Economic policy coordination in the EMU and Brazil

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Abstract

In this paper, we investigated two cases of regions that used expansionary fiscal policies in recent years to increase short-term economic activity: the European Monetary Union and Brazil. Using impulse response functions, we estimated the effects of fiscal stimuli in a New-Keynesian framework provided by the Markov-switching dynamic stochastic general equilibrium (MSDSGE) model. We produced a set of regime-dependent results that suggest that 1) economic policies should be analyzed from a coordination perspective and 2) the selected cases need continuous institutional development in order to make better use of fiscal instruments and to make more accommodative public debt decisions.

Keywords: Policy coordination, EMU, Brazil, Regime dominance, Markov switching, MSDSGE.

Resumo

Neste artigo investigamos dois casos de regiões que usaram políticas fiscal expansionistas nos últimos anos para aumentar a atividade econômica de curto prazo: a União Monetária Européia e o Brasil. Usando funções de impulso resposta, estimou-se os efeitos de estímulos fiscais em uma estrutura Novo-Keynesiana fornecida pelo modelo Markov-switching dynamic stochastic general equilibrium (MSDSGE). Os resultados dependentes dos regimes sugerem que 1) as políticas econômicas devem ser analisadas sob uma perspectiva de coordenação e 2) os casos selecionados precisam de desenvolvimento institucional contínuo para fazer melhor uso dos instrumentos fiscais e tomar decisões mais acomodativas sobre a dívida pública.

Palavras-chave: Coordenação de políticas, ZME, Brasil, Dominância de regimes, Markov switching, MS-DSGE.

JEL Code: E10, E60, O20.

Área 4: Macroeconomia, Economia Monetária e Finanças.

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1 Introduction

The effectiveness of economic policy management depends on many factors, including how shocks affect the economy and policy interactions. There is an increasing need for the coordinated use of economic policy instruments (ECD, 2002; Tabak and Tabata, 2004; Sehović, 2014; Cevik et al, 2014; Gros and Alcidi, 2015; Leino and Saarenheimo, 2016). Thus, a variety of approaches to policy interaction and policy dominance emerge, as found in Chung et al (2007), Fragetta and Kirsanova (2010), Troy and Leeper (2011), Traum and Yang (2011), Cebi (2012), Bianchi (2012), Barros and Lima (2014), Bianchi and Ilut (2014), Cevik et al (2014), and Kliem et al (2016).

The majority of countries that have engaged in expansionary policies in recent years are now facing difficulties, as indicated by several consecutive periods of fiscal deficits. In this sense, two cases of inflation targeters (ITers) require our immediate attention, e.g., the European Monetary Union (EMU) and Brazil. While the first comprises a group of independent sovereign states, the second is a country of sovereign federative states. In Brazil, the lack of coordination in its economic policies has often been the source of macroeconomic imbalance. Pires and Andrade (2009) found that the greater the composition of the debt indexed to the short-term interest rate, the longer the duration of the economic cycle.

Three arguments lead us to recognize these cases as a singular opportunity for analysis. First, both regions present common components of business cycle dynamics. Second, the optimal decisions of their fiscal institutions demand compliance from the member states (EMU) and federative states (Brazil). Third, during the sampled period (2000-2016), both selected cases of study were experiencing multiple institutional changes that affected their economic policy coordination and enforcement. From institutions point of view, the monetary policy in Brazil is executed by the Central Bank of Brazil (BCB) and in the EMU it is the European Central Bank (ECB). The Brazilian fiscal holder, for instance, is the National Treasury Secretariat (STN), from recently created Ministry of Economy, and in the EMU it corresponds to the European Commission (EC).

Thus, a conflict potentially emerges, since the institutional obligations of the fiscal holder regarding interest rates and other goal variables are distinct from those of the monetary holder (Dixit, 2001). The considerable debt crises in the EMU and Brazil and their effects led to an intense discussion about proposed diagnoses and the effectiveness of policy recommendations (Checherita and Rother, 2010; Ferreira, 2014; Kramolišová and Spáčilová, 2015). The EC established the Stability and Growth Pact (SGP) in 1997, which imposes a set of restrictions on members concerning deficits and public debt. However, the new scenario of debt crisis brought the reform of the SGP through the Treaty on Stability, Coordination and Governance (TSCG) and the implementation of country specific recommendations (CSRs), which have proven to be difficult in practice (Gros and Alcidi, 2015).

In Brazil, the political cycle from the early 2000s was the main platform for short-term economic policies. The Growth Acceleration Program (Programa de Aceleração do Crescimento – PAC), based on increasing credit and massive investment in infrastructure, prevails form 2003 to 2006 and 2007 to 2011. Replaced by the New Macroeconomic Matrix (Nova Matriz Macroeconômica – NME) (2011-2014 and 2016), the exhaustion of the economic model led to a severe internal crisis also characterized by *creative accounting* and *fiscal peddling* (Chalhoub et al, 2017). It was followed by stagflation (2012Q3-2013Q2 and 2014Q2-2014Q3), over 13 million Brazilian people unemployed and an impeachment process in 2016. Hence, our motivation is to understand the role of government expenditure and its effect on macroeconomic indicators in this unique cross-regional case, to build more effective policy coordination in light of these experiences.

We first estimate the parameters of policy dominance regimes for the period from 2000 to 2016. Next, supported by a Markov-switching dynamic stochastic general equilibrium (MSDSGE) model originally proposed by Davig and Leeper (2011), we simulate the dynamic impact of a positive increase in public spending using these estimated parameters. This framework allows us estimate the regimes' parameters and use them as the contour conditions in the second stage of the modeling. We estimate the steady state and simulate the impulse

response functions (IRFs) of public spending increases to analyze how inflation control, interest rate and debt sustainability decisions are coordinated. Our paper is divided into five sections in addition to this brief section 1. In section 2, we present the specification of the economic policy regimes and the MSDSGE setup. The data sample and the estimation procedures are described in section 3, and the results are presented and discussed in section 4. Finally, general conclusions are drawn in section 5.

