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How Financial Stress Can Impact Fiscal and Monetary Policies: Threshold VAR Analysis for Brazilian Economy

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Abstract: This study examines economic policy responses in Brazil during periods of financial stress, with a particular emphasis on the dynamics of both the impulse and rule components of fiscal policy. We offer novel empirical evidence on policy responses under both low and high stress conditions, utilizing monthly data that span the past two decades. To this end, we construct a Financial Stress Index (FSI) and integrate it into a threshold-VAR framework. Additionally, we employ five distinct methodologies to decompose fiscal policy into its impulse and rule components. Our analysis yields two main findings. First, fiscal policy exhibits procyclical behavior in its impulse component and countercyclical behavior in its rule component across both regimes. Second, while monetary policy is countercyclical during high stress conditions, its impact remains largely statistically non-significant. These results suggest that policymakers should exercise caution when timing the implementation of expansionary fiscal policies, carefully considering the phase of the business cycle. Moreover, our findings carry significant implications for the ongoing discourse on fiscal stimulus and debt stabilization strategies, particularly in the context of financial stress.

Keywords: fiscal policy; financial stress index; threshold VAR; generalized impulse response analysis

JEL Classification: C53; E43; G17

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1. Introduction

The debate on the role of fiscal policy as a stabilizing instrument for output fluctuations remains ongoing. This debate was significantly amplified by the global economic crisis that began in 2008 and the subsequent COVID-19 pandemic (Davoodi et al. 2022). These events underscored the limitations of orthodox monetary policy tools as many central economies had nearly exhausted these measures with interest rates already close to zero, which further highlights the critical role of fiscal policy.

The fiscal authority is expected to exhibit countercyclical policies, particularly during recessions (Claessens et al. 2009). Ideally, the government should increase spending during economic downturns and reduce it during upturns, thereby stabilizing output fluctuations (OCDE 2003). However, policymakers may sometimes respond procyclically during periods of economic growth, creating asymmetry and exacerbating the business cycle. This means deficits increase during recessions but do not decrease during growth periods, resulting in an asymmetric impact on the business cycle.

Recent literature highlights the significant role of fiscal and monetary policy uncertainty in causing economic and financial disruptions. The authors in Hong et al. (2024) introduce a novel news-based measure of Fiscal Policy Uncertainty across 189 countries, showing its substantial contractionary effects such as decreased industrial production in both Advanced and Emerging Economies. The authors in Aizenman et al. (2024) discuss the challenges for Emerging Economies amid high global financial uncertainty, inflation, and rising debt-to-GDP ratios post Global Financial Crisis and COVID-19 pandemic. They emphasize the exacerbated vulnerabilities due to global monetary tightening and suggest strengthening domestic macroeconomic fundamentals. Other authors have examined how fiscal and monetary policies in Emerging Economies respond to increased economic and financial uncertainty during recent crises, such as the COVID-19 pandemic and the Russia–Ukraine conflict (see, for example, Lastauskas and Nguyen 2024; Makololo and Seetharam 2020, among others).

This paper investigates fiscal policy asymmetries in Brazil, a nation with one of the largest debt-to-GDP ratios among Emerging G20 Countries (IMF 2024). First, we use techniques to decompose fiscal variables into rule and impulse components to ascertain whether these components exhibit symmetry during periods of high and low financial stress. Additionally, we analyze the response of monetary policy during these times.

Shortly before the 2008 financial crisis, Brazil achieved investment-grade status as a result of sustained fiscal and monetary policy efforts. These efforts included measures adopted from 1999 onwards, such as inflation targeting, a floating exchange rate, and the introduction of the Fiscal Responsibility Law (Holland 2019). However, there is consensus that Brazil faces a chronic fiscal problem (Giambiagi 2021), which was exacerbated by the global recession from 2007 to 2010, triggered by the financial crisis originating in the US subprime mortgage markets (Tourinho and O.Brum 2020). This fiscal issue is evident in the acceleration of gross public debt growth. After remaining relatively stable at around 60% from 2007 to 2013, the debt-to-GDP ratio resumed its upward trajectory, reaching 88.59% in 2020. The increase in fiscal deficits and public debt, linked to expansionary fiscal policies during aggregate demand downturns associated with crises, has also sparked discussions about financial markets' perceptions of fiscal sustainability.

Additionally, in 2015, Brazil entered one of the most severe economic recessions in its history (e.g., Lisboa and Pessôa 2019; Manoel et al. 2024), leading to deteriorating fiscal results and a downgrade to speculative grade status. Between 2014 and 2017, the country experienced unprecedented fiscal deterioration due to a combination of factors. These included a lack of fiscal control, ensuing political instability, and the necessary measures taken by the government to address the issues. These elements primarily contributed to the economic recession of 2014–2016.

Determining whether the economy is in a state of crisis is inherently challenging. In the Brazilian case, The Business Cycle Dating Committee (CODACE) at Fundação Getulio Vargas (FGV) has been utilizing a methodology akin to that of the US National Bureau of Economic Research in order to identify and date recessions in Brazil since 1980[1]. Also, the authors in Gomes et al. (2024) study the modeling business cycles through Markov-switching models in the context of structural breakers and outliers. A substantial body of literature explores the interconnections between economic activity, financial markets, financial stability, and financial crises (e.g., Claessens et al. 2012; Illing and Liu 2003; Monin 2019; Oet et al. 2015; Sandahl et al. 2011; Slingenberg and De Haan 2011). Notably, Balakrishnan et al. (2011) employs the Financial Stress Index (FSI) to investigate financial market turbulence across advanced and Emerging Economies. During the 2008 crisis peak, Emerging Economies experienced significant reactions, evidenced by a sharp rise in the FSI. The author in Moriyama (2010) finds that increased economic stress, as identified by the FSI, may explain about half of the decline in real GDP growth in Emerging Markets. Also, the authors in Soave (2020), who estimate the FSI using the method proposed by Koop and Korobilis (2014), suggest that financial friction plays a crucial role in the business cycles in Emerging Markets.

Empirical studies also show that financial instability and economic downturns are closely related (Baxa et al. 2013; Cardarelli et al. 2011). Researchers have examined the relationship between economic policies and financial stress. For instance, the authors in Li and St-Amant (2010) explore the links between monetary policy, the business cycle, and Canada's financial sector, concluding that contractionary monetary policy has a more significant impact during severe financial stress. Moreover, Park and Mercado (2014) analyzed FSI data from 25 emerging markets between 1992 and 2012, finding that both regional and non-regional FSIs increased significantly during domestic financial stress.

The authors in Stona et al. (2018), for instance, examine the macroeconomic dynamics during periods of instability in the Brazilian financial market from 2000 to 2015. They introduce the Brazil Financial Stress Index as a proxy for financial stress and assess its interaction with real activity, inflation, and monetary policy. Their findings suggest that an expansionary monetary policy can exacerbate adverse situations. Additionally, the authors in Wichmann and Portugal (2013) investigate the existence of asymmetries in economic policy responses across economic cycles from 2001 to 2010. They suggest that fiscal rules are faster and less asymmetric than other policies, while monetary policy responds more strongly to variations in the output gap.

Since the existing literature on economic policy responses in Brazil is not comprehensive, this paper introduces a novel approach by using the FSI, in accordance with Balakrishnan et al. (2011), as a threshold variable to link financial sector conditions and economic policy responses. We establish two economic states: low-stress (economic growth) and high stress (economic downturn) (Afonso et al. 2018; Alessandri and Mumtaz 2017; Galvão and Owyang 2018). To estimate the parameters governing these regimes, we employ a threshold-VAR (TVAR) method to assess nonlinearities in Brazilian economic policies.

This modeling approach offers significant advantages from a policy perspective as it enables the monitoring of financial stability measures and their regime changes over time. In empirical studies, the primary tools used to capture nonlinearities in fiscal and monetary policy responses are Markov-switching Vector Autoregression (MS-VAR) and Smooth Transition Vector Autoregression (STVAR) models (Evgenidis and Tsagkanos 2017; Li and St-Amant 2010). Regime-switching models typically impose endogenous switches, whereas TVAR models treat the threshold variable as exogenous. This allows for the study of regime switches that result from shocks to other variables within the system (Ferraresi et al. 2015). Another advantage of TVARs is their simplicity in estimation: they are nonlinear multivariate systems of equations that model nonlinearity additively and can be estimated through ordinary least squares (OLS). Once estimated, the state-dependent dynamics of TVARs allow for nonlinear and asymmetric impulse response functions.

We begin by estimating a TVAR model without decomposing fiscal policy into rule and impulse components (mainstream). Following this, we explore five specifications to decompose the fiscal policy, with each specification constituting a separate TVAR exercise. The results indicate that Brazil's fiscal policy is predominantly procyclical in impulse throughout both regimes, which suggests asymmetry in this component. In contrast, the rule was countercyclical in most specifications and both regimes. Monetary policy exhibited mixed signals across specifications and regimes, resulting in no definitive conclusions.

The outline of the paper is as follows: Sections 2 and 3 present the methods for filtering impulse fiscal and the TVAR, respectively. Section 4 introduces the Financial Stress Index. Section 5 presents the dataset and our empirical findings, and lastly, Section 6 concludes.

2. Methods for Filtering Impulse Fiscal Policy

When analyzing the path of economic policy, whether fiscal or monetary, it is important to keep in mind that it has automatic and discretionary components (Ilzetzki 2011; Talvi and Vegh 2005; Tornell and Lane 1999). These components can present different paths, so it is possible that procyclicity is present in only one of the components. For example, there is a possibility that the rule component is countercyclical and the discretionary component is procyclical.

The definition of the rule says that the balance increases (decreases) when the output gap rises (lowers). The fiscal impulse can have a greater degree of asymmetry, predominantly countercyclical in the financial stress regime and procyclical in regimes without stress monetary policy can have a countercyclical response during regimes with stress

(Balassone et al. 2010; Hercowitz and Strawczynski 2004; Sorensen et al. 2001). The central bank can be more tolerant of the economy's heating during periods without financial stress, accepting a little more inflation.

According to Woodford (2003), in economies that adopt an inflation-targeting regime, the real interest rate gap is a measure of the stance of monetary policy. On the other hand, there is no consensus in the literature on a measure for the fiscal policy stance. In the absence of a consensual definition, the variation in the structural primary balance as a percentage of GDP, also called fiscal impulse, is generally used as an indicator of the fiscal policy stance (Vitek 2023).

The literature suggests several approaches to calculating the fiscal impulse. Among them, the most frequently cited are as follows: (1) International Monetary Fund (IMF); (2) The Organization for Economic Cooperation and Development (OECD); (3) The Dutch approach, Dutch. Specifically, the IMF defines the cyclically adjusted fiscal stance as follows:

$$\mathrm{FS}_{\mathrm{IMF}} = \left(G_t - \frac{G_0}{Y_0^P} Y_t^P\right) - \left(T_t - \frac{T_0}{Y_0^P} Y_t\right). \tag{1}$$

Therefore, the fiscal impulse measure defined by the International Monetary Fund (IMF) can be expressed as follows:

$$\mathrm{FI}_{\mathrm{IMF}} = \Delta\mathrm{FS}_{\mathrm{IMF}} = \left(\Delta G - \frac{G_0}{Y_0^P} \Delta Y^P\right) - \left(\Delta T - \frac{T_0}{Y_0^P} \Delta Y\right). \tag{2}$$

where G is the government spending, T is the government revenues, Y and Y^P refers to actual and potential GDP, respectively. The subscripts 0 refers to the base year and t the current period.

