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FISCAL MULTIPLIER IN BRAZIL: THE ROLE PLAYED BY CONTROLS

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CENTRO DE DESENVOLVIMENTO E PLANEJAMENTO REGIONAL

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Sumário

Fiscal multiplier in Brazil: the role played by controls

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Abstract

There is no consensus on the size and significance of fiscal spending multipliers in Brazil, reflecting a broader debate in international literature. Different model specifications hinder comparisons across studies. We find that controlling for the monetary policy interest rate and a measure of sovereign risk leads to insignificant linear and state-dependent multipliers. However, excluding these covariates results in significant multipliers, albeit with a substantially poorer goodness-of-fit. The inclusion of sovereign risk markedly changes the conclusions. Our findings are robust across various robustness checks, including different estimates for the probability of being in a recessionary state and specifications normally used in the literature. Given the strong evidence of sovereign risk's influence on the business cycle in emerging economies, particularly Brazil, its inclusion is essential for accurately studying fiscal multipliers.

Keywords: Fiscal Policy, Fiscal Multiplier, Local Projection, State-Dependency, Sovereign Risk.

Resumo

Não há consenso sobre o tamanho e significância do multiplicador de gastos fiscais no Brasil, o que está alinhado com a literatura internacional. Diferentes especificações dos modelos dificultam comparação entre estudos. Verificamos que controlar pela taxa de juros de política monetária e por uma medida de risco soberano resulta em multiplicadores não significativos, seja nos modelos lineares ou com dependência de estado. Significância é observada ao excluir essas variáveis, contudo à custa de substancial deterioração no ajuste dos modelos. Incluir o risco soberano claramente altera as conclusões. Nossos resultados são robustos à utilização de diferentes medidas de probabilidade da economia se encontrar em estado recessivo e diferentes especificações usualmente apresentadas na literatura. Dadas as fortes evidências sobre a influência do risco soberano nos ciclos econômicos de países emergentes, incorporá-lo aos modelos é essencial em estudos sobre multiplicadores fiscais.

Palavras-chaves: Política fiscal, multiplicador fiscal, projeção local, dependência de estado, risco soberano

JEL Codes: E32, E62, H5, H62, H63

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1. Introduction

As noted in Ramey (2019), research on fiscal multipliers has experienced a resurgence following the implementation of fiscal packages worldwide to mitigate the adverse effects of the 2007–2009 financial crisis. The importance of this topic further increased with the adoption of expansive fiscal policies in response to the COVID-19 recession in 2020. Disagreements about the magnitude of fiscal multipliers and the stabilizing role of fiscal policy continue to fuel academic debate.

Using the case of Brazil, our contribution to this debate is twofold. First, we show how omitting relevant covariates from econometric models can affect the results reported in the literature. Second, using a more comprehensive set of controls, we estimate both linear and state-dependent fiscal multipliers.

Following global patterns, the literature on Brazil also presents mixed findings. Cavalcanti & Silva (2010) and Holland et al. (2020) find no evidence of significant linear multipliers, whereas Matheson & Pereira (2016) report a peak linear multiplier of around 0.5. Alves et al. (2019) estimate significant one-year multipliers ranging from 0.7 to 1.2. In contrast, nonlinear models yield heterogeneous results: Orair et al. (2016) estimate a significant multiplier during recessions (2.2) but not during periods of growth, while Alves et al. (2019) identify a higher multiplier during regular periods (3.4) than during recessions (2.7). Grudtner & Aragon (2017) and Holland et al. (2020) find no significance regardless of the state of the economy. We argue that these disparities are partly due to differences in the set of control variables.

Orair et al. (2016) and Alves et al. (2019) use lags of government spending, government revenue, and GDP — a baseline commonly adopted in fiscal impulse studies, following Blanchard & Perotti (2002). Grudtner & Aragon (2017) add lags of public debt and the exchange rate, while Holland et al. (2020) include lags of the Brazilian monetary policy interest rate (SELIC). We show that including the SELIC rate significantly affects the estimated multipliers, likely due to its lagged effects on GDP.[3]

None of these studies, however, include a measure of sovereign risk, despite substantial evidence of its important role in driving business cycles in Brazil and other emerging economies.[4] Moreover, sovereign risk may also endogenously influence fiscal policy — especially in Brazil, where fiscal rules

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[3] Auerbach & Gorodnichenko (2017) highlight the importance of incorporating a measure of monetary policy among the covariate set when estimating fiscal multipliers to address potential interactions between monetary and fiscal policy.

[4] Recent findings for Brazil include Ferreira & Valério (2022), Fernández et al. (2017), and Fernández et al. (2018). The list of works showing the importance of sovereign risk shocks in determining the business cycle is extensive and includes Mendoza (1991), Calvo et al. (1993), Uribe & Yue (2006), Bocola (2016), Arellano et al. (2017), among others. Liu (2023) verifies that even for the USA, government finances influence the size of the spending multiplier, which is found to be positive in states of low debt/GDP and negative in states of high debt/GDP.

mandate minimum spending in various areas as a share of government revenue, which itself fluctuates with the business cycle.[5]

We find that including a sovereign risk measure among the covariates is critical: it renders both linear and state-dependent multipliers statistically insignificant. This result holds even after controlling for dummy variables representing the 2008/2009 global financial crisis and Brazil's deep recession from 2014Q2 to 2016Q4, the most severe since 1900. Conversely, excluding the sovereign risk variable (EMBI) alone is sufficient to produce significant multipliers, consistent with previous findings, but at the cost of substantially worse model fit, as measured by R^2, adjusted R^2, and the Akaike Information Criterion (AIC).

As a byproduct of our analysis, we observe that the 2014Q2–2016Q4 Brazilian recession appears to have imposed a persistent constraint on the country's growth rate, lasting through the end of our sample in 2019Q4. Official, seasonally adjusted statistics show that real GDP in 2016Q4 was 8.2% lower than in 2014Q1. Across all our models, we find a highly significant negative level dummy for the period from 2014Q2 to 2019Q4.

An important issue in this literature concerns the variable used as an instrument for fiscal shocks. In studies focused on Brazil, Orair et al. (2016) and Alves et al. (2019) expand the traditional measure of government expenditure in goods and services (the "G" in the NIPA) by including other non-financial public sector spending. This broader measure incorporates direct transfers to families through pensions and social programs, public investment, and credit subsidies provided by state-owned banks, particularly the Brazilian National Development Bank (BNDES). We adopt their methodology, as it offers a broader perspective on different manners of implementing fiscal policy, and update their fiscal spending and revenue time series up to the fourth quarter of 2019. In contrast, Grudtner & Aragon (2017) and Holland et al. (2020) use the standard NIPA "G", thus excluding public investment, transfers to families, and subsidies to firms and households from their analysis.

We base our econometric analyses on local projection (LP) (Jordà (2005)). One of the main advantages of LP for our goals is that it is more conducive to inference of state dependent specifications compared to vector autoregression methods such as smooth transition VAR and threshold VAR.[6]

Different theoretical perspectives predict varying impacts of fiscal stimulus. Keynesian models view fiscal policy as an effective tool for stimulating the economy during periods of slackness, with increased government expenditure boosting output, household income, and consumption, thereby creating a positive feedback loop known as the Keynesian fiscal spending multiplier. Conversely, another perspective suggests that fiscal expansion could contract output if public debt is perceived as

[5] Sovereign risk also acts as a conduit for global shocks, as shown by Akıncı (2013), Fernández et al. (2017), Fernández et al. (2018), Ferreira & Valério (2022). In particular, Ferreira & Valério (2022) verify that Brazilian GDP, its sovereign risk, and the monetary policy interest rate respond to shocks in world demand, world supply, and world uncertainty, which together account for about 32% of the 1-year forecasting error variance (FEV) of the country's GDP and 63% for 4-year forecasting. Direct shocks applied to a measure of sovereign risk are found to contribute about 20% of the 2- and 4-year FEV. Similar figures are reported by Fernández et al. (2018).