2 Model setup

Sargent and Wallace (1981) were pioneers in studying the interaction between fiscal and monetary policy and investigating determinants of the price level. Leeper (1991) describes possible regions for the parameter spaces, i.e., their interaction and dominance given both forms of economic policy, which may be characterized as follows: Region I – the monetary authority deploys its policies independently, and there is monetary dominance (AM/PF), i.e., fiscal policy is passive; Region II – there is fiscal dominance, which is also referred to as active fiscal policy (PM/AF); Region III – there is passive monetary and passive fiscal policy (PM/PF); Region IV: there is active monetary and active fiscal policy (AM/AF). AM/PF is characterized by a balanced budget to promote the stabilization of the debt/GDP relation . Hence, Ricardian theory is viewed as having prevailed.

The empirical evidence of fiscal-monetary policy coordination has been investigated in many countries using different models (Dungey and Fry, 2009; Fragetta and Kirsanova, 2010; Cebi, 2012; Algozhina, 2012; Barros and Lima, 2014; Cevik et al, 2014; Ferreira, 2014; Cazacu, 2015; Kliem et al, 2016). The model considers elements of New-Keynesian paradigms found in real business cycle theory: nonlinearity and the correct identification of the matrix of contemporary effects between variables (Blanchard, 2018). The first step is to define the MS(M)-VAR(p) to represent the changes in monetary and fiscal policy regimes, defined as x_t. Then, we estimate the parameters of the monetary side (α_i) and fiscal side (β_i). Krolzig (2000) describes the MSVAR as

$$x_t = \nu(S_t) + A_1(S_t)x_{t-1} + ... + A_p(S_t)x_{t-p} + \varepsilon_t. \tag{1}$$

$\nu(S_t)$, $A_1(S_t)$,..., $A_p(S_t)$ are the parameter shift functions and describe the dependence of the parameters on each realized regime. They indicate that a permanent change in the mean of such parameters in the current regime causes an immediate jump in the observed time-series stochastic processes to a new once-and-for-all level, depending only on the current regime. $\varepsilon_t|S_t$ is a Gaussian term conditioned to each regime s_t, with $\varepsilon|S_t \sim$ i.i.d. $(0, \sum(S_t))$. In addition, p is the number of lags, n is the variables' matrix dimension, and S is the number of unobserved regime realizations, $S_t \in \{1,2\}$ for our case. Therefore, the intercept term in equation (1) assumes a different value depending on the current regime:

$$\nu(S_t) = \begin{cases} \nu_1, \ for \ S_t = 1 \\ \nu_2, \ for \ S_t = 2 \end{cases} \tag{2}$$

The stochastic processes of policies are such that the probability of being in state k in period $(t+1)$ depends only on the current state. The conceived economy includes 1) governments – the fiscal authorities that tax consumers, buy consumer goods, issue debt, and assume responsibility for the money supply as the monetary holder; 2) households and 3) firms that produce the final goods in monopoly competition. Finally, the hypothesis of price frictions (Gali et al, 2003) is assumed, as well as the possibility of market imperfections.

1) Government

The set of policies is characterized for two transition equations, which represent the monetary (r_t) and fiscal sides (τ_t) of the investigated economies, described in equations (5) and (6), respectively. These equations underline that 1) monetary policy endogenously depends on the basic interest rate reaction to changes in inflation and the deviation in the output gap from the calculated values of the steady state and that 2) the government's

revenue endogenously depends on deviations in public debt; government spending and the output gap, i.e., the response of taxes to the output gap, change the responses to debt and government purchases. The dynamic impacts of government purchases are assumed to be as in Davig et al (2006) and according to (G_t) are

$$log(G_t) = log(\bar{G})(1-\rho) + \rho log(G_{t-1}) + \varepsilon_t. \tag{3}$$

where G_t are government purchases, $\bar{G}$ are the steady state government purchases, ρ is the correlation parameter of government spending, and $\varepsilon_t \sim N(0,\sigma^2)$. Thus, the government's optimal choice $\{G_t, M_t, B_t, \tau_t\}$ must satisfy the flow of its budget identity. Additionally, we adopted the standard concept of the sequential equilibrium of markets, taking into account the need for market clearing for public funding.

$$G_t = \tau_t + \frac{M_t - M_{t-1}}{P_t} + \frac{B_t}{P_t} - \frac{(1+r_{t-1})B_{t-1}}{P_t} \tag{4}$$

where τ_t is the government's purchase-to-output ratio, B_t is a public bond for one period, r_t is the interest rate, P_t is the price level in period t, and M_t is the money supply, with $M_{t-1} > 0$ and $(1-r_{t-1})B_{t-1}$. The inference of dating non-observable regimes is made by filtering and smoothing the probabilities using the estimator developed in Hamilton (1990). For parameter estimation, we use the expectation-maximization algorithm (EM) originally described by Dempster et al (1977). Following Equation (1), the fiscal policy rule is

$$\tau_t = \gamma_0(S_t^F) + \gamma_b(S_t^F)b_{t-1} + \gamma_y(S_t^F)y_t + \gamma_g(S_t^F)g_t + \gamma_\tau(S_t^F)\varepsilon_t^\tau. \tag{5}$$

where $\varepsilon_t^\tau \sim N(0,1)$, S_t^F indicates the fiscal policy regime, γ_0 is the intercept, and γ_i represents the respective elasticity parameters, while b_{t-1} is the debt-to-GDP ratio in $(t-1)$, and g_t is the government's primary spending as the GDP ratio. If $\gamma_b > 0$, the fiscal policy is passive, if otherwise, the fiscal policy is active.

