works of Woodford (2001), Schmitt-Grohé and Uribe (2003), Galí (2008), De Castro et al. (2015), Moura (2015), Krause and Moyen (2016) and Costa Junior, Cintado and Sampaio (2017). Thus, this paper contributes in a point of fundamental importance in public finance: investigating the responses of economic variables to contractionary shocks, having as a distinction between these the adoption of rules to contain government spending. In other words, is the adoption of a fiscal rule able to mitigate the negative effects of contractionary shocks on public debt?

To this end, we will consider four scenarios: without fiscal rule and with fiscal rules (public spending cap rule, debt rule and a hybrid rule). Thus, this study may generate positive effects through the investigation of the aforementioned agenda by providing a better understanding of the effects of

adopting rules to contain public spending in periods of macroeconomic uncertainty, an agenda of great relevance in the current situation of the Brazilian economy. Thus, this article is part of an attempt to formulate prospective studies to guide medium and long-term development strategies.

The results found showed that fiscal rules soften the effects of deterioration in public accounts in times of contractionary shocks. In addition, the hybrid rule, composed of the EC 95 and the rule proposed by Wesselbaum (2017), shows that in the first periods after the interest rate shock, there is a lower reaction of the fiscal variables compared to the other treated rules. Therefore, the implementation of the hybrid rule can generate higher fiscal gains than those generated by EC 95, especially in the short run. Moreover, this hybrid rule can provide a fiscal escape in periods of economic recession captured by the business cycle component.

In addition to the findings already described, we also performed the following analyses: sensitivity and economic volatility. All results favor the adoption of fiscal rules and show that they help stabilize the economy in the face of contractionary economic shocks.

In addition to this introduction, this paper consists of five more parts. Section 2 presents some general information regarding fiscal rules and introduces the main motivators of this study. Then, section 3 shows the DSGE model, and the tax rule specifications used. Section 4 presents and analyzes the main results of the model. Finally, section 5 concludes with final considerations. Additionally, some additional information is provided in Appendices A and B.

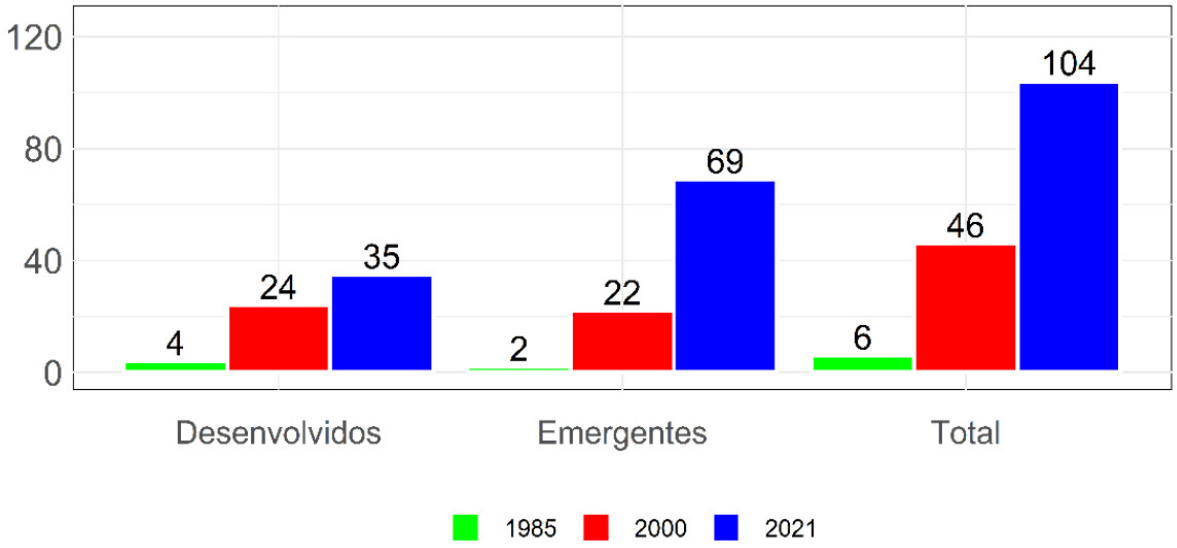
2. Motivation

Over the past thirty-six years, an increasing number of countries have incorporated numerical rules in the conduct of fiscal policy. According to Kotia and Lledó (2016), a fiscal rule can be defined as a durable constraint on fiscal policy through numerical limits on budget aggregates. In the words of Gbohoui and Paul (2020), such constraints are useful in dealing with deficit biases (which can lead to excessive debt levels) and pro-cyclical policies (exacerbating business cycles), ultimately helping to promote more prudent and stabilizing fiscal policies.

When we compare the evolution of the adoption of fiscal rules by Advanced and Emerging Economies it is possible to see that in 1985 only six economies in the world adopted fiscal restrictions (4 advanced and 2 emerging economies), increasing to 104 in 2021 (35 advanced and 69 emerging economies), representing a growth of 1633%. More details about this evolution can be seen in Figure 1.

In terms of type, these can be classified in four different ways: budget balance rules, debt rules, expenditure rules, and revenue rules, applicable to the central (or general) government or to the public sector. It is important to note that countries, over time, have adopted a combination of rules that are closely linked to debt sustainability. At the fiscal level, the main argument for the adoption of these fiscal targets is the concern with deficit bias.

Picture 1 - Number of countries with tax rules by country group

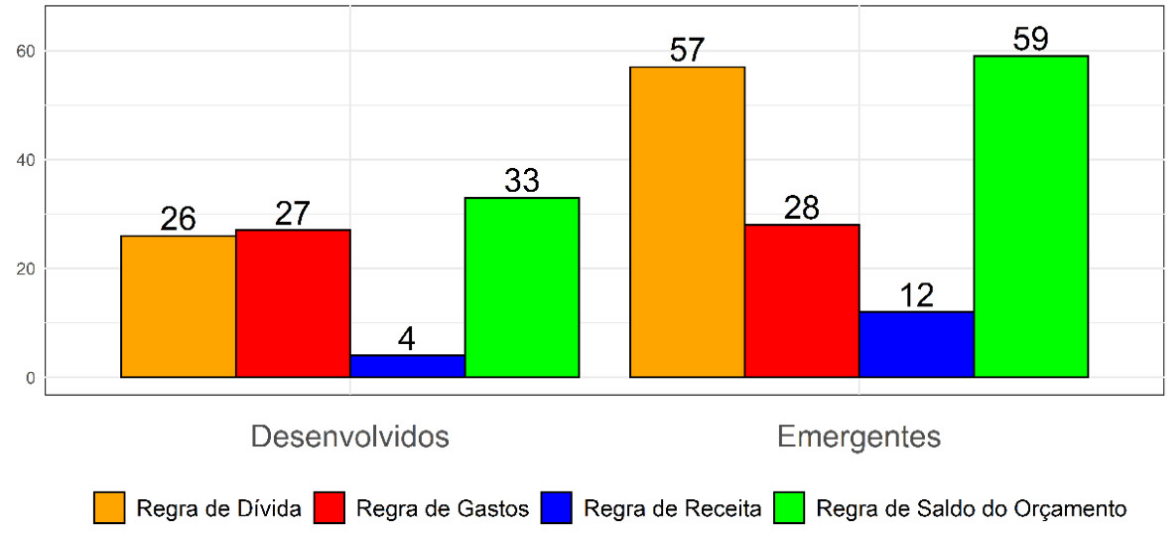


Developed – Emerging – Total

Source: IMF fiscal rules database.

In Figure 2 we can see that there is a significant proportion of countries that adopt balanced budget and debt targets in combination. Preconditions (2009) describes that this reflects governments' preferences for rules with a close link to fiscal sustainability.

Picture 2 - Number of countries with tax rules by type and country group, 2021



Developed – Emerging

Debt Rule – Spending Rule – Revenue Rule – Budget Balance Rule

Source: IMF fiscal rules database.

These four types of fiscal rules can be discerned based on the type of budget aggregate they seek to restrict and the main characteristics. Table 1 briefly details the positives and negatives associated with the use of the different rules.

In the specific case of Brazil, some instruments were adopted in order to make the macroeconomic environment less volatile and with greater stability of public spending, among these, we highlight the implementation of the inflation targeting regime, floating exchange rate regime and Fiscal Responsibility Law (LRF). However, as Jesus, Besarria, and Maia (2018) point out, after the Subprime crisis, the government began to adopt countercyclical policies to prevent a slowdown in economic activity, which had repercussions, above all, on Brazilian tax collection.

Table 1 - Main Characteristics of the Tax Rules

Rule Type	**Advantages**	**Disadvantages**
Debt Rule	- Direct link to debt sustainability - Easy to communicate and monitor	- Impact of fiscal policy on the debt/GDP ratio is not immediate - No economic stabilization features - The debt can be affected by variables that the government does not control
Budget Balance Rule	- Clear operational vision - Direct link to debt sustainability - Easy to communicate and monitor	- No economic stabilization features - The balance can be affected by variables that the government does not control - Not directly linked to debt sustainability
Expense Rule	- Clear operational vision - Enables economic stabilization - Reduces the size of government	- May lead to unwanted changes in the structure of spending
Revenue Rule	- Reduces the size of government - Can improve revenue management - Can avoid pro-cyclical spending	- Not directly linked to debt sustainability - No economic stabilization features

Source: Schaechter, Kinda, Budina, and Weber (2012a).

Among them we have the reduction of the tax on industrialized products of durable goods, a fact that culminated in the increase of government liabilities, and the institution in 2011 of Law No. 12,546, which determines the payroll exemption with the purpose of replacing the incidence of the employer's social security contribution on payroll by the incidence on sales. From 2014 on, successive primary deficits occurred, causing a worsening in public accounts.