The OECD approach calculates cyclically adjusted government revenues and expenditures as follows:

$$\mathrm{T}_{\mathrm{ADJ}} = \left[T - \eta_{\mathrm{T}} \frac{T_{t-1}}{Y_{t-1}} (Y_t - Y^P)\right], \tag{3}$$

$$\mathrm{G}_{\mathrm{ADJ}} = \left[G - \eta_{\mathrm{G}} \frac{G_{t-1}}{Y_{t-1}} (U_t - U^P)\right], \tag{4}$$

where T_{ADJ} and G_{ADJ} is the adjusted government budgetary income and spending, respectively. U_t refers to the unemployment rate, while U^P represents the natural rate of unemployment, which occurs when the economy is operating at its potential[2]. η_{T} and η_{G} are the elasticity of government expenditure and revenues relative to GDP, and the subscript $t-1$ refers to the previous period. Thus, the OECD fiscal impulse is defined as the change in the cycle-adjusted balance:

$$\mathrm{FI}_{\mathrm{OECD}} = \Delta\mathrm{G}_{\mathrm{ADJ}} - \Delta\mathrm{T}_{\mathrm{ADJ}}. \tag{5}$$

The Dutch method (Dutch) for calculating the fiscal impulse is given by the following:

$$\mathrm{FI}_{\mathrm{Dutch}} = \left(\Delta G - \frac{\Delta Y^P}{Y_{t-1}^P} G_{t-1}\right) - \left(\Delta T - \frac{\Delta Y}{Y_{t-1}} T_{t-1}\right). \tag{6}$$

The IMF approach calculates the fiscal impulse using a reference year in which the real GDP is close to potential (the output gap is close to zero). The OECD method requires the calculation of the elasticities of government revenues and expenditures, which, in the case of the IMF method, are implicitly considered to be unitary. The Dutch approach is similar to that of the IMF, with the only difference being the choice of reference year, as it uses the previous year as its basis.

In addition to the methods previously presented for measuring the fiscal impulse, two regression-based approaches are also considered: one proposed by the IMF and another estimated using the Kalman filter. Specifically, the regression-based fiscal impulse measure is calculated as the difference between a hypothetical government primary balance, assuming no changes in economic conditions, in period t, and the actual government primary balance outcome in $t-1$ (IMF 2009). The change in the government's primary balance compared to the previous period is decomposed as follows:

$$\begin{aligned}\Delta B_t &= B(P_t, E_t) - B(P_{t-1}, E_{t-1}) \\ &= [B(P_t, E_t) - B(P_t, E_{t-1})] + [B(P_t, E_{t-1}) - B(P_{t-1}, E_{t-1})], \\ &= \Delta B_t^E + \Delta B_t^P, \end{aligned} \tag{7}$$

where the term $B(P_t, E_{t-1})$ refers to the primary balance that would occur under the policies of period t, P_t, and the economic conditions of $t-1$, E_{t-1}. Thus, the variation in the primary balance can be decomposed into two components: one due to changes in economic conditions and the other resulting from changes in discretionary policies.

Assuming that GDP growth is a proxy for economic conditions, the following equations are estimated:

$$T_t = \alpha_T + \beta_T \cdot g_t + \gamma_T \cdot t_t + u_t \tag{8}$$
$$G_t = \alpha_G + \beta_G \cdot g_t + \gamma_G \cdot t_t + e_t, \tag{9}$$

where T is the government's current revenue as a percentage of GDP, G is the government's expenditure as a percentage of GDP, g_t is the real growth of GDP, t_t is a time trend, and u_t and e_t are error terms. With this, it is possible to estimate the adjusted revenue and expenditure that would occur if economic growth remained at the same level as in the previous period:

$$\begin{aligned}T_t^{\text{ADJ}} &= \hat{\alpha}_T + \hat{\beta}_T \cdot g_{t-1} + \hat{\gamma}_T \cdot t_t + \hat{u}_t \\ G_t^{\text{ADJ}} &= \hat{\alpha}_G + \hat{\beta}_G \cdot g_{t-1} + \hat{\gamma}_G \cdot t_t + \hat{e}_t.\end{aligned}$$

Thus, the primary balance that would have occurred in period t if the growth rate had been the same as in $t-1$ can be calculated. The fiscal impulse measure is obtained by the difference between the adjusted primary balance in period t and the actual primary balance in $t-1$.

$$\begin{aligned}\text{FI}_{\text{IMF2008}} &= (T_t^{\text{ADJ}} - G_t^{\text{ADJ}}) - (T_{t-1} - G_{t-1}) \\ &= (\hat{\gamma}_T - \hat{\gamma}_G) + (\hat{u}_t - \hat{u}_{t-1}) - (\hat{e}_t - \hat{e}_{t-1}).\end{aligned} \tag{10}$$

Another approach involves extracting a time series of the unobservable component for the government's primary balance response (%GDP) using the Kalman filter. Considering that fiscal policy consists of the variation in the primary balance, $S_t = B_t - B_{t-1}$, this allows for a state-space representation, enabling the Kalman filter to be used for parameter estimation at each point in time. This representation consists of a measurement equation, which represents the evolution of the series S_t over time, and a state transition equation.

$$S_t = z_t' \alpha_t + \mu_t \tag{11}$$
$$\alpha_t = \Lambda_t \alpha_{t-1} + \eta_t, \tag{12}$$

where z_t represents the output gap, which measures the difference between an economy's actual GDP and its potential GDP. It is a measure of the economy's current position in the business cycle. Therefore, the fiscal policy component $z_t' \alpha_t$ depends on the economic cycle. The residual terms μ_t and η_t are normal with zero mean, variances σ_μ^2 and σ_η^2, and satisfy $\mathbb{E}\{\mu_t \eta_t\} = 0$.

Note that, unlike the methodologies previously considered, in the Kalman filter-based approach, the impact of the economic cycle on fiscal policy varies over time. The intuition behind this is that the weight given to fluctuations in the output gap may change over time.

3. Financial Stress Index

An episode of financial stress can be defined as a period of interruption in financial markets' normal functioning (Hakkio et al. 2009), such as generated by the uncertainties brought the COVID-19. A period of financial stress has at least one of these features: increased uncertainty about the value of fundamental assets (Bakas and Triantafyllou 2020; Zhang et al. 2020), increased uncertainty about other investors' behavior (Bogdan et al. 2021), increased information asymmetry between lenders and borrowers, less willingness to hold risky assets, decreased desire to keep assets less liquid (flight to liquidity), see Davig et al. (2010) for detailed descriptions.

Balakrishnan et al. (2011) developed an index of financial stress for emerging markets based on the existing index of Cardarelli et al. (2009) for developed countries. This index is composed of five variables, namely: "banking sector beta", stock market returns, stock market volatility, sovereign debt spreads, and exchange market pressure index EMPI. The β_t of the banking sector is obtained as follows:

$$\beta_{i,t} = \frac{cov(r^{\mathrm{M}}_{i,t}, r^{\mathrm{B}}_{i,t})}{\sigma^2_{\mathrm{M}}}, \tag{13}$$

where r^{M}_t represents the annual rates of return of the general stock market and r^{B}_t the rates of return of the shares of companies in the banking sector, the covariance and variance were calculated based on a 12-month moving window. When $\beta_t > 1$, it is clear that the banking sector presents greater volatility than the rest of the market[3]. The return of the stock market consists of the year-on-year change in the stock index multiplied by -1. Thus, a decline in stock prices implies an increase in stock market stress.

The third variable is the volatility of the stock market. Higher volatility in the stock market can cause an increase in uncertainty and cause an increase in financial stress. The authors in Balakrishnan et al. (2011) estimated such volatility using a GARCH specification (1,1) for an auto-regressive process variance with 12 lags. However, we use the Exponentially Weighted Moving Average (EWMA) volatility models, considering the six-month moving average of the square of the stock index's monthly growth rate.

The fourth variable is the sovereign debt spreads. It is defined by the EMBI+ (Emerging Market Bond Index Plus) and is a proxy for country risk. An increase in EMBI+ implies a perception, on the part of the market, that investing in a particular economy has become riskier, which, in turn, can lead to an increase in financial stress. Lastly, the EMPI captures depreciation of exchange rate and declines in international reserves, and is defined for country i in month t as follows:

$$\mathrm{EMPI}_{i,t} = \frac{(\Delta e_{i,t} - \mu_{i,\Delta e})}{\sigma_{i,\Delta e}} - \frac{(\Delta RES_{i,t} - \mu_{i,\Delta RES})}{\sigma_{i,\Delta RES}}, \tag{14}$$

where $\Delta e_{i,t}$ and $\Delta RES_{i,t}$ represent changes in the domestic exchange rate and international reserves, respectively, while $\mu_{i,\Delta e}$ and $\sigma_{i,\Delta RES}$ represent the mean and standard deviation of the variable i. It is clear that the EMPI+ consists of the sum of variables $\Delta e_{i,t}$ and $\Delta RES_{i,t}$ standardized. Domestic currency depreciation as reductions in international reserves pressure the foreign exchange market and, as a result, increases financial stress.

To yield the aggregate Financial Stress Index, we standardized the five components, summed them up, and computed the moving average of six months:

$$FSI_t = \beta_t + SMR_t + SMV_t + EMBI_t + EMPI_t. \tag{15}$$

The next section introduces the threshold-VAR methods and Nonlinear Impulse Response Functions.

4. Threshold-VAR and Nonlinear Impulse Response Functions

In order to investigate the potential presence of nonlinearities in the responses of fiscal and monetary policies, we consider TVAR models with two regimes. The threshold vector autoregression (TVAR[4]) methodology is a vector autoregression extension that allows the capture of nonlinear relationships. The authors in Balke (2000) noted that for TVAR, it is relatively intuitive and straightforward to capture nonlinearities generated, for instance, by changes in regimes and asymmetries. A TVAR model with two regimes can be represented as follows:

$$Y_t = \left(D^{(1)} + B^{(1)}(L)Y_{t-1}\right)I_t + \left(D^{(2)} + B^{(2)}(L)Y_{t-1}\right)(1 - I_t) + e_t, \quad (16)$$

where Y_t is the vector of endogenous variables, $B^{(1)}(L)$ and $B^{(2)}(L)$ are lag polynomial matrices, e_t are structural disturbances, and I_t it is an indicator function that assumes the value 1, when the threshold variable c_t (the financial stress index in our case), with d lags is less than the critical threshold value τ, and 0, otherwise. The parameter d is known as the delay parameter. Algebraically, we have the following:

$$I_t = \begin{cases} 1, \text{ when } c_{t-d} < \tau \\ 0, \text{ when } c_{t-d} > \tau. \end{cases} \quad (17)$$

Thus, the model identifies two distinct regimes based on the values of c_{t-d} and τ. Thus, the indicator variable effectively separates the two regimes and allows regimes to switch endogenously.

The Equation (16) can present a nonlinear path throughout the autoregressive system's complete trajectory. However, by dividing this trajectory into two parts (that is, where it is less than the threshold value and where it is greater than the threshold value), the system has a linear path. However, the TVAR model is linear within each regime, but the changes in the parameters across regimes account for nonlinearities.

Tong (1978) noted there is a possibility that the system space is composed of at least two subspaces. Although such a system is linear in all segments, it will operate in a nonlinear manner if you consider the space as a whole. In autoregressive modeling with threshold effect (TAR), a threshold variable is defined to capture the system's movement from one space to another, see Tsay (1989).

The asymmetry of the model described by Equations (16) and (17), which is captured by the threshold variable, allows the constants vector to switch between regimes.

The threshold variable c_t can be modeled into the Y_t vector, allowing the regime change to be endogenously determined by the system. Since the TVAR considers all endogenous variables, shocks in any of the vector variables Y_t can, through their impact on the variable, induce a regime change.

4.1. Econometric Specification

We estimated six TVAR models. They are formed by the (Δgap_t) product gap variation, inflation (π_t), the variation in the nominal interest rate (Δi_t), and changes in the fiscal policy's discretion and rule components, that is, the (if_t) fiscal impulse and the rule tax (rf_t).

In addition to the dataset, the cyclical and discretionary components of fiscal policy were in the estimations, as defined by the OECD, IMF (2006), and IMF (2008) methodologies, and by the Dutch versions and Kalman filter method (see Section 2).