[6] See Plagborg-Møller & Wolf (2021) for a thorough comparison between LP and VAR, including their asymptotic properties.

unsustainable, leading to higher sovereign spreads, risk premia, and interest rates, as discussed by Bocola (2016). For instance, Liu (2023) report negative spending multipliers in high public debt/GDP states due to increased risk premiums. Auerbach & Gorodnichenko (2013) estimate average quarterly responses close to -0.2 for OECD countries outside of recessions, possibly due to concerns about public debt sustainability. The classical view emphasizes the crowding-out effect, typically not predicting positive impacts from fiscal impulses.

To address these varying scenarios, the empirical literature has increasingly employed nonlinear models that allow fiscal multipliers to change depending on the state of the economy, with notable contributions from Auerbach & Gorodnichenko (2012), Miyamoto et al. (2018), and Ramey & Zubairy (2018). Despite the use of such models, the international literature has not reached a consensus. Some studies find that government spending multipliers exceed 1 during recessions but are insignificant during normal periods (e.g., Auerbach & Gorodnichenko (2012); Auerbach & Gorodnichenko (2013); Fazzari et al. (2015); Caggiano et al. (2015)). However, other studies report multipliers below 1 with no significant differences between economic states (e.g., Owyang et al. (2013); Ramey & Zubairy (2018)). Recent theoretical models suggest counter-cyclical effects of government spending, often relying on significant labor market or financial frictions (e.g., Michaillat (2014); Canzoneri et al. (2016)), while standard New-Keynesian DSGE models generally predict multipliers around 1, regardless of the economic cycle (e.g., Sims & Wolff (2018); Zubairy (2014)).

The remainder of the paper proceeds as follows: Section 2 describes the data, with special attention to the adjustment of the government fiscal statistics, extending the approach of Orair et al. (2016) until 2019. Section 3 discusses the econometric methodology, explaining the identification strategy, the measurement of the multiplier, and inference. Section 4 presents the logistic model adopted to capture the transition between states of economic activity in the economy, explaining in detail how the parameters of the model are obtained. Section 5 reports the estimates of linear government spending multipliers, while Section 6 presents the results for state-dependent models. Throughout these last two sections, we estimate several models that show the impact of using different covariates, which also serves as a robustness check of our conclusions. Section 7 concludes.

2. Data

We utilize quarterly data spanning from 1999Q1 to 2019Q4. The time series for government expenditure and revenue are based on the methodology proposed by Orair et al. (2016), which we extend to cover up to 2019Q4. A key motivation for adopting this methodology is to correct for widespread creative accounting practices used by the Federal Government between 2011 and 2014, which aimed to artificially inflate the reported primary surplus.[7]

According to Orair et al. (2016), a more accurate measurement of Brazilian government expenditure requires adjustments to the baseline statistic, which consists of total spending by the central government and transfers from the Federal Government to states and municipalities. These adjustments include: (i) subtracting deposits into the Brazilian sovereign wealth fund, the LC100/01 fund[8], and the capital injection into Petrobras in 2010Q3; and (ii) adding transfers to the Brazilian Development Bank (BNDES) and liabilities recorded on the Central Bank's balance sheet due to delayed reimbursements from the National Treasury to state banks and official funds, which were also responsible for executing fiscal policy measures mandated by the Federal Government[9]. For revenue, the baseline is the total revenue of the Central Government, from which we exclude the tax relief account and losses from asset transactions. The monthly adjusted time series are then converted into quarterly data, deflated using the GDP deflator (2019Q2 = 100), and seasonally adjusted using the X13 ARIMA-SEATS method, in this sequence.

We use the official quarterly GDP series published by the Brazilian Institute of Geography and Statistics (IBGE). To ensure consistency with the processing of the government expenditure and revenue series, we use GDP at current prices, deflate it using the same GDP deflator, and seasonally adjust it using the same method (X13 ARIMA-SEATS).

We also include two additional variables in the analysis: the SELIC rate and the Emerging Market Bond Index (EMBI) for Brazil.[10]

There are two main justifications for choosing this sample period. First, the current methodology for computing the Central Government's accounts —produced by the Brazilian National Treasury — is available from 1997 onward. Second, Brazil adopted a floating exchange rate regime in January 1999, abandoning the previous crawling peg regime. Since the size of fiscal multipliers is known to vary under different exchange rate regimes,[11] we begin our sample in 1999Q1, following the approach of Orair et al. (2016) and Grudtner & Aragon (2017). In contrast, Alves et al. (2019) and Holland et al. (2020) begin their samples in 1997. Although we conduct robustness checks using alternative control variables,

[7] These practices, often referred to as creative accounting, were widely criticized by experts, journalists, politicians, and the general public. Mendes (2022) includes short articles by various specialists that describe, among other issues, distortions in fiscal statistics. Unfortunately, the book is available only in Portuguese.

[8] Established by Complementary Law number 110/01, the LC100/01 fund provides assistance to workers in certain unemployment situations.

[9] These liabilities represent expenditures executed by federal banks (Banco do Brasil and Caixa Econômica Federal) and federal funds (Finame and FGTS). According to Brazilian fiscal law, the National Treasury must reimburse these institutions, which was not occurring, leading to the registration of these amounts as liabilities on the Central Bank's balance sheet.

[10] Both series are available at www.ipeadata.gov.br.

[11] For instance, Ilzetzki et al. (2013) show that fiscal multipliers are generally larger under fixed exchange rate regimes.

including data from 1997 and 1998 is not central to our analysis, which aims to evaluate fiscal multipliers under the current regime.

3. The Econometric Model

Our analysis employs the local projection (LP) method developed by Jordà (2005), which has been further advanced in studies such as Auerbach & Gorodnichenko (2013), Miyamoto et al. (2018), and Ramey & Zubairy (2018) to explore the dynamic effects of fiscal policies[12]. Our baseline LP model with state dependence is described by the following equations:

$$\begin{aligned} x_{t+h} = {} & f(k_{t-1})\left[\alpha_{A,h} + \Psi_{A,h}(L)z_{t-1} + \beta_{A,h} shock_t\right] \\ & + [1 - f(k_{t-1})]\left[\alpha_{B,h} + \Psi_{B,h}(L)z_{t-1} + \beta_{B,h} shock_t\right] + \epsilon_{t+h} \end{aligned} \quad (1)$$

and $f(k) = \frac{\exp(-\gamma k_t)}{1+\exp(-\gamma k_t)}$, with $\gamma > 0$, $E(k_t) = 0$, and $E(k_t^2) = 1$,

where x_{t+h} represents the response variable at horizon *t*+*h* $(h = 0,1,\cdots,H)$, z_{t-1} is a vector of lagged control variables, $shock_t$ is the fiscal shock, $f(k_t)$ is a logistic function bounded between 0 and 1 that indicates the likelihood of being in the states A (recession) and B (not recession), and k_t is a business cycle index normalized to have a mean of zero and unit variance. The coefficients $\beta_{A,h}$ and $\beta_{B,h}$ capture the state-dependent response of x_{t+h} to $shock_t$, while ϵ_{t+h} is the error term.