For Jesus, Besarria, and Maia (2018), the combination of reduced economic activity, falling revenues, and rising expenses caused public debt indicators to grow rapidly, and it did not take long for debt sustainability to gain prominence in economic debates.

However, as of the third quarter of 2014, the level of primary surplus was always below the necessary level, causing an expansion in the share of debt, causing it to exceed 70% of GDP by the end

of 2015 and, soon after, we had the negative impacts caused by the Covid-19 pandemic, observed in 2020. This scenario of greater fiscal fragility, which began in 2014, led the government to implement, in 2016, the public spending cap rule, also known as Constitutional Amendment No. 95/2016 (EC 95).

Six years after the implementation of this rule it is possible to highlight some fiscal results derived from it, as can be seen in Table 2. This discussion is present in Giambiagi and Pires (2022) and in it the authors point out that after 2015, over 4 years, the public deficit shrank by about 1% of GDP each year until 2019, with most of this improvement resulting from a reduction in the weight of interest expenses.

In addition, Giambiagi and Pires (2022) emphasize that from 2016 to 2019 central government spending has declined as a proportion of GDP, but less than imagined at the time of the approval of the cap rule, a reflection of the low growth process of the economy and the delay in the approval of the pension reform.

Table 2 - Fiscal Outcome 2010/2020: "Actual Payment" Criterion (% GDP)

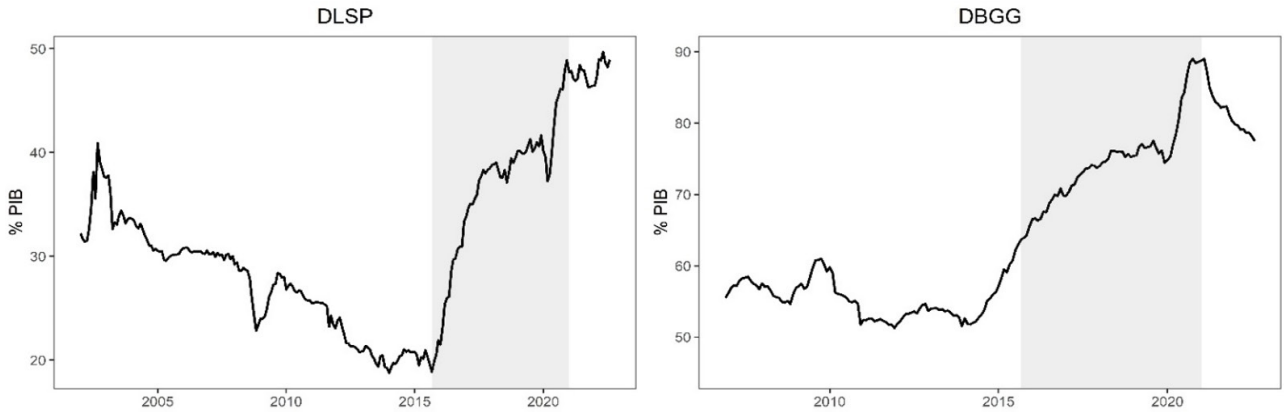
	2015	2016	2017	2018	2019	2020	2021	2022
Net revenue Federal Government	17,40	17,36	17,53	17,53	17,76	16,12	18,19	17,80
Expenditure Federal Government	19,42	19,93	19,42	19,30	19,05	26,08	18,59	18,11
Settings	0,07	0,03	0,09	0,11	0,09	-0,02	-0,01	0,00
Central Government	-1,95	-2,54	-1,80	-1,66	-1,20	-9,98	-0,41	-0,31
States and Municipalities	0,16	0,07	0,11	0,05	0,20	0,52	1,13	0,40
State-Owned Enterprises	-0,06	-0,02	0,01	0,07	0,16	0,05	0,03	0,00
Primary Total	-1,85	-2,49	-1,68	-1,54	-0,84	-9,41	0,75	0,09
Interest	8,37	6,49	6,09	5,41	4,97	4,18	5,17	7,50
NSFP	10,22	8,98	7,77	6,95	5,81	13,59	4,42	7,41

Sources: Giambiagi and Pires (2022)

When we observe the public sector net debt (DLSP) and general government gross debt (GGBG) series, we notice that both have an upward trajectory starting in 2015, derived in part from the consecutive primary deficits that began in 2014. The period that follows the implementation of the rule (hatched area) is not accompanied by an instantaneous change in debt dynamics, as already described. However, it is possible to see that a slight reduction occurs in 2019, suggesting a possible

trend reversal. The final period of the analysis, beginning in 2020, already contemplates the extraordinary spending phase linked to the Covid-19 pandemic, representing an atypical moment for public accounts.

Picture 3 - Recent evolution of the public sector net debt (DLSP) and general government gross debt (GGBG)

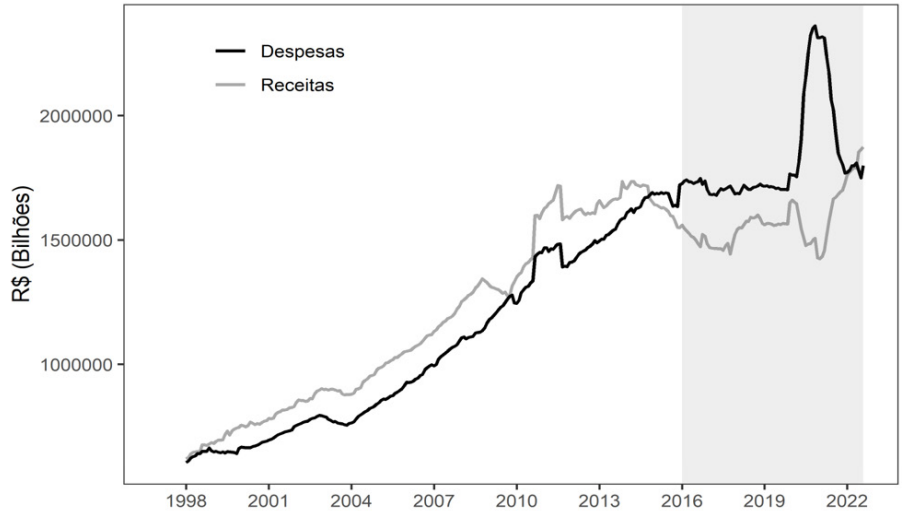


Source: Own elaboration.

Another way to observe the effect of the implementation of EC 95 in public accounts is to follow the evolution of government revenues and expenses before and after the implementation of the rule. In Figure 4 it is possible to see that government revenues and expenses had very similar behavior until the end of 2014, with revenues exceeding expenses in almost the entire period. However, as of November 2014, there were consecutive primary deficits, also associated with a reduction in economic activity and a drop in tax collection. This more unstable fiscal scenario contributed to the behavior of the debt series reported in Figure 3.

Something that becomes evident when observing Figure 4 is that the government expenditure series begins to have a more stable behavior from the year 2017. Even so, the fall in revenues causes the government to run a deficit, with the difference between revenues and expenses peaking in 2021, a time linked to the contractionary effects of the Covid-19 pandemic.

Picture 4 - Evolution of Government Revenue and Expenditure



Bilhões = Billions

Despesas = Expenditures

Receitas = Revenues

Source: Own elaboration.

Beyond Brazil, we have seen evolution in the discussion about the implementation of the rules and their effects on debt sustainability. The Covid-19 pandemic has brought new components to this debate, including possible escape clauses that may make the rules more flexible in atypical events or moments, particularly in an environment of weakened public finances and greater uncertainties associated with macroeconomic and fiscal development. In this sense, Preconditions (2009) and Schaechter, Kinda, Budina and Weber (2012b) argue that these clauses should:

1. take into account a very limited range of factors that allow such escape clauses to be triggered by legislation, promoting an unambiguous and stable link between the numerical target and the ultimate goal, such as public debt sustainability;
2. Bring clear guidance on the interpretation and determination of these events (including voting rules for the supervisory board);
3. Specification of the path back to the rule and the handling of accumulated deviations. This can be achieved by incorporating a mechanism that forces the correction of past deviations in a well-defined time frame, raising the cost of deviations, as well as an explicit enforcement procedure;

Preconditions (2009) adds that the fiscal target should have sufficient flexibility to respond to shocks so that the rule at least does not exacerbate their adverse macroeconomic impact. Depending on the country's circumstances, flexibility may be needed to deal with output, inflation, interest rate and exchange rate volatility, and other unforeseen shocks (e.g., natural disasters).

