Sources of Economic Growth in the Brazilian Boom and Bust Cycle

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Área 4: Macroeconomia, Economia Monetária e Finanças

Abstract: I identify the main structural fragilities that drive the volatility of Brazilian economic growth and shed light on the main obstacles to economic recovery. Using a neoclassical growth model for a small open economy with time-varying wedges – that could emerge from shocks to productivity and frictions in the labor, bonds, and capital markets – I decompose the boom-bust cycle of 2003-2016 into its contributing factors. I find that productivity is the main wedge accounting for the behavior of the observed investment, consumption, and output, especially until 2009. After the Global Financial Crisis and mainly during the 2014–2016 recession, the labor wedge gradually gained importance in accounting for the movements in the observed data. In addition, the labor wedge is the best predictor of the observed labor movements throughout the 2000s and 2010s.

Key-words: Business cycle; Economic fluctuations; Brazilian economy.

JEL Codes: E1; E32; E60.

Resumo: São identificadas as principais fragilidades estruturais que impulsionam a volatilidade do crescimento econômico e os principais obstáculos à recuperação econômica brasileira. Um modelo de crescimento neoclássico para uma pequena economia aberta com *wedges* variantes no tempo - que podem surgir de choques na produtividade e fricções nos mercados de trabalho, títulos e capitais -, é utilizado para decompor os fatores responsáveis pelo ciclo de expansão e contração de 2003–2016. Os resultados apontam que a produtividade é o principal fator responsável pelo comportamento do investimento, consumo e produto, especialmente até 2009. Após a Crise Financeira Global e durante a recessão de 2014–2016, o *wedge* do trabalho ganhou gradualmente importância na decomposição das flutuações econômicas. Além disso, o *wedge* do trabalho é o melhor preditor da flutuação das horas trabalhadas ao longo dos anos 2000 e 2010.

Key-words: Ciclos de negócios; Flutuações econômicas; Economia Brasileira.

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1 Introduction

I identify the main structural fragilities that drive the volatility of the Brazilian economic growth by decomposing the boom-bust cycle of 2003-2016 into its contributing factors. The analysis is based on the Business Cycle Accounting (BCA) procedure and has two purposes. First, measure which wedge is the main channel of the fluctuation in the business cycle, and second, focus the policy discussion on the on the wedges that drive the business cycle.

Between 2014 and 2016 Brazil experienced an economic crisis that resulted in the lowest cumulative growth and longest consecutive periods of recession since 1980; -8,6% over 11 quarters.[1] Growth collapsed, inflation rose and the country faced severe political instability that contrast with the economic performance in the 2000s. From 2000 to 2010 the annual average GDP growth was 3.7%, the market share of global exports of agricultural commodities increased from around 4 percent in 2002–2004 to 7 in 2012, and the terms of trade increase significantly; rising by 24.6 percent between 2000 and 2010.

Although the fall in commodities price by half from 2011 to 2016 has negatively affected all Latin American countries the economic downturn was particularly strong in Brazil resulting in one of the worst economic crisis in the country's recent history. In 2015, annual investment contracted 14% and the consumer confidence index plunged from 80 in January to 65 in December. [2] By May, 2017, the unemployment rate had peaked at 16% in the Metropolitan Region of São Paulo, the highest value since the series started in 1985. [3] The deterioration of the macroeconomic situation during the 2014–16 crisis is evident in Figure 1.

The economic instability highlighted the structural fragilities that prevent productivity growth such as low trade openness, poor infrastructure, impaired credit market and inefficiencies in the tax system, regulation, labor markets, and credit policies (Spilimbergo and Srinivasan, 2019). The lower economic growth also exposed the vulnerability of inflexible public spending, with mandatory expenses representing the main share of public expendure (around 80% in 2017). The fiscal imbalance accelerated when growth began to falter, and previous pressures in the government budget combined with low revenue resulted in a nominal deficit around 9 percent of GDP in 2015. [4]

Structural reforms are the key to improving Brazil's long-term growth prospects. But reform involves selecting policy priorities because of capital and political constraints. By decomposing business cycle fluctuations into contributing factors, we can identify the patterns in Brazilian economic volatility and shed light on the main obstacles to economic recovery. From the business cycle model, we can also map the wedges to a detailed model and draw policies to tackle economic frictions that result in higher economic efficiency.