The TVAR model in Equation (18) can be estimated as follows:

$$X_t = \left(A_0^{(1)} + A_0^{(1)}(L)X_{t-1}\right)I_t + \left(A_0^{(2)} + A_1^{(2)}(L)X_{t-1}\right)(1 - I_t) + e_t, \quad (18)$$

where X_t is the vector of endogenous variables (Δgap_t,π_t,Δi_t,if_t,rf_t), $A_0^{(s)}$ is the regime vector's constants $s = \{1,2\}$, $A^{(s)}(L)$ is the coefficients matrix, and e_t is the error vector, as follows:

$$X_t = \begin{bmatrix} \Delta gap_t \\ \pi_t \\ \Delta i_t \\ if_t \\ rf_t \end{bmatrix}, \quad A_0^{(s)} = \begin{bmatrix} A_{10}^{(s)} \\ A_{20}^{(s)} \\ A_{30}^{(s)} \\ A_{40}^{(s)} \\ A_{50}^{(s)} \end{bmatrix}, \quad A^{(s)}(L) = \begin{bmatrix} A_{11}(L) & A_{12}(L) & \cdots & A_{15}(L) \\ A_{21}(L) & A_{22}(L) & \cdots & A_{25}(L) \\ \vdots & \vdots & \ddots & \vdots \\ A_{31}(L) & A_{32}(L) & \cdots & A_{35}(L) \end{bmatrix}, \quad e_t = \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \\ e_{5t} \end{bmatrix}. \tag{19}$$

The indicator function I_t takes a value of 1 when the economy is under a stress regime in the financial markets and 0 otherwise. I_t is similar to Equation (17):

$$I_t = \begin{cases} 1, \text{ when } fsi_{t-d} > \tau \\ 0, \text{ when } fsi_{t-d} \leq \tau. \end{cases} \tag{20}$$

4.2. Nonlinear Impulse Response Functions

Once the estimation of TVAR is accomplished, it is possible to evaluate whether or not the economic dynamics differ across regimes. In standard linear VARs, the response to a shock is computed assuming that a shock only hits the economy at a particular point in time but neither before nor during the forecasting horizon. Linear VARs are thus history-independent, and reactions to shocks are strictly proportional to the shock itself. However, these convenient properties do not hold within the class of nonlinear models, so Koop et al. (1996) developed a computation of generalized impulse response functions (GIRF).

In threshold-VARs, the reaction of an endogenous variable to a shock depends on the history, the state of the economy, the size of the shock under analysis at time 0, and the size and the sign of all the shocks hitting the economy within the period of interest. The GIRFs approach relies on the simulation of data depending on which regime the system is in at the time the shock hits the economy (the history Ω_{t-1} up to point t). The advantage of GIRFs is not only that it allows for the analysis of regime-dependent responses, but also that the effects of shocks of different sizes and directions can be analyzed. Due to this history and shock dependence, GIRFs lend themselves as an appropriate framework to explore the above-mentioned dimensions of nonlinearity such as regime dependencies, asymmetries (positive vs. negative shocks), and shock nonlinearity (small vs. large shocks).

$$\begin{aligned} GIRF = E[X_{t+m} \mid \varepsilon_t, \varepsilon_{t+1} = 0, \ldots, \varepsilon_{t+m} = 0, \Omega_{t-1}] - \\ E[X_{t+m} \mid \varepsilon_t = 0, \varepsilon_{t+1} = 0, \ldots, \varepsilon_{t+m} = 0, \Omega_{t-1}], \end{aligned} \tag{21}$$

where X_{t+m} is a vector of variables at horizon k, Ω_{t-1} is the information set available before the time of shock t. This implies that there is no restriction regarding the symmetry of the shocks in terms of their sizes because the effects of a ε_t shock depend on the magnitude of the current and subsequent shocks. Moreover, in the high stress regime, the size of the fiscal shock matters since a small shock is less likely to induce a change in the regime. Likewise, the impulse responses depend also on the entire history of the variables that affect the persistence of the different regimes. Therefore, to get complete information about the dynamics of the model, the impulse responses have to be simulated for various sizes and the signs of the shocks. The algorithm proceeds as follows.

The general idea is to simulate the model for any possible starting point over the time horizon of interest by feeding the system with bootstrapped shocks and repeating the exercise by adding a new shock of a specific size (1 or 2 times the standard deviation of the fundamental shock in the linear model). The procedure is done hundreds of times with a newly generated series of bootstrapped residuals. Finally, the responses to shocks specific to a particular regime are recovered by averaging the simulation results.

5. Data and Empirical Results

5.1. Data

We employ Brazilian monthly data for the period between January 2003 throughout July 2024. We obtained most of the series through the Time Series Management System of the Central Bank of Brazil (BACEN)[5]. The variables and their respective sources are specified below:

- Inflation rate (π): represented by the Extended National Consumer Price Index (IPCA) is the reference for the Brazilian inflation-targeting system, measured in monthly variation and calculated by The Brazilian Institute of Geography and Statistics (IBGE) (BACEN code: 433).
- Unemployment rate (U): We use the rate estimated by Alves et al. (2015) and updated by BACEN in the Inflation Report Statistical Annexes[6].
- Domestic product (y): We use the GDP accumulated over 12 months, in constant values from July 2024, adjusted using the IPCA. (BACEN code: 4380).
- Domestic interest rate (i) represented by the annualized Over-Selic rate accumulated in the month, released by the Central Bank (BACEN code: 4189).
- Government revenue (T) consists of total federal government revenue over 12 months, in constant values from July 2024, adjusted using the IPCA (BACEN code: 7544).
- Government spending (G) equivalent to the total federal government expenditure over 12 months, in constant values from July 2024, adjusted using the IPCA (BACEN code: 7547).
- Primary surplus (B) represented by the primary result of the central government over 12 months, in constant values from July 2024, adjusted using the IPCA[7].
- EWZ: 12 Months return to measure the performance of the domestic capital market.
- MSCI Financial Brazil: 12 Months return to measure companies' performance in financial sector.
- USD-BRL Exchange rate: average quotation of the US dollar (sale) published by the Central Bank (BACEN code: 3698).
- International reserves: consist of international funds under the liquidity concept (in USD million), published by the Central Bank (BACEN code: 3546).
- The (EMBI+): measured in base points and released by JPMorgan.

5.2. Empirical Findings

We present the results of the benchmark TVAR model (henceforth mainstream) and five TVAR models that include the fiscal impulse methods—OECD, IMF (2006), Dutch, IMF (2008), and Kalman filter. These methods are described in Section 2. Our results are from 2003 January through July 2024, a time interval that includes data related to COVID-19. Figure 1 presents the FSI, the threshold variable: values above zero are related to a high stress state and below zero are regarded as a low stress regime. Shaded ranges are relative to FSI periods above zero. In these cases, we consider high stress Regime or economic downturn. One can see eleven periods of financial stress, the last of which was due to COVID-19.

According to the threshold variable, we have 61.5% of observations in the low stress Regime and 38.5% in the high stress Regime.

The FSI highlights specific periods of stress: When Luiz Inácio Lula da Silva assumed the presidency of Brazil in 2003, the country was facing uncertainty in economic policies. The 2008 financial crisis was triggered by the collapse of the US housing market, leading to the bankruptcy of Lehman Brothers and a global recession known as the Great Recession. In 2015, the Brazilian economy encountered significant economic challenges. Lastly, in 2020, the COVID-19 pandemic caused a sudden halt in economic activities, resulting in a global recession.

To perform the TVAR estimations, we calculate the first difference of the variables in the vector X_t, Equation (19). Also, we performe stationarity tests, lag selection, and lineary tests, see results in Appendix B.

Stationarity tests are used to determine whether a time series is stationary. A time series is stationary when its statistical properties, like mean and variance, remain constant over time. Identifying stationarity is crucial because many time series analysis and modeling methods, such as ARIMA, VAR, and TVAR models, assume the series is stationary. If a series is non-stationary, the relationships between variables may be unstable over time, making accurate forecasting and analysis challenging. Common stationarity tests include the Augmented Dickey-Fuller (ADF) test, the Phillips-Perron (PP) test, and the KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test.

We perform these tests in the time series used in the models and show the results in Table A1 reports the stationarity. All entries are at least 10% of statistical significance. We also tested the presence of nonlinearities in the six specifications defined in Sections 2 and 4. In Table A2 (Panel A), we present the results of Bayesian information criteria to select the TVAR lags. Also, a formal test was performed to confirm the nonlinearity of fiscal and monetary responses. The LR test shown in Table A2 (Panel B) indicated that modeling with regime-switching is the most appropriate, as the null hypothesis of linearity was rejected. This result may justify the use of the TVAR model. In general, stationarity tests show that all variables are stationary, the TVAR lag selection indicates 1 lag as optimal for models, and LR Linearity Tests reject model linearity for all setups. The estimated parameter results are presented in Appendix B.

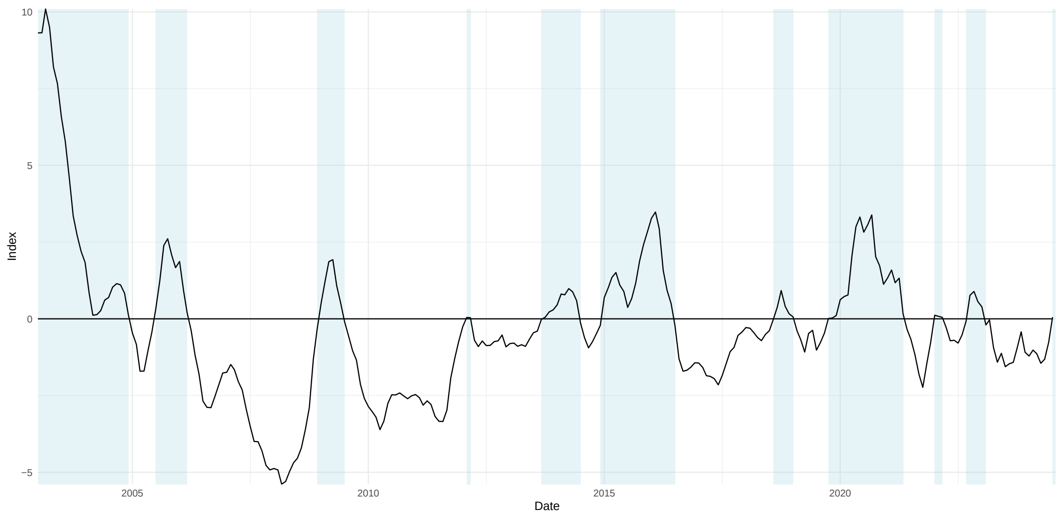

Figure 1. Financial Stress Index. Note: This figure presents the FSI from January 2003 through July 2024. Values above zero indicate a high stress regime, while values below zero signify a low stress regime. Shaded areas represent periods where the FSI exceeds zero, corresponding to high stress regime or economic downturns. There are eleven identified periods of financial stress, with one of the most recent attributed to COVID-19.

When we observe positive signs for parameters between variables from $t-1$ to t, it indicates that the relationship between these variables moves in the same direction. Conversely, a negative parameter in a low-stress regime might remain negative in a high stress regime, suggesting that the variable's response varies with economic conditions. For instance, the parameter governing the relationship between the output gap (Gap_{t-1}) and (Impulse_t) being negative in low stress regime suggests that fiscal policy might be procyclical.

In the TVAR mainstream model, during the low stress regime, the output gap (Gap_{t-1}) significantly impacts the balance (Balance_t) with a coefficient of 0.254. In the high stress regime, the output gap (Gap_{t-1}) significantly affects the balance (Balance_t) with a coefficient of 0.452, see Table A3. This indicates the countercyclical role of past economic performance in shaping current fiscal outcomes across different stress regimes. However, we find different results with the inclusion of Impulse of fiscal policy.