Table 3 - Fiscal Rules during Covid-19: Selected Country Examples

Steps	Dates
Brazil	Brazil in 2020 declared a public calamity that allowed it not to meet the primary fiscal deficit and other requirements of the fiscal responsibility legislation. It also amended its constitution to create a war budget (an additional 8.4% of GDP relaxation for COVID-19 related measures) from the regular budget and exempted the government from the ban on borrowing and financing current expenditures.
Colombia	The Social Investment was sanctioned in September 2021, which indicated the introduction of a medium-term debt anchor and the revision of the structural ceiling of the net primary balance. The ceiling varies according to the level of debt. In the short term, the government sets a transition path of deficits during 2022-25. At the same time, the fiscal council (Autonomous Fiscal Rules Committee) would have greater operational independence to oversee fiscal rules
India	India activated the escape clause in February 2020 and allowed a temporary deviation from the deficit of no more than 0.5% percentage point of GDP per year and raised the FY2019/20 and FY20/21 deficit to 0.5% percentage point of GDP above the previous estimate to 3.8 and 3.5% of GDP, respectively. With the significant economic consequences of the pandemic, the government suspended the fiscal rule until FY20/21 to provide fiscal support and announced that the FRBM Law will be amended to reflect the fiscal path revised by the authorities.
Poland	Poland has an escape clause that allows higher spending limits in case of war and national emergency and natural disasters. The epidemic was added to the clause in 2020, along with a change that the clause applies whenever projected real GDP growth is 2% below the 6-year historical average. This provided the scope to increase the deficit by up to 8% of GDP.
United Kingdom	The government activated the escape clause in March 2020. In October 2021, the government reinstated the fiscal rules as part of the post-pandemic fiscal framework. The rules require the government to target a balanced current budget by the third year of the rolling forecast period, a cap on net government investment of 3% of GDP on average over the rolling period, declining public sector net debt (excluding the Bank of England) by the third year of the five-year rolling forecast period, a cap on welfare spending, and innovation with a focus on the public sector balance sheet.

Source: Adapted from Davoodi et al. (2022)

However, it is essential to distinguish between temporary and persistent shocks. In this regard, Davoodi et al. (2022) point out that the Covid-19 pandemic caused many countries to activate escape clauses to temporarily suspend rule limits within the fiscal framework, allowing flexibility to adapt the extraordinary budget to households and firms. Other countries, without escape clauses, have had to resort to ad hoc suspensions or modifications of the rules or introduce new fiscal rules.

As can be seen, the proposals for improving the current fiscal rule of the Brazilian economy should take into consideration clauses that can be triggered at atypical times, always maintaining the idea of predictability and stability for economic agents.

3. Empirical strategy

The DSGE model developed in this paper seeks to incorporate the most striking characteristics of the Brazilian economy and is mainly based on the works of Woodford (2001), Schmitt-Grohé and Uribe (2003), Galí (2008), De Castro et al. (2015), Moura (2015), Krause and Moyen (2016) and Costa Junior, Cintado and Sampaio (2017). The New-Keynesian model describes an open economy in which there is habit formation in consumption, distortionary taxation, nominal rigidities, and monopolistic competition. Moreover, it is divided into four major blocks: households, firms, the external sector, and the government.

There are two types of households: Ricardian (optimizing) and non-Ricardian (restricted). The families in the first group provide labor, physical capital, consume and invest in government bonds; the families in the second group also provide labor and consume, however, they do not have access to the bond, financial and capital markets, and therefore consume all their income each period, and therefore do not present Ricardian behavior.

Production is divided into two categories: final goods (retailers) and intermediate goods (wholesalers). The firm producing final goods operates in a competitive market and transforms the goods produced by wholesalers into a homogeneous basket. On the other hand, the firms producing intermediate goods are inserted in a monopolistic competition market and employ capital and labor supplied by households, as well as domestic and foreign inputs in the production process of the intermediate good. Importantly, as in Moura (2015) and Costa Junior, Cintado, and Sampaio (2017), the production function of the domestic input uses not only private capital and labor, but also public capital representing the infrastructure conditions of the economy.

The economy exports domestically produced goods and imports inputs to be used in the production process of the intermediate good. Thus, the external sector is composed of foreign demand for domestic goods, balance of payments, risk premium, interest, and external inflation. The risk premium is inserted into the model to make it stationary, according to the technique proposed by Schmitt-Grohé and Uribe (2003). The central government is subdivided into two agents: fiscal and monetary authority. The fiscal authority is responsible for tax collection, income transfers and for issuing securities, which are used to finance public consumption and investment expenditures. Expenditure on public consumption and investment follow movement rules conditioned by the debt stock and the primary surplus. In turn, the monetary authority is responsible for controlling the dynamics of prices, following the inflation targeting regime.

3.1 Families

The present model contains two types of households indexed by j ∈ (0, 1), where one part ω_R does not have access to the bond market, being called non-Ricardian or rule-of-thumb due to the impossibility of intertemporal substitution between consumption and savings. On the other hand, the remaining portion (1 -) of households has access to the financial market. ω_R) of households has access to the financial market, government bonds and capital, and thus is able to intertemporally allocate consumption and savings, these households are called Ricardian. Both offer labor in a competitive market, so the wages received are identical and flexible.

3.1.1. Ricardian Families (R)

The Ricardian household chooses among consumption, savings, investment and leisure in order to intertemporally maximize its level of expected utility. In its saving decision, it can allocate among physical capital, foreign securities, and domestic government securities. Let R ∈ (0, 1 - ω_R) be the index of a Ricardian family, then its maximization problem can be described by:

$$E_t \sum_{t=0}^{\infty} \beta_t \left[\frac{\left(C_{R,t} - hC_{R,t-1}\right)^{1-\sigma}}{1-\sigma} - \frac{N_{R,t}^{1+\varphi}}{1+\varphi} \right] \tag{1}$$

The budget constraint can be expressed by:

$$\begin{aligned} (1+\tau^c)\left(C_{R,t} + I_{P,t}\right) + K_{P,t}\left[\psi_1(U_t - 1) + \frac{\psi_2}{2}(U_t - 1)^2\right] + \frac{B_t}{P_t} + S_t\frac{B_t^*}{P_t} \\ = (1-\tau^w)\frac{W_t}{P_t}N_{R,t} + (1-\tau^K)R_t^K U_t \frac{K_{P,t}}{P_t} + (1+R_{t-1})\frac{B_{t-1}}{P_t} \\ + S_t(1+\phi_{t-1}R_{t-1}^*)\frac{B_t^*}{P_t} + (1-\omega_1)TRG_t \end{aligned} \tag{2}$$

In addition, the maximization problem is also subject to the following law of motion of physical capital:

$$K_{P,t+1} = (1-\delta^K)K_{P,t} + I_{P,t}\left[1 - \frac{\chi}{2}\left(\frac{I_{P,t}}{I_{P,t-1}} - 1\right)^2\right] \tag{3}$$

where $C_{R,t}$ denotes consumption, $N_{R,t}$ is the hours of labor supplied, h is the parameter referring to habit formation in consumption, βt denotes the discount factor, φ is the inverse of the Frisch labor elasticity $K_{P,t}$ is the physical capital U_t is the utilization rate of capital $I_{P,t}$ is investment, B_t is government bonds, B_t^* are foreign bonds, S_t is the nominal exchange rate, ϕ_t is the country risk, W_t is the nominal wage, TRG_t are transfers, χ is a parameter related to the sensitivity of investment costs, δ^K is the depreciation rate; τ^K, τ^w e τ^c are the tax rates on capital, income and consumption, respectively.

The choice between consumption and savings is followed by the Euler equation for short-term securities, found from the first-order conditions of the Ricardian family problem:

$$1 = \beta_t E_t \left(\frac{\lambda^R_{1,t+1}}{\lambda^R_{1,t}} \frac{P_t}{P_{t+1}} \right) [1 + R_t] \tag{4}$$

The real exchange rate is defined as the price of the foreign consumer good, expressed in terms of the local currency, relative to the price of the domestic consumer good, according to:

$$E_t = \frac{S_t P^*_t}{P_t} \tag{5}$$

in which P_t^* denotes the price of the foreign commodity in terms of the international currency.

3.1.2. Non-Ricardian (NR) Families

The problem of the non- Ricardian household is simpler, since they do not have access to the financial market. The liquidity constraint makes it impossible for these households to maximize utility intertemporally, so the consumption of non- Ricardian agents must exhaust all their income each period. The problem for non- Ricardian households can be expressed by:

$$E_t \sum_{t=0}^{\infty} \beta_t \left[\frac{\left(C_{NR,t} - hC_{NR,t-1}\right)^{1-\sigma}}{1-\sigma} - \frac{N^{1+\varphi}_{NR,t}}{1+\varphi} \right] \tag{6}$$

conditioned to the following budget constraint:

$$(1 + \tau^c) C_{NR,t} = (1 - \tau^w) \frac{W_t}{P_t} N_{NR,t} + \omega_R TRG_t \tag{7}$$

where $C_{NR,t}$ is consumption and $N_{NR,t}$ are the hours of labor offered by agents in t.

3.2 Companies

3.2.1. Companies Producing Final Goods

The final goods production sector is composed of a continuum of retail firms, indexed by $j \in (0, 1)$, that purchase the intermediate good, $Y_{j,t}$ produced by the wholesale firms and transform them into a homogeneous good, Y_t which is sold at the price P_t, according to:

$$Y_t = \left[\int_0^1 Y_{j,t}^{\frac{\Psi-1}{\Psi}} dj \right]^{\frac{\Psi}{\Psi-1}} \tag{8}$$

where $\Psi > 1$ represents the elasticity of substitution among intermediate goods.

The representative retail firm maximizes its profit subject to the production function, given the price of the intermediate good and the final good, the result is the demand curve each retailer faces, which can be expressed by:

$$Y_{j,t} = \left(\frac{P_{j,t}}{P_t}\right)^{-\Psi} Y_t \tag{9}$$

the above expression implies that the demand for the j-th intermediate good is decreasing with respect to relative prices and increasing with respect to the output of the final good. Substituting Equation 9 into 8 gives the corresponding price index:

$$P_t = \left[\int_0^1 P_{j,t}^{1-\Psi}\, dj\right]^{\frac{1}{1-\Psi}} \tag{10}$$

Equation 10 is the pricing rule for final goods in the economy.

