Univeridade Federal de Minas Gerais
Faculdade de Ciências Econômicas
Centro de Desenvolvimento e Planejamento Regional

Berto Carvalho da Silva Junior

Evaluating the presence of state dependent fiscal multiplier in Brazil

Belo Horizonte
2021

Berto Carvalho da Silva Junior

Evaluating the presence of state dependent fiscal multiplier in Brazil

Dissertação apresentada ao Programa de Mestrado em Economia do Centro de Desenvolvimento e Planejamento Regional (Cedeplar/UFMG) como requisito parcial para obtenção do título de Mestre em Economia.

Orientador: Prof. Dr. Mauro Sayar Ferreira.

Belo Horizonte

2021

Ficha Catalográfica

S586e 2021

Silva Junior, Berto Carvalho da.
Evaluating the presence of state dependent fiscal multiplier in Brazil [manuscrito] / Berto Carvalho da Silva Junior. – 2021.
48 f.: il.

Orientador: Mauro Sayar Ferreira.
Dissertação (mestrado) - Universidade Federal de Minas Gerais, Centro de Desenvolvimento e Planejamento Regional.
Inclui bibliografia (f. 45-46) e apêndices.

1. Política tributária - Brasil - Teses. 2. Finanças públicas – Brasil – Teses. 3. Economia – Teses. I. Ferreira, Mauro Sayar, 1972- . II. Universidade Federal de Minas Gerais. Centro de Desenvolvimento e Planejamento Regional. III. Título.

CDD: 306

Elaborada pela Biblioteca da FACE/UFMG – 0019/2022
Fabiana Santos CRB6 2530

UNIVERSIDADE FEDERAL DE MINAS GERAIS
FACULDADE DE CIÊNCIAS ECONÔMICAS
CENTRO DE DESENVOLVIMENTO E PLANEJAMENTO REGIONAL
PROGRAMA DE PÓS-GRADUAÇÃO EM ECONOMIA

FOLHA DE APROVAÇÃO

BERTO CARVALHO DA SILVA JÚNIOR

EVALUATING THE PRESENCE OF STATE DEPENDENT FISCAL MULTIPLIER IN BRAZIL

Dissertação apresentada ao Programa de Pós-Graduação em Economia, da Faculdade de Ciências Econômicas da Universidade Federal de Minas Gerais, para obtenção do título de Mestre em Economia, área de concentração em Economia.

Aprovado em Belo Horizonte, 29 de outubro de 2021.

BANCA EXAMINADORA – participações por videoconferência:

Prof. Mauro Sayar Ferreira (Orientador) (Cedeplar/FACE/UFMG)

Prof. Igor Viveiros Melo Souza (Cedeplar/FACE/UFMG)

Prof. Roberto Accioly Perrelli (Fundo Monetário Internacional – FMI)

ÉDSON PAULO DOMINGUES
Coordenador do Programa de Pós-Graduação em Economia

Documento assinado eletronicamente por **Igor Viveiros Melo Souza**, **Professor do Magistério Superior**, em 03/11/2021, às 15:10, conforme horário oficial de Brasília, com fundamento no art. 5º do Decreto nº 10.543, de 13 de novembro de 2020.

Documento assinado eletronicamente por **Mauro Sayar Ferreira**, **Professor do Magistério Superior**, em 08/11/2021, às 09:12, conforme horário oficial de Brasília, com fundamento no art. 5º do Decreto nº 10.543, de 13 de novembro de 2020.

Documento assinado eletronicamente por **Roberto Accioly Perrelli**, **Usuário Externo**, em 08/11/2021, às 11:59, conforme horário oficial de Brasília, com fundamento no art. 5º do Decreto nº 10.543, de 13 de novembro de 2020.

Documento assinado eletronicamente por **Edson Paulo Domingues**, **Professor do Magistério Superior**, em 08/11/2021, às 17:14, conforme horário oficial de Brasília, com fundamento no art. 5º do Decreto nº 10.543, de 13 de novembro de 2020.

A autenticidade deste documento pode ser conferida no site https://sei.ufmg.br/sei/controlador_externo.php?acao=documento_conferir&id_orgao_acesso_externo=0, informando o código verificador **1051743** e o código CRC **018D7A49**.

Referência: Processo nº 23072.256366/2021-26 SEI nº 1051743

Resumo

Este estudo utiliza o método de projeção local para investigar o tamanho do multiplicar fiscal brasileiro considerando a possibilidade de impactos distintos dependendo do estado da atividade econômica. A análise recorre as series temporais do governo central brasileiro ajustadas de acordo com a metodologia desenvolvida por Orair, Gobetti e Siqueira (2016), estendidas até 2019 neste trabalho, com a finalidade de incorporar despesas que não foram propriamente contabilizadas nas séries oficiais. O multiplicador do gasto do governo no PIB após um ano possui tamanho em torno de 2 nos períodos de recessão e -2 no regime de crescimento regular, sugerindo um efeito crowding out neste ultimo caso. Os multiplicadores do gasto do governo no consumo das famílias e investimento após um ano são significantes e próximos de 0.8 durante recessões e no estado de crescimento regular são negativos, mas sem significância. O efeito multiplicador no valor adicionado das indústrias e serviços após um ano possui tamanho próximo de 1 nos períodos de recessão e é não significativo durante o regime de expansão.

Palavras-chave: Política Fiscal, Gastos do Governo, Ciclos de Negócios, Finanças Públicas.

Abstract

This study uses local projection technique to investigate the size of the fiscal multiplier in Brazil after allowing for the possibility of distinguished impacts depending on the state of the economic activity. The analyses rely on the time series of central government expenditure adjusted according to the methodology developed by Orair et al. (2016), which we extend until 2019, to incorporate expenses that have not been properly placed in the government account. The 1-year fiscal expenditure multiplier on the GDP is around 2 during states of slackness and -2 in regular states, suggesting a crowding out effect in the last case. The 1-year fiscal expenditure multiplier on household consumption and investment is significant and close to 0.8 in states of slackness being negative but not significant in regular states of economic activity. The 1-year multiplier on industry and service value added are close to 1 in slackness, and not significant during regular states.

Keywords: Fiscal Policy, Government Spending, Business Cycles, Public Finance.

List of Tables

List of Figures

Contents

1 Introduction

Since the emergence of the global recession and financial crises of 2007-2008, the fiscal multipliers research agenda has been going through a Renaissance, according to Ramey (2019). This movement aims to tight the lack of consensus shown in the public discussion concerning the fiscal stimulus packages introduced across the world in order to prevent deep recessions. Disagreements about the size of fiscal multipliers and whether fiscal policy play a stabilizing role are part of the usual debate.

According to the classical view, government spending should provoke crowding out effects that would make fiscal policy ineffective to affect the product. The Keynesian view sees fiscal policies as an effective tool to stimulate the economy in the presence of slackness. To account for these possibilities, the empirical literature has advanced to consider models in which the fiscal multiplier may vary according to the states of the economy, the work of Auerbach & Gorodnichenko (2012) being an important reference[1].

We conduct a deep investigation about the impacts of the Brazilian government spending taking into account the possibility of having different responses according to the state of the economy characterized by its slackness. We evaluate the dynamic effects on GDP, its supply and demand components. These exercises are conducted after updating until 2019 the adjusted fiscal spending variable, which methodology developed by Orair et al. (2016) aimed at correcting for the misreporting and parafiscal policies by previous Brazilian governments and that does not appear in the regular spending statistics of the central government. The econometric framework is based on Jordà (2005) local projection (LP) following Auerbach & Gorodnichenko (2013), Miyamoto et al. (2018) and Ramey & Zubairy (2018) contributions. This method allows direct estimation of dynamic effects such as impulse responses and became a popular framework in the fiscal multiplier research, which attributes it some advantages compared to the vector autoregression (VAR) also commonly used in this literature. We highlight three aspects mentioned in the literature[2]. First, LP is more parsimonious and robust to misspecifications because it not requires the solution of a system of equations and do not impose the dynamic restrictions implicitly embedded in VARs. Second, to estimate cumulative effects both the shock and fiscal variable can have measurement error as long as their measurement errors are uncorrelated. Third, its state-dependent specification is more conducive for inference compared to state-dependent vector autoregression methods such as

[1]The literature also recognizes that country and regional structural characteristics may affect the size of the fiscal multipliers (see Ilzetzki et al. (2013), Batini et al. (2014), Hory (2016), and Ramey (2019)).

[2]The asymptotic properties of local projection and the equivalence of impulse responses based on local projection and vector autoregression are cutting-edge knowledge and so far there exists little theoretical guidance as to which method is preferable in practice. See Plagborg-Møller & Wolf (2021) for a brief review.

Smooth Transition VAR and Threshold VAR.

We verify that government expenditure in Brazil depend on the slackness in the economy and must play an important role as stabilizing tool during periods of recession. The 1-year integral cumulative multiplier is around 2. We find positive and significant demand-side effects during recession, but not as large as advocated by the original Keynesian literature. Our estimates suggest that an effective expansionary fiscal plan should account for the dynamic effects on the supply side due to 1-year integral effects above one on industry and services value add. The estimates for the expansion regime suggests an negative cumulative multiplier. However, exploiting the cumulative multipliers on output components during expansion we find no significant results to support for this matter.

Besides bringing this broader view that shed light on the channels through which the fiscal policy has mostly been operating in the Brazilian economy, we also add new evidences to this topic that has not been consensual for Brazil. Table 1 reports all the recent government spending multipliers estimates. Orair et al. (2016) estimates significantly higher government spending multipliers during recessions. Grudtner & Aragon (2017) find no evidence that the effect of fiscal shocks depends on the amount of slack. Alves et al. (2019) present potentially pro-cyclical government spending multipliers, while Holland et al. (2020) show that state-dependent multipliers for Brazil are typically not robust against alternative specifications and are unstable in longer horizons.

The international literature, mostly focused on the case of developed economies, has mainly reported a countercyclical government spending multipliers, considerably greater than 1 during recessions and modest estimates during expansions (e.g., Auerbach & Gorodnichenko (2012); Auerbach & Gorodnichenko (2013); Fazzari et al. (2015); and Caggiano et al. (2015)). Other studies have found multipliers below 1 with no significant difference during recessions or times of slack (e.g., Owyang et al. (2013); Alloza (2017); and Ramey & Zubairy (2018)). Robust findings produced with a variety of data, methods and identification strategies indicate multipliers around one. The recent results of theory and quantitative models also predict government spending multipliers around the unit and show that countercyclical markups depend on significant frictions[3]

This paper proceeds as follows: in Section 2 we describe the data and the central government time series adjustment extending Orair et al. (2016) contribution; Section 3 explain the econometric framework, the identification strategy and the measurement of multiplier reported; in Section 4 we present the estimates of government spending multipliers on GDP

[3]The recent theoretical models that predict countercyclical effects of government spending rely on serious labor market frictions (e.g., Michaillat (2014)) or financial frictions (e.g., Canzoneri et al. (2016)). Standard New Keynesian DSGE models typically do not predict higher multipliers during recessions (e.g., Sims & Wolff (2018); and Zubairy (2014)).

and its components; Section 5 provide a discussion of our results; and Section 6 concludes.