In the TVAR OECD model, during the low stress regime, the output gap (Gap_{t-1}) significantly impacts the balance (Balance_t) with a coefficient of 0.642 and the impulse (Impulse_t) with a coefficient of -0.442. In the high stress regime, the output gap (Gap_{t-1}) significantly affects the balance (Balance_t) with a coefficient of 0.926 and the impulse (Impulse_t) with a coefficient of -0.459, see Table A4. These results suggest an influence of the past output gap on current fiscal outcomes and nonconventional policy measures across different stress regimes.

The results in the TVAR IMF (2006) model also suggest an influence of past output gap on current fiscal outcomes and procyclical measures across different stress regimes, see Table A5 . During the low stress regime, the output gap (Gap_{t-1}) significantly impacts the balance ($Balance_t$) with a coefficient of 0.261 and the impulse ($Impulse_t$) with a coefficient of −0.091. In the high stress regime, the output gap (Gap_{t-1}) significantly affects the balance ($Balance_t$) with a coefficient of 0.742 and the impulse ($Impulse_t$) with a coefficient of −0.737.

We find similar results in the TVAR Dutch model as prior TVAR IMF (2006) and OECD, see Table A6. During the low stress regime, the output gap (Gap_{t-1}) significantly impacts the balance ($Balance_t$) with a coefficient of 0.182 and the impulse ($Impulse_t$) with a coefficient of −0.432. In the high stress regime, the output gap (Gap_{t-1}) significantly affects the balance ($Balance_t$) with a coefficient of 0.422 and the impulse ($Impulse_t$) with a coefficient of −0.802.

The TVAR IMF (2008) model differs from the results of previous models. During the low stress regime, the output gap (Gap_{t-1}) significantly impacts the balance ($Balance_t$) with a coefficient of −0.466 and the impulse ($Impulse_t$) with a coefficient of 0.628. In the high stress regime, the output gap (Gap_{t-1}) significantly affects the balance ($Balance_t$) with a coefficient of −0.482 and the impulse ($Impulse_t$) with a coefficient of 0.883, see Table A7. Even though it presents results opposite to previous TVAR OECD, IMF (2006), and Dutch models, this one still points to a procyclical behavior in fiscal policy, however in the Balance.

Lastly, TVAR Kaman model differs from all models presented previously, see Table A8. During the low stress regime, the output gap (Gap_{t-1}) does not significantly impact the balance ($Balance_t$) and the impulse ($Impulse_t$). In the high stress regime, the output gap (Gap_{t-1}) significantly affects the balance ($Balance_t$) with a coefficient of 0.137.

To make the data analysis more robust, we use generalized impulse response functions (GIRFs) in the TVAR results to understand the nonlinear dynamics between economic variables under different regimes, see Section 4.2. GIRFs allow for the analysis of how positive shocks to the output gap, for instance, affect other variables over time, providing a more direct and flexible interpretation. By applying a positive shock to the output gap, we can record responses in fiscal impulse, fiscal rule, and monetary policy and also obtain confidence intervals. This helps capture the interactions between these variables in both regimes.

To clarify the possible policy sets of results, we have summarized them as follows:

- Low Stress (i.e., Growth) Regime:
  - Expected Policy: Countercyclical—Contractionary Policy;
  - Nonconventional Policy: Procyclical—Expansionary Policy;
- High Stress (i.e., Downturn) Regime:
  - Expected Policy: Countercyclical—Expansionary Policy;
  - Nonconventional Policy: Procyclical—Contractionary Policy.

First, we describe the mainstream model in the low stress regime, which, by definition, represents a period of economic growth. Observing the two lower panels of Figure 2, a positive shock to the output gap results in a positive response in the Balance and a negative response in the Selic rate. This indicates that fiscal policy is contractionary (countercyclical), aligning with what is prescribed in the literature, whereas monetary policy (SELIC) is expansionary (procyclical), albeit only slightly different from zero, between approximately 7.5 and 10 months after the shock.

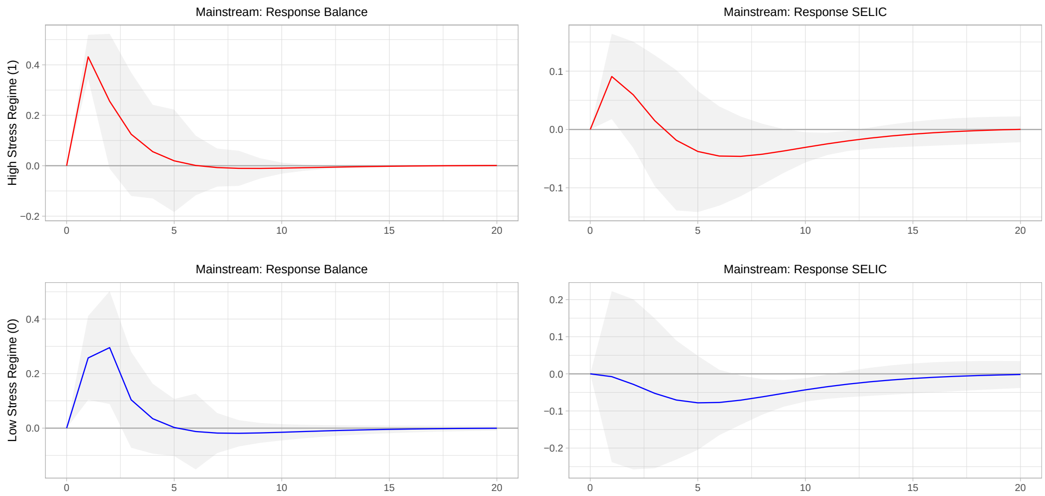

Figure 2. Generalized impulse response functions of the TVAR mainstream. Response of the Fiscal Balance and Interest Rate (SELIC) to One Positive Unit Shock of Output Gap. Note: This figure shows the generalized impulse response functions (GIRF) of the TVAR mainstream. Confidence bands (95%) were obtained from the empirical distribution of simulated GIRFs assuming normality. These results suggest the policies were countercyclical in all regimes to Balance and countercyclical to SELIC only in high stress regimes.

In the high stress regime, characterized by an economic downturn, the results are presented in the two upper panels of Figure 2. Here, applying a positive shock to the output gap also results in a positive response in the Balance. Conversely, a negative shock to the output gap would yield a negative Balance, demonstrating that fiscal policy is expansionary (countercyclical). Regarding monetary policy, applying the same analogy, a negative shock to the output gap results in a negative monetary policy response, suggesting that monetary policy is expansionary (countercyclical). Thus, under both policies, we observe expansionary (countercyclical) measures. Therefore, the mainstream model suggests that fiscal policy is countercyclical in both regimes, while monetary policy is countercyclical only in the high stress regime.

In the OECD model, within the low stress regime (economic growth), we decompose fiscal policy into Balance and Impulse, see Figure 3. The response of Balance to a positive shock in the output gap is statistically positive in the initial periods, suggesting that this component of fiscal policy is contractionary (countercyclical). However, Impulse is statistically negative in the initial periods, suggesting that this component of fiscal policy is expansionary (procyclical). Monetary policy, however, does not show statistically significant signals.

In the high stress regime, a period of economic downturn, monetary policy also does not show signals different from zero. However, the Balance of fiscal policy is positive after a positive shock in the output gap; otherwise, it would be negative after a negative shock in the output gap. Thus, we observe that part of fiscal policy is expansionary during an economic stress, responding in a countercyclical manner. Also analyzing the signals oppositely, the response of Impulse would be positive to a negative shock in the output gap, indicating that it is contractionary during a stress period (procyclical). Therefore, this model suggests that fiscal policy responds with asymmetric forces, with Balance being countercyclical and Impulse being procyclical.

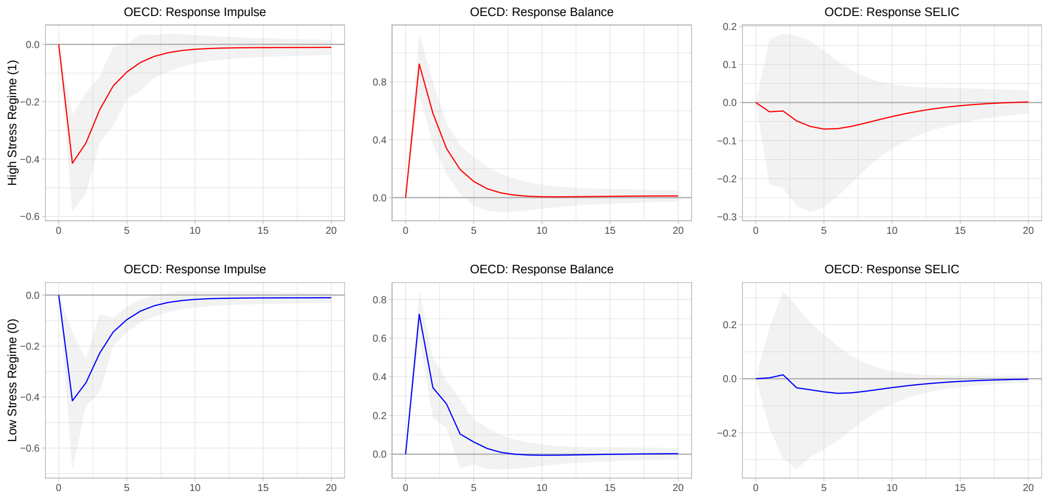

Figure 3. Generalized impulse response functions of the TVAR OECD. Response of the Fiscal Balance and Interest Rate (SELIC) to One Positive Unit Shock of Output Gap. Note: This figure shows the generalized impulse response functions (GIRF) of the TVAR OECD. Confidence bands (95%) obtained from the empirical distribution of simulated GIRFs assuming normality. These results suggest the Balance was countercyclical, however the Impulse was procyclical.

In the IMF (2006) model, as shown in Figure 4, the results suggest the same interpretation as the OECD model in the disaggregations of fiscal policy and in both regimes: in the low stress regime, the response of Balance is contractionary (countercyclical) and Impulse is expansionary (procyclical). In the high stress regime, the response of Balance is expansionary (countercyclical) and Impulse is contractionary (procyclical). On the other hand, monetary policy is significantly expansionary in the high stress regime (countercyclical), but without statistically significant results in the low stress period. Therefore, this model also suggests that fiscal policy responds with asymmetric forces, with Balance being countercyclical and Impulse being procyclical. Also, the Dutch model presents similar results to the IMF (2006) model, see Figure 5. Fiscal policy responds with asymmetric forces, with Balance being countercyclical and Impulse being procyclical.

The model that stands out from the others is the IMF (2008), as shown in Figure 6, as the responses of Balance and Impulse are opposite to those in the Dutch, IMF (2006), and OECD models. In the low stress regime, the response of Balance to a positive shock in the output gap is negative, indicating an expansionary movement (procyclical), and the response of Impulse is positive, suggesting a contractionary movement (countercyclical). In the high stress regime, the response of Balance is contractionary (procyclical), as there would be an increase in Balance in response to a negative shock in the output gap during an economic crisis, while Impulse is expansionary (countercyclical). On the other hand, monetary policy does not show statistically significant signals in either regime. Nonetheless, the IMF (2008) model also suggests that fiscal policy responds with asymmetric forces, with Balance being procyclical and Impulse countercyclical.

Lastly, we have the Kalman model, see Figure 7. In this analysis, the results suggest that only in the high stress regime do we observe statistically significant responses, specifically in the responses of Balance and the SELIC. At this point, both fiscal and monetary policies exhibit expansionary movements during a crisis, meaning they are countercyclical, which aligns with the results of the Dutch and IMF (2006) models.