3.2.2 Intermediate Goods Producing Companies

3.2.2.1. First Stage: Household Input Production

The firm producing intermediate goods solves its problem in three stages: first, it chooses the optimal combination of labor and private capital to produce the domestic input ($Y_{j,t}^{D}$); subsequently, in order to determine the optimal level of production ($Y_{j,t}$), the firm chooses between domestic and imported inputs; finally, the firm determines the price of the product. In the first stage, the firm operates in perfect competition to produce the domestic input, using the following production technology:

$$Y_{j,t}^{D} = A_t\left(K_{P,j,t}\right)^{\alpha_1} N_{j,t}^{\alpha_2}\left(K_{G,j,t}\right)^{\alpha_3} \tag{11}$$

where α_1, α_2 e α_3 denote the proportions employed of private capital, labor and public capital in the production process of domestic inputs, respectively. The variable At captures the technological level of the economy, which is exogenously determined and evolves according to the following law of motion:

$$\log(A_t) = (1-\rho_A)\log(A_{ss}) + \rho_A \log(A_{t-1}) + \varepsilon_t^A \sigma_{a,t} \tag{12}$$

where ε_t^A is an i.i.d process $(0,\sigma^A)$ and ρ_A is the persistence of the technology shock and finally $\sigma_{a,t}$ denotes the uncertainty shock.

The uncertainty shock is modeled as a second moment (volatility) shock on total productivity in the economy according to a first-order AR(1) autoregressive process, as in Bloom (2009), Born and Pfeifer (2014), Basu and Bundick (2017), and Bloom et al. (2018):

$$\log(\sigma_{a,t}) = (1 - \rho_{\sigma_a}) \log(\sigma_a) + \rho_{\sigma_a} \log(\sigma_{a,t-1}) + \varepsilon_t^{\sigma_a} \quad (13)$$

where is $\varepsilon_t^{\sigma a}$ a white noise process iid $\sim (0,\sigma_a)$ and $\rho_{\sigma a}$ represents the persistence of the uncertainty shock.

The j-th firm producing the domestic input determines the optimal choice of production factors with the objective of minimizing its total production costs. The first-order conditions (OCCs) of this problem provide the optimal relationships:

$$W_t = P_{j,t}^D (1 - \alpha_2) \frac{Y_{j,t}^D}{N_{j,t}} \quad (14)$$

$$R_t^K = P_{j,t}^D \alpha_1 \frac{Y_{j,t}^D}{K_{j,t}} \quad (15)$$

where $P_{j,t}^D$ denotes the shadow price of the production function, i.e., it is equivalent to the marginal cost of the j-th firm, so marginal cost can be expressed by:

$$P_{j,t}^D = \left(\frac{1}{A_t K_{G,j,t}^{\alpha_3}}\right) \left(\frac{R_t^K}{\alpha_1}\right)^{\alpha} \left(\frac{W_t}{\alpha_2}\right)^{1-\alpha} \quad (16)$$

since the firm producing domestic inputs operates under perfect competition, the price of the input will be equal to the marginal cost of producing it.

3.2.2.2. Second Stage: Intermediate Goods Production

In the second stage of the production process, the firm operates under monopolistic competition and chooses between domestic ($Y_{j,t}^D$) and imported inputs ($M_{j,t}$) to produce the intermediate good (Yj,t), according to the following technological specification:

$$Y_{j,t} = \left[\omega_2^{\frac{1}{\xi}} \left(Y_{j,t}^D\right)^{\frac{\xi-1}{\xi}} + (1 - \omega_2)^{\frac{1}{\xi}} M_{j,t}^{\frac{\xi-1}{\xi}}\right]^{\frac{\xi}{\xi-1}} \quad (17)$$

where ω_2 denotes the proportion of the domestic input in the production process and ξ represents the elasticity of substitution between domestic and imported inputs.

The j-th intermediate good producing firm determines the optimal choice of inputs aiming to minimize its total production costs according to:

$$\min_{Y^D,M} P_{j,t}^D Y_{j,t}^D + M_{j,t} S_t P_t^* \tag{18}$$

conditioned to the production technology described in Equation 17. The first order conditions of the problem provide the optimal quantities of each input demanded by the monopolistic firm:

$$Y_{j,t}^D = \omega_2 \left(\frac{CM_{j,t}}{P_{j,t}^D} \right)^{\xi} Y_{j,t} \tag{19}$$

e

$$M_{j,t} = (1 - \omega_2) \left(\frac{CM_{j,t}}{S_t P_t^*} \right)^{\xi} Y_{j,t} \tag{20}$$

The marginal cost is proportionally determined by the use of the inputs in the production process, so it becomes a proportion of the prices prevailing at that time, according to:

$$\mathrm{CM_{j,t}} = \left[\omega_2 \left(P_{j,t}^D \right)^{1-\xi} + (1 - \omega_2) S_t (P_t^*)^{1-\xi} \right]^{\frac{1}{1-\xi}} \tag{21}$$

3.2.2.3. Third Stage: Pricing à la Calvo

In the present paper, the evolution of aggregate prices follows that proposed by Calvo (1983), in which each firm can readjust its prices with probability (1 - θ) in any period, while θ producers keep their prices unchanged[1]. Given the fraction θ of retailers that do not readjust their prices in t, the aggregate price evolves according to:

$$P_t = \left[\theta P_{t-1}^{1-\Psi} + (1 - \theta)(P_t^*)^{(1-\Psi)} \right]^{\frac{1}{(1-\Psi)}} \tag{22}$$

Note that in the limit case, when there is no price rigidity (θ = 0), the above condition results in price setting under flexible prices. Thus, one can interpret μ as the mark-up in the absence of frictions in the frequency of price adjustment.

3.3. External Sector

The external sector is represented by the foreign demand for domestic goods, the equilibrium condition governing the balance of payments, the risk premium, and the laws of motion of the interest rate and the external price level. Following what is proposed in Costa Junior, Cintado and Sampaio (2017), the demand for exports follows an autoregressive rule of motion that depends on a stabilization component on the real exchange rate and a stochastic process, according to:

1 In this context, the parameter θ can be interpreted as a price stickiness index and the average duration of price contracts is $(1-\theta)^{-1}$.

$$\frac{X_t}{X_{ss}} = \left(\frac{X_{t-1}}{X_{ss}}\right)^{\gamma_X} \left(\frac{E_{t-1}/P_{t-1}}{S_{ss}/P_{ss}}\right)^{(1-\gamma_X)} Z_t^X \quad (23)$$

where γ_X represents an autoregressive smoothing parameter and Z_t^X denotes an exogenous shock on the volume of exports, which follows the following specification:

$$\log(Z_t^X) = (1-\rho_X)\log(Z_{ss}^X) + \rho_X \log(Z_t^X) + \varepsilon_t^X \quad (24)$$

where ε_t^X is an i.i.d process $(0,\sigma^X)$ and ρ^X is the persistence of the shock in the level of exports.

The balance of payments (BOP) describes a country's trade relations with the rest of the world. It can be represented, in equilibrium, by the equivalence between the flow of imports and exports of goods, services, and capital. Thus, the balance of payments can be described by:

$$S_t(B_t^* - B_t^* \phi_t R_t^*) = \mathrm{NX_t} \quad (25)$$

where $NX_t = P_{t-1}{}^{*}S_tM_t - P_tX_t$ denotes net exports in nominal terms. Thus, the left-hand side of Equation 25 represents the net position in foreign assets, while the right-hand side denotes the nominal current account balance.

Based on De Castro et al. (2015) and Moura (2015), the risk premium (ϕ_t) is defined as a function of the difference in the balance of international reserves in Equation 25 and its steady state value:

$$\phi_t = \psi_3 \exp\left(\frac{S_t B_{t+1}^*}{P_t Y_t} - \frac{S_{ss} B_{ss}^*}{P_{ss} Y_{ss}}\right) Z_t^\phi \quad (26)$$

where Z_t^ϕ represents a first-order autoregressive shock to risk, according to:

$$Z_t^\phi = (1-\rho_\phi)\log(Z_{ss}^\phi) + \rho_\phi \log(Z_{t-1}^\phi) + \varepsilon_t^\phi \quad (27)$$

where ε_t^ϕ is an i.i.d. shock $(0,\sigma^\phi)$.

Finally, the dynamics of prices (P^*) and the international interest rate (R^*) are defined exogenously to the model, according to the following laws of motion:

$$\log(R_t^*) = (1-\rho_{R^*})\log(R_{ss}^*) + \rho_{R^*}\log(R_{t-1}^*) + \varepsilon_t^{R^*} \quad (28)$$

$$\log(P_t^*) = (1-\rho_{P^*})\log(P_{ss}^*) + \rho_{P^*}\log(P_{t-1}^*) + \varepsilon_t^{P^*} \quad (29)$$

where $\varepsilon_t^{R^*}$ e $\varepsilon_t^{P^*}$ follow stochastic processes with zero mean and variance equal to σ^{R^*} e σ^{P^*}, respectively.

3.4. Government

3.4.1. Fiscal Authority

The fiscal authority is responsible for tax collection, issuing government bonds, and for income transfers to households. The government's tax revenue comes from the collection of taxes on income (τ^w), capital income (τ^k) and on consumption and investment spending (τ^c). Thus, government tax revenue (TAX_t) can be expressed by:

$$\mathrm{TAX_t} = \tau^c\left(C_{R,t} + C_{NR,t}\right)P_t + \tau^W W_t\left(N_{R,t} + N_{NR,t}\right)P_t + \tau^K(R_t^K - \delta^K)K_t \quad (30)$$

The government's primary result, SP_t, denotes the effort, in terms of savings, made to maintain public debt at sustainable levels, and is denoted by the following equation:

$$SP_t = TAX_t - G_t \quad (31)$$

if $SP_t < 0$, the primary result will be in deficit. On the other hand, when $SP_t > 0$, it implies a primary surplus. It is important to note that the government's entire borrowing requirement is financed solely by issuing domestic securities. Thus, the government's budget constraint, expressed in real terms, can be represented as follows:

$$\frac{B_t}{P_t} + \frac{TAX_t}{P_t} = \frac{\mathrm{TS_t}}{P_t} + (1 + R_t)\frac{B_{t-1}}{\pi_t} + \frac{\mathrm{TRG_t}}{P_t} \quad (32)$$

where TS_t is government spending in period t.