Table 1: State-Dependent Government Spending Multipliers for Brazil

Authors	Sample	Method	Slack	Regular	Concluding remarks
Orair, Siqueira, & Gobetti (2016)	2002.M1 2016.M4	Smooth Transition VAR	2.23[(1)]	0.15[(1)]	Higher multipliers during recessions. The effects of Investment spending and transfers payments are particularly expressive.
Grudtner & Aragon (2017)	1999.Q1 2015.Q4	Smooth Transition VAR	1.75[(2)]	0.94[(2)]	Government spending multiplier does not depend on the slackness.
Alves, Rocha, & Gobetti (2019)	1997.Q1 2017.Q2	Local Projection	2.70[(2)]	3.47[(2)]	Higher multipliers during expansions, however, is generally not statistically different from regular periods.
Holland, Marçal, & de Prince (2020)	1997.Q1 2018.Q2	Threshold VAR	1.48[(3)]	0.20[(3)]	The lack of robustness suggests that government spending multipliers are no significant in all cases.

Notes: Theses evidences uses Blanchard & Perotti (2002) identification strategy explicitly or implicitly orthogonalizing the fiscal variable, which is equivalent to ordering the government spending variable first in a Cholesky decomposition to obtain the identified government spending shocks. See Ramey (2016) for a review about the identification methods.
(1) 48 months cumulative multiplier.
(2) 8 quarters cumulative multiplier.
(3) 4 quarters cumulative multiplier.

2 Data

The analyses are conducted using quarterly data from 1999Q1 to 2019Q4. Besides evaluating the GDP fiscal multiplier, we investigate the impact on its components, the reason why we use the following variables from the Quarterly National Accounts System (SCNT) computed by the Brazilian Institute of Geography and Statistics (IBGE): GDP deflator, nominal GDP, household consumption, investment expenditure, export and import of goods and services, trade, agriculture value added (VA), industry VA, services VA, manufacturing VA, and construction VA. We employ a methodology to correct Central Government Primary Balance accounts, which published time series are nominal. For consistency, following the same procedure applied to central government time series, nominal GDP and its components are deflated by the GDP deflator (2019Q2 = 100) and deseasonalized using the standard X13 method, .

Data for government expenditure and tax revenue is based on the methodology proposed by Orair et al. (2016), which we extend until 2019Q4. They use the Central Government Primary Balance data from the Brazilian National Treasury (STN) to add and subtract some sub-accounts from the primary result to correct a practice extensively adopted by the Federal government from 2011 to 2014 whose main goal was to show high primary surplus by means of what has become known as "creative accounting".

For the government expenditure, the starting point is the sum of central government total expenditure plus intergovernmental transfers to local governments, (i) from which we withdraw deposits in the Brazilian sovereign wealth fund and LC100/01 fund[4] and unilateral transfers to capitalize the Federal oil company (Petrobras) in 2010Q3, (ii) and add the transfers to the Brazilian Development Bank (BNDES) and the time series on liability adjustment from the Central Bank of Brazil that corrects delayed transfers to banks and funds (Banco do Brasil, Caixa Econômica Federal, Finame and FGTS). For the central government receipts, (i) the starting point is the central government total revenue, (ii) from which we withdraw the tax relief accounts and the loss from asset transactions. The expenditure and the revenue adjusted series are deflated by the GDP deflator (2019Q2 = 100) and deseasonalized using the standard X13 method.

Since the GDP and components may react to sovereign risk premium shocks and to international shocks, we include EMBI Br+ (or simply EMBI hereafter) as a measure of sovereign risk. Its inclusion is very attractive, since sovereign risks are impacted by local macroeconomic uncertainties and global shocks, all of them affecting domestic business cycles.

[4]LC100/01 fund was created by the local complementary law number 110/01 as an assistance fund for workers exposure to some specific unemployment situations.

In particular, the Brazilian GDP negatively correlates with EMBI (see Ferreira & Valério (2020)). The Central Bank monetary policy rate (SELIC) is also included among the controls, since it affects output.

Two reasons justify the sample range. First, the current methodology for the central government accounts computed by the Brazilian National Treasury is available from 1997. Second, Brazil was under a crawling peg exchange rate system until January of 1999, after which the country started adopting a free floating policy. Since the size of fiscal multiplier tends to vary across exchange rate regime, we decided to work with information starting in the first quarter of 1999[5]. The Appendix A contains details about the data and the transformations we conduct.

[5]For instance,Ilzetzki et al. (2013) show that fiscal multipliers are larger in countries under fixed exchanged rate regime

3 Methodology, Specification and Identification

3.1 The Econometric Model

We investigate the state dependence of government spending multipliers for the Brazilian economy employing local projection (LP) methods developed by Jordà (2005) and advanced by Auerbach & Gorodnichenko (2013), Miyamoto et al. (2018) and Ramey & Zubairy (2018) in the context of fiscal multiplier analyses. Besides its simplicity, some desired properties has contributed for the increase in popularity achieved by LP[6]. Compared to vector autorregression (VAR), local projection is more parsimonious and robust to mispecifications because obtaining its impulse response functions does not require solving a system of equations and imposing dynamic restrictions implicitly embedded in VARs. In the context of fiscal multiplier, cumulative effects are not biased if the shock and the fiscal variable have measurement errors as long as they are uncorrelated. Third, its state-dependent specification is more conducive for inference compared to state-dependent vector autoregression methods such as Smooth Transition VAR and Threshold VAR.

The baseline local projection model with state dependence is based on the following equations:

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

and

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

where x_{t+h} is the response variable at horizon $t + h$ ($h = 0, ..., H$), z_{t-1} is a vector of lagged control variables and its parameters, $shock_t$ is the fiscal shock, $f(k_t)$ is a logistic function to weight the likelihood between complementary states A and B and the transition variable k_t is an index of the business cycle (normalized to have unit variance). The state dependent coefficients $\beta_{A,h}$ and $\beta_{B,h}$ capture the response of x_{t+h} to a shock at time t. In particular, $\beta_{A,h}$ and $\beta_{B,h}$ describe, respectively, the response of x_{t+h} when the economy is in recession or not. The sub-section X contains details concerning this logistic function.

[6]The asymptotic properties of local projection and the equivalence of impulse responses based on local projection and vector autoregression are cutting-edge knowledge and so far there exists little theoretical guidance as to which method is preferable in practice. See Plagborg-Møller & Wolf (2021) for a brief review.

Some authors try to capture the state of the economy using a dummy variable to indicate periods in which a business cycle related variable exceeds a certain threshold (e.g. Ramey & Zubairy (2018), Bernardini & Peersman (2018), Miyamoto et al. (2018)). This approach, however, makes more sense when dealing with a large temporal range in which several recessionary periods are identified in the data. In our case of a relative small temporal range, the use of the logistic function ensures a consistency gain since we may describe the state of the business cycle using the entire interval ranging from 0 to 1.

The traditional linear model to evaluate the size of fiscal multiplier is a special case of model 1 when states do not matter, which leads to

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

In this case, the collection of β_h for $h = 0, ..., H$ corresponds to the usual impulse response function. Plagborg-Møller & Wolf (2021) shows that for a VAR based structural identification that is equal to the LP specification the impulse response functions produced by both methods are asymptotically equivalent.

The baseline control vector z_t includes 4 lags of quarter over quarter growth rate of real GDP, real government spending, real tax revenue, and EMBI, and the first difference of Brazilian Central Bank monetary policy interest rate (SELIC). These lagged variables intend to guarantee that estimates of β_A and β_B only capture the relation between fiscal shocks at time t and the response variable, once past shocks and feedback dynamics are supposedly controlled. Figure 1 presents the evolution of these control variables.

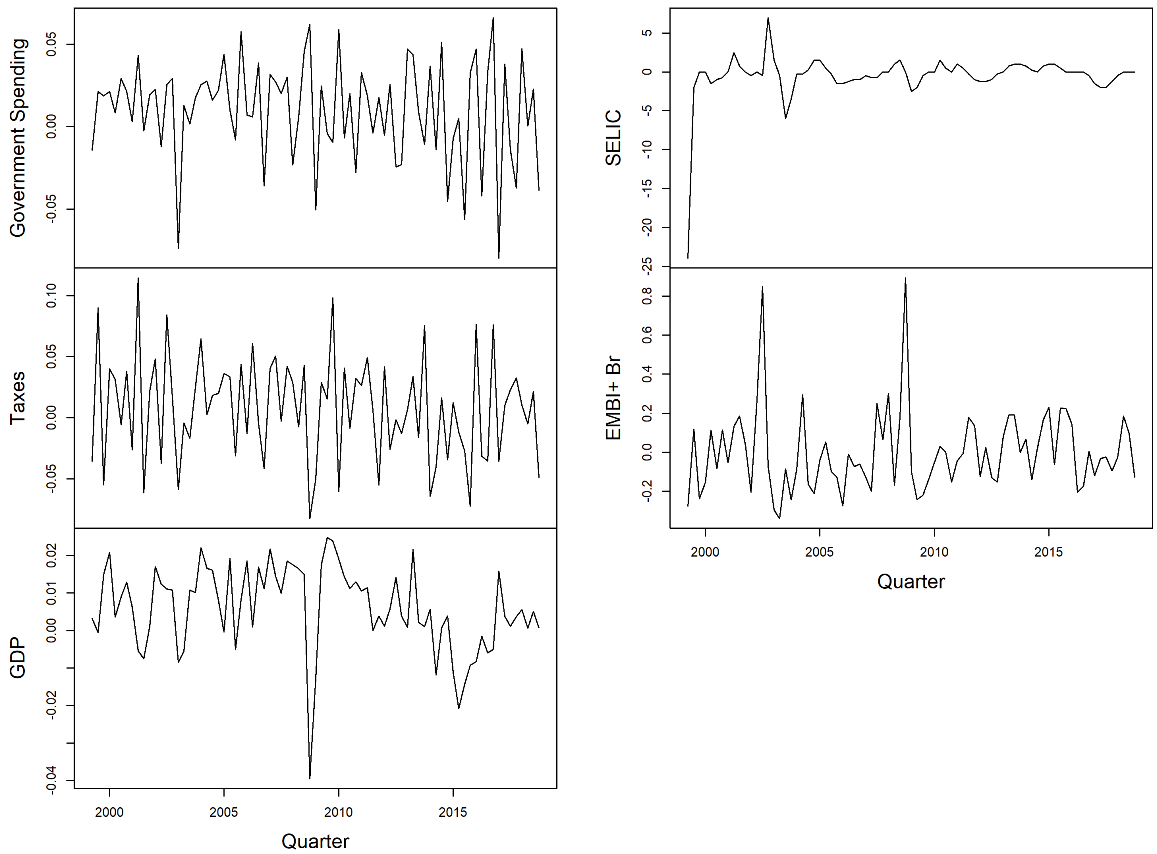

Figure 1: Baseline Control Variables

Notes: The baseline control variables are the quarter growth rate of real GDP, real government spending, real tax collected, EMBI+ Brazil and the first difference of Brazilian target for federal funds rate.

A potential flaw associated with the Jordà method is the serial correlation in the error terms induced by the successive leading of the dependent variable. Jordà (2005) assumes that the error terms of the local projection follow some form of moving average structure whose order is a function of the horizon, $h = 0, 1, ..., H$. Although the point estimates remain unbiased in the presence of serial correlation it can reduce the estimator efficiency since there is no guarantee that the estimator is BLUE, i.e. it is potentially not the unbiased estimator with minimum variance, and the standard error may not be conducive for inference. As argued by Jordà (2005), Auerbach & Gorodnichenko (2013) and Ramey & Zubairy (2018) the use of an estimate of the covariance matrix robust to heterokedasticity and autocorrelation enables the inference in a local projection framework and enhance efficiency[7]. For this

[7]According to Jordà (2005) the efficiency of these estimators can be improved upon recursively including

matter we estimate standard errors using robust to heterokedasticity and autocorrelation (HAC) estimators based on Newey & West (1987). The estimates of spending multipliers presents robust standard errors in parenthesis and p-values testing the null hypothesis of no state-dependence.