The institutional monetary policy frameworks of the EMU and Brazil are defined by a Markov-switching forward-looking Taylor rule (Taylor, 1993). The monetary authority manages a loss function, which represents the side effects of its decisions on investment and the output gap. This rule means that the nominal interest rate, r_t, depends only on inflation π_t and the output gap y_t and is described as

$$r_t = \alpha_0(S_t^M) + \alpha_\pi(S_t^M)\pi_t + \alpha_y(S_t^M)y_t + \alpha_r(S_t^M)\varepsilon_t^r. \tag{6}$$

where π_t is the inflation rate, y_t is the output gap, α_0 is the intercept, α_i represents the respective monetary elasticity parameters and $\varepsilon_t^r \sim N(0,1)$, and S_t^M indicates the monetary policy regime. Note that for $\alpha_\pi > 1$ and $\alpha_y > 0$, monetary policy is active. Otherwise, it is considered passive. Both policies develop according to the transition probability matrix T^*, described as follows:

$$T^* = \begin{bmatrix} prob_{i,i} & prob_{k,i} \\ prob_{i,k} & prob_{k,k} \end{bmatrix}$$

The elements $prob_{i,k}$ of the transition matrix represent the probability of being in regime i and of changing to regime k, respectively. Hence, the MSDSGE allows us to simulate shocks depending on policy dominance through the terms ε_t^r (Equation (6)) and ε_t^τ (Equation (5)).

2) Households

There is an identical continuum number of households $j \in (0,1)$ that receive remunerations for work, i.e., nominal wages, then decide the optimal allocation of consumption (C_t), money and bonds, whose returns are risk free. C_t is defined as the aggregate value of different consumption goods, N_t is the total amount of hours worked, and M_t/P_t represents the real money supply. The representative household chooses $\{C_t, N_t, M_t, B_t\}$ to maximize the following utility function U:

$$E_t \sum_{i=0}^{\infty} \beta^i \left[\frac{C_{t+i}^{1-\sigma}}{1-\sigma} - \chi \frac{N_{t+i}^{1+\eta}}{1+\eta} + \delta \frac{(M_{t-i}/P_{t+i})^{1-\kappa}}{1-\kappa} \right] \tag{7}$$

where β is assumed to be the intertemporal choice discount rate, σ is the intertemporal substitution elasticity of consumption, η represents the elasticity of the labor supply, κ is the elasticity of real money demand, δ is the speed of money circulation, and χ is defined as the steady state labor supply, with $0 < \beta < 1$, $\sigma > 0$, $\eta > 0$, $\kappa > 0$, $\chi > 0$ and $\delta > 0$. $E(.)$ represents the mathematical expectation operator, and $c_{j,t}$ is the path of different consumption goods and is combined with C_t using the aggregator developed in Dixit and Stiglitz (1977).

$$C_t = \left[\int_0^1 c_{jt}^{\frac{\theta-1}{\theta}} \mathrm{d}j \right]^{\frac{\theta}{\theta-1}} \tag{8}$$

where θ is the consumption indexation parameter, with $\theta > 1$. The budget constraint of households is represented by

$$C_t + \frac{M_t}{P_t} + \frac{B_t}{P_t} + \tau_t \leq \left(\frac{W_t}{P_t} \right) N_t + \frac{M_{t-1}}{P_t} + \frac{(1+r_{t-1})B_{t-1}}{P_t} + \pi_t. \tag{9}$$

where $1 + r_{t-1}$ is the risk-free nominal interest rate between periods $t-1$ and t, and $\pi_{i,t}$ are firm profits. Households maximize (8) subject to (9), characterizing their decision regarding real monetary demand, nominal interest rates and consumption goods:

$$\frac{M_t}{P_t} = \delta^{\kappa} \left(\frac{r_t}{1+r_t} \right)^{-1/\kappa} C_t^{\sigma/\kappa} \tag{10}$$

3) Firms

There is a continuum number of firms $j \in (0,1)$ that operate in monopolistic competition producing j goods using labor N. The production function is given by $y_{jt} = ZN_{jt}$, where Z is the aggregate technology, which is homogeneous among firms and considered to be constant. We observe the following demand curve of firm j by aggregating consumer and government demand:

$$y_{jt} = \left(\frac{p_{jt}}{P_t} \right)^{-\theta} Y_t \tag{11}$$

with Y_t defined as $C_t + G_t = Y_t$; the market equilibrium is

$$ZN_{jt} = \left(\frac{p_{jt}}{P_t} \right)^{-\theta} Y_t. \tag{12}$$

After some algebra, optimal price p_t^*, i.e., the first-order condition, assumes that a $1-\varphi$ ratio of firms adjust their prices in each period, while the remaining φ ratio update their prices according to the most recent inflation observed:

$$\frac{p_t^*}{P_t} = \left(\frac{\theta}{\theta-1} \right) \frac{\mathrm{E}_t \sum_{i=0}^{\infty} (\varphi\beta)^i (Y_{t+i} - G_{t+i})^{-\sigma} \left(\frac{P_{t+i}}{P_t} \right)^{\theta} \Psi_{t+i} Y_{t+i}}{\mathrm{E}_t \sum_{i=0}^{\infty} (\varphi\beta)^i (Y_{t+i} - G_{t+i})^{-\sigma} \left(\frac{P_{t+i}}{P_t} \right)^{\theta-1} Y_{t+i}} \tag{13}$$

Since all firms that optimize their prices in t choose the same price, p_t^* does not depend on j. This specification indicates that firms choose p_t^* before the realization of the currency growth rate in t. In this sense, p_t^* influences firm j's profits, but it cannot achieve the new optimization.

4) Steady state

Public debt in the steady state is fixed and independent of the regimes and it is calculated by replacing the fiscal policy rule in the budget constraint equation of the government, maintaining the deterministic value of the stationary state output equal to one. The fiscal policy rule for the intercept is solved as follows:

$$\gamma_0(S_t^F) = G - m(\frac{\pi}{1+\pi}) - b(1+\gamma(S_t^F) - \frac{\beta^{-1}}{1+\pi}) \tag{14}$$

where $\gamma_0(S_t^F)$ and $\gamma(S_t^F)$ change according to the current fiscal regime. This procedure is applied by substituting the monetary policy rule into the money demand.

Government purchases affect the equilibrium in this New-Keynesian framework by following transmission channels: $\Delta G_t > 0$ increases demand for the goods sold by monopolistically competitive intermediate goods-producing firms. Thus, intermediate goods-producing firms face demand and set prices by raising their demand for labor. *Ceteris paribus*, greater labor demand increases real wages (W_t/P_t) and real marginal costs. Next, firms (i) that have the option to reoptimize their prices will increase them.