Finally, as in Jesus, Besarria and Maia (2020b) and Cavalcanti et al. (2018b) public debt (T_t) is determined by the ratio between government revenues and expenditures as a proportion of GDP:

$$\frac{D_t}{Y_t} = \frac{R_{t-1}D_{t-1}}{Y_t} + \frac{SP_t}{Y_t} \quad (33)$$

where, coeteris paribus, an increase in spending implies an increase in debt. On the contrary, in the scenario in which the volume of primary revenues is greater than the level of expenditures, there is a reduction of public debt.

3.4.1.2. Public Spending and Fiscal Rules

The main instrument of fiscal policy is public spending, which can be converted into investment in order to promote public capital accumulation or intended to cover public consumption expenditures. In this context, the fiscal authority adopts the following principle to promote spending, which responds to movements in the public debt stock and the level of the primary surplus, according to:

$$\frac{I_t^G}{I_{ss}^G} = \left(\frac{I_t^G}{I_{ss}^G}\right)^{\gamma_G} \left[\left(\frac{B_t}{B_{ss}}\right)^{\gamma_D} \left(\frac{SP_t}{SP_{ss}}\right)^{\gamma_{SP}}\right]^{(1-\gamma_G)} Z_t^{I^G} \quad (34)$$

The consumption spending rule follows the following specification:

$$\frac{G_t}{G_{ss}} = \left(\frac{G_t}{G_{ss}}\right)^{\gamma_G} \left[\left(\frac{B_t}{B_{ss}}\right)^{\gamma_D} \left(\frac{SP_t}{SP_{ss}}\right)^{\gamma_{SP}}\right]^{(1-\gamma_G)} Z_t^G \quad (35)$$

where γ_G is an autoregressive component of public spending, γ_D is the sensitivity of public spending to debt, γ_{SP} is the sensitivity of public spending due to movements in the primary surplus. The terms Z_t^{IG} e Z_t^G are shocks to investment and public consumption, respectively. These shocks follow the following specification:

$$\log(I_t^G) = (1 - \rho_{I^G}) \log(I_{ss}^G) + \rho_{I^G} \log(I_{t-1}^G) + \varepsilon_t^{I^G} \quad (36)$$

and

$$\log(G_t) = (1 - \rho_G) \log(G_{ss}) + \rho_G \log(G_{t-1}) + \varepsilon_t^G \quad (37)$$

both shocks have zero mean and variance equal to σ^G and σ^{IG}, respectively. The terms ρ_G e ρ_{IG} denote the persistence of the shocks.

Thus, total public spending (TS_t) is obtained by adding public investment and consumption expenditures:

$$TS_t = P_t(G_t + I_t^G) \quad (38)$$

3.4.1.3. Fiscal Rules

Finally, as in the work of Jesus, Besarria and Maia (2020a) it is assumed that the government may implement two fiscal rules that will limit government spending: EC 95 and the Wesselbaum rule (2017). So these restrictions will be compared with the base model, described above.

The Wesselbaum rule (2017) was proposed for the case of the United States fiscal authority. This rule is characterized as a fiscal constraint on government spending, based on public debt and the business cycle. In this case, the rule allows for a relaxation for times of economic crisis, thus allowing the government to be able to spend more in periods of a downward business cycle. This can be represented by the following expression:

$$TS_t = -\gamma_d d_t - \gamma_Y Y_t \quad (39)$$

d_t the actual stock of government debt, $\gamma_d \geq 0$ represents the debt stabilization target and $\gamma_Y \geq 0$ is the business cycle stabilization target. The sign of γ_d indicates that when the stock of public debt rises, the

government must necessarily reduce its current spending; it already γ_Y suggests that when the business cycle is up, the government should reduce its participation in the economy. In this case, the rule establishes an inverse relationship between government spending and debt and the business cycle.

The subsequent rule is represented by EC 95 and, in this case, current government spending will be equal to past spending corrected for inflation, in other words, Brazilian public spending will be frozen in real terms. The following expression represents this rule:

$$TS_t = (1 + \pi_{t-1})TS_{-1} \tag{40}$$

where TS_t the current government expenditure corrected for inflation.

Finally, a junction between the principles of the rule postulated by EC 95 and the one proposed by Wesselbaum (2017) was performed, according to:

$$TS_t = (1 + \pi_{t-1})TS_{-1} - \gamma_d d_{t-} - \gamma_Y Y_t \tag{41}$$

The above fiscal rule seeks to promote, to some extent, a more flexible fiscal framework than the one in force in the Brazilian economy.

3.4.2. Monetary Authority

The role of the monetary authority consists in controlling inflation; to achieve this objective, the Inflation Targeting Regime (IMR) is adopted and thus determines the economy's basic interest rate according to a Taylor rule (1993). Thus, the Central Bank's reaction function assumes the following specification:

$$\frac{R_t}{R_{ss}} = \left(\frac{R_{t-1}}{R_{ss}}\right)^{\phi_R} \left[\left(\frac{\pi_t}{\pi_{ss}}\right)^{\phi_\pi} \left(\frac{Y_t}{Y_{ss}}\right)^{\phi_Y}\right]^{1-\phi_R} Z_t^R \tag{42}$$

where ϕ_R represents the authority's preference for maintaining a smooth interest rate path, ϕ_π represents the response sensitivity of interest rates to the deviation between observed and expected inflation, ϕ_Y is the sensitivity of interest rates to business cycles, and finally Z_t^R represents the stochastic monetary policy shock, which follows the following specification:

$$\log(Z_t^R) = (1 - \rho_R)\log(Z_{ss}^R) + \rho_R \log(Z_{t-1}^R) + \varepsilon_t^R \tag{43}$$

where ε_t^R is an i.i.d process $(0,\sigma^R)$ and ρ_R denotes the persistence of the monetary policy shock.

3.5. Aggregation and Equilibrium Condition

Once the optimal behavior of the agents in the economy has been described, the interaction among them must be established to determine the macroeconomic equilibrium. The aggregation of homogeneous goods is given by the weighted average of the variables, so the aggregate level of any variable can be obtained from:

$$= \int_0^1 X_{h,t}\, \partial h = (1 - \omega_R) X_{i,t} + \omega_R X_{j,t} \tag{44}$$

Finally, to close the model, the goods market equilibrium condition is given by:

$$Y_t = C_t + I_t^P + I_t^G + G_t + X_t \tag{45}$$

The equilibrium of the model consists of the solution of the sequence of endogenous variables such that the conditions defining the equilibrium are satisfied.

3.6. Calibration

The model developed in this research has about 40 structural parameters, available in Appendix A, which were rescued from prominent works in the national literature, in order to align the model to the Brazilian context. In the calibration of the households, both Ricardian and non-Ricardian, the discount factor and the parameter referring to the consumption habit were collected from Cavalcanti et al. (2018b). The values referring to the productive aspect of the economy (firms) were extracted from the work of Costa Junior, Cintado, and Sampaio (2017). In relation to the tax rates referring to labor, capital and income taxation, these followed the proposal by Silva, Paes and Ospina (2015) in order to reproduce the values practiced in the Brazilian economy.

The parameters referring to the preferences of the monetary authority, with respect to the elasticity of response of interest rates to deviations of inflation from target and the output gap, as well as the smoothing rate were extracted from the SAMBA model, developed by De Castro et al. (2015). The parameters related to the preferences of the fiscal authority, such as expenditure smoothing, the response of the primary surplus to public spending and the debt stock follow the values proposed by Moura (2015). The parameters referring to the alternative spending rule were taken from Jesus, Besarria and Maia (2020b). With regard to the parameters that make up the uncertainty shock, these were collected from the work of Besarria, Aragón, Silva and Nóbrega (2021).

4. Discussion and analysis of the results

This section aims to analyze the effects of three shocks: uncertainty shocks, monetary policy and productivity. Four scenarios will be taken into account for government spending in each shock: government spending considering as benchmark the DSGE model developed here; the government using the fiscal rule proposed by Wesselbaum (2017); the government implementing the EC 95 fiscal rule as proposed by Jesus, Besarria and Maia (2020a) and finally, a hybrid fiscal rule proposed by the present paper.

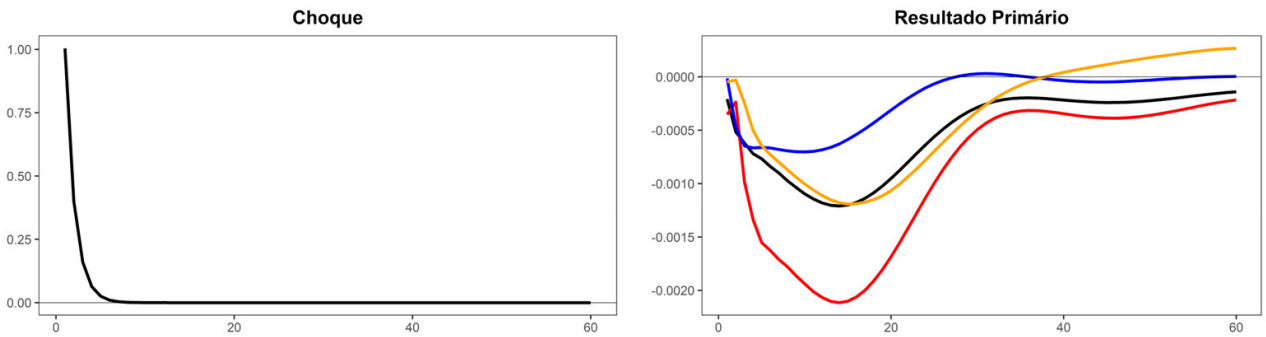
Since the objective of this paper is focused on the analysis of the effects of contractionary shocks on the public accounts, this section will consider only the most relevant fiscal variables of the model. However, we also provide the impulse response functions on the real variables of the economy, available in Appendix B.