To guide empirical work I use the neoclassical growth model for a small open economy of Lama (2011) for estimation and historical decomposition. In the model time-varying wedges are introduced in an open-economy version of the neoclassical growth model. The wedges could emerge from shocks to productivity and frictions in the labor, bonds, and capital markets.

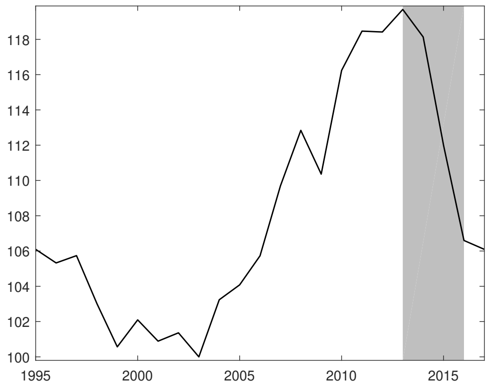
The paper is related to the macroeconomic literature on business cycles and resource misallocation, especially the works based on the Business Cycle Account methodology, developed by Chari, Kehoe, and McGrattan (2007). Important contributions to this literature includes

[1] Brazilian Dating Committee of Economic Cycles (CODACE)

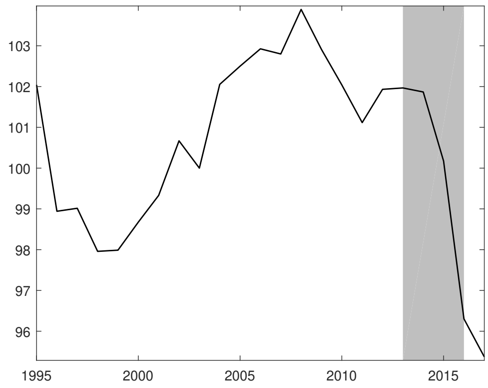
[2] seasonally adjusted data from Fundação Getulio Vargas (FGV)

[3] Fundação Sistema Estadual de Análise de Dados, Pesquisa de Emprego e Desemprego (Seade/PED)

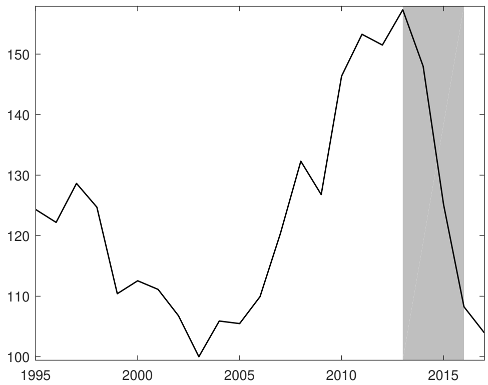
[4] consolidated fiscal balance from BACEN — Central Bank of Brazil



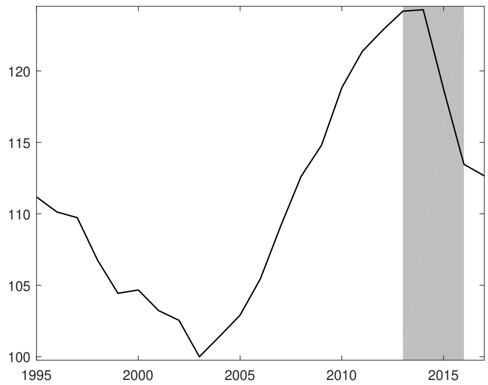
(a) Output



(b) Labor



(c) Investment



(d) Consumption

Note: aggregate per capita annual data over the 1995–2017 period detrended by the average growth rate. All values are normalized to equal 100 in 2003, and the shaded areas in the figure correspond to the recession period between 2014–2016.