Some authors utilize a dummy variable to differentiate between recessionary and normal states of the business cycle (see Ramey & Zubairy (2018), Bernardini & Peersman (2018), Miyamoto et al. (2018)). Although this is a straightforward and intuitive strategy, it is more suitable for extended time series with multiple recession periods. Given our relatively short dataset spanning 21 years, employing a logistic function, as in Auerbach & Gorodnichenko (2012), enhances consistency by allowing the business cycle state to take any value between 0 and 1.

The traditional linear model for estimating fiscal multipliers is a special case of equation 1, where state dependence is not considered:

$$x_{t+h} = \alpha_h + \Psi_h(L)z_{t-1} + \beta_h shock_t + \epsilon_{t+h}. \quad (2)$$

In this model, the set of β_h for $h = 0,1,\cdots,H$ forms the impulse response function.

A potential issue with impulse responses from local projection is the presence of serial correlation in the error terms, induced by leading the dependent variable, which may lead to a moving average

[12] For a comprehensive comparison between VAR and LP, see Plagborg-Møller & Wolf (2021).

structure and reduce estimator efficiency. To address this and enhance efficiency, we follow Jordà (2005), Auerbach & Gorodnichenko (2013), and Ramey & Zubairy (2018), using heteroskedasticity and autocorrelation-consistent (HAC) standard errors.

The Fiscal Multiplier

There are various methods to calculate fiscal multipliers. Blanchard & Perotti (2002) use peak multipliers, representing the maximum output response following a government expenditure shock. Auerbach & Gorodnichenko (2013) consider the average quarterly output response to a government spending shock at $t = 0$. However, we adopt the cumulative (or integral) multiplier approach used by Mountford & Uhlig (2009), which accounts for the cumulative response from 0 to h in relation to the cumulative expenditure response over the same period, $\frac{\Delta gdp_{t,t+h}}{\Delta g_{t,t+h}}$. This method acknowledges that a fiscal stimulus initiated at $t = 0$ may persist beyond $t = 0$, thus requiring consideration of the entire sequence of additional spending to accurately measure the output response.

To facilitate inference, we estimate models 1 and 2 by regressing the cumulative response on a set of covariates z_{t-l} and on $shock_t$, where $shock_t$ now represents the cumulative expenditure shock from 0 to h. These cumulative variables are defined as:

$$w_{t+h} = \frac{W_{t+h} - W_{t-1}}{GDP_{t-1}}, \tag{3}$$

where W denotes the level of any target variable. For GDP, we have $x_{t+h} = \frac{GDP_{t+h} - GDP_{t-1}}{GDP_{t-1}}$, and for shock $shock_{t+h} = \frac{G_{t+h} - G_{t-1}}{GDP_{t-1}}$.[13] Figure 1 illustrates these two transformed variables for $h = 4$. As discussed by Hall (2009) and Barro & Redlick (2011), normalizing all variables by GDP_{t-1} simplifies the interpretation of the coefficients $\beta_{A,h}$, $\beta_{B,h}$, and β_h, which, following Ramey & Zubairy (2018), can be directly interpreted as multipliers without additional transformations.[14]

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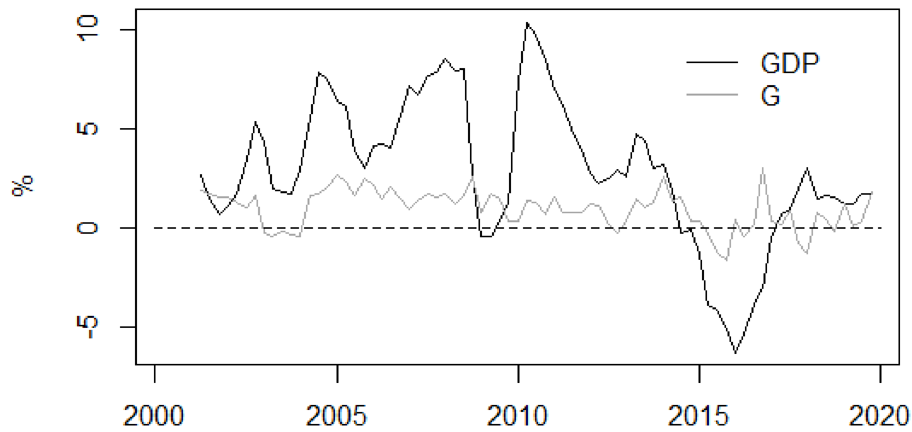
[13] An alternative approach involves a two-stage estimation, where forecast errors of government spending from a prediction model are used as the expenditure shock ($shock_t$) in the second-stage regressions of models 1 and 2. For instance, using the linear model 2, the cumulative multiplier would be computed as $m_h = \frac{\beta_h^y}{\beta_h^g}$, where β_h^y is the impulse response coefficient of GDP to $shock_{t+h}$. However, inference on m_h is complex and often requires simulation methods. Thus, we opt for single-stage estimation. Importantly, the Frisch-Waugh-Lovell theorem ensures the equivalence of coefficients estimated via one-stage or two-stage methods.

[14] A common practice is to log-transform variables, which results in elasticity coefficients requiring ex post transformation to derive the multiplier. For example, consider the model $ln(Y) = B_0 + B_1 ln(G) + U$, where U is an iid innovation. The partial derivative $\frac{\partial Y}{\partial G}\frac{1}{Y} = B_1 \frac{1}{G}$ is not the multiplier, which is instead $\frac{\partial Y}{\partial G} = B_1 \frac{Y}{G}$. The use of averages for Y and G for conversion can lead to bias, as shown by Ramey & Zubairy (2018). This bias can be avoided by pre-transforming the variables as in equation 3. For example, let $y_{t+h} = \frac{Y_{t+h} - Y_{t-1}}{Y_{t-1}}$ and $shock_{t+h} =$

Figure 1: 4 quarters cumulative growth rate of *GDP* and normalized *G*



Notes: GDP and G correspond, respectively, to the normalized 4 quarters cumulative growth rate of GDP $\frac{GDP_{t-4}-GDP_{t-1}}{GDP_{t-1}}$ and government spending $\frac{G_{t+4}-G_{t-1}}{GDP_{t-1}}$.

Identification

The government spending shock is identified using the standard Blanchard & Perotti (2002) institutional approach, which assumes that discretionary fiscal policy does not contemporaneously respond to output. This assumption is particularly reasonable when using quarterly data[15].

In addition to not responding to fluctuations in current economic activity, a shock is by definition an unpredictable event. Our challenge is to filter out any predictable components of government spending to ensure that the remaining component likely represents a genuine spending shock. We approach this by including four lags of the control vector z_{t-l} (l = 1,2,3,4), which comprises quarter-over-quarter growth rates of GDP, government spending, tax revenue, EMBI, and the first difference of the SELIC rate. The inclusion of the last two variables differentiates our econometric specification from those used by Orair et al. (2016), Grudtner & Aragon (2017), and Alves et al. (2019), with the inclusion of EMBI further expanding on the covariate set utilized by Holland et al. (2020).