3.2 Identification

The government spending shock is identified using the standard Blanchard & Perotti (2002) institutional approach, which assumes that a discretionary fiscal policy does not respond to output contemporaneously as it is likely to take longer than a quarter for government purchases to respond to changes in economic activity. This strategy implies that a fiscal shock is the part of central government spending that is orthogonal to past control variables, which guarantees that a shock is not forecastable[8]. This is the benchmark approach to identify fiscal shocks in the literature, which is also convenient in our context of a short time series[9], and it is an additional reason for including a substantial among of lags in the controls.

The literature on state-dependent fiscal multiplier typically proposes two approaches to deal with the identification problem. The first relies on a two stage estimation procedure where the forecast errors of the government spending, based on a first stage prediction model regression, is used as the identified expenditure shock ($shock_t$), which is later used in equations 1 and 2 as a regressor in the second stage. As explained in the next subsection, we report cumulative multipliers, which requires computing the impulse response of the GDP and of the government expenditure. For example, the linear impact multiplier at time $t = 0$ is $m_0 = \frac{\beta_0^y}{\beta_0^g}$, where β_0^y is the output response to $shock_0$ and β_0^g is the expenditure response. A problem is that inference on m_0 becomes less trivial within this approach.

The second approach is a one-stage estimation where the output variable and the fiscal variable are initially transformed to the same reference unit before being used in the regres-

the residuals of the stage $t + h - 1$ local projection as regressors in the stage $t + h$. The ongoing literature propose methods to access the structure of the error terms. If the error term is known, a more efficient parameter can be estimated with generalized least squares. See Lusompa (2021) for a brief review.

[8]In the context of VAR this non predictability is attained by introducing lags of the variables that form the system.

[9] Ramey (2016) discusses the limits of the standard Blanchard & Perotti (2002) identification scheme. In the context of the US economy, Ramey (2011) tries to identify fiscal shocks relying on a narrative identification strategy based on time series of the U.S. military news. Auerbach & Gorodnichenko (2012) and Miyamoto et al. (2018) rely on deviations between private forecasts of the government spending and the actual spending as a measure for fiscal shock. We are not aware of long time series of forecasts for the spending of the Brazilian government in order to implement this last approach, and Brazil has not engaged with constancy in events like wars that would require extra spending to allow considering it as a proxy of fiscal shock.

sion. The transformed government spending series can then be interpreted as the cumulative government expenditure response following the fiscal shock at t as long as the control vector filter the predictable components of the response and the fiscal variables. Our preferred approach is this one, based on a single regression, since the coefficients (and their standard errors) on the cumulative transformed government expenditure series correspond to the actual multipliers (and their standard errors).

3.3 The Fiscal Multiplier

The literature has considered different approaches to compute fiscal multipliers. Blanchard & Perotti (2002) report peak multipliers, which is the maximum output response following a government expenditure shock. Auerbach & Gorodnichenko (2013) consider the mean quarter output response with respect to government spending shock at $t+0$. Mountford & Uhlig (2009) consider the integral multiplier, which is the cumulative output response, up to a time h following the shock, with respect to the cumulative expenditure response until h. This strategy captures the actual timing that a fiscal policy is implemented and its potential impact on output that is expected to be spread over time.

Since we follow the last strategy, the econometric model is already estimated considering the cumulative government expenses and output. In particular, let's define the response variable x_{t+h} as

$$x_{t+h} = \frac{X_{t+h} - X_{t-1}}{Y_{t-1}} \tag{3}$$

where X_{t+h} is the level of the response variable of interest at $t+h$ and Y_{t-1} is the GDP at $t-1$. This normalization, which is also used by Hall (2009) and Barro & Redlick (2011), leaves all variables in the same unit and already considers the cumulative response.

Another advantage for using the transformation proposed by 3 has to do with the final computation of the fiscal multiplier. A standard approach in the literature is to estimate the models using log transformed variables, which results in elasticity coefficients that need to be transformed (*ex post* conversion) to obtain the multiplier. As an example, suppose the model is estimated as in Blanchard & Perotti (2002): $ln(Y) = B_0 + B_1 ln(G) + U$, where U is an *iid* innovation. The partial derivative of Y with respect to G is $\frac{\partial Y}{\partial G}\frac{1}{Y} = B_1\frac{1}{G}$, but the multiplier is $\frac{\partial Y}{\partial G} = B_1\frac{Y}{G}$, where averages of Y and G are commonly used in this *ex post* conversion.

Since the ratio $\frac{Y}{G}$ may vary over time, Ramey & Zubairy (2018) show that this procedure can bias the multiplier estimates, which can be avoided using the *ex ante* transformation according to equation 3 that should also be applied to the *shock* series. In this case, $shock_t$ present in 1 and 2 is replaced by $shock_{t+h} = \frac{G_{t+h} - G_{t+1}}{Y_{t-1}}$, which is the same transformation applied to the response variable of interest. For simplicity, suppose $y_{t+h} = \frac{Y_{t+h} - Y_{t+1}}{Y_{t-1}}$ and the following model: $y_{t+h} = C_0 + C_1 shock_{t+h} + error$, with an error *iid*. The partial derivative of y_{t+h} with respect to $shock_{t+h}$ is $\frac{\partial y_{t+h}}{\partial shock_{t+h}} = C_1$, where C_1 is the cumulative multiplier that accounts for the integral response of output relative to the fiscal shock at $t = 0$ and its impact on the sequence of accumulated expenditure until $t + h$.

Replacing these transformed variables in 1, the state dependent cumulative fiscal multipliers from $t + 0$ to $t + h$ are obtained from the estimation of $\beta_{A,h}$ and $\beta_{B,h}$ using a directly 1 stage model. Similarly, the cumulative fiscal multiplier when states do not matter is obtained after estimating β_h in equation 2 using the transformed variables. Figure 2 shows the response variable GDP and government expenditure normalized according to Equation 3 at $h = 0$.

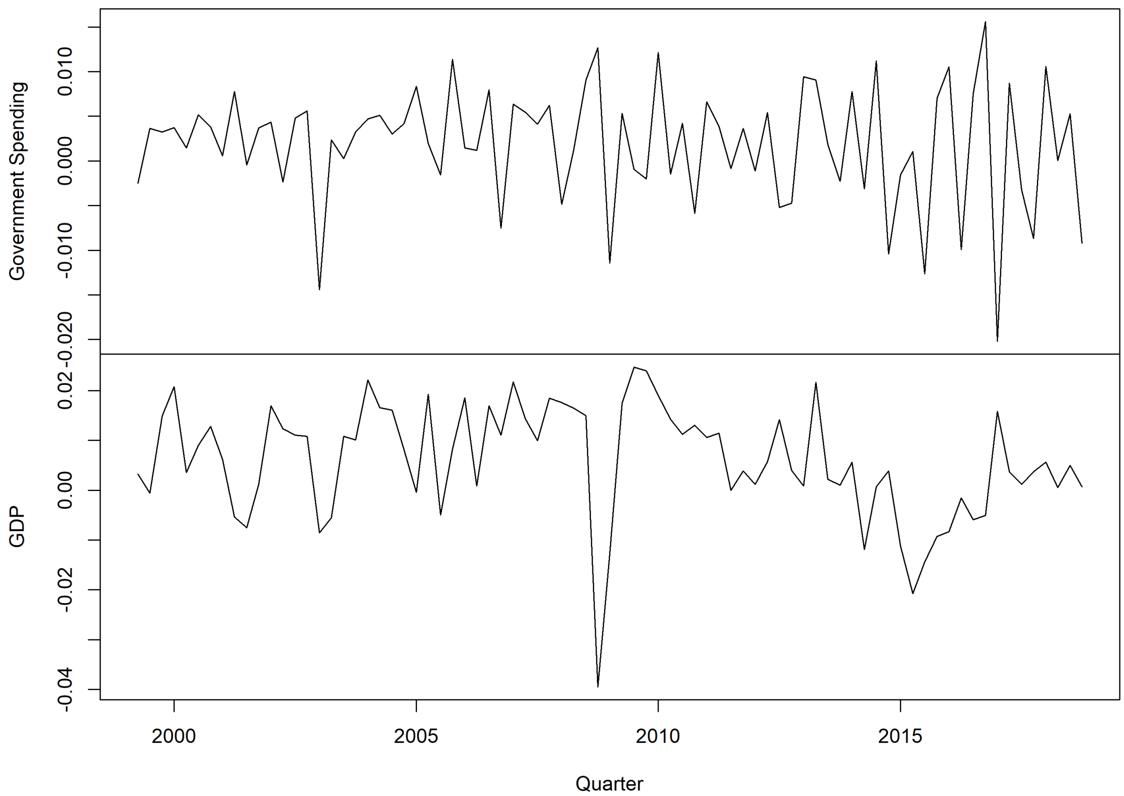

Figure 2: Normalized GDP and Government Spending

Notes: Real GDP and real government spending, both normalized following equation 3 at $h = 0$.

3.4 Recession Transition State

Following Auerbach & Gorodnichenko (2012), we identify measures of slackness to use in the logistic function $f(k_t)$ that defines probability of recession. We construct the transition function assuming higher probability of slackness as $f(k_t)$ tends to 1, in which case $1 - f(k_t)$ would tend to 0. Some papers use a dummy variable to capture states of recession (e.g., Ramey & Zubairy (2018) and Bernardini & Peersman (2018)), but given our short time series we would have to rely on a small number of observation indicating recessionary state. The use of the logistic function overcomes this problem, ensuring greater consistency by using a continuous probability measure.

The construction of the logistic function $f(k_t)$ requires a k_t transition variable, with zero mean and unit variance, to characterize the states, and an estimate for the parameter γ. Regarding the first requirement, there is no prescription of the best measure for the transition variable k_t. For this reason, we base on previous literature and select the following candidates to measure slackness: 2, 5, and 7 quarters moving averages of output growth rate; a capacity utilization index (NUCI); the cyclical component of output measured by the residual of the HP filtered output with $\lambda = 1600$; and the cyclical component of output measured by the residual of the Hamilton filter on output with $h = 8$ and $p = 4$[10].

We calibrate γ to guarantee that in 22% of the quarters of our sample the economy is in the slack state, which is consistent with the recession dating for Brazil according to CODACE[11]. All 6 potential measures of slack are submitted to a selection based on two criteria: (i) the calibration of γ matches $Pr(f(k_t) > 0.78) = 0.22$ in the observed recession quarters, and (ii) $\gamma < 4$. For higher values of γ, $f(k_t)$ returns values very close to zero or one and this threshold $\gamma < 4$ is applied to avoid degenerated functions with extreme values that mischaracterize quarters of recession. Only the 2 and 5 quarters moving averages of growth rate, with $\gamma = 1.3$ and $\gamma = 3.25$ respectively, satisfies these restrictions. Following Alves et al. (2019) and Grudtner & Aragon (2017), we use the 5-quarter moving average as our baseline transition variable, since it is the benchmark transition variable in previous studies of the Brazilian case and may provide more adequate comparisons. Auerbach & Gorodnichenko (2013) argues that the moving average growth rate over a year may capture the output gap and thus the degree of slack in the economy, but we also conduct estimates using 2 quarters moving average for robustness. Figure 3 shows the fit of the logistic function with the 5-quarter moving average growth rate.