Figure 1: Observed variables (2003=100)
Source: Own Elaboration (2019)

Simonovska and Söderling (2015), Chakraborty and Otsu (2013), Kersting (2008), and Kobayashi and Inaba (2006). My work is most related to Chakraborty and Otsu (2013) and Simonovska and Söderling (2015). Chakraborty and Otsu (2013) analyze the growth period in the developing economies of Brazil, Russia, and India that occurred during the 2000s. Simonovska and Söderling (2015) measure the most important wedges to the business cycle fluctuations in Chile between 1998–2007, and propose policy recommendations based on the empirical findings.

For most of the 2000s, I find that productivity is the main wedge accounting for the behavior of the observed investment, consumption, and output. The same result is drawn for the 2010s, although the labor wedge gradually gained importance in accounting for the movements in the observed data in that period, especially in the 2014–2016 recession. The labor wedge is the most useful for explaining the share of worked hours. While the capital and bond wedges play a minor role in explaining the Brazilian business cycle between 2003—2017.

2 Small Open Economy Model

The framework described below is designed to estimate the importance of the wedges, which can be mapped to market distortions, in explaining the volatility in output, labor, investment, and consumption. I consider a small open economy growth model with four types of wedges as in Lama (2011). Four types of wedges include capital, labor, investment, and efficiency that measures distortions in each of these markets.

The model includes optimizing households and firms, a government that follows a balanced budget policy, and households hold international bonds. Firms have access to a constant returns to scale technology, and households supply labor and own the capital stock that is rent it to firms. Fluctuations in the aggregates are induced by wedges, therefore, we create a historical decomposition of the business cycle by turning on and off the individual wedges. Using the historical decomposition we are able to quantify the importance of each wedge in explaining economic fluctuations in Brazil.

2.1 Households

There is a large (measure one) population of infinitely lived households. The preferences over streams of consumption and leisure are given by

$$E_0 \sum_{t=0}^{\infty} N_t \beta^t U\left(c_t, l_t\right) \qquad \beta \in (0,1), \tag{1}$$

where β is the discount factor, c_t is the per capita consumption, l_t the per capita labor supply, and N_t is the population size.

The households maximize expected utility over per capita consumption and leisure subject to the budget constraint

$$(1+n)b_{t+1} + c_t + i_t \leq (1-\tau_{lt})w_t l_t + (1-\tau_{kt})r_t k_t + (1+\tau_{bt})(1+r_t^*)b_t + T_t, \tag{2}$$

the capital accumulation law

$$(1+n)k_{t+1} = (1-\delta)k_t + i_t - \phi\left(\frac{i_t}{k_t}\right)k_t, \tag{3}$$

and an upward-sloping supply curve for foreign funds

$$(1+r_t^*) = (1+r^*)\left(\frac{b_t}{b^*}\right)^v. \tag{4}$$

where b_t denotes the international bonds, w_t the wage rate, r_t the capital rental rate, k_t the capital stock, i_t the investment, T_t the government transfers, n the population growth rate, $\delta \in (0,1)$ the depreciation rate, ϕ the capital adjustment cost, b^* the total debt, and r_t^* the foreign interest rate. The parameter ν is strictly positive and the positive correlation between r_t^* and b^* is interpreted as a risk premium for the investors resulting from the increase in the perceived probability of default when the economy has a high absolute level of foreign debt.

The households face distortions in the consumption-labor decisions caused. The distortions are represented by three wedges in the budget constraint(Equation 2): capital wedge, $(1+\tau_{kt})$; labor wedge, $(1-\tau_{lt})$; and bond wedge, $(1+\tau_{bt})$. The wedges reduce the households disposable income and change the allocation of resources across within the economy creating misallocation.