3 Estimation

We sampled data from the first quarter of 2000 to the third quarter of 2016. The time series used were collected from the ECB (EMU), the BCB and the STN (Brazil). Potential output was estimated using the Hodrick–Prescott (HP) filter proposed by Hodrick and Prescott (1997). All series were calculated for quarterly frequency, considering the previous period for each observation and removing the seasonal effect. To estimate the public debt for Brazil, we first decompose the federal revenues into National Treasury revenue (NTR) and social security revenue (SSR). We performed the LR linearity test and estimated the reaction functions displayed in Table 1. The monetary and fiscal reaction functions are both nonlinear.

Table 1: Linearity test and estimated monetary and fiscal policy rules

	EMU		Brazil	
Hypothesis	Log Likelihood Ratio (LR)		Log Likelihood Ratio (LR)	
H_0 / H_1	65.355*		78.90*	
Monetary rule	Active $S_t^M = 1$	Passive $S_t^M = 2$	Active $S_t^M = 1$	Passive $S_t^M = 2$
α_0	0.0027*	0.0027*	0.0971457*	0.0971457*
	(0.0014)	(0.0014)	(0.006703)	(0.006703)
α_π	1.1231*	0.2404*	1.05004*	0.236153**
	(0.0736)	(0.0857)	(0.08220)	(0.1074)
α_y	0.3743*	-0.0396	-0.236861	-0.155058
	(0.0672)	(0.1131)	(0.2502)	(0.1602)
α_r^2	0.0050*	0.0050*	0.0167996*	0.0167996*
	(0.0004)	(0.0004)	(0.001465)	(0.001465)
Hypothesis	Log Likelihood Ratio (LR)		Log Likelihood Ratio (LR)	
H_0 / H_1	102.090*		101.55*	
Fiscal rule	Active $S_t^M = 1$	Passive $S_t^M = 2$	Active $S_t^M = 1$	Passive $S_t^M = 2$
γ_0	0.4650*	0.4650*	-0.0106801	-0.0106801
	(0.0090)	(0.0090)	(0.01207)	(0.01207)
γ_b	0.1596*	0.0340*	0.0763671*	-0.0192454
	(0.0042)	(0.0071)	(0.01352)	(0.0071)
γ_y	-0.4142*	0.0582*	0.271490*	0.613291*
	(0.0437)	(0.0191)	(0.03806)	(0.07672)
γ_g	-0.3002*	-0.0957*	1.05617*	1.03803*
	(0.0237)	(0.0273)	(0.05816)	(0.09816)
γ_τ^2	0.0011*	0.0011*	0.00333171*	0.00333171*
	(0.0001)	(0.0001)	(0.0002905)	(0.0002905)

Source: ECB, the BCB and the STN data.
Note: $*$ 1% significance. H_0: The rule is linear. H_1: The rule is nonlinear.

Seeking robust results, we used different criteria for the changes, e.g., other specifications were tried, from regime-dependent mean (MSM(M)-VAR(p)) to the regime-dependent intercept and heteroscedasticity (MSIAH(M)-VAR(p)). Due to insufficient degrees of freedom (micronumerosity), we estimated the MSM(M)-VAR(p) considering two regimes. Two MSVAR systems of variables were estimated, including 1) monetary variables: GDP gap, interest rate (Selic rate in Brazil) and inflation and 2) fiscal variables: public debt, government spending and revenues. The first regime (AM/PF) for the EMU is characterized by the use of the interest rate as a reaction function to inflation. For regime 2, there is a passive monetary (PM/AF) policy reaction function for both cases, given that $\alpha_\pi < 1$. Similarly, in regime 1, the parameter of reaction regarding the potential output deviations was stationary, and during regime 2, it was negative.

The parameters associated with the public debt of the EMU were positive and statistically significant, indicating the AM/PF regime during the analyzed period. However, the parameter was smaller in the second regime and considered less passive (AM/PF-), while compared to regime 1 (AM/PF+), it was considered more passive. The fiscal authority had a stronger reaction to the soft budget constraint in the AM/PF+ regime. For Brazil, the parameters of public debt were positive and statistically significant only in regime 1 (AM/PF). Those parameters associated with the GDP gap and government spending registered positive signs and were statistically

significant in regime 2 (PM/AF). The transition matrix of the EMU T^M_{EMU} (at left) indicates that the probability of permanence in the AM regime is 96.39%, while the probability of changing to the PM/AF regime is 3.61%. Furthermore, the probability of remaining in the second regime is 98.96%.

On the right, the probability of persistence in AM/PF (T^M_{BR}) is 96.74%, while the probability of continuing in the AM/PF regime is 99.12%. For the EMU, the T^F_{EMU} matrix, for instance, reports that the probability of persisting in the AM/PF+ regime is 95.79%. However, the probability of permanence in the AM/PF- is 93.31%. In Brazil, the fiscal side represented by T^F_{BR} indicates that the probability of remaining in the PM/AF regime is 95.79%, and the probability of persisting in the AM/PF is 93.31%.

$$T^M_{EMU} = \begin{bmatrix} 0.9639 & 0.0104 \\ 0.0361 & 0.9896 \end{bmatrix} \quad T^M_{BR} = \begin{bmatrix} 0.9674 & 0.0088 \\ 0.0326 & 0.9912 \end{bmatrix}$$

$$T^F_{EMU} = \begin{bmatrix} 0.9579 & 0.0669 \\ 0.0421 & 0.9331 \end{bmatrix} \quad T^F_{BR} = \begin{bmatrix} 0.98249 & 0.01024 \\ 0.017511 & 0.98976 \end{bmatrix}$$

Figure 3 in Appendix A (section 5) illustrates the probabilities of regimes 1 and 2. Both were more persistent than those estimated in Davig and Leeper (2011) and Cevik et al (2014). Previous evidence in Brazil regarding the AM/PF regime (1995-1997) was also observed in Tanner and Ramos (2003), Gadelha and Divino (2008) and Barros and Lima (2014). They found that the implementation of the Real Plan was the cause of the changes. In the EMU, the AM/PF+ regime was observed during 2002Q4-2004Q1 and 2006Q2-2009Q2, while the AM/PF- regime prevailed during 2004Q2-2006Q1. From a monetary policy perspective, the change in regimes registered in 2009 indicates an interest rate reduction. However, the AM/PF- regime was characterized by higher interest rates (2.92%).