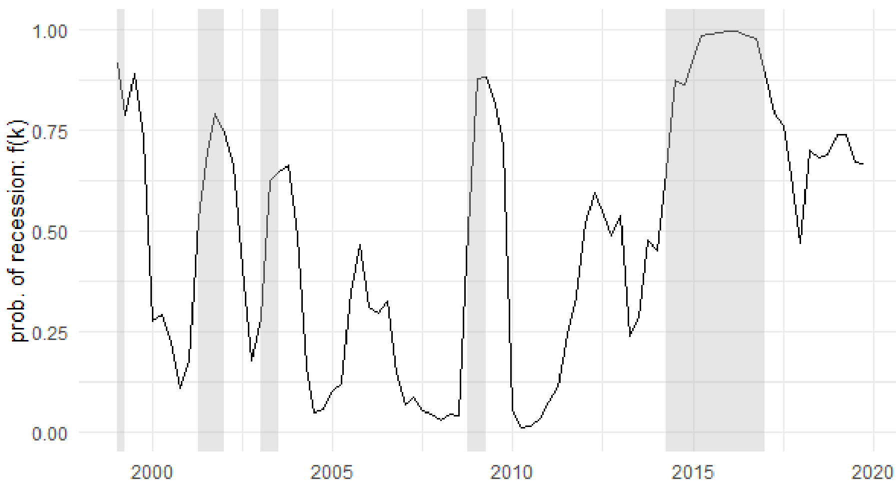
$\frac{G_{t+h}-G_{t-1}}{Y_{t-1}}$, and consider the model $y_{t+h} = C_0 + C_1 shock_{t+h} + error_{t+h}$. The partial derivative $\frac{\partial y_{t+h}}{\partial shock_{t+h}} = C_t$ directly provides the multiplier, accounting for the cumulative output response relative to the initial fiscal shock and the consequent series of accumulated expenditures.

[15] Ramey (2016) discusses the limitations of the standard Blanchard & Perotti (2002) identification scheme. In the U.S. context, Ramey (2011) identifies fiscal shocks using a narrative strategy based on U.S. military news time series. Auerbach & Gorodnichenko (2012) and Miyamoto et al. (2018) use deviations between private forecasts of government spending and actual spending to measure fiscal shocks. However, we are unaware of long time series forecasts for Brazilian government spending, and Brazil's lack of significant military engagements makes the narrative strategy more challenging.

4. Computing the Transition State $f(k_t)$

Two inputs are required to construct the time series for $f(k_t)$: a variable k_t that encapsulates business cycle information, and an estimate of γ. For k_t, we consider 2-, 5-, and 7-quarter moving averages (MAs) of GDP growth rates. We implement a grid search to identify values of γ that ensure 22% of the

Figure 2: Probability of being in a recessionary state according to the logistic function *f*(*k*) where *k* is a 5-quarter moving average of the GDP growth rate.



Notes: The shaded areas correspond to recessionary quarters according to CODACE. The solid black line represents the probability of being in a recessionary regime, calculated using the logistic function $f(k) = \frac{\exp(-\gamma k_t)}{1+\exp(-\gamma k_t)}$, with $\gamma = 2.20$.

quarters in our sample are classified as in a slack state, aligning with the percentage of recessionary quarters in Brazil according to CODACE's business cycle dating[16]. Specifically, we select γ so that $\Pr(f(k_t) > 0.78) = 0.22$. All three measures of k_t yield intervals for γ that meet this criterion, and we use the mean value within each interval. For MA(2), we find $\gamma \in [2.50, 2.61]$, and we use $\gamma = 2.55$; for MA(5), γ ranges from [2.08, 2.32], and we use $\gamma = 2.20$; for MA(7), γ lies between [2.73, 2.77], leading us to adopt $\gamma = 2.75$.

Figures 2, 5, and 6 (the latter two in the appendix) compare the evolution of $f(k_t)$ for MA(5), MA(2), and MA(7) against shaded quarters that indicate recessionary periods. All three measures show a higher probability of slackness during recessions and a lower probability during non recessionary quarters. However, differences arise upon closer examination. The excessive smoothing of MA(7) yields a relatively low probability of slackness during the recessions of 2001Q2-2001Q4, 2003Q1-

[16] CODACE is a committee that dates recessionary periods in Brazil.

2003Q2, and 2008Q4-2009Q1, but correctly delivers small $f(k_t)$ in non recessionary quarters. On the other extreme, $f(MA(2))$ correctly indicates a high probability of slackness during recessions, but at the cost of also suggesting a high probability of slackness in non recessionary quarter. We find that $f(MA(5))$ provides a more balanced view, making it our benchmark measure for $f(k_t)$ throughout the paper. Importantly, our robustness checks - discussed later - show that our conclusions remain consistent whether using MA(2) or MA(7), although $f(MA(5))$ offers the best fit. Additionally, using MA(5) facilitates comparisons with Alves et al. (2019) and Grudtner & Aragon (2017), who also use this measure to compute $f(k_t)$. Furthermore, Auerbach & Gorodnichenko (2013) suggest that a moving average of more than four quarters of GDP growth is sufficient to capture the output gap and thus the degree of economic slackness.

Regarding the choice of using the average value for γ, Figure 4 in the appendix illustrates the evolution of $f(MA(5)_t)$ for the minimum and maximum grid values of γ: 2.08 and 2.32, respectively. The differences between them are negligible, supporting the mean γ = 2.20 as a reasonable choice.

5. Results for the Linear Model

We begin by presenting the results for the linear model described in Equation 2. A key concern is the potential bias due to the omission of important control variables not considered in previous studies. To address this, we test several specifications. Our hypothesis is that the exclusion of the monetary policy interest rate and a measure of sovereign risk premium may undermine the argument that $\frac{G_{t+h}-G_{t-1}}{GDP_{t-1}}$ captures exogenous fiscal shocks, as these variables have well-known lagged effects on GDP growth. This concern is heightened by the potential endogenous reaction of government spending to shocks transmitted through these variables.

Box A in Table 1 presents the estimates for the linear model 2. The column h = 0 shows the impact multiplier, while the remaining columns display the cumulative multipliers for h = 1 to h = 4. We also report robust HAC standard errors for $\hat{\beta}_h$ in parentheses and the *p-value* in brackets, along with R^2, and *adjusted-*R^2.

The results indicate significance at standard confidence levels only for h = 4, with $\hat{\beta}_4$ = 1.3547. The other estimates are close to zero, the highest being 0.7618 (*p-value* = 0.1638) for h = 3. The R^2 around 0.45 across all cases suggests a reasonable explanatory power. Despite this, visual inspection of the residuals in Figure 3 reveals a large negative error associated with the 2008 financial crisis, which can bias estimates.

To address this concern, we introduce the dummy variable D.2008Q4t, such that D.2008Q4t = 1 for any quarter in which 2008Q4 falls within the interval [t,t + h], and 0 otherwise. For example, when estimating the 1-quarter cumulative multiplier, D.2008Q4t = 1 for both 2008Q3 and 2008Q4.

Another critical period that could bias the estimates is the recession from 2014Q2 to 2016Q4. This recession was notably severe and prolonged, with GDP in 2016Q4 being 8.2% lower than in 2014Q1 (seasonally adjusted). The average quarter-over-quarter growth rate from 2000Q2 to 2014Q1 was 3.64%, compared to -0.46% from 2014Q2 to 2019Q4. Even after the recession, growth remained sluggish, averaging 1.86% annually from 2017Q1 to 2019Q4. In 2019Q4, real GDP was only 0.1% higher than in 2014Q1. The residuals for the 4-quarter forecasting equation in Figure 3 show negative residuals persisting from 2014Q2 to 2016Q4, further justifying the inclusion of the $D.brecession_t$ dummy, which is set to 1 for all $t \geq 2014Q2$, and 0 otherwise. This dummy captures a possible structural shift evident from the data starting in 2014Q2 to the end of our sample.