2.2 Firms

There is a continuum of identical firms in a perfectly competitive market, that combines capital and labor using a production technology function $A_t F(k_t, (1+\gamma)^t l_t)$. The parameter A_t is the stochastic component of total factor productivity (productivity), and $(1+\gamma)$ is the labor-saving technological trend. The decision problem of a firm to hire capital and labor services is static. The maximum one period profit function π_t satisfies

$$\pi_t = \max_{n_t, k_t \geq 0} A_t F(k_t, (1+\gamma)^t l_t) - r_t k_t - w_t l_t. \tag{5}$$

2.3 Government

The government collects the capital and labor tax wedges, pays interest on the international bonds, and the surplus or deficit is redirected to the households as a lump-sum transfer, T_t. In each period the government budget constraint holds

$$T_t = \tau_{kt} r k_t + \tau_{lt} w_t l_t - \tau_{bt} \left(1 + r_t^*\right) b_t. \tag{6}$$

2.4 Equilibrium Conditions

The equilibrium is summarized by the aggregate resource constraint,

$$A_t F\left(\widehat{k}_t, l_t\right) = \widehat{c}_t + \widehat{i}_t + \left[(1+n)(1+\gamma)\widehat{b}_{t+1} - \left(1 + r_t^*\right)\widehat{b}_t\right]; \tag{7}$$

the first-order conditions given by the capital Euler equation,

$$U_{ct} = \beta E_t \left[U_{ct+1}\left(1 + r_{t+1}^k\right)\right]; \tag{8}$$

the Euler equation for bonds,

$$U_{ct} = \beta E_t \left[U_{ct+1}\left(1 + \tau_{bt+1}\right)\left(1 + r_{t+1}^*\right)\right]; \tag{9}$$

and the allocation between consumption and leisure,

$$-\frac{U_{lt}}{U_{ct}} = \left(1 - \tau_{lt}\right) A_t F_{lt}, \tag{10}$$

where $\hat{v}_t$ denote variables detrended by the rate of technological progress, $\hat{v}_t = v_t/\left(1+\gamma\right)^t$, and the interest rate on capital is given by

$$1 + r^k_{t+1} = \left(1 - \phi'\left(\frac{\widehat{i}_t}{\widehat{k}_t}\right)\right)\left[(1-\tau_{kt+1})A_{t+1}F_{kt+1} + \frac{1}{1-\phi'\left(\frac{\widehat{i}_{t+1}}{k_{t+1}}\right)}\right. \\ \left.\left((1-\delta) - \phi\left(\frac{\widehat{i}_{t+1}}{\widehat{k}_{t+1}}\right) + \phi'\left(\frac{\widehat{i}_{t+1}}{\widehat{k}_{t+1}}\right)\frac{\widehat{i}_{t+1}}{\widehat{k}_{t+1}}\right)\right]. \tag{11}$$

Note that the wedges are essentially residuals from the first-order conditions that affect prices. The wedges can be mapped to specific frictions such as taxes, subsidies, market power, and trade restrictions. Particularly, the model presents four channels from which distortions can be mapped to bonds, productivity, labor, and capital wedges.

2.5 Measuring the Wedges

To decompose the business cycle in wedges we need to ensure that the dynamic expectations for the agents are the same in a model with wedges and without. In the Euler equations for capital (Equation 8) and bonds (Equation 9), there are expectations about the future states of the economy, that are unobserved, so to close the model we need to specify a stochastic process process for the event $s^t = \left[\log\left(\frac{A_t(s^t)}{A}\right), \log\left(\frac{1-\tau_{lt}(s^t)}{1-\tau_l}\right), \log\left(\frac{1-\tau_{kt}(s^t)}{1-\tau_k}\right), \log\left(\frac{1+\tau_{bt}(s^t)}{1+\tau_b}\right)\right]$,