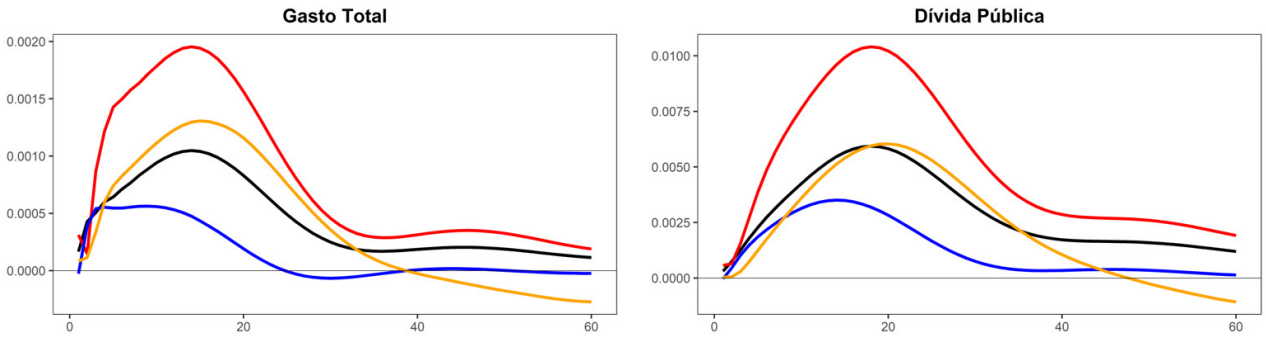
In general, the monetary policy and uncertainty shocks had typical contractionary impacts, with a reduction in economic activity, a drop in consumption, being in accordance with the theoretical expectation. Our results also showed that the response of the fiscal variables is negative, that is, deterioration of the public accounts. Our point of investigation is to know how fiscal rules can smooth the effects of these contractionary shocks.

Figure 5 presents the response of the fiscal variables in the model (primary result, government spending and public debt) after a positive uncertainty shock. The impulse-response result shows that an increase in uncertainty has a negative impact on the government's primary result and that government spending increases with a higher level of uncertainty. That is, in this scenario the government incurs a primary deficit, consequently the public debt grows.

It is also possible to see from Figure 5 that in the scenario of increased uncertainty level the government accounts are in a worse situation when the fiscal authority does not use any fiscal rule (red line). The model with no fiscal rule presented the largest drop in the primary surplus and the largest increase in public debt. The opposite occurs when the government uses the Wesselbaum rule (2017), where the use of this fiscal rule provides a less challenging fiscal scenario for the fiscal authority.

Figure 5 – IRF: Uncertainty Shock





Choque = Shock / Resultado Primário = Primary Result / Gasto Total = Total Expenditure

Dívida Pública = Public Death

Source: Own elaboration.

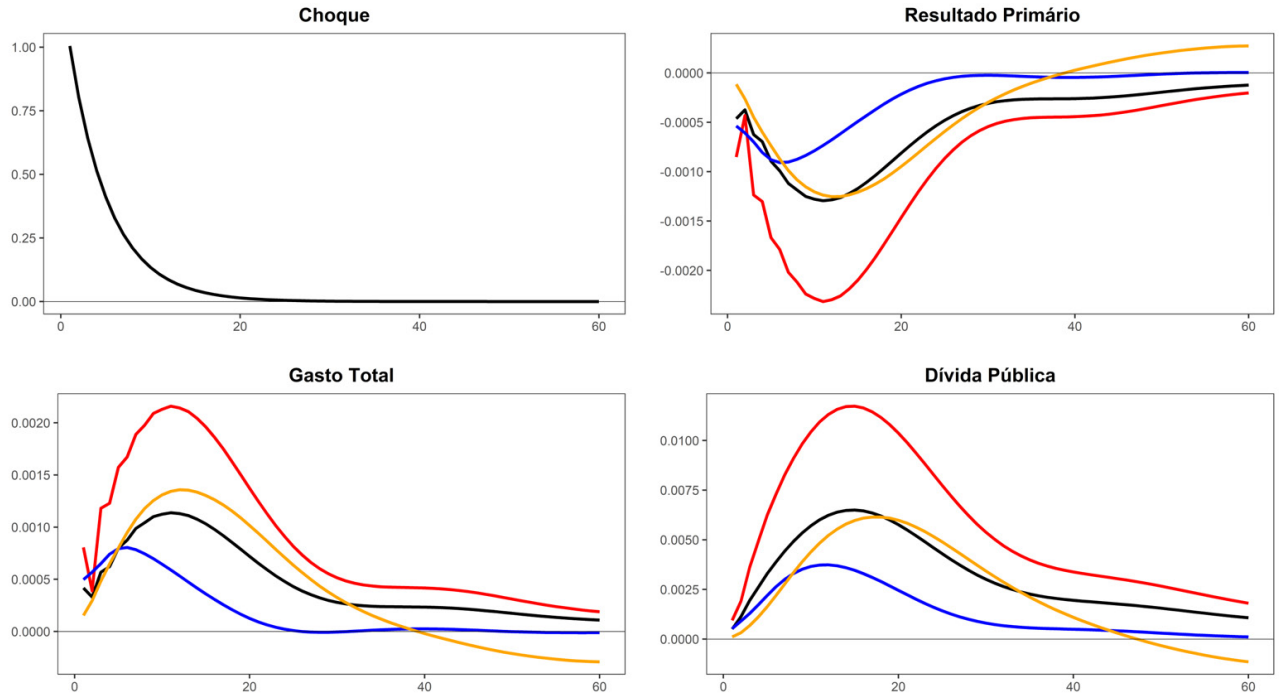
(1) Note: The blue line corresponds to the rule grounded in Wesselbaum (2019); the black line corresponds to the spending rule postulated in EC no. 95/2016; The orange line corresponds to the hybrid spending rule; finally, the red line corresponds to the benchmark model, i.e., with no fiscal rule at all.

Wesselbaum (2017) in his work also found that after an uncertainty shock the use of fiscal rules helps to reduce the government's fiscal vulnerability to increased uncertainty in the economy. The hybrid rule showed a similar response to the EC 95 rule, so that in some periods the reaction between the two rules alternate with each other, that is, in some periods the EC 95 presents a higher reaction and in others a lower reaction to the hybrid rule. This fact occurs due to the fact that the hybrid rule incorporates the main component of the EC 95, but with a greater flexibility provided by the business cycle component.

Figure 6 illustrates the response of the fiscal variables to a contractionary monetary policy shock. The responses of the variables were in line with what was expected and found widely in the literature. In this case, an increase in the nominal interest rate reduces the government's primary result, increasing spending and public debt. These results can also be found in the works of Valli and Carvalho (2010), Benegas and Marinho (2017), Cavalcanti et al. (2018a) and Jesus, Besarria and Maia (2020a). These authors also checked the effects of a restrictive monetary policy shock considering that fiscal policy is administered through fiscal rules and monetary policy follows a Taylor rule.

As can be seen, in a scenario where the government applies no rule in conducting fiscal policy, fiscal variables react more strongly to the monetary policy shock. In this case, with no fiscal rule the result is higher levels of public debt compared to a scenario of using any of the three fiscal rules tested. Figure 6 also shows that the Wesselbaum (2017) rule provides a smaller reaction of the fiscal variables compared to the EC 95 rule and the hybrid rule.

Figure 6 – IRF: Monetary Policy Shock



Choque = Shock / Resultado Primário = Primary Result

Gasto Total = Total Expenditure / Dívida Pública = Public Death

Source: Own elaboration.

(1) Note: The blue line corresponds to the rule grounded in Wesselbaum (2019); the black line corresponds to the spending rule postulated in EC no. 95/2016; The orange line corresponds to the hybrid spending rule; finally, the red line corresponds to the benchmark model, i.e., with no fiscal rule at all.