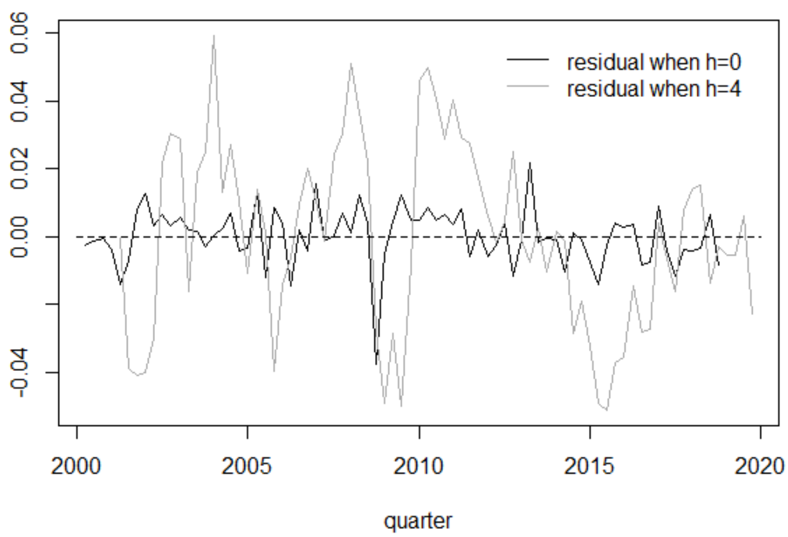
Table 1: Base estimates according to the linear local projection model

	h = 0	h = 1	h = 2	h = 3	h = 4
		Box A: linear model			
Multiplier	-0.1810	-0.0251	0.3868	0.7618	1.3547
	(0.3309)	(0.4430)	(0.4423)	(0.5396)	(0.6752)
	[0.5867]	[0.9549]	[0.3857]	[0.1638]	[0.0499]
R^2	0.4553	0.4382	0.4690	0.4541	0.4410
adj-R^2	0.2394	0.2156	0.2586	0.2378	0.2195
		Box B: linear + *D*.2008*Q*4			
Multiplier	0.1224	0.2955	0.6927	0.9820	1.4726
	(0.2134)	(0.3209)	(0.3686)	(0.4938)	(0.6674)
	[0.5687]	[0.3614]	[0.0658]	[0.0520]	[0.0318]
D.2008*Q*4	-0.0526***	-0.0616***	-0.0583***	-0.0547***	-0.0476***
	(0.0052)	(0.0076)	(0.0107)	(0.0127)	(0.0133)
R^2	0.6586	0.6343	0.6074	0.5668	0.5221
adj-R^2	0.5142	0.4795	0.4413	0.3836	0.3199
		Box C: linear + *D*.2008*Q*4 + *D.brecession*			
Multiplier	0.0298	0.0360	0.1733	0.3032	0.6238
	(0.1986)	(0.2742)	(0.3763)	(0.4381)	(0.5430)
	[0.8815]	[0.8960]	[0.6470]	[0.4921]	[0.2560]
D.2008*Q*4	-0.0495***	-0.0546***	-0.0488***	-0.0443***	-0.0380***
	(0.0050)	(0.0065)	(0.0103)	(0.0116)	(0.0112)
D.brecession	-0.0073***	-0.0189***	-0.0282***	-0.0371***	-0.0453***
	(0.0027)	(0.0038)	(0.0055)	(0.0073)	(0.0108)
R^2	0.6923	0.7188	0.7165	0.6991	0.6714
adj-R^2	0.5536	0.5920	0.5886	0.5634	0.5232

Notes: Estimates based on equation 2, with h representing quarters following the shock. *D*.2008*Q*4 is a *dummy* variable to filter the impact of the 2008/2009 global financial crisis, while *D.brecession* is a dummy variable to capture the lasting impact of the 2014Q2-2016Q4 Brazilian recession until the end of our sample in 2019Q4. *multiplier* is the cumulative (integral) spending multiplier for the GDP (β_h of equation 2). HAC standard errors are in parentheses and *p-value* in brackets. *** means significance at 1% confidence level.

Boxes B and C in Table 1 display the results after incorporating $D.2008Q4$ and $D.2008Q4 + D.brecession$ into the linear model 2. In both cases, the dummies are highly significant. Including them increases both R^2 and $adjusted - R^2$. The most substantial improvement is observed with the inclusion of *D.brecession*. For instance, for $h = 4$, the model with both dummies achieves an R^2 of 0.6714, compared to 0.5221 with only $D.2008Q4$ and 0.4410 without them. The improvement is even more pronounced in *adjusted*-R^2, which is 0.5232 in the full model, 0.3199 when incorporating $D.2008Q4$, and 0.2195 in the base specification. Similar patterns are observed for $h = 0,1,2,3$, strongly indicating that the specification including both dummies is the most appropriate for assessing the spending multiplier's size and significance. These findings also suggest an important structural break after 2014Q2.

Figure 3: Residuals of the linear model for 0- and 4-quarter ahead forecasting equation



Notes: The residuals are obtained from the linear local projection model 2 without the inclusion of any *dummy* variable.

Analyzing the estimated multipliers from the most comprehensive model (Box C), we find them to be generally insignificant at standard confidence levels, with the highest *p-value* (0.2560) observed for the 4-quarter multiplier ($\hat{\beta}_4 = 0.6238$). However, when only $D.2008Q4$ is included (Box B), $\hat{\beta}_4 = 1.4726$ with a *p-value* of 0.0318, close to the estimates of the unrestricted specification. The general pattern across h is that the substantial improvement in the model fit after including both *dummies* results in non-significant multipliers.

Our conclusion about the insignificance of the linear spending multiplier aligns with previous findings for Brazil by Cavalcanti & Silva (2010) and Holland et al. (2020), but contrasts with Alves et al. (2019), who report significant 1-year multipliers ranging from 0.7 to 1.2, and Matheson & Pereira (2016), who find a significant peak linear multiplier around 0.5. The values reported by Alves et al.

(2019) are similar to those obtained from our more restrictive specifications regarding the use of dummy variables.

Our findings are also consistent with key studies in the literature: Auerbach & Gorodnichenko (2013) estimate an insignificant mean quarterly response of around 0.14 over a 1-year horizon for OECD countries, while Ramey & Zubairy (2018), whose methodology we closely follow, estimate a non-significant 2-year integral linear multiplier of 0.38 for the USA. Additionally, Auclert et al. (2018) report cumulative multipliers of 0.4 under balanced budget fiscal policy and 1.3 under debt-financed policy, in a model with heterogeneous agents. These values are within the range of our estimates.

Controls for the Linear Model

Comparing results across studies can be challenging due to differences in covariates. In the Introduction, we noted that while some studies on Brazil include controls for the monetary policy interest rate, none account for a measure of sovereign risk. This omission is significant, given substantial evidence that the Brazilian business cycle is strongly influenced by sovereign risk shocks, or that sovereign risk acts as a conduit for global shocks (e.g., Ferreira & Valério (2022) and Fernández et al. (2018)).

To assess the importance of *SELIC* and *EMBI*, we examined the impact of omitting these controls. For brevity, we focus on the 2- and 4-quarter ahead forecasting equations of our preferred specification, which includes *D.*2008*Q*4 + *D.brecession*, as well as a model without dummies, since none of the cited studies include them. The results are presented in Table 2, with the restricted specification in Box A and the full dummy model in Box B.

The last two columns of Box B show the results when *SELIC* and *EMBI* are excluded. Under these conditions, R^2 and *adjusted-*R^2 are notably lower than in the full model presented in Box C of Table 2. For $h = 2$, the R^2 and *adjusted-*R^2 decrease to 0.5716 and 0.4626, respectively, compared to 0.7165 and 0.5886 when both *SELIC* and *EMBI* are included. For $h = 4$, the values drop to 0.5796 and 0.4727, respectively, compared to 0.6714 and 0.5232 in the unrestricted model. The absence of these controls results in significant 2- and 4-quarter integral multipliers at the 5% level, with point estimates of 0.5590 and 0.8948[17], which are higher than the insignificant estimates of the full model (0.1733 and 0.6238, respectively). A similar pattern is observed when *SELIC* and *EMBI* are omitted individually. For instance, excluding *EMBI* results in an *adjusted-*R^2 of 0.5554 and 0.4868 for $h = 2$ and $h = 4$, respectively, while the multipliers increase to 0.3049 and 0.7032, with the latter reaching 10% significance. When only *SELIC* is excluded, the *adjusted-*R^2 drops to 0.4895 and 0.4696 for $h = 2$ and $h = 4$, respectively, with multipliers rising to 0.3188 and 0.7591, the latter being significant at 5%.