The very recent PM/AF regime, in turn, registered an interest rate of 0.45%. In addition, the change to the PM/PF- regime (2009Q3-2012Q1). In this period, we verified a reduction in the public deficit as a proportion of GDP in the bloc. While Davig and Leeper (2011) registered for the US the AM/PF (2000-2001), PM/PF (2002-2003) and PM/AF (2004-2011) regimes, distinct results were found for the Czech Republic, Estonia, Hungary and Slovenia by Cevik et al (2014). Figure 1 synthesizes the four possible combinations between monetary and fiscal policy in the selected cases:

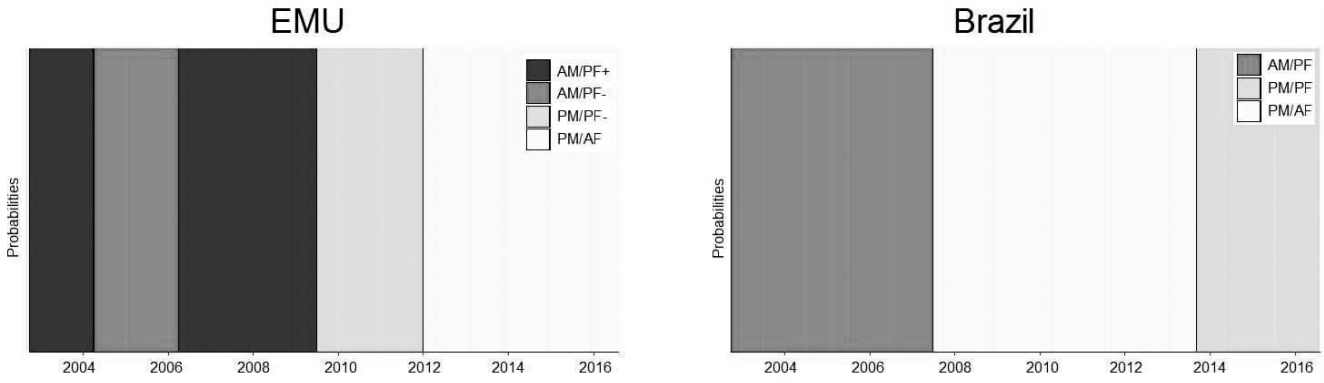

Figure 1: Estimated policy regimes for the EMU and Brazil
Source: ECB, the BCB and the STN data.

In Brazil, three policy regimes were observed: AM/PF (2000:Q1-2007:Q2), PM/PF (2007:Q3-2013:Q4), and PM/AF (2013Q4-2016Q3). Table 2 shows the estimated parameters for fiscal and monetary rules used to calibrate the MSDSGE model. For a goodness of fit diagnosis of policy regimes, additional information

is displayed in Figure 4 in Appendix A (section 5). In addition, we followed the stability and identification conditions to obtain the steady state.

Table 2: Description of the MSDSGE calibrated parameters

Parameter	Description	EMU		Brazil	
		Value	Source	Value	Source
β	Intertemp. choice discount rate	0.995	ECB	0.985	VC (2010)
σ	Intertemp. substitution elasticity of consumption	1	P (2016)	1	FP (2017)
η	Elasticity of labor supply	1	ECB	1	FP (2017)
κ	Elasticity of real money demand	1.9	E	2.3	E
δ	Velocity of money circulation	4.3	E	6.06	E
$\bar{\chi}$	Steady state labor supply	0.2	DL (2011)	0.2	DL (2011)
φ	Proportion of firms that cannot re-optimize prices	0.66	DL (2011)	0.66	DL (2011)
μ	Firms' markup	1.2	P (2016)	1.15	BL (2014)
$\bar{G}$	Steady state govern. spending/GDP	0.2	E	0.169	E
$\bar{B}$	Steady state public debt/GDP	0.78	E	0.266	E
$\bar{\pi}$	Steady state inflation rate	0.02	P (2016)	0.045	BL (2014)
ρ	Correlation of govern. spending	0.9	E	0.9	E
	Monetary Policy Rules				
α_{π_1}	Inflation in regime 1	1.1321	E	1.05004	E
α_{π_2}	Inflation in regime 2	0.2404	E	0.236153	E
α_{y_1}	GDP gap in regime 1	0.3743	E	0.0000	E
α_{y_2}	GDP gap in regime 2	0.0000	E	0.0000	E
	Fiscal policy rules				
γ_{b_1}	Debt in regime 1	0.1596	E	0.0763671	E
γ_{b_2}	Debt in regime 2	0.0340	E	0.0000	E
γ_{y_1}	GDP gap in regime 1	-0.4142	E	1.05617	E
γ_{y_2}	GDP gap in regime 2	0.0582	E	1.03803	E

Source: ECB, the BCB and the STN data.
Note: Estimated = E; Pariès et al (2016) = P (2016); Davig and Leeper (2011) = DL (2011); Vereda and Cavalcanti (2010) = VC (2010); Frascaroli and Paes (2017) = FP (2017); Barros and Lima (2014) = BL (2014); European Central Bank = ECB.

Among the theoretical considerations, we report that 1) if the expected inflation and the expected marginal real cost present the same values in time, a firm chooses $p*$ to equal the expected marginal real cost; 2) it should be assumed that a firm expects an increase in marginal real costs in the future. Hence, anticipating this increase, the firm chooses a $p*$ that is higher than the expected marginal real cost, perhaps because it may not be possible to adjust $p*$ when the marginal real cost materializes (front loading); and 3) firms expect an increase in future inflation that is higher than $E(p*)$. The lag of one period implies that the relative price of a firm falls. To compensate, the firm incorporates future changes in the rate of inflation into $p*$. This variable is also directly affected by the proportion of firms that are allowed to update their prices $(1-\varphi)$. If the proportion of such firms rises, inflationary inertia also increases.