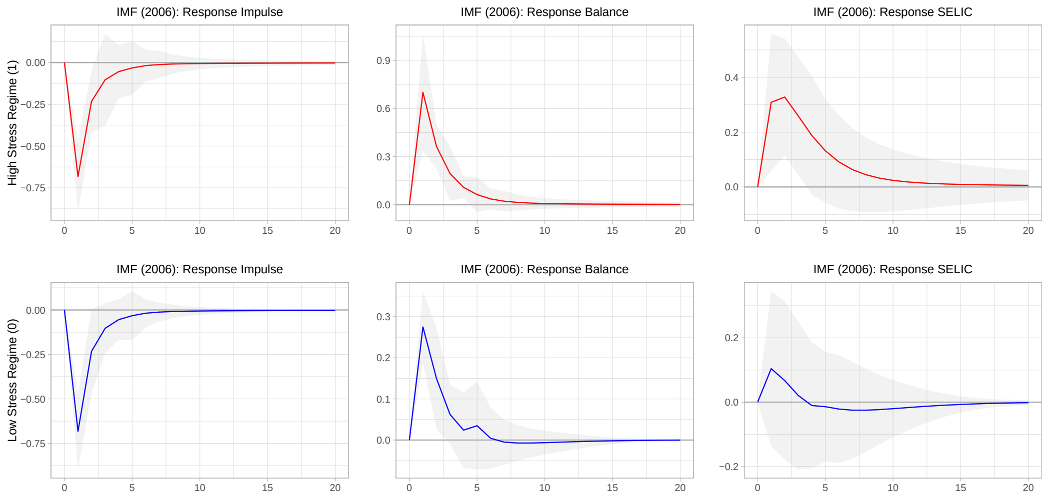

Figure 4. Generalized impulse response functions of the TVAR IMF (2006). Response of the Fiscal Balance and Interest Rate (SELIC) to One Positive Unit Shock of Output Gap. Note: This figure shows the generalized impulse response functions (GIRF) of the TVAR IMF (2006). Confidence bands (95%) were obtained from the empirical distribution of simulated GIRFs assuming normality. These results suggest the impulse fiscal response was procyclical in both regimes, while the fiscal rule was countercyclical.

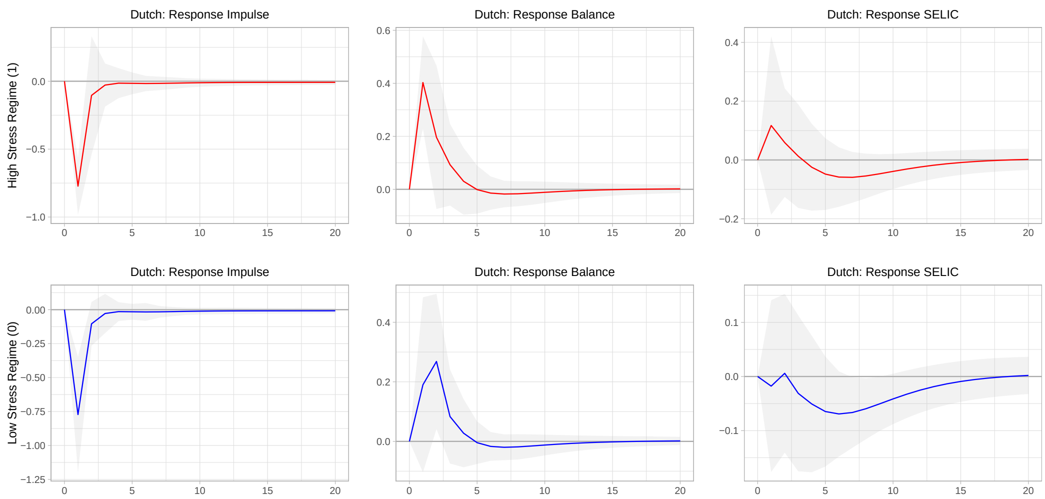

Figure 5. Generalized impulse response functions of the TVAR Dutch. Response of the Fiscal Balance and Interest Rate (SELIC) to One Positive Unit Shock of Output Gap. Note: This figure shows the generalized impulse response functions (GIRF) of the TVAR Dutch. Confidence bands (95%) were obtained from the empirical distribution of simulated GIRFs assuming normality. These results suggest the impulse fiscal response was procyclical in both regimes, while the fiscal rule was countercyclical.

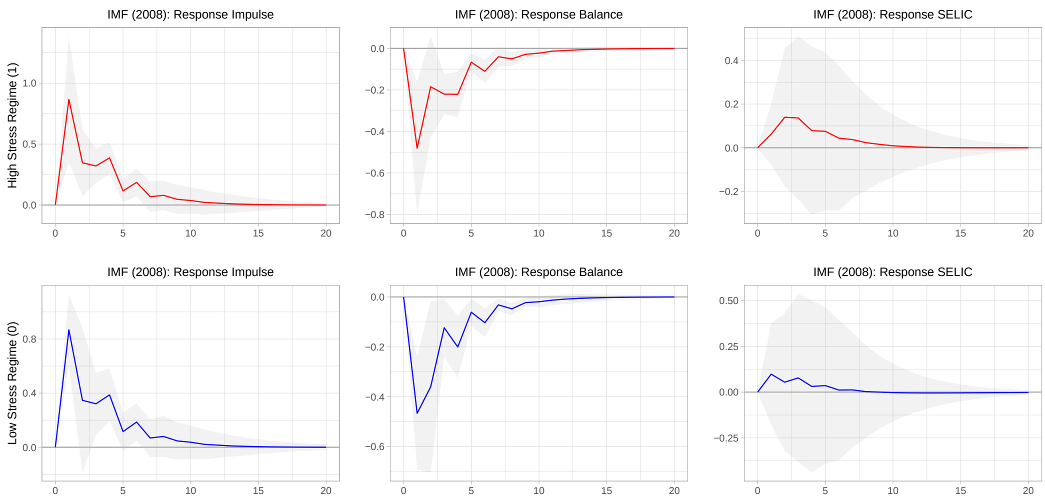

Figure 6. Generalized impulse response functions of the TVAR IMF (2008). Response of the Fiscal Balance and Interest Rate (SELIC) to One Positive Unit Shock of Output Gap. Note: This figure shows the generalized impulse response functions (GIRF) of the TVAR IMF (2008). Confidence bands (95%) were obtained from the empirical distribution of simulated GIRFs assuming normality. These results suggest the Balance was procyclical and the Impulse was countercyclical.

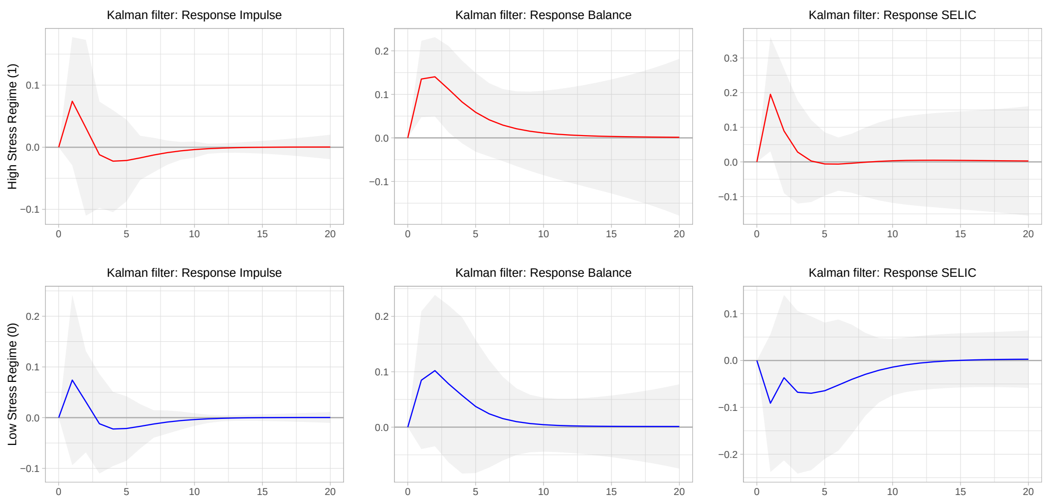

Figure 7. Generalized impulse response functions of the TVAR Kalman. Response of the Fiscal Balance and Interest Rate (SELIC) to One Positive Unit Shock of Output Gap. Note: This figure shows the generalized impulse response functions (GIRF) of the TVAR Kalman. Confidence bands (95%) were obtained from the empirical distribution of simulated GIRFs assuming normality. These results suggest the Impulse was procyclical in both regimes, while the Balance response was also countercyclical.

It is worth noting that only the OECD model takes into account the unemployment rate and the structural unemployment rate, which could make its results more robust. Therefore, the fact that the results of the Dutch and IMF (2006) models are also similar to the OECD model helps to strengthen the interpretation of the presented exercises; that is, fiscal policy responds with asymmetric forces, with Balance being countercyclical and Impulse procyclical. Even the results of the IMF (2009) model also suggest that fiscal policy responds with asymmetric forces in both cycles.

In summary, the mainstream model indicates that fiscal policy is countercyclical in both low stress (growth) and high stress (crisis) regimes, with monetary policy being countercyclical only in high stress. The OECD model decomposes fiscal policy into Balance (countercyclical) and Impulse (procyclical), showing asymmetric responses in both regimes, with monetary policy showing no significant signals. The IMF (2006) model aligns with the OECD model, indicating countercyclical Balance and procyclical Impulse, with monetary policy being expansionary in high stress. The Dutch model produces similar results to the IMF (2006) model. On the contrary, the IMF (2008) model shows opposite responses: Balance is procyclical and Impulse countercyclical in both regimes, with no significant monetary policy signals. The Kalman model reveals statistically significant countercyclical responses for both fiscal and monetary policies in the high stress regime, aligning with the Dutch and IMF (2006) models. The robustness of the OECD model is strengthened by considering unemployment rates, with similar results in the Dutch and IMF (2006) models supporting the interpretation of asymmetric fiscal policy responses.

Also, by using generalized impulse response functions (GIRFs), we capture the nonlinear dynamics and initial statistical significance of fiscal impulse, balance, and monetary policy responses. This comprehensive analysis underscores the importance of considering methodological approaches when interpreting fiscal policy impacts, ensuring robust and context-sensitive economic assessments.

These results are consistent with broader studies such as those by Ilzetzki and Végh (2008), which found overwhelming evidence to support the idea that procyclical fiscal policy in developing countries is indeed a reality and not fiction. The main contributions of our results are twofold. First, we present five methods to disaggregate fiscal policy into rule and impulse, allowing for comparisons among results and creating a scoreboard based on statistical significance. Second, the confidence interval of the generalized impulse response function provides robustness that is absent in Wichmann and Portugal (2013), whose results also suggest asymmetries in fiscal policy.

Our results are in line with Arena and Revilla (2009), which discusses procyclical fiscal policy in Brazil, with evidence from the states. Their results suggest the existence of a procyclical fiscal policy in Brazil at the state level. However, the introduction of the Fiscal Responsibility Law in 2000 helped to reduce spending-side procyclicality in Brazilian states.

Moreover, assuming the hypothesis of procyclical spending is inefficient for smoothing economic cycles, the results from Holland et al. (2020) further support this inefficiency. They argue that while fiscal policy predominantly operated in a countercyclical manner, monetary policy was procyclical. Additionally, They argue that estimates of the government spending multiplier are generally close to zero. While higher multipliers are reported using TVAR and other methods, these are not robust due to specification issues. Therefore, this introduces further inefficiencies in the Brazilian economy.

In general, for economies with procyclical fiscal policy, some suggestions include implementing countercyclical policies, Bova et al. (2014). This involves adopting fiscal policies that counter economic fluctuations by increasing public spending during recessions and reducing it during economic expansions. Maintaining fiscal stability is also crucial, ensuring a balanced budget and avoiding excessive fiscal deficits that could exacerbate economic fluctuations. Additionally, it is important to promote structural reforms that improve the efficiency of the public sector and reduce reliance on procyclical fiscal policies. These measures can help mitigate the negative effects of procyclical fiscal policies and promote a more stable and sustainable economy.