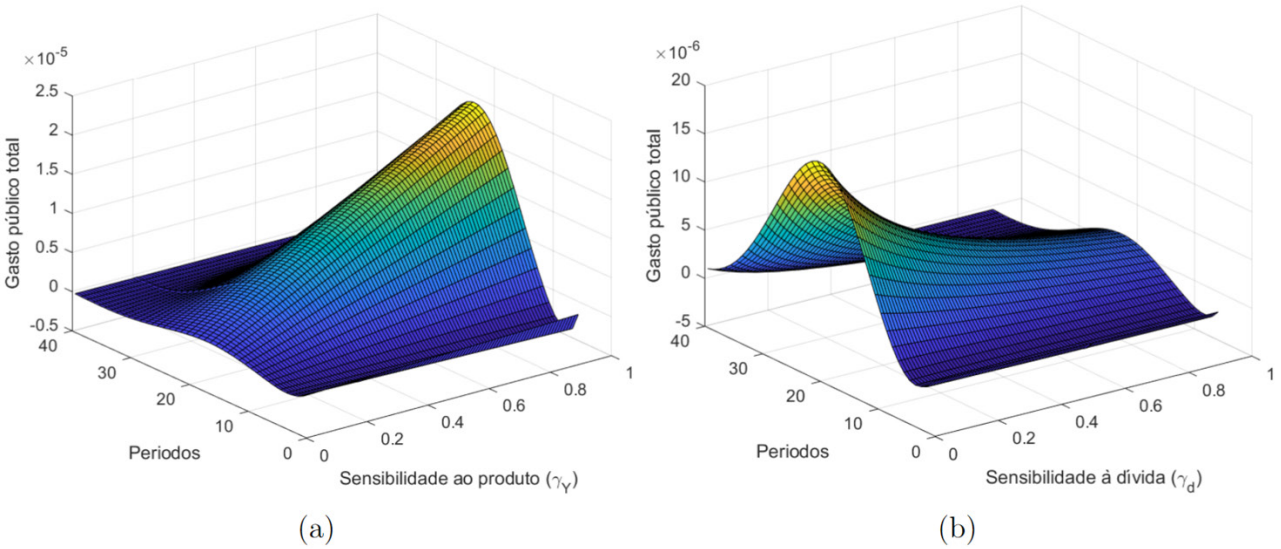
However, the hybrid rule in the first periods after the interest rate shock provides a smaller reaction of fiscal variables in relation to the other fiscal rules. Therefore, the implementation of the hybrid rule can generate higher fiscal gains than the EC 95, especially in the short run, and provide a fiscal escape in periods of economic recession captured by the business cycle component. Jesus, Besaria, and Maia (2020a) also found similar results for EC 95 and the Wesselbaum (2017) rule.

4.1. Sensitivity of the spending rule to changes in the response parameters

In order to investigate the response of public spending to a broad set of different values of the response parameters of the fiscal rule (Equation 39), proposed by Wesselbaum (2017), a sensitivity analysis was performed. Briefly, the idea is to simulate a shock - in this case, economic uncertainty - on the model variables for a large number of times and allow the parameter of interest to assume several values in this process with everything else constant, to then stack the impulse response functions and obtain important analytical elements regarding the relationship between the variable and the parameter studied. In this sense, Figure 7 presents the result of the sensitivity analysis of public spending as a

function of the output-sensitivity (γ_Y) - shown in Figure 7a - and the sensitivity-response to debt (γ_d) - presented in Figure 7b.

Figure 7 – Sensitivity analysis of the spending rule to the response parameters as a result of an economic uncertainty shock



Gasto Público Total = Total Public Expenditure / Períodos = Periods /

Sensibilidade ao produto = Sensibility to the Product

Source: Own elaboration.

In general, the results presented in Figure 7a showed that as the response sensitivity of public spending to output increases (γ_Y) increases, the higher is the level of spending determined by the fiscal rule as a result of an uncertainty shock. This behavior arises from the contractionary effect of the shock on output, which induces an increase in spending in order to combat the recessive economic cycle. This type of public spending correction mechanism is extremely important in periods of depressed economic activity, as were the most severe periods of the Covid-19 pandemic throughout 2020 and 2021. In the Brazilian case, the rule formulated from EC 95 does not have such flexibility, which generated the need to resort to congress for approval (extra ceiling) of credit to obtain the necessary resources for income maintenance policies for the classes most affected by the lockdowns, such as, for example, Bill 1066/2020, which established the Emergency Aid in the year 2020.

On the other hand, Figure 7b suggests that as the response sensitivity of public spending to the debt level increases (γ_d), the lower is the public spending limit set by the fiscal rule when an uncertainty shock occurs. Unlike the previous parameter, the objective now is to ensure sustainable levels for government liabilities. That is, the intention is to ensure rationality in public spending by setting limits on the amount available for expenditure.

4.2. Volatility Analysis

In this section, similarly to the work of Jesus, Besarria, and Maia (2020a), the effects that fiscal rules generate on the volatility of the economy's main variables after a restrictive monetary policy shock will be addressed. One of the objectives linked to the implementation of fiscal rules is the stability of economic expectations, in other words, to increase the predictability of economic responses, making the economy more stable. The measure of economic stability that will be adopted for this analysis is volatility of variables in the face of contractionary shocks, different fiscal rules. The volatility of each variable (X_t) is calculated using the methodology presented by Suh (2012). The calculation of (σ_x), can be defined as the sum of squares of the impulse-response function values during 50 quarters after the shock:

$$\sigma_x = \frac{\sum_{i=0}^{50} \beta^i (\partial X_{t+i} / \partial e_t)}{50} \tag{46}$$

where, the term $\partial X_t/\partial e_t$ represents as the value of the impulse-response function of the endogenous variable in the model receiving the shock, being X_t is the steady state endogenous variable and e_t the residual of the impulse-response function. In Table 4 we present the effects of different fiscal rules on the volatility of the economy.

Table 4 - Effects of the different fiscal rules on the volatility of the economy

	Tax Rule	Primary Surplus	Total Expenditure	Debt
Uncertainty	Baseline	0.0146	0.0125	0.4038
	EC 95	0.0047	0.0035	0.1316
	Wesselbaum	0.0014	0.0009	0.0367
	Hybrid	0.0014	0.0009	0.0367
Monetary Policy	Baseline	0.0160	0.0140	0.5158
	EC 95	0.0050	0.0039	0.1580
	Wesselbaum	0.0018	0.0012	0.0394
	Hybrid	0.0018	0.0012	0.0394

Source: Own elaboration.

In this analysis we compare the responses of the fiscal variables to shocks of uncertainty, monetary policy, and productivity, taking as a reference an economy without fiscal rules (baseline). As can be seen, the economy becomes more stable or less volatile when we associate the responses of the primary surplus, total spending, and debt variables, obtained in the scenarios with fiscal rules, with the model without fiscal constraint.

Overall, the results suggest that fiscal rules make the economy more stable, either in the face of contractionary (uncertainty and monetary policy) or productivity shocks. The debt rule proposed by Wesselbaum (2017) and hybrid rule perform better from the point of view of stability or smaller fiscal fluctuations.

5. Final Considerations

In recessionary periods, fiscal policymakers face an important trade-off related to the intertemporal allocation of resources between the increase in public spending in the current period and the subsequent increase in the tax burden in the future to finance such expenditures. Notwithstanding the importance of such anti-cyclical measures, they have direct contemporaneous effects on the stock of public debt, and may in some situations lead the government to a situation of insolvency, thus threatening the financial stability of the economy. On the other hand, and no less important, there is also the urgent economic-social dilemma: the government must act with precision and agility to minimize the impacts of the reduction of the real income of the economy on the less favored strata of the population.

In Brazil, the last few years have been marked by the economic recession brought on as a consequence of the Covid-19 pandemic and its devastating economic-social impacts. From the public finances point of view, the debate was focused on the adoption of measures to combat the recessionary cycle, such as the Emergency Employment Support Program (Law no. 14.043/20), withdrawal of the FTGS (M.P. no. 1.105/22), among others; and measures of a welfare nature, given the situation of public calamity, such as: the Emergency Aid (M.P. nº 1.039/20, 1.000/20 e 1.056/21) and the institution of the Brazil Aid (M.P. 1.061/21). However, the Proposals of Amendment to the Constitution nº 23/2021 and nº 1/2022, indirectly and directly opened space for the expansion of public spending attached to the fiscal rule in force, raising the debate about a possible flexibilization or even extinction of the current Brazilian spending rule.

In this sense, this paper has shown the importance of fiscal rules for the stability of public spending and public debt in the face of recessionary or contractionary economic shocks. Moreover, this study showed that the direction towards more flexible fiscal rules does not compromise the efficiency of fiscal rules in stabilizing public spending. The results obtained through the DSGE model corroborate this hypothesis and, in addition, it was possible to verify positive effects that proposals to improve the fiscal rule, currently in force in Brazil, can bring.

This discussion can generate positive effects for public finances by helping to clarify the impacts of changes in the fiscal rules on public accounts, and can assist policymakers in an eventual adjustment process of the Brazilian fiscal rule, bringing benefits to society by helping to reduce the recessionary impacts on the fiscal side and, consequently, on the economy as a whole.

For future research, it is suggested to investigate rules with varying response parameters over time. In addition, rules with adjustment triggers can also be investigated, especially those linked to the overall level of public debt.