4 Results

The EMU's GDP was below its potential during the periods from 2003 to 2006 and from 2009 to mid-2015, also consequence of the 2008 crisis (Algozhina, 2012). Assuming that increased public spending would lead to a rise in private consumption, particularly in the short term, the EC implemented expansionist policies through fiscal stimulus packages. Fiscal policy was procyclical in the AM/PF+ regime, while it was countercyclical in the AM/PF-. Besides, in periods of economic expansion our results suggest that governments reduce the revenue/GDP ratio in the AM/PF+, while in the AM/PF-, this ratio increases. In parallel, with the annualized inflation near the annual target of 2% (2002 – 2008), seems that the ECB enacted a quantitative easing policy. This was indicated by the annualized basic interest rate reduction from 4.98% to 0.72% in the fourth quarter of 2009 and its negative correlation with the output gap.

Furthermore, the public expenditure parameters for both regimes were statistically significant and had negative signs. These outcomes suggest that an increase in the public spending/GDP ratio reduces fiscal revenues. As a consequence, the public debt increased from 68.6% of GDP (2008) to 91.3% (2013). From this period on, this value remained stable at near 90.7% of the EMU's GDP in 2016. The Brazilian output was below its potential in the period of 2002 to 2003, 2009 and during 2013 to 2016. It was registered an upward trend in inflation (over 10% per year) and paradoxically, lower interest rates as well. The period of 2015-2016 was characterized by rising interest rates, public expenditures in relation to GDP and unemployment for over 13 million Brazilian people. This latter period was marked by so-called *creative accounting* (2007-2013), which mitigated and distorted information about public debt sustainability.

The elasticity of the demand of money, the velocity of monetary circulation and the steady state inflation rate reflect that Brazil has historically experienced much more difficulty managing inflation than the EMU. The steady state government spending/GDP, the steady state public debt/GDP, the parameters of debt and the GDP gap in the AM/PF regime also highlight that fiscal instruments were less elastic in Brazil than in the EMU. Figure 2 highlights the IRFs, which represent the simulation of positive shocks of 3% on the residues ε_t of government spending (equation (5)).

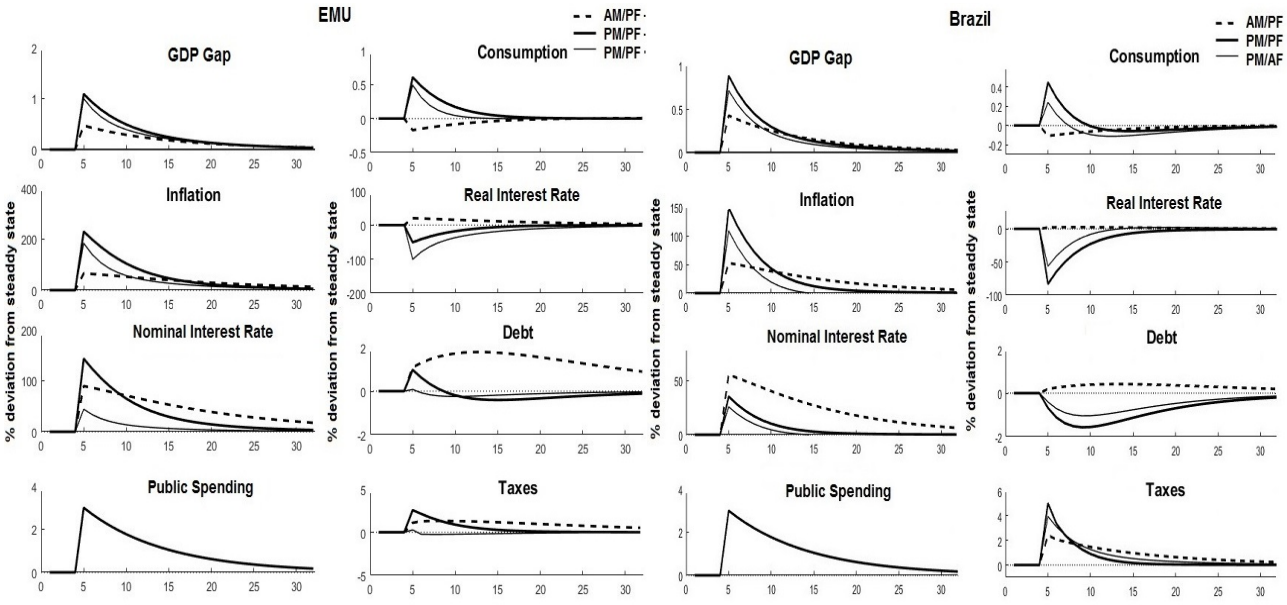

Figure 2: Impulse response function of a shock on the residues of government spending of 3%
Source: ECB, the BCB and the STN data.

As expected, the IRFs in Brazil were more elastic than those registered in the EMU and for all regimes, the

output gap increases. A greater magnitude of responses (> 1) is observed in the EMU when the PM/PF- regime prevails, followed by the PM/PF+. In Brazil, the magnitude of responses (< 1) suggests the relative inefficiency of public expenditure with respect to GDP. Except for the monetary dominance regime (AM/PF-), there is an increase in private consumption, as claimed by fiscal theory. In the AM/PF regime, private consumption falls, consistent with Ricardian theory, and the effect also implies a consumption drop. In the AM/PF regime the shock suggests that the monetary holder reacts with higher nominal interest rates. Otherwise, the fiscal holder must raise taxes to finance the increase in incremental expenditures. Thus, the agents incorporate this future fiscal responsibility into their expectations, e.g., current and future consumption decisions. In contrast, increases in interest rates were lower than increases in inflation in other regimes.