6. Concluding Remarks

This paper examines the responses of fiscal and monetary policies during periods of financial stress in Brazil. Using the Financial Stress Index (FSI) as a threshold variable, the study identifies two states: low-stress (economic growth) and high stress (economic downturn). Findings from various TVAR models indicate significant asymmetries in fiscal policies. The research covers data from January 2003 to July 2024, including the economic disruption caused by COVID-19, which was marked by significant fiscal interventions aimed at mitigating the economic downturn.

The mainstream model shows countercyclical fiscal policy in both regimes, with monetary policy being countercyclical only in high stress. The OECD model finds asymmetric fiscal responses: Balance is countercyclical and Impulse is procyclical, with no significant monetary signals. The IMF (2006) and Dutch models align with the OECD results. The IMF (2008) model stands out, showing procyclical Balance and countercyclical Impulse, with no significant monetary signals. The Kalman model finds statistically significant countercyclical fiscal and monetary responses in high stress, which is similar to the Dutch and IMF (2006) models. The OECD model's consideration of unemployment rates adds robustness to its findings, which are supported by similar results in the Dutch and IMF (2006) models.

Therefore, this study underscores the significance of incorporating methodological approaches when analyzing the impacts of fiscal policy, which indicates that the government's fiscal policy has predominantly exhibited procyclical tendencies in terms of Impulse. This highlights the necessity for more robust and context-sensitive economic assessments to ensure the stability and sustainability of economic policies.

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Data Availability Statement: The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding authors.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A. Algorithm for Generalized Impulse Response Function

We follow Baum and Koester (2011) algorithm to estimate the generalized impulse response function (GIRF) specific to each regime (high stress and low stress) with R observations:

1. Pick a history Ω^r_{t-1};
2. Pick a sequence of shocks by bootstrapping the residuals of the TVAR taking into account the different variance-covariance matrix characterizing each regime;
3. Given the history Ω^r_{t-1}, the estimated TVAR coefficients and bootstrapped residuals, simulate the evolution of the model over the period of interest;
4. Repeat the previous exercise by adding a new shock at time 0;
5. Repeat B times the steps from 2 to 4 ;
6. Compute the average difference between the shocked path on the non-shocked one;
7. Repeat steps from 1 to 6 over all the possible starting points;
8. Compute the average GIRF associated with a particular regime with R observations as follows:

$$y_{t+m}(\varepsilon_0) = \frac{1}{R}\sum_{r=1}^{R} \frac{y_{t+m}\left(\Omega^r_{t-1} \mid \varepsilon_0, E^*_{t+m}\right) - y_{t+m}\left(\Omega^r_{t-1} \mid \varepsilon^*_{t+m}\right)}{B}$$

Once GIRFs are obtained, we apply the algorithm in Schmidt (2013) to compute the related confidence bands:

1. Generate artificial data recursively using the coefficients and residuals from the TVAR;

2. Use recursive data to recalculate TVAR coefficients as well as residuals;
3. Use the empirical data and the coefficients and residuals in 2 and calculate the GIRFs as described above;
4. Repeat steps 1–3 S times to generate an empirical GIRF distribution and obtain confidence intervals for the desired significance.

We used B = 500, R = 500, and S = 1000. All of the calculations were carried out using R programming language and package `tsDyn`, see (Fabio Di Narzo et al. 2009; R Core Team 2021).

Appendix B. Stationarity Tests, Lag Selection, Lineary Tests, and Threshold-VAR Parameters Estimations

Table A1. Stationarity tests.

Time Series	ADF	KPSS (4L)	KPSS (12L)	PP (4L)	PP (12L)
Output Gap	−5.023	0.042	0.034	−6.486	−6.351
IPCA	−4.884	0.080	0.075	−8.442	−8.464
SELIC	−5.416	0.189	0.140	−6.890	−7.292
Balance	−5.185	2.544	1.119	−8.321	−8.085
Impulse OECD	−4.940	0.033	0.033	−15.23	−15.22
Impulse IMF (2006)	−4.754	0.041	0.040	−10.22	−10.09
Impulse Dutch	−4.984	0.120	0.107	−15.28	−15.43
Impulse IMF (2008)	−4.704	0.034	0.034	−14.05	−14.02
Impulse Kalman	−6.280	0.052	0.060	−15.93	−16.14

Note: This table reports the stationarity tests of time series used in our models until now. The tests are Augmented Dickey–Fuller test (ADF), Kwiatkowski–Phillips–Schmidt–Shin tests (KPSS), and Phillips-Perron tests (PP). All entries are least 90% of statistical significance. The variables IPCA, SELIC, Balance, and FSI represent the inflation rate, the realized interest rate, the primary surplus, and the Financial Stress Index, respectively. The Output gap, interest rate, and Balance are in first difference.

Table A2. TVAR lag selection and LR Linearity Tests.

Panel A: TVAR Lag Selection							
	Lags	Mainstream	OECD	IMF (2006)	Dutch	IMF (2008)	Kalman
	1	**−14,712.6**	**−17,585.8**	**−18,177.6**	**−17,888.4**	**−19,494.5**	**−18,233.7**
	2	−14,588.9	−17,384.7	−17,947.5	−17,744.1	−19,868.3	−18,027.0
Panel B: LR Linearity Tests							
	LR Test	52.765	62.58	72.82	60.04	81.76	64.18
	p-value	3.7×10^{-13}	2.5×10^{-15}	1.4×10^{-17}	9.2×10^{-15}	1.5×10^{-19}	1.1×10^{-15}

Note: Panel (A) reports the TVAR lag selection based on Bayesian information criterion (BIC), in which bold entries represent the chosen model. Panel (B) reports LR Linearity Tests. The null hypothesis is of model linearity.

Table A3. TVAR mainstream.

	Low Stress Regime (0)					**High Stress Regime (1)**				
	$\mathbf{Gap}_{t-1}$	$\mathbf{IPCA}_{t-1}$	$\mathbf{SELIC}_{t-1}$	$\mathbf{Balance}_{t-1}$	$\mathbf{FSI}_{t-1}$	$\mathbf{Gap}_{t-1}$	$\mathbf{IPCA}_{t-1}$	$\mathbf{SELIC}_{t-1}$	$\mathbf{Balance}_{t-1}$	$\mathbf{FSI}_{t-1}$
Gap_t	**0.525**	0.022	0.040	**0.115**	−0.011	**0.662**	**0.063**	0.023	0.100	0.008
	0.08	0.04	0.05	0.05	0.01	0.07	0.04	0.04	0.06	0.01
IPCA_t	**−0.569**	**0.444**	0.140	0.159	−0.037	**−0.302**	**0.539**	**0.302**	0.033	−0.027
	0.15	0.08	0.10	0.10	0.03	0.14	0.07	0.09	0.12	0.02
SELIC_t	−0.009	**0.104**	**0.749**	0.066	−0.001	0.102	**0.104**	**0.710**	**−0.046**	**−0.056**
	0.09	0.05	0.06	0.06	0.02	0.09	0.04	0.05	0.07	0.01
Balance_t	**0.254**	0.091	**0.131**	**0.217**	0.006	**0.452**	**0.125**	0.001	**0.513**	−0.007
	0.11	0.06	0.07	0.08	0.02	0.10	0.05	0.06	0.08	0.01

Table A3. *Cont.*

	Low Stress Regime (0)					High Stress Regime (1)				
	Gap$_{t-1}$	**IPCA$_{t-1}$**	**SELIC$_{t-1}$**	**Balance$_{t-1}$**	**FSI$_{t-1}$**	**Gap$_{t-1}$**	**IPCA$_{t-1}$**	**SELIC$_{t-1}$**	**Balance$_{t-1}$**	**FSI$_{t-1}$**
FSI$_t$	0.132	−0.062	**0.207**	−0.178	**0.983**	**−0.361**	0.068	**0.221**	−0.102	**0.925**
	0.18	0.08	0.11	0.12	0.03	0.16	0.08	0.10	0.13	0.02

Note: This table reports the TVAR mainstream parameters in low stress regime. Entries in bold indicates statistically significant at the 10% level. The variables GAP, IPCA, SELIC, Balance, and FSI represent the output gap, inflation rate, realized interest rate, primary surplus, and Financial Stress Index, respectively.

Table A4. TVAR OECD.

	Low Stress Regime (0)						High Stress Regime (1)					
	Gap$_{t-1}$	**IPCA$_{t-1}$**	**SELIC$_{t-1}$**	**Impulse$_{t-1}$**	**Balance$_{t-1}$**	**FSI$_{t-1}$**	**Gap$_{t-1}$**	**IPCA$_{t-1}$**	**SELIC$_{t-1}$**	**Impulse$_{t-1}$**	**Balance$_{t-1}$**	**FSI$_{t-1}$**
GAP$_t$	**0.441**	0.018	0.041	**0.070**	**0.119**	−0.007	**0.634**	**0.065**	−0.002	0.018	**0.089**	0.007
	0.088	0.040	0.050	0.039	0.044	0.013	0.086	0.038	0.048	0.036	0.049	0.010
IPCA$_t$	**−0.738**	**0.463**	0.158	−0.010	**0.253**	−0.024	**−0.293**	**0.536**	**0.323**	−0.037	0.029	−0.024
	0.169	0.077	0.096	0.075	0.085	0.026	0.165	0.073	0.093	0.069	0.094	0.020
SELIC$_t$	−0.047	**0.089**	**0.740**	**0.097**	0.040	−0.002	−0.053	**0.107**	**0.740**	−0.029	0.101	**−0.039**
	0.101	0.046	0.057	0.045	0.051	0.015	0.099	0.043	0.055	0.041	0.056	0.012
Impulse$_t$	**−0.442**	0.066	**0.115**	−0.036	**0.969**	**0.040**	**−0.459**	−0.026	−0.021	0.067	**1.063**	**0.030**
	0.121	0.055	0.068	0.053	0.060	0.018	0.118	0.052	0.066	0.049	0.067	0.014
Balance$_t$	**0.642**	0.042	0.038	0.060	**0.178**	−0.027	**0.926**	**0.184**	−0.011	0.103	**0.185**	**−0.033**
	0.170	0.077	0.096	0.075	0.085	0.026	0.166	0.073	0.093	0.069	0.094	0.020
FSI$_t$	0.251	−0.080	**0.189**	−0.004	**−0.205**	**0.973**	−0.262	0.060	**0.243**	−0.042	−0.134	**0.920**
	0.201	0.091	0.114	0.089	0.101	0.030	0.196	0.086	0.110	0.082	0.112	0.024

Note: This table reports the TVAR mainstream parameters in low stress regime. Entries in bold indicates statistically significant at the 10% level. The variables GAP, IPCA, SELIC, Balance, and FSI represent the output gap, inflation rate, realized interest rate, primary surplus, and Financial Stress Index, respectively.

Table A5. TVAR IMF 2006.