Overall, the results in Table 2 demonstrate that both *EMBI* and *SELIC* significantly impact the future dynamics of GDP. Omitting these variables degrades the model's fit and increases the estimated

[17] These significant estimates are similar to those reported by Alves et al. (2019), who do not include *SELIC* and *EMBI* among their covariates.

multipliers, which may even become significant at standard confidence levels. The results in Box A, where no dummies are included, exhibit similar patterns.

6. State-Dependent Multiplier

Table 3 presents the estimates of the state-dependent multipliers for 0- to 4-quarter cumulative growth of GDP. Box A shows the estimates without any dummy variables, while Box B displays the results after incorporating dummies *D.*2008*Q*4 and *D.brecession*, which is our preferred specification due to the substantial improvement in R^2 and *adjusted*-R^2: the *adjusted*-R^2 increases from 0.2801 to 0.6384 for h = 0 and from 0.3379 to 0.5823 for h = 4. Additionally, Box B indicates that both dummies are significant at conventional significance levels from h = 0 to h = 3, with only *D.brecession* remaining significant when h = 4. These results reinforce our initial perception of a structural break beginning around 2014Q2.

Table 2: The influence of covariates in the linear local projection model

	No EMBI		No SELIC		No EMBI, no SELIC	
	h = 2	*h* = 4	*h* = 2	*h* = 4	*h* = 2	*h* = 4
Box A: no *dummies*						
Multiplier	0.5899	1.6109	0.7055	1.6801	0.9237	1.8491
	(0.5370)	(0.6775)	(0.6015)	(0.7700)	(0.6153)	(0.7570)
	[0.2766]	[0.0208]	[0.2457]	[0.0333]	[0.1385]	[0.0175]
R^2	0.3754	0.3375	0.3342	0.3340	0.2090	0.2725
adj-R^2	0.1892	0.1399	0.1356	0.1353	0.0404	0.1174
Box B - dummies: *D.*2008*Q*4 and *D.brecession*						
Multiplier	0.3049	0.7032	0.3188	0.7591	0.5590	0.8948
	(0.3827)	(0.4107)	(0.2669)	(0.3710)	(0.2570)	(0.2129)
	[0.4291]	[0.0925]	[0.2374]	[0.0456]	[0.0336]	[0.0001]
R^2	0.6695	0.6186	0.6206	0.6058	0.5716	0.5796
adj-R^2	0.5554	0.4868	0.4895	0.4696	0.4626	0.4727

Notes: Estimates of the government spending multiplier of the GDP based on the linear local projection equation 2, with h representing quarters following the shock. The complete set of covariates includes lags on the growth rate of GDP, government expenses, tax collection, EMBI and lags on the first difference of SELIC. Box A reports results when no *dummy* variable is included, being comparable to Box A in table 1. Box B reports results when dummy variables *D.*2008*Q*4 and *D.brecession* are included, being comparable to Box C in table 1. HAC standard errors are in parentheses and *p-value* in brackets.

Table 3: State-Dependent Spending Multipliers - $f(k)$ with k as a MA(5) of GDP Growth

	h = 0	h = 1	h = 2	h = 3	h = 4
			Box A: No Dummies		
β_A (slackness)	-0.6051	-0.6067	0.2270	1.1007	1.4030
	(0.7696)	(0.9128)	(0.8563)	(0.9191)	(1.3839)
	[0.4375]	[0.5111]	[0.7926]	[0.2398]	[0.3183]
β_B (no slackness)	0.0758	0.6052	0.1627	-0.2863	0.7706
	(0.8570)	(0.9752)	(0.7480)	(0.9793)	(1.3354)
	[0.9301]	[0.5393]	[0.8292]	[0.7719]	[0.5679]
R^2	0.6887	0.7303	0.7853	0.7506	0.7137
$adj - R^2$	0.2801	0.3762	0.5035	0.4232	0.3379
p-value when H_1: β_A=β_B	0.6195	0.4286	0.9597	0.3936	0.7985
		Box B: Dummies *D.*2008Q4 and *D.brecession*			
β_A *(no slackness)*	-0.4740	-0.5012	-0.3619	0.3494	0.1050
	(0.4475)	(0.7015)	(0.6089)	(0.7879)	(1.1631)
	[0.2980]	[0.4805]	[0.5568]	[0.6606]	[0.9287]
β_B *(no slackness)*	0.1551	0.4816	0.3659	0.0508	0.9789
	(0.6518)	(0.8507)	(0.5873)	(0.8392)	(0.9309)
	[0.8135]	[0.5755]	[0.5380]	[0.9521]	[0.3014]
D.2008Q4	-0.0390***	-0.0472***	-0.0304***	-0.0227*	-0.0145
	(0.0060)	(0.0063)	(0.0076)	(0.0132)	(0.0119)
D.brecession	-0.0103**	-0.0175***	-0.0226***	-0.0311***	-0.0431***
	(0.0038)	(0.0048)	(0.0044)	(0.0053)	(0.0080)
R^2	0.8534	0.8647	0.8649	0.8448	0.8307
$adj - R^2$	0.6384	0.6663	0.6668	0.6171	0.5823
p-value when H_1: β_A = β_B	0.5079	0.4506	0.3814	0.8335	0.6605

Notes: Estimates of the government spending multiplier for GDP based on equation 1 with a transition function $f(k)$ where k is a 5-quarter moving average of GDP growth. h represents quarters following the shock. The complete set of covariates includes lags on the growth rate of GDP, government expenses, tax collection, EMBI, and lags on the first difference of SELIC (monetary policy interest rate). Box A reports results when no dummy variable is included, while Box B reports results when the dummy variables $D.2008Q4$ and *D.brecession* are included. HAC standard errors are in parentheses, and *p-values* are in brackets. *, **, and *** represent significance at 10%, 5%, and 1% confidence levels, respectively.

Focusing on the results in Box B, the *p-values* in brackets indicate that the estimated multipliers are insignificant at standard confidence levels, regardless of the forecasting horizon or the state of the business cycle. For example, the lowest *p-values* are 0.2980 for the slackness multiplier at h = 0 ($\hat{\beta}_A$ = −0.4740) and 0.3014 for the no-slackness multiplier at h = 4 ($\hat{\beta}_B$ = 0.9789). This pattern of insignificant estimates persists even in the no-dummies model, as evidenced by the *p-values* in Box A. Consistent with these findings, the *p-values* for testing $H_0: \beta_A = \beta_B$ against $H_1: \beta_A \neq \beta_B$, reported in the last row of each box, are also quite high.

Our findings align with those of Grudtner & Aragon (2017) and Holland et al. (2020), who also find no evidence of significant state-dependent fiscal multipliers. However, their analyses use a narrow measure of government spending, which does not fully capture fiscal policies implemented through public investment, loans, subsidies to firms, or direct transfers to households. In contrast, our findings diverge from those of Orair et al. (2016) and Alves et al. (2019), who used a similar measure of *G* but do not employ the same controls as our study. Orair et al. (2016) report a significant 4-year slackness multiplier of approximately 2.2, while Alves et al. (2019) estimate a significant 2-year cumulative slackness multiplier of 2.7 and a non-slackness multiplier of around 3.4.