[10]Using quarterly economic data, Hamilton (2018) suggests a linear model on a univariate time series shifted ahead by h periods (forecast horizon), regressed against a series of variables constructed from varying lags of the series by some number of periods p (number of regressors). More specifically, the Hamilton method with suggested default parameters $h = 8$ and $p = 4$ is computed as follows:

$$x_{t+8} = \alpha_0 + \alpha_1 x_t + \alpha_2 x_{t-1} + \alpha_3 x_{t-2} + \alpha_4 x_{t-3} + u_{t+8}$$

The random component is simply the difference between the original series and its h look ahead.

[11]CODACE is a committee that maintains a chronology of Brazilian business cycles.

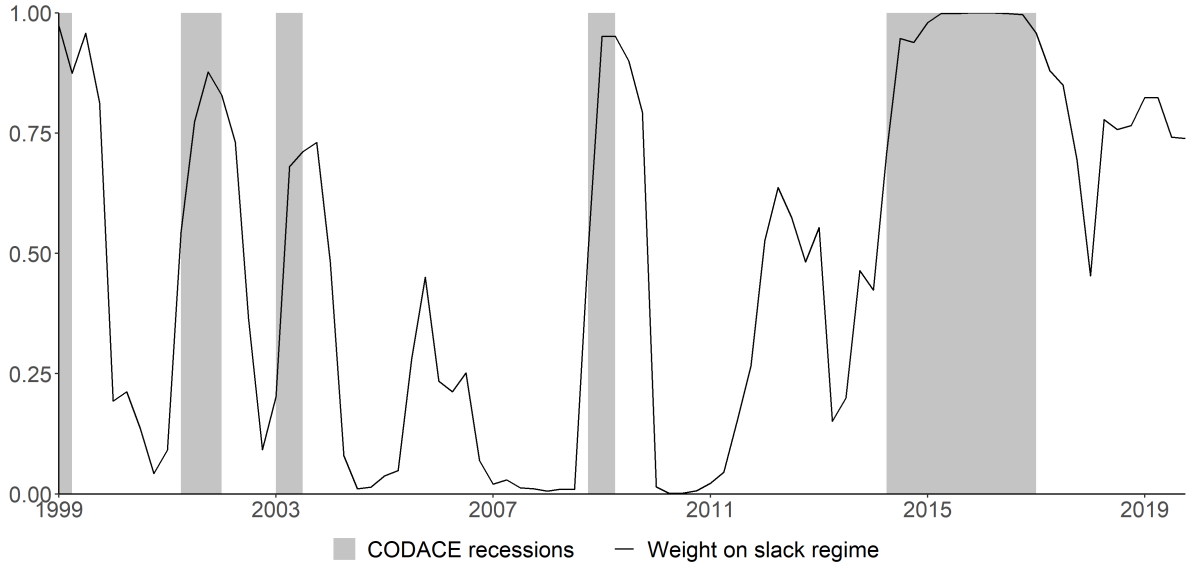

Figure 3: CODACE Dates and Weight on Recession Regime

Notes: The shaded areas show the quarters of recession according to CODACE. The solid black line shows the weight of the observations on recession regime, based on logistic function $f(k_t)$ with 5-quarter moving average growth rate and $\gamma = 3.25$.

4 Results

4.1 Linear Multiplier

Although the literature emphasizes the relevance of taking into account states related to business cycle, we start presenting results from a linear not state dependent specification to have them as benchmarks[12]. Table 2 and Figure 4 shows the impulse responses and government spending multipliers based on the linear model from equation 2. We present the dynamic effects of an initial government spending shock equal to 1% of GDP.

Table 2: Estimates of Linear Spending Multipliers

Horizon	Impact Multiplier	Half-year integral	1-year integral
Linear Model	-0.18	-0.25	0.09
	(0.28)	(0.47)	(0.55)

Notes: The values in parentheses under the multipliers give the standard errors based on Newey & West (1987) formula robust to heterokedasticity and autocorrelation.

The impact multiplier of -0.18 rises to an integral multiplier of 0.09 one year after the shock, but these estimates are all insignificant. Comparing to other linear models for Brazil, our results are in line with the findings of Cavalcanti & Silva (2010) and Holland et al. (2020), but oppose those reported by Matheson & Pereira (2016) who find a significant peak multiplier around 0.5 on the impact. Our linear estimates are smaller than documented in the recent literature for other countries. Employing a similar identification strategy, Ramey & Zubairy (2018) find a 2-year integral multiplier of 0.38 for US and Auerbach & Gorodnichenko (2013) estimate the mean quarter response around 0.14 over 1-year horizon for OECD countries.

[12]See Koop et al. (1996) for impulse response analysis in nonlinear multivariate models.

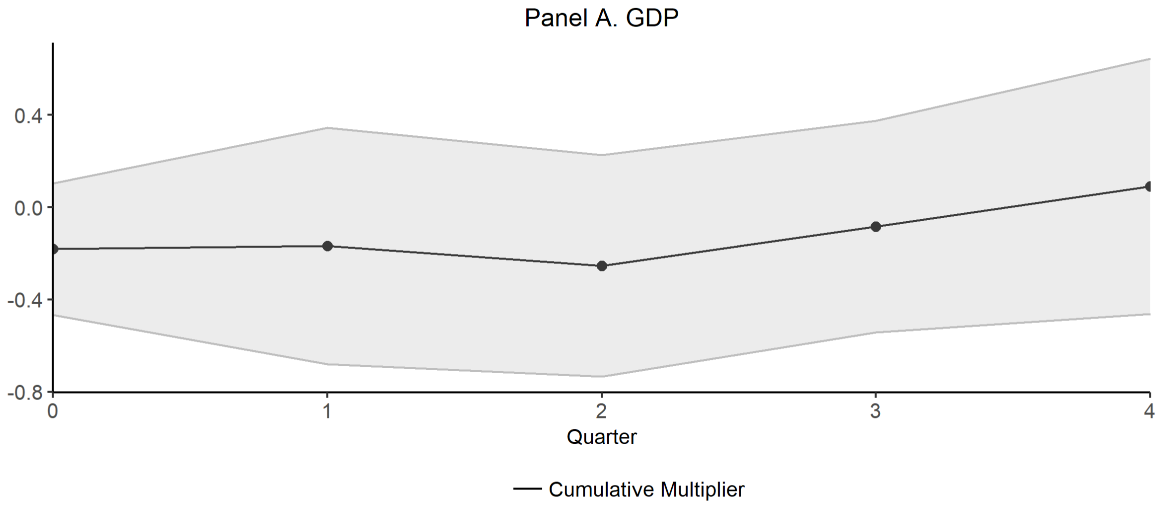

Figure 4: Linear Government Spending Multiplier

Notes: The solid black line shows the cumulative multiplier based on the linear model in the equation 2. The shaded bands show the one standard deviation confidence interval based on Newey & West (1987) standard errors.

4.2 Multipliers during Times of Slack

This section presents the main results of our investigation: the government spending multipliers of the GDP in different states of economic activity. Figure 5 and Table 3 shows the state-dependent impulse responses induced by an initial spending shock equal to 1% of GDP. The impact multiplier on output is positive around 0.5 in the recession regime and increases monotonically reaching an integral multiplier around 2.9 one-year after the initial shock. At other hand, the output initial response during expansions is negative around -0.5, decreasing more drastically during the first two quarters and reaching an integral effect around -1.7 one-year after. The estimates support the hypothesis of state dependence according to the slack of the Brazilian economy. The difference in the punctual estimates across the states is relevant since the impact multiplier and becomes more significant over the following 4-quarters integral effect.

The magnitude of multipliers during recessions is in consonance with state-dependent evidences for Brazil, but differs in response timing. Orair et al. (2016) findings supports the state dependent hypothesis and report a 4-year spending multipliers around 2.2. Grudtner &

Table 3: Estimates of State-Dependent Spending Multipliers

Horizon	*Recession*	*Expansion*	*p-Value*
Impact Multiplier	0.51	-0.48	HAC = 0.10
	(0.32)	(0.49)	
Half-year integral	1.52^{***}	-2.14^{**}	HAC < 0.01
	(0.36)	(0.83)	
1-year integral	2.96^{***}	-1.75	HAC = 0.02
	(0.90)	(1.18)	

Notes: The values in parentheses under the multipliers give the standard errors based on Newey & West (1987) formula robust to heterokedasticity and autocorrelation. (*) for the 10% critical value. (**) for the 5% critical value. (***) for the 1% critical value. p-Value column presents the test for difference in multipliers across states of slack. HAC indicates the heterokedasticity and autocorrelation consistent p-Value based on Newey & West (1987) testing the null hypothesis of no state-dependence.

Aragon (2017) estimate a 2-year integral effect around 1.8 during recessions and Alves et al. (2019) repot a 2-year cumulative multiplier with size 2.7, but both studies find no evidence that spending multipliers depend on the slackness. Despite this congruence, regarding the magnitude of multiplier during expansions we find no previous evidence in the Brazilian case that adheres to our findings since the most moderate measures in the previous researches in Table 1 are between 0.1 and 0.2. Negative spending multipliers are no so unusual in the general state-dependent literature. Auerbach & Gorodnichenko (2013) find quarter mean responses on GDP slightly negative with size -0.2 based on a panel data local projection for a large number of OECD countries. We are cautious about the sizes of multipliers during expansions and propose to investigate this measure more deeply exploiting the state dependent effects of fiscal stimulus on GDP components.

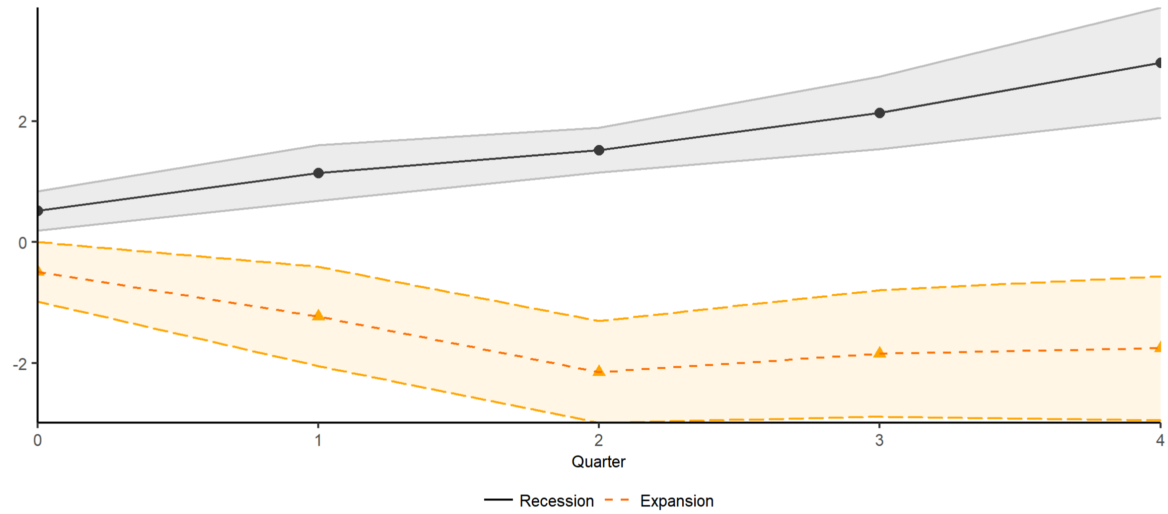

Figure 5: State-Dependent Spending Multipliers

Notes: The graph shows the quarter-to-quarter cumulative government spending multiplier during periods of recession and expansion. The solid line shows the cumulative multiplier during recession. The dashed line shows the cumulative multiplier in times of expansion. The shaded bands show the one standard deviation confidence interval based on Newey & West (1987) standard errors.