	Low Stress Regime (0)						High Stress Regime (1)					
	Gap$_{t-1}$	**IPCA$_{t-1}$**	**SELIC$_{t-1}$**	**Impulse$_{t-1}$**	**Balance$_{t-1}$**	**FSI$_{t-1}$**	**Gap$_{t-1}$**	**IPCA$_{t-1}$**	**SELIC$_{t-1}$**	**Impulse$_{t-1}$**	**Balance$_{t-1}$**	**FSI$_{t-1}$**
GAP$_t$	**0.576**	0.028	0.042	−0.094	0.014	−0.010	**0.760**	**0.064**	0.018	−0.163	−0.110	0.011
	0.105	0.040	0.051	0.135	0.156	0.014	0.105	0.038	0.047	0.175	0.203	0.011
IPCA$_t$	**−0.446**	**0.457**	0.150	−0.176	−0.108	−0.033	−0.031	**0.525**	**0.265**	**−0.566**	−0.634	−0.011
	0.199	0.076	0.097	0.256	0.297	0.026	0.199	0.073	0.088	0.333	0.386	0.021
SELIC$_t$	0.097	**0.107**	**0.749**	−0.213	−0.160	0.003	**0.329**	**0.086**	**0.681**	**−0.442**	**−0.596**	**−0.041**
	0.119	0.045	0.058	0.154	0.178	0.016	0.119	0.044	0.053	0.199	0.232	0.012
Impulse$_t$	−0.091	**−0.089**	−0.102	0.227	0.024	0.001	**−0.737**	−0.063	0.028	**1.224**	**0.904**	−0.014
	0.139	0.053	0.068	0.179	0.207	0.018	0.139	0.051	0.062	0.232	0.270	0.015
Balance$_t$	**0.261**	**0.117**	0.084	−0.128	0.098	0.008	**0.742**	0.069	−0.046	**−0.787**	−0.391	**0.029**
	0.124	0.047	0.060	0.159	0.184	0.016	0.124	0.046	0.055	0.207	0.240	0.013
FSI$_t$	−0.109	−0.082	**0.189**	0.350	0.359	**0.975**	**−0.663**	0.080	**0.258**	0.607	0.620	**0.910**
	0.235	0.089	0.114	0.302	0.350	0.031	0.235	0.086	0.104	0.392	0.456	0.025

Note: This table reports the TVAR mainstream parameters in low stress regime. Entries in bold indicates statistically significant at the 10% level. The variables GAP, IPCA, SELIC, Balance, and FSI represent the output gap, inflation rate, realized interest rate, primary surplus, and Financial Stress Index, respectively.

Table A6. TVAR Dutch.

	Low Stress Regime (0)						High Stress Regime (1)					
	Gap$_{t-1}$	**IPCA$_{t-1}$**	**SELIC$_{t-1}$**	**Impulse$_{t-1}$**	**Balance$_{t-1}$**	**FSI$_{t-1}$**	**Gap$_{t-1}$**	**IPCA$_{t-1}$**	**SELIC$_{t-1}$**	**Impulse$_{t-1}$**	**Balance$_{t-1}$**	**FSI$_{t-1}$**
GAP$_t$	**0.546**	0.028	0.043	−0.041	0.079	−0.009	**0.712**	0.062	0.010	−0.036	0.034	0.004
	0.085	0.040	0.051	0.056	0.080	0.014	0.078	0.039	0.048	0.064	0.086	0.011
IPCA$_t$	**−0.499**	**0.458**	0.153	−0.087	0.004	−0.032	−0.241	**0.528**	**0.297**	−0.141	−0.119	−0.016
	0.162	0.076	0.097	0.107	0.153	0.026	0.150	0.074	0.092	0.123	0.165	0.021
SELIC$_t$	−0.023	**0.106**	**0.750**	0.046	0.103	−0.004	0.129	**0.099**	**0.748**	−0.066	−0.146	**−0.039**
	0.096	0.045	0.058	0.064	0.091	0.016	0.089	0.044	0.055	0.073	0.099	0.012
Impulse$_t$	**−0.432**	−0.096	−0.123	**0.149**	**0.831**	0.020	**−0.802**	−0.101	−0.113	**0.357**	**0.739**	0.024
	0.135	0.064	0.081	0.090	0.128	0.022	0.125	0.062	0.077	0.103	0.138	0.018

Table A6. *Cont.*

	Low Stress Regime (0)						High Stress Regime (1)					
	Gap_{t-1}	$IPCA_{t-1}$	$SELIC_{t-1}$	$Impulse_{t-1}$	$Balance_{t-1}$	FSI_{t-1}	Gap_{t-1}	$IPCA_{t-1}$	$SELIC_{t-1}$	$Impulse_{t-1}$	$Balance_{t-1}$	FSI_{t-1}
$Balance_t$	**0.182**	**0.116**	0.085	0.045	**0.271**	0.003	**0.422**	**0.086**	0.009	−0.011	**0.456**	0.006
	0.103	0.049	0.062	0.069	0.098	0.017	0.096	0.047	0.059	0.078	0.106	0.013
FSI_t	0.044	−0.082	0.186	0.044	0.027	**0.980**	**−0.469**	0.087	**0.251**	**0.253**	0.151	**0.913**
	0.190	0.090	0.114	0.126	0.180	0.031	0.177	0.087	0.109	0.144	0.194	0.025

Note: This table reports the TVAR mainstream parameters in low stress regime. Entries in bold indicates statistically significant at the 10% level. The variables GAP, IPCA, SELIC, Balance, and FSI represent the output gap, inflation rate, realized interest rate, primary surplus, and Financial Stress Index, respectively.

Table A7. TVAR IMF 2008.

	Low Stress Regime (0)						High Stress Regime (1)					
	Gap_{t-1}	$IPCA_{t-1}$	$SELIC_{t-1}$	$Impulse_{t-1}$	$Balance_{t-1}$	FSI_{t-1}	Gap_{t-1}	$IPCA_{t-1}$	$SELIC_{t-1}$	$Impulse_{t-1}$	$Balance_{t-1}$	FSI_{t-1}
GAP_t	**0.682**	0.063	0.016	0.055	−0.145	−0.007	**0.676**	0.059	0.010	0.081	0.109	0.004
	0.090	0.040	0.050	0.056	0.095	0.013	0.082	0.040	0.047	0.062	0.103	0.010
$IPCA_t$	**−0.446**	**0.477**	0.133	0.061	−0.059	−0.034	**−0.443**	**0.503**	**0.327**	0.113	0.313	−0.024
	0.174	0.079	0.098	0.110	0.185	0.026	0.160	0.077	0.092	0.121	0.201	0.020
$SELIC_t$	0.100	**0.132**	**0.727**	0.048	−0.106	0.002	0.060	**0.105**	**0.759**	−0.028	−0.008	**−0.044**
	0.104	0.047	0.058	0.065	0.110	0.015	0.095	0.046	0.055	0.072	0.120	0.012
$Impulse_t$	**0.628**	−0.004	0.106	**0.181**	**0.548**	0.004	**0.883**	0.013	0.020	**0.423**	**0.436**	−0.010
	0.169	0.076	0.095	0.107	0.179	0.025	0.155	0.075	0.089	0.118	0.195	0.019
$Balance_t$	**−0.466**	0.091	0.021	0.087	−0.209	−0.010	**−0.482**	0.089	0.015	0.118	0.161	0.005
	0.133	0.060	0.074	0.083	0.140	0.019	0.121	0.059	0.070	0.092	0.153	0.015
FSI_t	0.151	−0.060	0.180	−0.094	−0.197	**0.983**	−0.273	0.093	**0.212**	−0.148	−0.295	**0.925**
	0.207	0.093	0.116	0.130	0.219	0.030	0.189	0.092	0.109	0.144	0.238	0.024

Note: This table reports the TVAR mainstream parameters in low stress regime. Entries in bold indicates statistically significant at the 10% level. The variables GAP, IPCA, SELIC, Balance, and FSI represent the output gap, inflation rate, realized interest rate, primary surplus, and Financial Stress Index, respectively.

Table A8. TVAR Kalman Filter.

	Low Stress Regime (0)						High Stress Regime (1)					
	Gap_{t-1}	$IPCA_{t-1}$	$SELIC_{t-1}$	$Impulse_{t-1}$	$Balance_{t-1}$	FSI_{t-1}	Gap_{t-1}	$IPCA_{t-1}$	$SELIC_{t-1}$	$Impulse_{t-1}$	$Balance_{t-1}$	FSI_{t-1}
GAP_t	**0.491**	0.016	0.028	0.058	**0.204**	−0.013	**0.668**	0.062	0.024	0.113	0.092	0.008
	0.087	0.040	0.052	0.077	0.099	0.013	0.090	0.038	0.045	0.117	0.087	0.010
$IPCA_t$	**−0.606**	**0.438**	0.127	0.097	0.255	−0.039	**−0.290**	**0.538**	**0.302**	0.057	0.018	−0.027
	0.167	0.077	0.099	0.147	0.190	0.026	0.172	0.073	0.086	0.224	0.168	0.018
$SELIC_t$	−0.096	**0.089**	**0.719**	−0.080	**0.291**	−0.006	**0.206**	**0.094**	**0.716**	0.160	**−0.176**	**−0.057**
	0.100	0.046	0.059	0.088	0.114	0.015	0.103	0.044	0.051	0.134	0.100	0.011
$Impulse_t$	0.080	0.027	**0.114**	0.045	**−0.289**	−0.001	0.074	**0.088**	−0.018	−0.043	0.037	−0.002
	0.086	0.040	0.051	0.076	0.098	0.013	0.089	0.038	0.044	0.116	0.087	0.009
$Balance_t$	0.084	**0.048**	−0.015	0.019	**0.743**	0.002	**0.137**	**0.060**	0.006	0.078	**0.778**	−0.002
	0.062	0.029	0.037	0.055	0.071	0.010	0.064	0.027	0.032	0.084	0.063	0.007
FSI_t	0.244	−0.044	**0.247**	0.010	**−0.468**	**0.989**	−0.317	0.065	**0.224**	−0.015	−0.158	**0.925**
	0.196	0.090	0.117	0.172	0.223	0.030	0.202	0.086	0.101	0.263	0.197	0.022

Note: This table reports the TVAR mainstream parameters in low stress regime. Entries in bold indicates statistically significant at the 10% level. The variables GAP, IPCA, SELIC, Balance, and FSI represent the output gap, inflation rate, realized interest rate, primary surplus, and Financial Stress Index, respectively.

Notes

1. https://portalibre.fgv.br/en/codace, accessed on 28 November 2024.
2. U^P and Y^P are estimated using the Hodrick-Prescott (HP) filter.
3. In the final FSI calculation, betas were only considered when their value was greater than one and when the returns of the banking sector's shares were less than the returns of the market as a whole.
4. Examples of vector autoregression analysis considering the threshold effect can be found in Afonso et al. (2018), Calza and Sousa (2005), Atanasova (2003), Balke (2000), Galbraith (1996), and McCallum (1991) .
5. https://www3.bcb.gov.br/sgspub, accessed on 28 November 2024.
6. https://www.bcb.gov.br/en/publications/statistical_annex, accessed on 28 November 2024.
7. https://www.tesourotransparente.gov.br/publicacoes/central-government-primary-balance-rtn-english/2024/7, accessed on 28 November 2024.

References

Afonso, Antonio, Jaromir Baxa, and Michal Slavík. 2018. Fiscal developments and financial stress: A threshold var analysis. *Empirical Economics* 54: 395–423. [CrossRef]

Aizenman, Joshua, John Beirne, Menzie D. Chinn, Yothin Jinjarak, and Donghyun Park. 2024. Monetary and fiscal policy challenges in emerging markets amid elevated uncertainty. *Journal of International Money and Finance* 149: 103–99. [CrossRef]

Alessandri, Piergiorgio, and Haroon Mumtaz. 2017. Financial conditions and density forecasts for us output and inflation. *Review of Economic Dynamics* 24: 66–78. [CrossRef]

Alves, Sergio Afonso Lago, and Angelo Marsiglia Fasolo. 2015. *Not Just Another Mixed Frequency Paper*. Brasília: Banco Central do Brasil.

Arena, Marco, and Julio E Revilla. 2009. *Pro-Cyclical Fiscal Policy in Brazil: Evidence from the States*. World Bank Policy Research Working Paper. Washington, DC: The World Bank, p. 5144.

Atanasova, Christina. 2003. Credit market imperfections and business cycle dynamics: A nonlinear approach. *Studies in Nonlinear Dynamics & Econometrics* 7: 1–22.