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Annex A - Model Parameters

Table 5 - Calibration Parameters (Open Economy Model)

Parâmetro	Característica	Valor	Referência
β	Intertemporal discount factor	0,989	Cavalcanti et al. (2018b)
σ	Inverse of the intertemporal elasticity of substitution	1,25	Moura (2015)
h	Persistence of the consumption habit	0,65	Cavalcanti et al. (2018b)
φ	Frisch elasticity of labor supply	0,25	Moura (2015)
χ	Sensitivity of the investment to the adjustment cost	1,00	Costa Junior, Cintado and Sampaio (2017)
δ_K	Private capital depreciation rate	0,025	Silva and Besarria (2018)
δ_G	Public capital depreciation rate	0,025	Cavalcanti and Vereda (2015)
α_1	Elasticity of private capital in production	0,30	Costa Junior, Cintado and Sampaio (2017)
α_2	Labor Elasticity in Production	0,60	Costa Junior, Cintado and Sampaio (2017)
α_3	Elasticity of public capital in production	0,10	Costa Junior, Cintado and Sampaio (2017)
θ	Price Rigidity Parameter	0,70	Lim and McNelis (2015)
Ψ	Elasticity of substitution among intermediate goods	6,00	Lim and McNelis (2015)
ξ	Elasticity of substitution between domestic and imported inputs	0,50	Moura (2015)
μ	Firm Mark-up	$\frac{\Psi}{\Psi-1}$	Predetermined
ω_R	Proportion of household with credit restrictions	0,50	De Castro et al. (2015)
ω_2	Proportion of domestic input in production	0,836	Costa Junior, Cintado and Sampaio (2017)
τ_C	Consumption tax	0,2313	Silva, Paes and Ospina (2015)
τ_W	Income tax	0,1713	Silva, Paes and Ospina (2015)
τ_K	Capital Tax	0,1441	Silva, Paes and Ospina (2015)
ψ_1	Sensitivity of the cost of not using the maximum installed capacity 1	$(1-\beta)$-$(1-\delta_K)$	Predetermined
ψ_2	Sensitivity of the cost of not using the maximum installed capacity 2	1,00	Costa Junior, Cintado and Sampaio (2017)
ψ_3	Elasticity of the risk premium to reserves international	0,082	Moura (2015)
ϕ_R	Interest rate smoothing term	0,79	De Castro et al. (2015)
ϕ_Π	Sensitivity of interest rates to inflation deviation	2,43	De Castro et al. (2015)
ϕ_Y	Sensitivity of interest rates to the output gap	0,16	De Castro et al. (2015)
ρ_R	Persistence of the monetary policy shock	0,79	De Castro et al. (2015)
γ_X	Export smoothing parameter	0,5	Costa Junior, Cintado and Sampaio (2017)

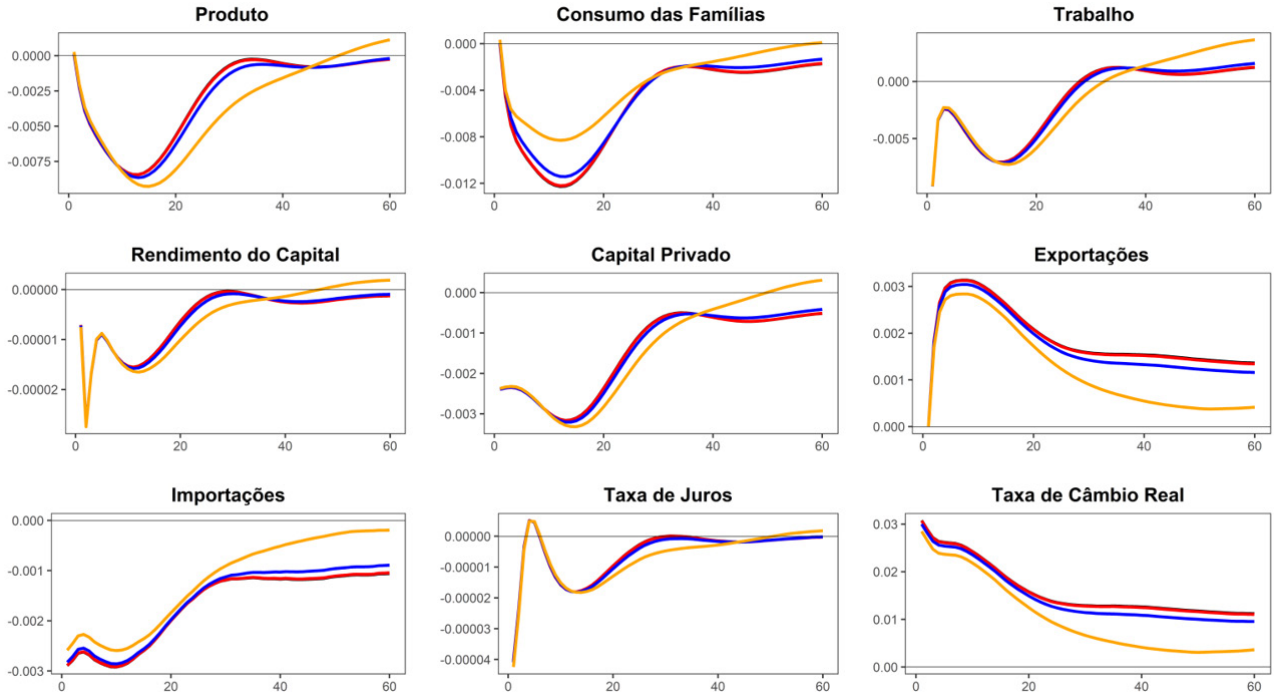
γ_G	Softening of government spending	0,956	Moura (2015)
γ_{SP}	Response of the surplus in the fiscal rule	0,30	Moura (2015)
γ_D	Debt response in the fiscal rule	0,750	Moura (2015)
ρ_A	Persistence of the productivity shock	0,95	Moura (2015)
ρ_{IG}	Persistence of the public investment shock	0,00	Costa Junior, Cintado and Sampaio (2017)
ρ_G	Persistence of the public spending shock	0,00	Costa Junior, Cintado and Sampaio (2017)
ρ_N	Persistence of the labor supply shock	0,50	Moura (2015)
ρ_{R^*}	Persistent shock to external interest	0,90	Moura (2015)
ρ_{P^*}	Persistent external price shock	0,500	Costa Junior, Cintado and Sampaio (2017)
ρ_ϕ	Persistence of the risk shock	0,34	Moura (2015)
ρ_X	Persistent export shock	0,25	Costa Junior, Cintado and Sampaio (2017)
γ_d	Sensitivity of the alternative rule to the level of debt	0,65	Jesus, Besarria and Maia (2020b)
γ_y	Sensitivity of the alternative rule to the product level	0,30	Jesus, Besarria and Maia (2020b)
$\rho_{\sigma a}$	Persistence of the Uncertainty Shock	0,80	Jesus, Besarria and Maia (2020b)

Source: Own elaboration.

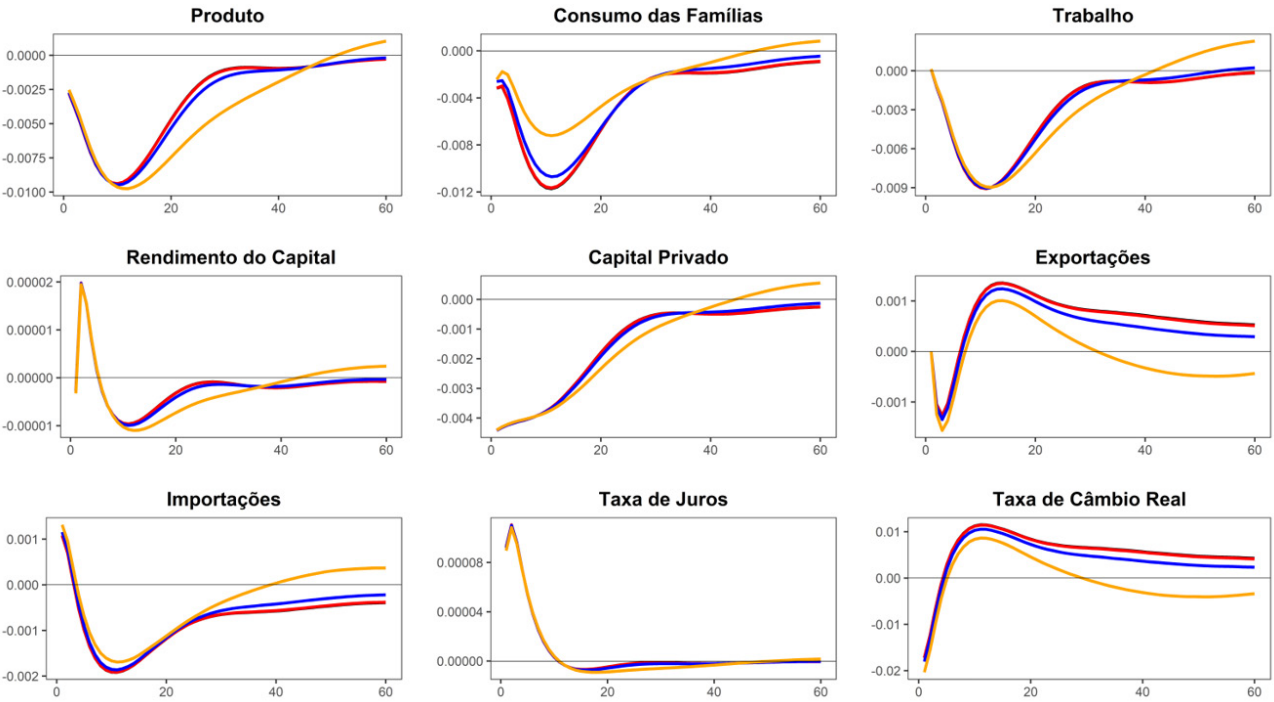
Annex B - Impulse-Response Functions in Real Variables

Figure 8 - IRF: Uncertainty Shock (A) and Monetary Policy Shock (B) on the economy's real variables

(A) Uncertainty Shock



(B) Monetary Policy Shock



Source: Own elaboration.

Produto = Product

Consumo das Famílias = Family Consumption

Trabalho = Labor

Rendimento de Capital = Capital Revenue

Capital Privado = Private Capital

Exportações = Exports

Importações = Imports

Taxa de Juros = Interest Rate

Taxa de Câmbio Real = Actual Exchange Rate

(1) Note: The blue line corresponds to the rule grounded in Wesselbaum (2019); the black line corresponds to the spending rule postulated in EC no. 95/2016; The orange line corresponds to the hybrid spending rule; finally, the red line corresponds to the benchmark model, i.e., with no fiscal rule at all.