4.3 Robustness Checks

The baseline model is based on practices that are both highlighted in the recent fiscal literature and feasible in the Brazilian case. To access whether the evidence produced with the baseline model is affected by variations in the specification, this section presents several robustness checks of the baseline results. Robustness estimates are summarized in Table 4. The overall estimate supports the initial evidence.

As the first change, a number of authors suggests to implement the normalization in the Equation 3 using a potential output measure instead the GDP itself (eg. Ramey & Zubairy (2018) and Bernardini & Peersman (2018)). We estimate two models where the variables are normalized by potential GDP using HP Filter (with a parameter $\lambda = 1600$) and Hamilton Filter (with parameters $h = 8$ and $p = 4$). Both models presents state-dependent multipliers that support the initial punctual estimates with slightly differences, and we find no significance in the 1-year integral multiplier during expansions.

The period from 2014Q2 to 2016Q4 comprises the greatest recession in Brazil according to CODACE business cycles dates. This time is characterized not only by recession, but political and economic turmoil that summed up in a general crisis whose aggregate effects

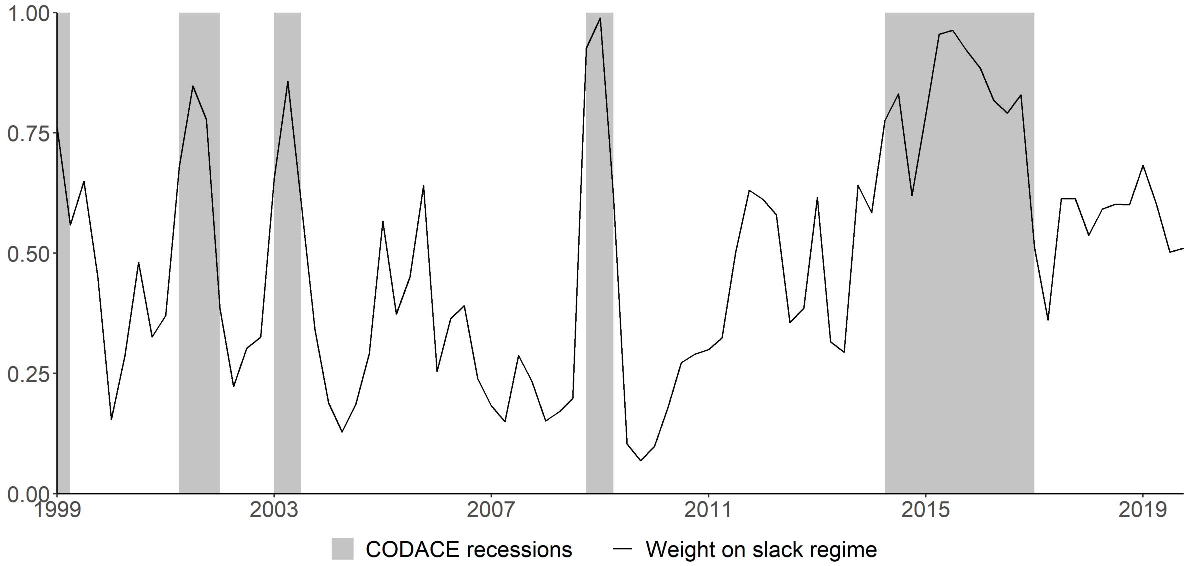

Figure 6: CODACE Dates and Alternative Weight on Recession Regime
Notes: The shaded areas show the quarters of recession according to CODACE. The solid black line shows the weight of the observations on recession regime, based on the 2-quarter moving average growth rate logistic function $f(k_t)$ with $\gamma = 1.30$.

can be seen in a abrupt trend change in Investments for example. A number of authors exclude the crises quarters as a attempt to provide additional information concerning the implications of this period on spending multipliers. Due to the short sample, we propose to use a dummy variable to account for these quarters. This add produces the most substantial change to the linear estimate, but remains non-significant, and we find no changes in the state-dependent multipliers.

As the last change we employ an alternative transition variable. As argued in the beginning of the Section X, the 2-quarter moving average of GDP growth rate is the only proper substitute for k_t among the initial candidates analysed. Thus, we estimate a model with an alternative $F(k_t)$ (with $\gamma = 3.25$) and controlling by the same variables as baseline specification. Figure 6 shows the fit of logistic function with the 2-quarter moving average of GDP growth rate. In this case the estimates suggests a greater impact multiplier during recessions and more negative effect in times of expansion, with no significance in the long-run multiplier for both states.

Table 4: Alternative Estimates of State Dependent Cumulative Multipliers

Model	*State*	*Impact Multiplier*	*Half-year integral*	*1-year integral*
Baseline	Linear	-0.18	-0.25	0.09
		(0.28)	(0.47)	(0.55)
	Recession	0.51	1.52***	2.96***
		(0.32)	(0.36)	(0.90)
	Expansion	-0.48	-2.14**	-1.75
		(0.49)	(0.83)	(1.18)
Normalization with Potential Output (HP Filter)	Linear	-0.18	-0.27	0.08
		(0.29)	(0.49)	(0.53)
	Recession	0.56*	1.54***	2.92***
		(0.33)	(0.36)	(0.92)
	Expansion	-0.53	-2.17***	-1.71
		(0.49)	(0.83)	(1.17)
Normalization with Potential Output (Hamilton Filter)	Linear	-0.18	-0.31	0.08
		(0.30)	(0.52)	(0.53)
	Recession	0.63*	1.58***	2.86***
		(0.34)	(0.37)	(0.95)
	Expansion	-0.61	-2.22***	-1.57
		(0.51)	(0.85)	(1.21)
with Dummy	Linear	-0.11	-0.02	0.54
		(0.29)	(0.45)	(0.48)
	Recession	0.46	1.36***	2.61***
		(0.34)	(0.40)	(0.96)
	Expansion	-0.52	-2.24***	-1.98**
		(0.46)	(0.76)	(0.84)
Alternative Transition Variable	Recession	1.39***	2.13***	1.32
		(0.40)	(0.66)	(1.13)
	Expansion	-1.21***	-2.31***	0.31
		(0.43)	(0.86)	(1.61)

Notes: The values in parentheses under the multipliers give the standard errors based on Newey & West (1987) formula robust to heterokedasticity and autocorrelation. (*) for the 10% critical value. (**) for the 5% critical value. (***) for the 1% critical value.

4.4 The Fiscal Multiplier on the Components of the Demand of the GDP

This section investigates whether household consumption and investment expenditure responds asymmetrically to government spending shocks according to the state of slackness. The reaction of both is central to the debate among classical and the Keynesian view of the economy, the first highlighting possible crowding out effects on investment, while the second calling attention for the role played by the marginal propensity to consume to further boost the economy after an initial increase in government expenditure in the presence of slackness. We also estimate state dependent fiscal multiplier on imports to exploit whether the fiscal stimulus is related to some degree of absorption of the foreign output according to the business cycles.

The estimates are based on equation 1 and 2. The normalized output response variable according to equation 3, x_t, is changed to household consumption, investment, and imports. For example, the linear cumulative multiplier on household consumption, β_h^C, is the coefficient of the following model

$$\frac{C_{t+h} - C_{t-1}}{Y_{t-1}} = \mu_h + \psi_h(L)z_{t-1} + \beta_h^C shock_{t+h} + \eta_{t+h} \tag{4}$$

where $\psi_h(L)z_{t-1}$ is the standard control vector in the equation 2.

Figure 7 and Table 5 presents the government spending dynamic effects on household consumption, investment and imports. We find fiscal effects on household consumption that are strictly Keynesian during recessions and classical in times of expansions punctual. The consumption multiplier has an impact around between -0.2 and 0.1 during recessions and around 0.2 in times of expansion. The consumption response in the recession regime remains stable around zero until 2-quarters after shock, and from then on rises to a significant 1-year integral effect with size 0.85. At the other hand, the response during expansions decreases monotonically to -0.5 and remains non-significant.

The fiscal stimulus on investment during recessions presents a stable integral effect around zero until 2-quarter after shock. The investment response in the two following quarters rises to a significant 1-year integral effect around 0.8. In times of expansion we find a positive and significant impact multiplier of 0.26, but in the two following quarters the integral response diminishes to -0.6 and loses significance.

Although we found evidence of state-dependence for household consumption only, the estimates of fiscal effects on both household consumption and investment are significant during recessions. The overall estimates suggests that a government spending shock which rises disposable income of agents during recessions is likely to induce some level of economic activity 2-quarters after shock. In times of expansion the impact response of investment is significant but may crowd out from next quarter onwards.

Regarding the government spending dynamic effects on imports, we find virtually zero multipliers on imports for all horizons. This finding suggest that a government spending shock are not related to some relevant degree of foreign output absorption.

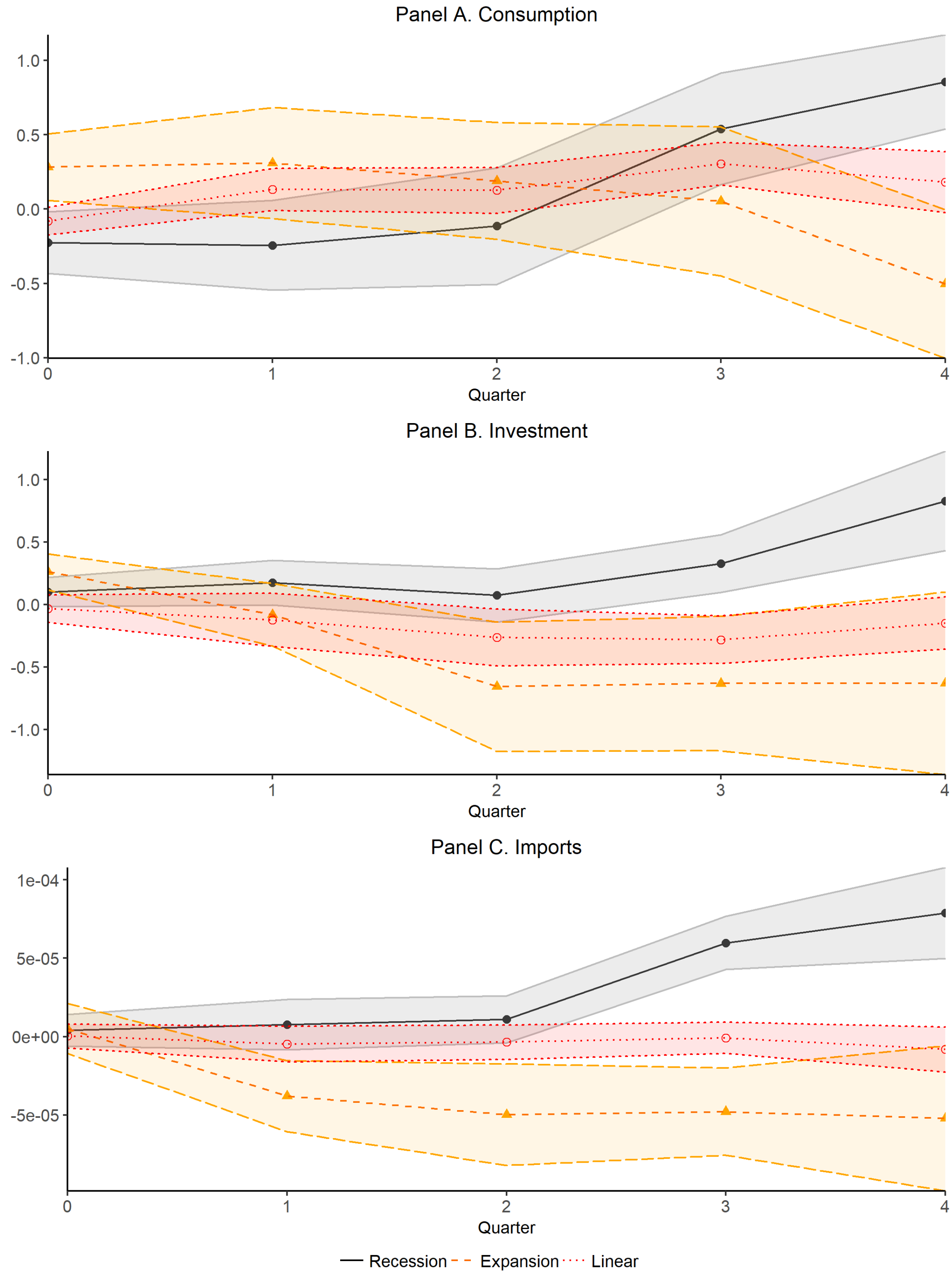

Figure 7: State-Dependent Multipliers on Demand Components

Notes: Panel *A* shows the cumulative multiplier on household consumption. Panel *B* shows the cumulative multiplier on investment. Panel *C* shows the cumulative multiplier on imports. The solid lines show the cumulative multiplier in periods of recession. The dashed lines show the cumulative multiplier in times of expansion. The dotted lines show the linear multiplier. The shaded bands show the one standard deviation confidence interval based on Newey & West (1987) standard errors.