Bakas, Dimitrios, and Athanasios Triantafyllou. 2020. Commodity price volatility and the economic uncertainty of pandemics. *Economics Letters* 193: 109283. [CrossRef]

Balakrishnan, Ravi, Stephan Danninger, Selim Elekdag, and Irina Tytell. 2011. The transmission of financial stress from advanced to emerging economies. *Emerging Markets Finance and Trade* 47 (Suppl. 2): 40–68. [CrossRef]

Balassone, Fabrizio, Maura Francese, and Stefania Zotteri. 2010. Cyclical asymmetry in fiscal variables in the eu. *Empirica* 37: 381–402. [CrossRef]

Balke, Nathan S. 2000. Credit and economic activity: Credit regimes and nonlinear propagation of shocks. *Review of Economics and Statistics* 82: 344–49. [CrossRef]

Baum, Anja, and Gerrit Koester. 2011. *The Impact of Fiscal Policy on Economic Activity over the Business Cycle-Evidence from a Threshold var Analysis*. Frankfurt: Deutsche Bundesbank.

Baxa, Jaromír, Roman Horváth, and Bořek Vašíček. 2013. Time-varying monetary-policy rules and financial stress: Does financial instability matter for monetary policy? *Journal of Financial Stability* 9: 117–38. [CrossRef]

Bogdan, Dima, Ştefana Maria Dima, and Ioan Roxana. 2021. Remarks on the behaviour of financial market efficiency during the COVID-19 pandemic. the case of vix. *Finance Research Letters* 43: 101967.

Bova, Ms Elva, Nathalie Carcenac, and Ms Martine Guerguil. 2014. *Fiscal Rules and the Procyclicality of Fiscal Policy in the Developing World*. Washington, DC: International Monetary Fund.

Calza, Alessandro, and João Sousa. 2005. Output and inflation responses to credit shocks: Are there threshold effects in the euro area? *Studies in Nonlinear Dynamics & Econometrics* 10: 1–21.

Cardarelli, Roberto, Selim Ali Elekdag, and Subir Lall. 2009. *Financial Stress, Downturns, and Recoveries*. IMF Working Papers. Washington, DC: International Monetary Fund, pp. 1–58.

Cardarelli, Roberto, Selim Elekdag, and Subir Lall. 2011. Financial stress and economic contractions. *Journal of Financial Stability* 7: 78–97. [CrossRef]

Claessens, Stijn, Hui Tong, and Shang-Jin Wei. 2012. From the financial crisis to the real economy: Using firm-level data to identify transmission channels. *Journal of International Economics* 88: 375–87. [CrossRef]

Claessens, Stijn, M Ayhan Kose, and Marco E Terrones. 2009. What happens during recessions, crunches and busts? *Economic Policy* 24: 653–700. [CrossRef]

Davig, Troy, and Craig Hakkio. 2010. What is the effect of financial stress on economic activity. *Federal Reserve Bank of Kansas City Economic Review* 95: 35–62.

Davoodi, Hamid R, Paul Elger, Alexandra Fotiou, Daniel Garcia-Macia, Xuehui Han, Andresa Lagerborg, W Raphael Lam, and Paulo Medas. 2022. Fiscal rules and fiscal councils. In *Recent Trends and Performance During the COVID-19 Pandemic*. Washington, DC: International Monetary Fund.

Evgenidis, Anastasios, and Athanasios Tsagkanos. 2017. Asymmetric effects of the international transmission of us financial stress. A threshold-var approach. *International Review of Financial Analysis* 51: 69–81. [CrossRef]

Fabio Di Narzo, Antonio, Jose Luis Aznarte, and Matthieu Stigler. 2009. *tsDyn: Time Series Analysis Based on Dynamical Systems Theory*. R Package Version 0.7. Oxford: Oxford University Press.

Ferraresi, Tommaso, Andrea Roventini, and Giorgio Fagiolo. 2015. Fiscal policies and credit regimes: A tvar approach. *Journal of Applied Econometrics* 30: 1047–72. [CrossRef]

Galbraith, John W. 1996. Credit rationing and threshold effects in the relation between money and output. *Journal of Applied Econometrics* 11: 419–29. [CrossRef]

Galvão, Ana Beatriz, and Michael T. Owyang. 2018. Financial stress regimes and the macroeconomy. *Journal of Money, Credit and Banking* 50: 1479–505. [CrossRef]

Giambiagi, Fabio. 2021. *Tudo Sobre O Déficit Público: Um Guia Sobre o Maior Desafio do País Para a Década de 2020*, 1st ed. São Paulo: Alta Books.

Gomes, Fábio A. R., Lívia C. M. Melo, and Gian Paulo Soave. 2024. Flexible markov-switching models with evolving regime-specific parameters: An application to brazilian business cycles. *Applied Economics* 56: 1705–22. [CrossRef]

Hakkio, Craig S., and William R. Keeton. 2009. Financial stress: What is it, how can it be measured, and why does it matter? *Economic Review* 94: 5–50.

Hercowitz, Zvi, and Michel Strawczynski. 2004. Cyclical ratcheting in government spending: Evidence from the oecd. *Review of Economics and Statistics* 86: 353–61. [CrossRef]

Holland, Márcio. 2019. Fiscal crisis in Brazil: Causes and remedy. *Brazilian Journal of Political Economy* 39: 88–107. [CrossRef]

Holland, Marcio, Emerson Marçal, and Diogo de Prince. 2020. Is fiscal policy effective in brazil? An empirical analysis. *The Quarterly Review of Economics and Finance* 75: 40–52. [CrossRef]

Hong, Mr. Gee Hee, Shikun (Barry) Ke, and Anh D. M. Nguyen. 2024. *The Economic Impact of Fiscal Policy Uncertainty: Evidence from a New Cross-Country Database*. IMF Working Papers 2024/209. Washington, DC: International Monetary Fund.

Illing, Mark, and Ying Liu. 2003. *An Index of Financial Stress for Canada*. Technical Report. Ottawa: Bank of Canada.

Ilzetzki, Ethan. 2011. Rent-seeking distortions and fiscal procyclicality. *Journal of Development Economics* 96: 30–46. [CrossRef]

Ilzetzki, Ethan, and Carlos A. Végh. 2008. *Procyclical Fiscal Policy in Developing Countries: Truth or Fiction?* Technical Report. Cambridge, MA: National Bureau of Economic Research.

IMF. 2009. Fiscal policy as a countercyclical tool. In *World Economic Outlook*. Washington, DC: International Monetary Fund, Chapter 5, pp. 159–96.

IMF. 2024. *Fiscal Monitor: Putting a Lid on Public Debt*. Washington, DC: International Monetary Fund.

Koop, Gary, and Dimitris Korobilis. 2014. A new index of financial conditions. *European Economic Review* 71: 101–16. [CrossRef]

Koop, Gary, M Hashem Pesaran, and Simon M Potter. 1996. Impulse response analysis in nonlinear multivariate models. *Journal of Econometrics* 74: 119–47. [CrossRef]

Lastauskas, Povilas, and Anh Dinh Minh Nguyen. 2024. Spillover effects of US monetary policy on emerging markets amidst uncertainty. *Journal of International Financial Markets, Institutions and Money* 92: 101956. [CrossRef]

Li, Fuchun, and Pierre St-Amant. 2010. *Financial Stress, Monetary Policy, and Economic Activity*. Technical Report. Ottawa: Bank of Canada.

Lisboa, Marcos, and Samuel Pessôa. 2019. *O Valor Das Ideias: Debate em Tempos Turbulentos*. São Paulo: Editora Companhia das Letras.

Makololo, Prudence, and Yudhvir Seetharam. 2020. The effect of economic policy uncertainty and herding on leverage: An examination of the brics countries. *Cogent Economics & Finance* 8: 1821482. [CrossRef]

Manoel, Alexandre, Marcos Lisboa, Marcos Mendes, and Samuel Pessôa. 2024. Gastos públicos nas tentativas de reeleição de 2014 e 2022: Rumo a uma crise econômica com forte ajuste fiscal em 2027? IBRE-FGV. Available online: https://blogdoibre.fgv.br/posts/gastos-publicos-nas-tentativas-de-reeleicao-de-2014-e-2022-rumo-uma-crise-economica-com-forte (accessed on 28 November 2024).

McCallum, John. 1991. Credit rationing and the monetary transmission mechanism. *The American Economic Review* 81: 946–51.

Monin, Phillip J. 2019. The ofr financial stress index. *Risks* 7: 25. [CrossRef]

Moriyama, Kenji. 2010. *The Spillover Effects of the Global Crisis on Economic Activity in Mena Emerging Market Countries—An Analysis Using the Financial Stress Index*. Washington, DC: International Monetary Fund.

OCDE. 2003. *Fiscal Stance over the Cycle: The Role of Debt, Institutions, and Budget Constraints*. *OECD Economic Outlook 74*. Paris: OECD.

Oet, Mikhail V., John M Dooley, and Stephen J. Ong. 2015. The financial stress index: Identification of systemic risk conditions. *Risks* 3: 420–44. [CrossRef]

Park, Cyn-Young, and Rogelio V. Mercado, Jr. 2014. Determinants of financial stress in emerging market economies. *Journal of Banking & Finance* 45: 199–224.

R Core Team. 2021. *R: A Language and Environment for Statistical Computing*. Vienna: R Foundation for Statistical Computing.

Sandahl, Johannes Forss, Mia Holmfeldt, Anders Rydén, and Maria Strömqvist. 2011. An index of financial stress for sweden. *S v ER ig ESR ik S Bank* 2: 49–67.

Schmidt, Julia. 2013. Country Risk Premia, Endogenous Collateral Constraints and Non-Linearities: A Threshold var Approach. May. Available online: https://www.semanticscholar.org/paper/a-Country-Risk-Premia%2C-Endogenous-Collateral-and-A-Schmidt/2c6c81260414e5cd70ebd53e782cd005f9df24fd (accessed on 28 November 2024).

Slingenberg, Jan Willem, and Jakob De Haan. 2011. *Forecasting Financial Stress*. Amsterdam: De Nederlandsche Bank.

Soave, Gian Paulo. 2020. Financial conditions and the business cycles in emerging markets. *Applied Economics Letters* 27: 1652–58. [CrossRef]

Sorensen, Bent E., and Oved Yosha. 2001. Is state fiscal policy asymmetric over the business cycle? *Economic Review-Federal Reserve Bank of Kansas City* 86: 43–64.

Stona, Filipe, Igor A. C. Morais, and Divanildo Triches. 2018. Economic dynamics during periods of financial stress: Evidences from brazil. *International Review of Economics & Finance* 55: 130–44.

Talvi, Ernesto, and Carlos A. Vegh. 2005. Tax base variability and procyclical fiscal policy in developing countries. *Journal of Development Economics* 78: 156–90. [CrossRef]

Tong, Howell. 1978. On a Threshold Model. Available online: https://www.researchgate.net/publication/243713686_On_a_Threshold_Model (accessed on 28 November 2024).

Tornell, Aaron, and Philip R. Lane. 1999. The voracity effect. *American Economic Review* 89: 22–46. [CrossRef]

Tourinho, Octavio A. F., and Angélica F. O.Brum. 2020. Políticas Fiscais para Estabilização da Dívida Pública: Uma abordagem de equilíbrio geral aplicada ao Brasil. *Estudos Econômicos* 50: 5–42. [CrossRef]

Tsay, Ruey S. 1989. Testing and modeling threshold autoregressive processes. *Journal of the American Statistical Association* 84: 231–40. [CrossRef]

Vitek, Francis. 2023. *Measuring the Stances of Monetary and Fiscal Policy*. IMF Working Papers 2023/106. Washington, DC: International Monetary Fund.

Wichmann, Roberta Moreira, and Marcelo Savino Portugal. 2013. Política fiscal assimétrica: O caso do brasil. *Revista Brasileira de Economia* 67: 355–78. [CrossRef]

Woodford, Michael. 2003. *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton: Princeton University Press.

Zhang, Dayong, Min Hu, and Qiang Ji. 2020. Financial markets under the global pandemic of COVID-19. *Finance Research Letters* 36: 101528. [CrossRef] [PubMed]