According to the hypothesis of monopolistic competition, the inflation increase is explained by two transmission channels: 1) firms observe their real marginal costs and a proportion ϕ of them are characterized by a forward-looking price reoptimization function. Thus, they can establish prices in anticipation of inflation. From another perspective, it is possible that a proportion $(1-\phi)$ of firms with a backward-looking price reoptimization function produce inflationary inertia, since *ceteris paribus* they reoptimize their prices by observing their past real marginal cost; 2) given the increase in government spending, demand increases and, consequently, so does the production of goods sold by firms in monopolistic competition. This increase in production implies a greater demand for labor, pushing real wages up, which leads firms to increase the real marginal cost. A posteriori, the increment of real marginal cost impacts the prices of goods, leading to inflation.

The closest results for inflation and interest rates were found in Fragetta and Kirsanova (2010), Kliem et al (2016) for Italy and Cebi (2012) for Turkey. The temporary increase in inflation in the AM/PF regimes is lower than that in other regimes. Hence, nominal interest rates increase with greater intensity, i.e., twice that observed in the PM/AF (the most recent regime in the EMU), in which the monetary holder did not react to interest rate increases. Meanwhile, negative real interest rate variation in the PM/AF and PM/PF regimes were registered in Brazil. In addition, the real interest rate remains constant in the case of AM/PF, indicating the same proportion of such changes in terms of increases in inflation.

However, the real interest rate in the EMU was three times the Brazilian rate during the PM/PF+ regime. Less elastic expansionary fiscal policies were suggested by the transitory trajectories represented by the IRFs. Public debt in the EMU increased to 2% (0.5% for Brazil) in relation to the steady state in the AM/PF+ regime. This trend shows persistence, and after thirty quarters, its deviation is almost 1%, while the corresponding response for Brazil is near zero. Public debt shows small fluctuations in relation to the steady state for the EMU and decreases between 1.5% and 2.0% for Brazil in the other regimes. In the EMU, taxes temporarily increased in the PM/PF+ regime, while in the PM/PF-, there was a 1% of reduction. This suggests a procyclical rule, e.g., the output gap had a significant rise in this regime.

Taxes had more elastic and positive responses in Brazil, registering a maximum of up to 5% in the PM/PF regime. Furthermore, such outcomes for inflation, real interest rates and public debt differ from Barros and Lima (2014). We found that taxes peaked at 3% in the EMU and 6% in Brazil during the PM/AF and PM/PF+ regimes, respectively. Comparatively, taxes increased in all regimes for the US in Davig and Leeper (2011), particularly the PM/PF (up to 2.5%). The debt/GDP ratio rise was almost null in the PM/PF- regime in the EMU and inelastic in Brazil. Besides, it increases instantaneously and strongly for the US in the PM/PF regime, also verified for the interest rate. The inflation response in Brazil was lower. As a consequence, the nominal interest rate was 180% in the US (PM/AF) and 50% in Brazil (AM/PF).

Considering the very last regimes for Brazil (PM/PF) and the EMU (PM/AF), Brazilian public debt has a higher opportunity cost than that of the EMU. This is a consequence of the country's 1) development state and 2) its debt ratio, which is almost 10% greater than similar countries and approximately 50% of GDP. Brazil also presents fewer degrees of freedom in terms of discretionary conditions for public expenditure decreases. Our empirical outcomes also support that it is necessary to reform the use of macroprudential tools to make them more systematic and thus improve the defective macroeconomic EMU policy framework. In addition, the CSRs

must reduce the heterogeneous member states' impacts on debt conditions to tighten fiscal policy.

5 Conclusion

The theoretical model of interaction and effectiveness of monetary-fiscal policy was built on micro foundations and macro-essential characteristics in a New-Keynesian framework. Institutions play a fundamental role in policy coordination, and their functioning was represented by the changes of regimes. The empirical strategy consisted of two steps suggested that the rise in public spending increased the output gap and inflation in both cases, in addition to increasing consumption and debt for the majority of regimes. Changes in the debt ratio and government budget deficits are found to be linearly and negatively correlated with growth.

The complex task of achieving fiscal balance in the EMU and Brazil led to public debt crises. Mainly from 2012 to 2016, PM/AF (fiscal theory) was observed in the EMU, which made the TSCG and CSRs necessary. Nonetheless, the EMU must achieve the real convergence of member states for aggregate expenditure ceiling establishes a commitment mechanism to countries forecast public expenditures. To stabilize successive primary deficits, Brazil needs urgent structural in-depth institutional reforms for the next several years. The first step in this agenda of transition to more accommodative debt management and a better use of fiscal instruments, is pension reform. Pension reform could deliver a reduction in distortionary tax effects, before tax system reform. Our results suggest that economic policy should be analyzed from a coordination perspective.

For economies with special characteristics such as Brazil, the opportunity cost of public choices is especially high, while for some EMU member states, the budget constraint seems to be a concern as well. Further studies might address how the debt crisis is endogenously transmitted to public bond risks in an open economy context. Although not the subject of this study, the influence of the external sector must be observed with caution. Improvements in macroprudential policy and qualitative analysis of public spending at the microeconomic level would be welcome as well.