Table 5: Estimates of State-Dependent Multipliers on Demand Components

	Linear	*Recession*	*Expansion*	*p-Value*
Consumption				
Impact Multiplier	-0.08	-0.22	0.28	HAC = 0.21
	(0.09)	(0.20)	(0.22)	
Half-year integral	0.12	-0.11	0.18	HAC = 0.61
	(0.15)	(0.39)	(0.39)	
1-year integral	0.18	0.85***	-0.50	HAC = 0.05
	(0.20)	(0.31)	(0.49)	
Investment				
Impact Multiplier	-0.03	0.10	0.26*	HAC = 0.45
	(0.10)	(0.11)	(0.14)	
Half-year integral	-0.26	0.07	-0.65	HAC = 0.25
	(0.22)	(0.21)	(0.51)	
1-year integral	-0.14	0.82**	-0.63	HAC = 0.18
	(0.21)	(0.39)	(0.73)	
Imports				
Impact Multiplier	3.8e-05	4e-06	5.1e-06	HAC = 0.95
	(7e-06)	(1e-05)	(2e-05)	
Half-year integral	-3.5e-04	1e-05	-4.9e-05	HAC = 0.13
	(1e-05)	(2e-05)	(3e-05)	
1-year integral	-8.2e-04	7.8e-05	-5.2e-05	HAC = 0.06
	(1e-05)	(3e-05)	(5e-05)	

Notes: The values in parentheses under the multipliers give the standard errors based on Newey & West (1987) formula robust to heterokedasticity and autocorrelation. (*) for the 10% critical value. (**) for the 5% critical value. (***) for the 1% critical value. p-Value column presents the test for difference in multipliers across states. HAC indicates the heterokedasticity and autocorrelation consistent p-Value based on Newey & West (1987) testing the null hypothesis of no state-dependence.

4.5 Production Side Fiscal Multipliers

We investigate the fiscal impact on the production side of the GDP. According to the classic model, the GDP is determined by the supply side, so a expansionary fiscal policy in the presence of a vertical output curve should would increase prices and crowd out investment.

The Keynesian perspective argues that a fiscal expansion during slackness can stimulate production that would react to attend the extra demand by relying on unemployed inputs.

The estimates are based on equation 1 and 2. The normalized output variable according to equation 3, x_t, is changed to the value add of industry, services, manufacturing and construction. For example, the linear cumulative multiplier on services value add, β_h^S, is the coefficient of the following model

$$\frac{S_{t+h} - S_{t-1}}{Y_{t-1}} = \mu_h + \psi_h(L)z_{t-1} + \beta_h^S shock_{t+h} + \eta_{t+h} \tag{5}$$

where $\psi_h(L)z_{t-1}$ is the standard control vector in the equation 2.

First, we investigate the state-dependent government spending effects on industries production and services. Figure 8 and Table 6 presents the estimates. We find disparate fiscal effects on industries and services across the states. The impact multiplier on industry value add is around zero during recession and increase monotonically to an 1-year integral measure around 1. In times of expansion, the estimates suggests that the impact of fiscal stimulus on industries is slightly positive and significant but may crowd out on the following quarters, and the 1-year integral measure is not significant. Regarding the dynamic effects on services in times of recession, we find a positive impact around 0.2 that may rise in the 2nd and 3th quarters after shock to a significant and stable cumulative multiplier around 1.2. During expansions the estimates of fiscal effects on services are not significant.

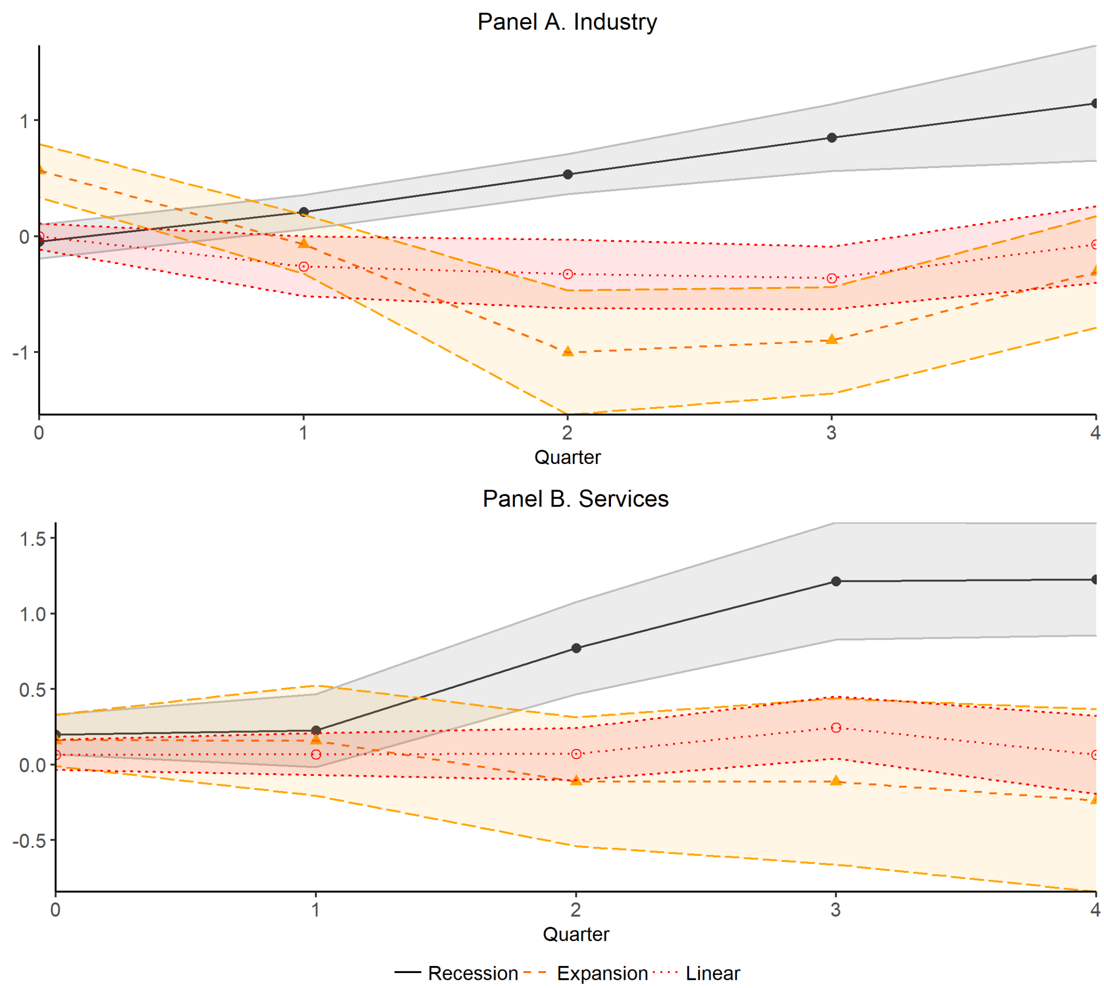

Figure 8: State-Dependent Multipliers on Industry and Services

Notes: Panel *A* shows the cumulative multiplier on industry value add. Panel *B* shows the cumulative multiplier on services value add. The solid lines show the cumulative multiplier in periods of recession. The dashed lines show the cumulative multiplier in times of expansion. The dotted lines show the linear multiplier. The shaded bands show the one standard deviation confidence interval based on Newey & West (1987) standard errors.

Since we find positive and significant responses of industry and services value add during recession, we turn to investigate the state-dependent fiscal effects on industries subcategories — manufacturing and construction value add — to exploit the sources of distinctive fiscal effects on aggregate industries according to business cycles. Figure 9 and Table 7 presents the estimates. We find that in times of recessions both manufacturing and construction value add respond positively and the 1-year integral measure is significant, around 0.3 for construction and 0.5 for manufacturing. The estimates in the regular regime show that expenditure

Table 6: Estimates of State-Dependent Multipliers on Industry and Services

	Linear	*Recession*	*Expansion*	*p-Value*
Industry				
Impact Multiplier	0.00	-0.04	0.56^{**}	HAC = 0.06
	(0.11)	(0.14)	(0.22)	
Half-year integral	-0.32	0.53^{***}	-1.00^{*}	HAC = 0.01
	(0.29)	(0.17)	(0.53)	
1-year integral	-0.07	1.14^{**}	-0.30	HAC = 0.11
	(0.33)	(0.49)	(0.48)	
Services				
Impact Multiplier	0.06	0.20	0.15	HAC = 0.86
	(0.09)	(0.13)	(0.16)	
Half-year integral	0.06	0.77^{***}	-0.11	HAC = 0.18
	(0.17)	(0.30)	(0.42)	
1-year integral	0.06	1.22^{***}	-0.23	HAC = 0.09
	(0.25)	(0.37)	(0.60)	

Notes: The values in parentheses under the multipliers give the standard errors based on Newey & West (1987) formula robust to heterokedasticity and autocorrelation. (*) for the 10% critical value. (**) for the 5% critical value. (***) for the 1% critical value. p-Value column presents the test for difference in multipliers across states. HAC indicates the heterokedasticity and autocorrelation consistent p-Value based on Newey & West (1987) testing the null hypothesis of no state-dependence.