Controls for the State-Dependent Model

We now explore various specifications by removing the *SELIC* rate, *EMBI*, and the dummy variables from the base model[18]. The results for five different specifications are in Table 4. We limit this analysis to h = 4, the horizon where we previously observed higher multipliers and smaller *p-values*. Each column, from *model* 0 to *model* 4, represents different specifications, characterized by the presence or absence of dummies, *SELIC*, and *EMBI*. To facilitate comparisons, *model* 0 replicates our preferred model, matching the last column of Box B in Table 3.

In *model* 1, where none of the three controls are present, we estimate a high slackness multiplier of 3.8743, which is significant at conventional levels (*p-value* = 0.0292). The no slackness multiplier is 1.2445 with a *p-value* of 0.2107. The R^2 and *adjusted*-R^2 are 0.4611 and 0.1692, respectively, much lower than the benchmarks of 0.8307 and 0.5823, indicating poorer model fit and suggesting that the large difference between estimated multipliers may be due to omitted variable bias. Orair et al. (2016) and Alves et al. (2019), which use similar measures of *G* and *T* as our study, also report high (and significant) slackness multipliers, 2.2 and 2.7, respectively. However, Orair et al. (2016) find the no-slackness multiplier to be insignificant, while Alves et al. (2019) report a significant multiplier around 3.4.

Model 2, which incorporates only *SELIC*, is a traditional specification according to our literature review. Our estimates using this model also indicate a high and significant slackness multiplier, $\hat{\beta}_A$ = 3.2499 with a *p-value* of 0.0062. The no-slackness multiplier is smaller (0.5242) and not significant at standard levels (*p-value* = 0.5737). It is worth noting that adding lags of differences of *SELIC* substantially improves the fit compared to model 1, since R^2 increases to 0.5871 and *adjusted*-R^2 to 0.2361, but the goodness-of-fit remains much worse than the benchmark model 0, suggesting omitted variable bias in the estimates of model 2.

[18] The base model includes the shock variable and lags of GDP growth, G, and tax revenues.

Table 4: 4-Quarter Cumulative State-Dependent Spending Multipliers of Different Specifications

	model 0	*model* 1	*model* 2	*model* 3	*model* 4
Dummies	yes	No	no	yes	yes
SELIC	yes	No	yes	no	yes
EMBI	yes	No	no	no	no
β_A (slackness)	0.1050	3.8743	3.2499	1.9606	1.2472
	(1.1631)	(1.7236)	(1.1245)	(1.1322)	(0.8219)
	[0.9287]	[0.0292]	[0.0062]	[0.0900]	[0.1374]
β_B (no slackness)	0.9789	1.2445	0.5242	1.1951	0.7991
	(0.9309)	(0.9811)	(0.9241)	(0.7142)	(0.5964)
	[0.3014]	[0.2107]	[0.5737]	[0.1010]	[0.1883]
*R*2	0.8307	0.4611	0.5871	0.6842	0.7812
$adj-R^2$	0.5823	0.1692	0.2361	0.4920	0.5739
AIC	-328.15	-277.32	-281.30	-313.41	-324.93
p-value when H_1: $\beta_A = \beta_B$	0.6605	0.2510	0.1237	0.6512	0.7197

Notes: Estimates of the 4-quarter cumulative government spending multiplier for GDP based on equation 1 with a transition function $f(k)$ where k is a 5-quarter moving average of GDP growth. Every specification includes 4 lags on the growth rate of GDP, government spending, and revenue. The line *dummies* indicates whether *D.*2008*Q*4 and *D.brecession* are included. Lines *SELIC* and *EMBI* indicate, respectively, whether 4 lags of the first difference of *SELIC* and 4 lags of the growth rate of *EMBI* are among the covariates. Model 0 is our base (complete) model, and its results are identical to those reported in the last column of Box B of Table 3. HAC standard errors are in parentheses, and *p-values* are in brackets.

To our knowledge, the literature on Brazil has not considered using dummies. In model 3, which includes only the dummies without *SELIC* and *EMBI*, the slackness multiplier is significant at the 10% level (1.9606), roughly half the estimate in model 1 without dummies. The no-slackness multiplier (1.1951) remains close to that in model 1, but with a *p-value* of 0.1010, which could be considered significant given the small degrees of freedom, a common argument for using a 68% confidence interval. These significant estimates are obtained even with improved model fit over model 1 by adding the dummies, as R^2 increases to 0.6842 and *adjusted-*R^2 to 0.4920. However, the fit is still worse than model 0, indicating that *SELIC* and *EMBI* play crucial roles in altering the results.

Lastly, in model 4, which includes *SELIC* and the dummies, the model fit improves further, with R^2 = 0.7812 and *adjusted-*R^2 = 0.5739, closer to but still lower than the values in model 0, which also has a lower AIC. Despite these modest differences in fit statistics, the improvements in model 0 significantly affect the estimated multipliers, especially $\hat{\beta}_A$, which is 0.1050 in our benchmark but 1.2472 (*p-value* = 0.1374) without *EMBI* in model 4. The estimated β_B becomes 0.7991 (*p-value* = 0.1883), compared to $\hat{\beta}_B$ = 0.9789 (*p-value* = 0.3014) in model 0.

In summary, the inclusion of various controls significantly impacts the estimated fiscal spending multipliers. Incorporating the monetary policy interest rate improves the model fit while maintaining the significance of the slackness multiplier. However, adding a measure of sovereign risk further enhances the fit, resulting in insignificant multipliers regardless of the state of the business cycle.

Robustness - Alternative Measures of $f(k)$

To assess the robustness of our conclusions, we examine how the results change when using $f(MA(2)_t)$ and $f(MA(7)_t)$ to estimate the probability of being in a non-slackness state of the business cycle. Consistent with our earlier analysis of the importance of each covariate, we focus only on the 4-quarter cumulative multiplier. This robustness check is conducted on our benchmark specification, which includes both dummies, *SELIC*, and *EMBI*. The results, presented in Table 5, show that although the point estimate multipliers differ slightly, they remain insignificant, with *p-values* exceeding 0.30. The table also indicates that our benchmark choice, $f(MA(5)_t)$, yields the highest R^2 and the lowest Akaike Information Criterion (AIC), suggesting it provides the best fit among the alternatives considered.

Table 5: 4-quarter cumulative state-dependent spending multipliers for different $f(z)$

	MA(5)	*MA*(2)	*MA*(7)
β_A (slackness)	0.1050	0.4102	0.9194
	(1.1631)	(0.9823)	(1.1239)
	[0.9287]	[0.6793]	[0.4198]
β_B (no slackness)	0.9789	0.4026	1.0523
	(0.9309)	(0.9013)	(1.0475)
	[0.3014]	[0.6583]	[0.3231]
*D*2008*Q*4	-0.0145	-0.0148	-0.0054
	(0.0119)	(0.0153)	(0.0206)
D.brecession	-0.0431***	-0.0376**	-0.0488***
	(0.0080)	(0.0137)	(0.0120)
*R*2	0.8307	0.7929	0.8024
adj.R^2	0.5823	0.4893	0.5125
AIC	-328.15	-313.06	-316.56
p-value when H_1: $\beta_A = \beta_B$	0.6605	0.9965	0.9402

Notes: Estimates of the 4-quarter cumulative government spending multiplier for GDP based on equation 1 with transition function $f(k)$ where k is a 2-, 5-, or 7-quarter moving average of GDP growth. HAC standard errors are in parentheses, and *p-values* are in brackets. *** indicates significance at the 1% confidence level.