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Appendix A

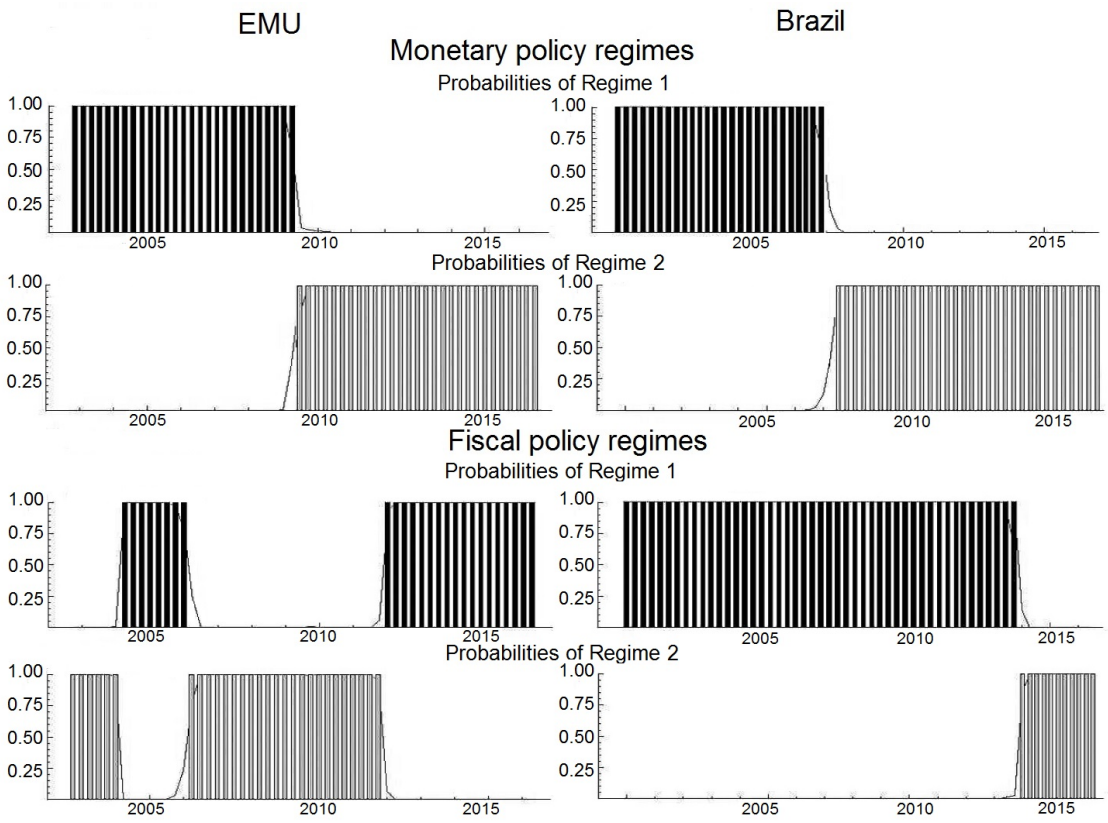

Figure 3: Estimated probabilities of policy regimes
Source: ECB, the BCB and the STN data.

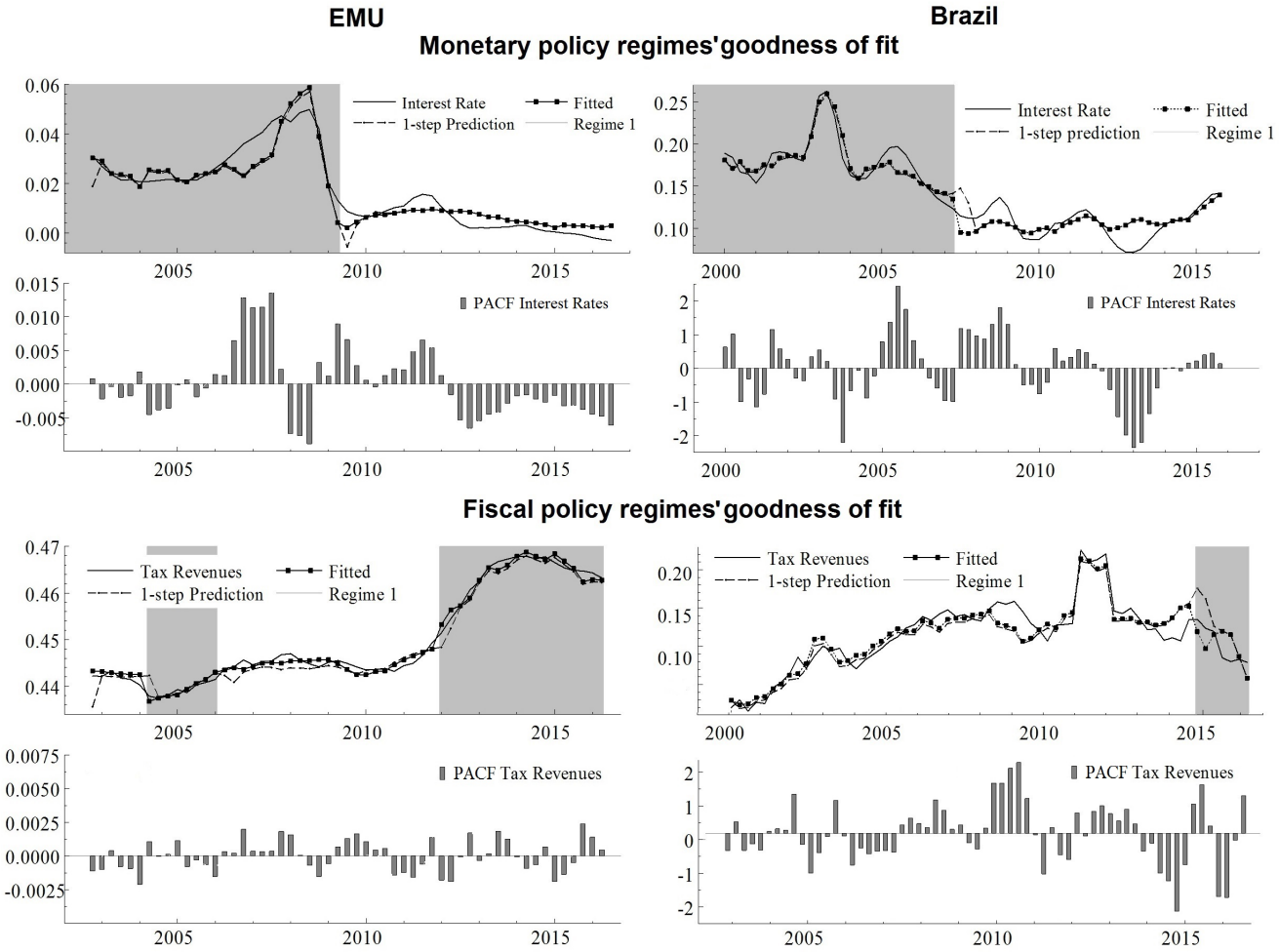

Figure 4: Policy regimes' goodness of fit
Source: ECB, the BCB and the STN data.