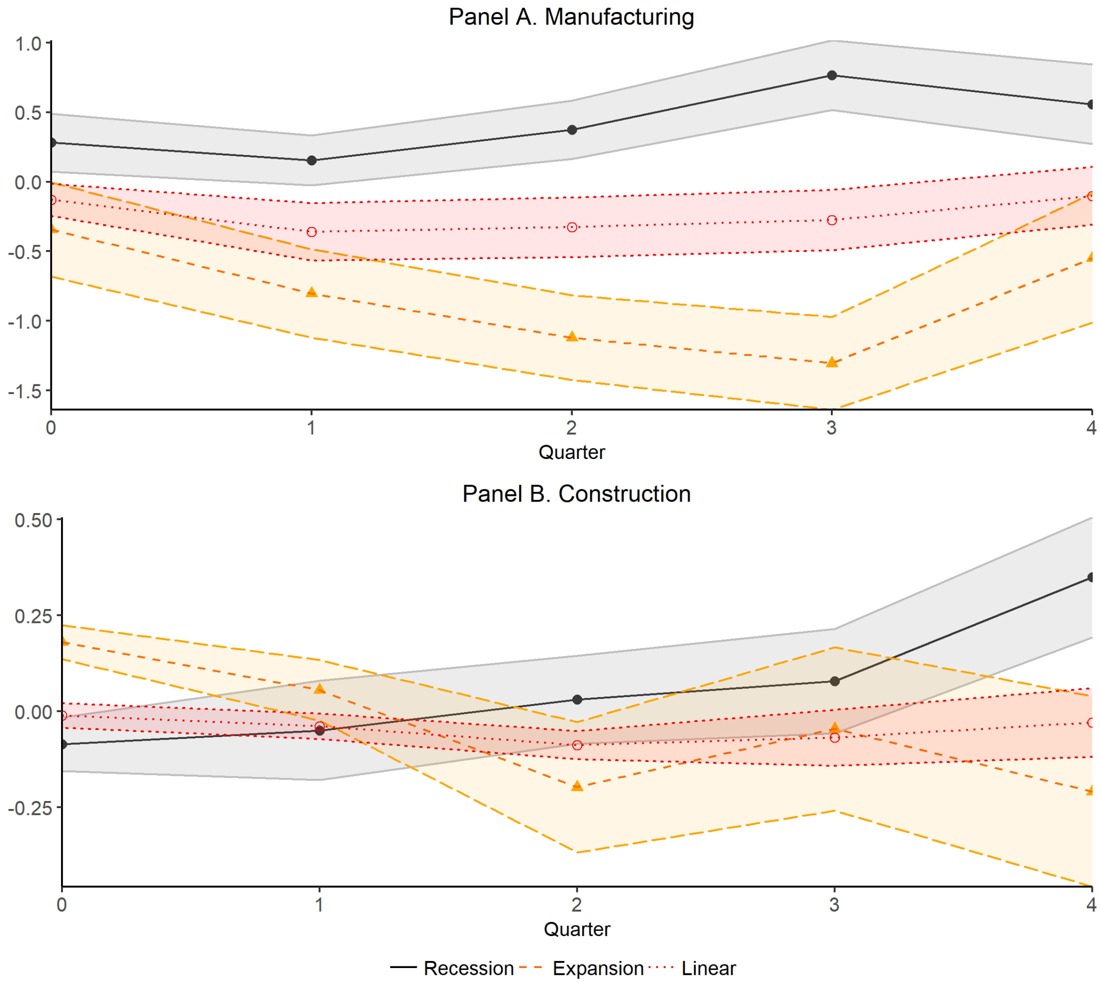

Figure 9: State-Dependent Multipliers on Manufacturing and Construction
Notes: Panel *A* shows the cumulative multiplier on manufacturing value add. Panel *B* shows the cumulative multiplier on construction value add. The solid lines show the cumulative multiplier in periods of recession. The dashed lines show the cumulative multiplier in times of expansion. The dotted lines show the linear multiplier. The shaded bands show the one standard deviation confidence interval based on Newey & West (1987) standard errors.

multipliers on manufacturing are not significant in the long-run and the impact multiplier on construction is positive and significant but loses significance two quarters after shock.

The overall estimates on the production side suggests that fiscal effects during recessions are strictly Keynesian and the fiscal stimulus may induce additional economic activity that rises the value add by industries and services. At other hand, in the case of services and construction value add we find evidence of an slightly positive and significant impact effect during times of expansion, but we find no evidence that this effect may be significant in the long-run, on the contrary, the punctual estimates suggest that fiscal stimulus may crowd out

Table 7: Estimates of State-Dependent Multipliers on Manufacturing and Construction

	Linear	*Recession*	*Expansion*	*p-Value*
Manufacturing				
Impact Multiplier	-0.13	0.28	-0.34	HAC = 0.21
	(0.11)	(0.20)	(0.33)	
Half-year integral	-0.32	0.37^{*}	-1.12^{***}	HAC < 0.01
	(0.21)	(0.20)	(0.30)	
1-year integral	-0.10	0.55^{**}	-0.54	HAC = 0.12
	(0.20)	(0.28)	(0.46)	
Construction				
Impact Multiplier	-0.01	-0.08	0.18	HAC < 0.01
	(0.03)	(0.06)	(0.04)	
Half-year integral	-0.08	0.03	-0.19	HAC = 0.37
	(0.03)	(0.11)	(0.16)	
1-year integral	-0.02	0.34^{**}	-0.20	HAC = 0.14
	(0.08)	(0.15)	(0.24)	

Notes: The values in parentheses under the multipliers give the standard errors based on Newey & West (1987) formula robust to heterokedasticity and autocorrelation. (*) for the 10% critical value. (**) for the 5% critical value. (***) for the 1% critical value. p-Value column presents the test for difference in multipliers across states. HAC indicates the heterokedasticity and autocorrelation consistent p-Value based on Newey & West (1987) testing the null hypothesis of no state-dependence.

this sectors as long its multiplier loses significance. These estimates suggest that the observed sated-dependence in the government spending multiplier on GDP can be supported by some underlying process on the production side.

5 Discussion

5.1 A dialogue with previous literature

The effects of fiscal policy is a major issue in macroeconomics and the econometric improvements regarding state-dependent and smooth transition regressions rekindled the long term debate about the aggregate implications of fiscal stimulus according to the business cycles. Employing local projection technique and a database that correct measurement errors in central government time series, we find an 1-year cumulative expenditure multiplier on GDP greater than 2 for the recession regime and around -2 during expansions, exploiting GDP components to support these findings. For the recession regime, the estimates suggest a positive and significant demand-side effects but less than 1 and positive and significant supply-side effects greater than 1. In the analysis of demand and supply side components during expansions we find no significance to corroborate the potential crowd-out on aggregate output.

The overall estimates from previous researches suggest that the issue of state-dependence of fiscal multipliers in Brazil remains open to discussion and our findings can be used to narrow the domestic debate. At one hand, Orair et al. (2016) estimates supports the state-dependence hypothesis, and reports a cumulative multiplier around 2.2 during recessions and a size 0.1 in the regular regime over a 16-quarter horizon. At other hand, Alves et al. (2019) and Grudtner & Aragon (2017) suggests that fiscal multipliers in Brazil are no state-dependent. These authors find cumulative spending multipliers above 2 over an 8-quarter and 16-quarter horizon respectively for both slackness and regular regimes. Holland et al. (2020) argues that the lack of robustness suggests that government spending multipliers are no significant at all.

Concerning the overall estimates in the recession regime, the size of baseline spending multiplier on GDP we report is in line with previous investigations of state-dependent spending multipliers in Brazil, but differs in response timing since the dynamic effects hits a cumulative multiplier on GDP around 2 more quickly than previous findings. The reported statistics also corroborate Orair et al. (2016) evidence that fiscal multipliers in Brazil are sensitive to the slackness in the economy.

Part of the non-congruence in our estimates relative to previous works may be due to some methodological differences. One of the most remarkable differences between these authors approach and our methodology is the model specification. Grudtner & Aragon (2017) and Alves et al. (2019) institutional identification rely on contemporaneous government spending series as fiscal shocks and employ control vectors with fiscal variables and output variable only. A number of authors argues that institutional identification appeal must be reduced in this case for not provide as many sufficient lags and regressors to attain unforecastability of fiscal shocks (see Ramey (2016) and Stock & Watson (2018)). For this matter, we include in our baseline control vector four lags of quarter growth rate of EMBI and first-differenced SELIC as argued in Section 3.2.

Regarding the estimates in times of expansion, the measure of baseline expenditure multiplier on GDP has no previous support in the literature of fiscal multiplier in Brazil. As mentioned in section 4.2, Orair et al. (2016) presents the most modest estimate of a cumulative multiplier during expansions in the previous studies, with a 16-quarter integral effect around 0.1. Looking at the 1-year integral effects on GDP components, we find negative punctual estimates for both demand and production side, but these have no statistical significance. Although we find no significance exploiting the GDP components during expansions, the potential negative effects of government spending are not novel in general literature. Employing a state-dependent panel data local projection for OECD countries, Auerbach & Gorodnichenko (2013) reports negative mean quarter responses of GDP, private consumption, private gross capital formation and employment in the private sector during expansions.

5.2 Policy Implications

A central fiscal policy argument in the Keynesian theory is that government spending induce additional economic activity when the economy slacks, and the Classical approach state that an expansionary fiscal policy may cause a short-run output improvement that fades out and induce rises in prices due to a vertical output curve, i.e. when a slack in production factors is less likely. In general, the responses we estimate for macroeconomic variables for the Brazilian economy are consistent with the Keynesian view that the size of spending multipliers should vary over the business cycle, with fiscal policy being more effective in recessions than in expansions, i.e. fiscal stimulus play an important role as a tool of output stabilization in deep recessions.

For the output components analysis on the demand side during recessions is remarkable that both household consumption and investment responses spend the impact quarter around zero and start do respond positively and significantly in the 2nd quarter after shock. These estimates suggest that marginal propensity to consume play an important role but is not high enough to create additional economic activity relative to the amount of public spending, since the 1-year cumulative multiplier is less than 1. The cumulative multipliers on demand components in general suggest that fiscal stimulus is more efficient during recessions but do not corroborate the large baseline government spending multiplier around 2.

At other hand, the 1-year integral response of output components value add are slightly greater than 1, which may support the baseline finding of a large government spending multiplier during recessions and provide insights to exploit the production side more deeply. Despite these estimates, the Classicals view of fiscal policy argues that an expansionary fiscal policy must induce an inflationary dynamics. For this matter, a complementary analysis of state-dependent dynamic effects of government spending on prices must be carried out in the future research.

As argued by Ilzetzki et al. (2013) and Ramey (2011) multipliers are very circumstantial and temporal, and to understand whether a particular estimate of fiscal effects is suitable one must understand how different circumstances affect multipliers and may vary from time to time. Therefore, the presented multiplier measures must be taken with caution and should not be used as invariant parameters.

Concerning the reported estimates in the expansion regime, we emphasize that the econometric framework proposed and the estimates produced along this work must not be evaluated in the sense of the well known literature in tradition of Alberto Alesina contributions regarding the hypothesis of a contractionary fiscal policy be expansionary, which evaluation requires a specific identification that is not the subject of this work. Second, is remarkable that our data cover quarters that are not included in the sample of previous studies and are characterized by stagnation, large public expenditures, low confidence and high unemployment, which is carried to our estimates.

Although the size of multipliers during recessions suggest that government expenditure must play an import role, the effects of fiscal policy must be planned within a more complex system. If we assume our most optimistic estimate as representative and consider the current ratio of tax collected over GDP in Brazil around 33%, an expansionary fiscal policy must be related to some degree of borrowing. Is well known that higher debt/GDP can trigger a rise of sovereign risk and the awareness of default may become self-fulfilling. Corsetti et al. (2013) and Bocola (2016) quantitative models show that confidence crises must negatively affect the dynamic effects of fiscal policy and the sizes of government spending multipliers. Thus, a more precise measure of fiscal effects requires a more elaborate system that account for other state-dependencies such as the sovereign distress state, and this is a subject for future research.

6 Concluding Remarks

In this paper we contribute to the debate on the efficiency of fiscal policy in Brazil. The current literature does not provide consensual evidence concerning the size of government spending multipliers and whether the effect of fiscal policy varies across the business cycles. To investigate these issues we employ a local projection model using adjusted fiscal series, correcting measurement errors in the official series, and logistic transition based on the moving average of GDP growth.