7. Concluding Remarks

The international literature lacks consensus on the size and significance of fiscal multipliers. Using Brazil as an example, we verify that part of this disagreement stems from the controls included in the estimated equations. In particular, we detail the influence of the monetary policy interest rate (SELIC)

and a measure of sovereign risk (EMBI BR+ from JP Morgan). Although several works already incorporate the former when estimating fiscal multipliers, controlling for past values of sovereign risk has largely been overlooked, despite substantial evidence of its impact on the business cycle in both developed and emerging economies,
particularly Brazil.

We closely replicate previous findings in the literature that report significant linear and state-dependent fiscal multipliers when *SELIC* and *EMBI* are excluded from controls. However, including them eliminates this significance and substantially improves goodness of-fit. Simply adding *SELIC* is insufficient to produce insignificant multipliers in all models we estimate, but combining *SELIC* and *EMBI* results in insignificant linear and activity dependent multipliers, regardless of whether dummy variables are introduced to capture specific moments faced by the Brazilian economy.

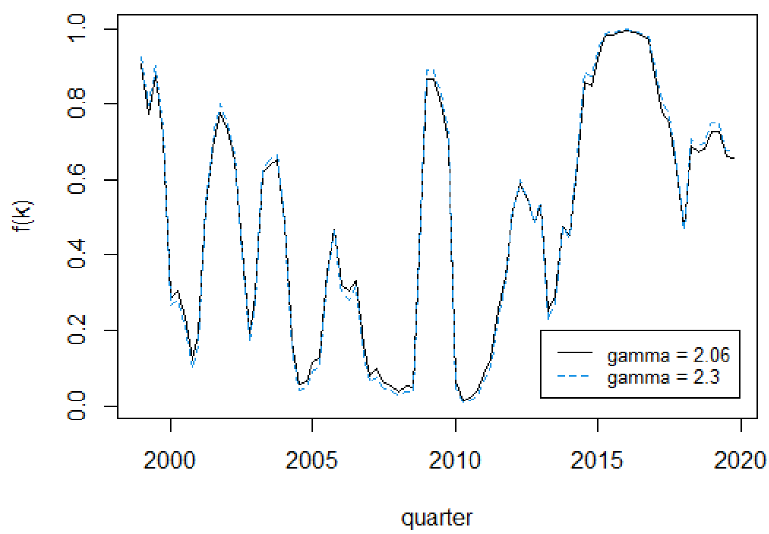
In particular, with regard to Brazil, as a byproduct of our investigation, we observe that the deep and prolonged recession from 2014Q2 to 2016Q4, which caused GDP to fall by nearly 9% and was the worst since 1900, appears to have permanently damaged the economy.

Regarding future research, there is ample room for revisiting works aimed at estimating fiscal multipliers in Brazil and other countries that have ignored important variables in the covariate set. In the case of emerging and developing economies, incorporating measures of sovereign risk seems essential given its significant influence on the business cycle. However, given the economic strain caused by the sovereign crisis in Mediterranean Europe in the mid-2010s, this control should not be overlooked even when conducting applied work for developed countries.

Finally, while evaluating different types of fiscal policy and their heterogeneous effects constitutes an important research avenue, these analyses should be conducted in models that properly incorporate a set of controls to capture the dynamics of the response variable. This need is also critical for filtering the endogenous dynamics of the variable used as an instrument for policy shocks when an exogenous instrument is unavailable.

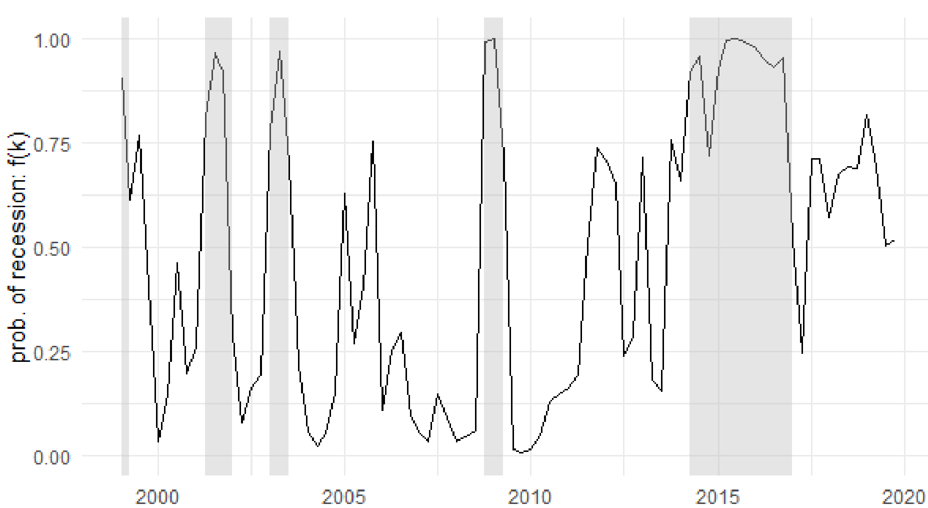
Appendix

Figure 4: Evolution of *f*(*k*) for *γ* = 2.06 and *γ* = 2.30 when *k* is the 5-quarter moving average for GDP growth.



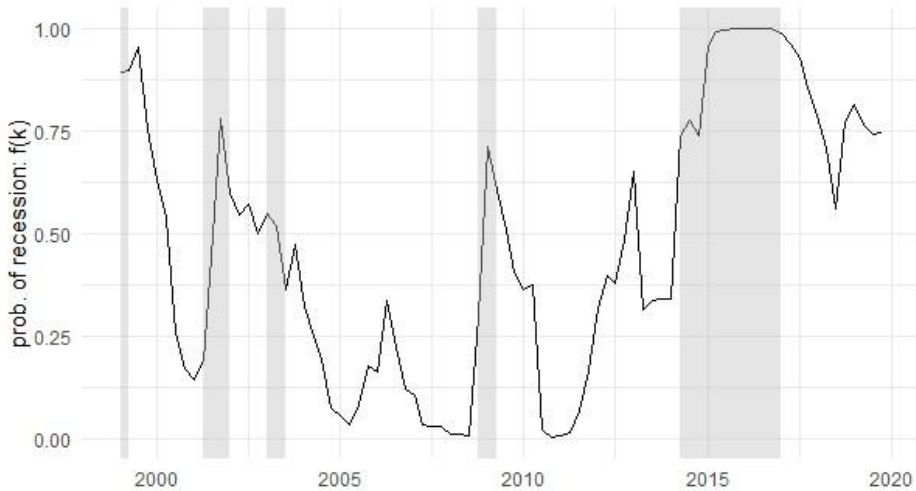
Notes: These correspond to the minimum and maximum values for *γ* that guarantee $Pr(f(k_t) > 0.78) = 0.22$. Given their similarity, we use the mean value: *γ* = 2.18.

Figure 5: Probability of Being in Recession According to the Logistic Function *f*(*k*) Where *k* is a 2-Quarter Moving Average for GDP Growth



Notes: The shaded areas correspond to quarters of recession according to CODACE. The solid black line represents the probability of being in recession according to the logistic function $f(k) = \frac{\exp(-\gamma k_t)}{1+\exp(-\gamma k_t)}$, with *γ* = 2.5550.

Figure 6: Probability of Being in Recession According to the Logistic Function *f*(*k*) Where *k* is a 7-Quarter Moving Average for GDP Growth



Notes: The shaded areas correspond to quarters of recession according to CODACE. The solid black line represents the probability of being in recession according to the logistic function $f(k) = \frac{\exp(-\gamma k_t)}{1+\exp(-\gamma k_t)}$, with $\gamma =$ 2.75.

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