We find that government spending multipliers are considerably larger in periods when recession is more likely. The main results suggests that a shock of 1% of government spending over GDP during recessions may induce a net cumulative increase on output around 2% after one year. Analyzing the components of GDP, we find that effects of fiscal policy on household consumption and investment are strictly Keynesian during recessions. On the supply side, the estimates suggests that the value added on industry and services are higher in times of slackness. However, the classical literature proposes that an increase in output is transmitted to prices in an economy with vertical supply curve and the investigation of the effects of fiscal policy on prices may be a subject for future research. The baseline estimates during expansions suggests negative spending multipliers, however we find no robust evidence to support this finding. Therefore, our more robust findings support previous evidence of state-dependence of fiscal multipliers across the business cycles with size around 2 during recessions.

Regarding the additional research in this field, two paths of development can be highlighted. First, as argued in Discussion section, the size of fiscal multipliers are highly circumstantial and there is a number of potential states in an economy which may distinguish the efficiency of fiscal policy. In this sense, for example, it would be feasible to observe a lower fiscal multiplier in a recession whereas the risk perception of agents outweighs the benefits of fiscal incentives. Therefore, is required to investigate the role of other prominent state variables and multi state scenarios with a proper identification to treat the endogeneity across the states. Second, the adjusted fiscal series can be disaggregated on monthly basis and stratified into subcategories of government spending, allowing a consistency gain and the investigation of more specific periods and expense categories.

References

Alloza, M. (2017). Is fiscal policy more effective in uncertain times or during recessions?

Alves, R. S., Rocha, F. F., & Gobetti, S. W. (2019). Multiplicadores fiscais dependentes do ciclo econômico: O que é possível dizer para o brasil? *Estudos Econômicos (São Paulo)*, *49*(4), 635–660.

Auerbach, A. J., & Gorodnichenko, Y. (2012). Measuring the output responses to fiscal policy. *American Economic Journal: Economic Policy*, *4*(2), 1–27.

Auerbach, A. J., & Gorodnichenko, Y. (2013). Output spillovers from fiscal policy. *American Economic Review*, *103*(3), 141–46.

Barro, R. J., & Redlick, C. J. (2011). Macroeconomic effects from government purchases and taxes. *The Quarterly Journal of Economics*, *126*(1), 51–102.

Batini, N., Eyraud, L., Forni, L., & Weber, A. (2014). *Fiscal multipliers: Size, determinants, and use in macroeconomic projections* (No. 14). International Monetary Fund.

Bernardini, M., & Peersman, G. (2018). Private debt overhang and the government spending multiplier: Evidence for the united states. *Journal of Applied Econometrics*, *33*(4), 485–508.

Blanchard, O., & Perotti, R. (2002). An empirical characterization of the dynamic effects of changes in government spending and taxes on output. *the Quarterly Journal of economics*, *117*(4), 1329–1368.

Bocola, L. (2016). The pass-through of sovereign risk. *Journal of Political Economy*, *124*(4), 879–926.

Caggiano, G., Castelnuovo, E., Colombo, V., & Nodari, G. (2015). Estimating fiscal multipliers: News from a non-linear world. *The Economic Journal*, *125*(584), 746–776.

Canzoneri, M., Collard, F., Dellas, H., & Diba, B. (2016). Fiscal multipliers in recessions. *The Economic Journal*, *126*(590), 75–108.

Cavalcanti, M. A., & Silva, N. L. (2010). Dívida pública, política fiscal e nível de atividade: uma abordagem var para o brasil no período 1995-2008. *Economia Aplicada*, *14*, 391–418.

Corsetti, G., Kuester, K., Meier, A., & Müller, G. J. (2013). Sovereign risk, fiscal policy, and macroeconomic stability. *The Economic Journal*, *123*(566), F99–F132.

Fazzari, S. M., Morley, J., & Panovska, I. (2015). State-dependent effects of fiscal policy. *Studies in Nonlinear Dynamics & Econometrics*, *19*(3), 285–315.

Ferreira, M. S., & Valério, A. C. (2020). *Global shocks and emerging economies: disentangling the commodity roller coaster.* UFMG/Cedeplar.

Grudtner, V., & Aragon, E. K. d. S. B. (2017). Multiplicador dos gastos do governo em períodos de expansão e recessão: evidências empíricas para o brasil. *Revista Brasileira de Economia*, *71*(3), 321–345.

Hall, R. E. (2009). By how much does gdp rise if the government buys more output? *Brookings Papers on Economic Activity*.

Hamilton, J. D. (2018). Why you should never use the hodrick-prescott filter. *Review of Economics and Statistics*, *100*(5), 831–843.

Holland, M., Marçal, E., & de Prince, D. (2020). Is fiscal policy effective in brazil? an empirical analysis. *The Quarterly Review of Economics and Finance*, *75*, 40–52.

Hory, M.-P. (2016). Fiscal multipliers in emerging market economies: can we learn something from advanced economies? *International Economics*, *146*, 59–84.

Ilzetzki, E., Mendoza, E. G., & Végh, C. A. (2013). How big (small?) are fiscal multipliers? *Journal of monetary economics*, *60*(2), 239–254.

Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American economic review*, *95*(1), 161–182.

Koop, G., Pesaran, M. H., & Potter, S. M. (1996). Impulse response analysis in nonlinear multivariate models. *Journal of econometrics*, *74*(1), 119–147.

Lusompa, A. (2021). Local projections, autocorrelation, and efficiency. *Federal Reserve Bank of Kansas City Working Paper*(21-01).

Matheson, T., & Pereira, J. (2016). *Fiscal multipliers for brazil*. International Monetary Fund.

Michaillat, P. (2014). A theory of countercyclical government multiplier. *American Economic Journal: Macroeconomics*, *6*(1), 190–217.

Miyamoto, W., Nguyen, T. L., & Sergeyev, D. (2018). Government spending multipliers under the zero lower bound: Evidence from japan. *American Economic Journal: Macroeconomics*, *10*(3), 247–77.

Mountford, A., & Uhlig, H. (2009). What are the effects of fiscal policy shocks? *Journal of applied econometrics*, *24*(6), 960–992.

Newey, W. K., & West, K. D. (1987). Hypothesis testing with efficient method of moments estimation. *International Economic Review*, 777–787.

Orair, R., Siqueira, F. d. F., & Gobetti, S. W. (2016). Política fiscal e ciclo econômico: uma análise baseada em multiplicadores do gasto público. *XXI Prêmio do Tesouro Nacional*.

Owyang, M. T., Ramey, V. A., & Zubairy, S. (2013). Are government spending multipliers greater during periods of slack? evidence from twentieth-century historical data. *American Economic Review*, *103*(3), 129–34.

Plagborg-Møller, M., & Wolf, C. K. (2021). Local projections and vars estimate the same impulse responses. *Econometrica*, *89*(2), 955–980.

Ramey, V. A. (2011). Identifying government spending shocks: It's all in the timing. *The Quarterly Journal of Economics*, *126*(1), 1–50.

Ramey, V. A. (2016). Macroeconomic shocks and their propagation. In *Handbook of macroeconomics* (Vol. 2, pp. 71–162). Elsevier.

Ramey, V. A. (2019). Ten years after the financial crisis: What have we learned from the renaissance in fiscal research? *Journal of Economic Perspectives*, *33*(2), 89–114.

Ramey, V. A., & Zubairy, S. (2018). Government spending multipliers in good times and in bad: evidence from us historical data. *Journal of Political Economy*, *126*(2), 850–901.

Sims, E., & Wolff, J. (2018). The output and welfare effects of government spending shocks over the business cycle. *International Economic Review*, *59*(3), 1403–1435.

Stock, J. H., & Watson, M. W. (2018). Identification and estimation of dynamic causal effects in macroeconomics using external instruments. *The Economic Journal*, *128*(610), 917–948.

Zubairy, S. (2014). On fiscal multipliers: Estimates from a medium scale dsge model. *International Economic Review*, *55*(1), 169–195.

Appendix

A Data

The estimates presented along this work are based on a quarterly sample balanced from 1999Q1-2019Q4. Table A1 lists the data used in the empirical analysis. For each variable, are reported the ID in the database, the scale, the source, and relevant remarks (e.g., variable transformation and aggregation method etc.). All monetary variables are deflated by GDP deflator and deseasonalized using the standard X13 method.

Table A1: Data

Variable	*ID*	*Scale*	*Source*	*Remarks*
Real GDP	Y	Level (million BRL)	IBGE/SCNT Quarterly National Accounts[1]	
Real Government Spending	G	Level (million BRL)	TN/RTN Central Government Primary Balance Database[2]	Measurement error adjustment extending the Orair et al. (2016) contribution. Quarterly aggregated by the sum of the monthly data.
Real Government Revenue	T	Level (million BRL)	TN/RTN Central Government Primary Balance Database[2]	Measurement error adjustment extending the Orair et al. (2016) contribution. Quarterly aggregated by the sum of the monthly data.
Real Consumption	C	Level (million BRL)	IBGE/SCNT Quarterly National Accounts[1]	
Real Investment	I	Level (million BRL)	IBGE/SCNT Quarterly National Accounts[1]	
Real Exports	X	Level (million BRL)	IBGE/SCNT Quarterly National Accounts[1]	
Real Imports	N	Level (million BRL)	IBGE/SCNT Quarterly National Accounts[1]	
Agriculture, forestry, livestock and fishing (Real value added)	O1	Level (million BRL)	IBGE/SCNT Quarterly National Accounts[1]	
Industry (Real value added)	O2	Level (million BRL)	IBGE/SCNT Quarterly National Accounts[1]	
Manufacturing (Real value added)	O21	Level (million BRL)	IBGE/SCNT Quarterly National Accounts[1]	
Construction (Real value added)	O22	Level (million BRL)	IBGE/SCNT Quarterly National Accounts[1]	
Services (Real value added)	O3	Level (million BRL)	IBGE/SCNT Quarterly National Accounts[1]	
GDP Growth	GR	Rate	Author's estimate	
2-quarter Moving Average Growth Rate	MA2	Rate	Author's estimate	
5-quarter Moving Average Growth Rate	MA5	Rate	Author's estimate	Right-aligned Moving Average.
7-quarter Moving Average Growth Rate	MA7	Rate	Author's estimate	Right-aligned Moving Average.
Potential GDP 1	YHP	Level (million BRL)	Author's estimate	Trend component of the HP Filter on Real GDP with $\lambda = 1600$.
Potential GDP 2	YHF	Level (million BRL)	Author's estimate	Trend component of the Hamilton Filter on Real GDP with $h = 8$ and $p = 4$.
Cyclical Output 1	CHP	Level (million BRL)	Author's estimate	Cyclical component of the HP Filter on Real GDP with $\lambda = 1600$.
Cyclical Output 2	CHF	Level (million BRL)	Author's estimate	Cyclical component of the Hamilton Filter on Real GDP with $h = 8$ and $p = 4$.
Capacity Utilization (Industry)	NUCI	Level (Index)	CNI-National Confederation of Industry[3]	Quarterly aggregated by the geometric mean of the monthly data.
EMBI	EGB	Level (Index)	JPMorgan	Quarterly aggregated by the geometric mean of daily data
EMBI+ Brazil	EBR	Level (Index)	JPMorgan	Quarterly aggregated by the geometric mean of daily data

(1) https://www.ibge.gov.br/en/statistics/economic/industry-and-construction/17262-quarterly-national-accounts.html?=&t=o-que-e
(2) https://www.tesourotransparente.gov.br/temas/estatisticas-fiscais-e-planejamento/estatisticas-fiscais-do-governo-geral
(3) http://www.portaldaindustria.com.br/statistics/industrial-indicators/