$$\log\left(A_t\right) = \left(1-\rho^A\right)\log(A) + \rho^A \log\left(A_{t-1}\right) + \varepsilon^A_t, \tag{12}$$

$$\log\left(1-\tau_{lt}\right) = \left(1-\rho^L\right)\log\left(1-\tau_l\right) + \rho^L \log\left(1-\tau_{lt-1}\right) + \varepsilon^L_t, \tag{13}$$

$$\log\left(1-\tau_{kt}\right) = \left(1-\rho^K\right)\log\left(1-\tau_k\right) + \rho^K \log\left(1-\tau_{kt-1}\right) + \varepsilon^K_t, \tag{14}$$

$$\log\left(1+\tau_{bt}\right) = \left(1-\rho^B\right)\log\left(1-\tau_b\right) + \rho^B \log\left(1+\tau_{bt-1}\right) + \varepsilon^B_t, \tag{15}$$

where the errors ε are independent identically distributed normal with mean zero and variance one.

3 Specification and Calibration Procedure

The procedures for the business cycle accounting can be summarized in four steps. First, we obtain the parameters of the model through calibration. Second, we use the data and the model results to estimate the stochastic process of the wedges by maximum likelihood.[5] Third, we compute a first-order approximation to the policy functions of the neoclassical model around the non-stochastic steady state. Last, we access the marginal contribution to the economic fluctuations in the observed data plugging the stochastic process of the wedges into the decision rules.

[5] The stochastic process is estimated using decision rules of the model along with observed data, so the third step is part of the second

To carry out an empirical analysis, we must choose functional forms and assigning parameter values. The empirical model consists of the following functional forms:

(i) utility function:

$$U\left(c,l\right) = \log c + (\psi) \log(1-l), \tag{16}$$

(ii) production function:

$$A_t F(k_t, (1+\gamma)^t l_t) = A_t \left[k^{\alpha}(1+\gamma)^t l^{1-\alpha} - r_t k_t - w_t l_t\right], \tag{17}$$

and (iii) adjustment costs:

$$\phi\left(\frac{i}{k}\right) = \frac{a}{2}\left(\frac{i}{k} - \delta - \gamma - n - \gamma n\right)^2, \tag{18}$$

where a is a parameter for the level of the adjustment cost.

We can separate the model's structural parameters into two categories: those that can only determine dynamics and those that, in addition to influencing the dynamics, determine the steady-state. Generally speaking, most of the parameters that determine the steady-state are calibrated to match the empirical statistics so that the model equilibrium matches the chosen statistics.

The statistics to calibrate the parameters are population growth, investment–GDP ratio, exogenous technological progress, discount factor, and leisure weight from the System of National Accounts for the period 1995–2017. [6] The debt–GDP ratio is calibrated as the average fraction of net foreign asset in the GDP as in Lane and Milesi-Ferretti (2007), and the remaining parameters are calibrated as in Lama (2011).Table 1 summarizes the selected values for the calibrated parameters.

Description	**Parameter**	**Value**
discount factor	β	0.93
leisure weight	ψ	3.25
capital share	α	0.3
capital adjustment cost parameter	a	0.25
exogenous technological progress	γ	2.55
population growth	η	1.8
depreciation rate	δ	0.5
elasticity of supply funds	ν	0.0001
debt–GPD ratio	b/y	0.33
investment–GDP ratio	i/y	0.19
interest rate	r	1.04

Table 1: Calibration to Brazilian Data
Source: Own Elaboration (2020)

[6] *Instituto Brasileiro de Geografia e Estatística* (IBGE)

The parameters that only determine the dynamics are estimated as by maximum likelihood using the data on output, consumption, worked hours, and investment from 1995 to 2017. The output is the GDP, consumption is the final consumption expenditure, and investment is the gross fixed capital formation. All variables are in constant 2010 prices detrended by the rate of technological progress and divided by the working-age population (15–64) [7], the exception is labor, that is the average share of hours worked by the population between 15–64 [8].

With all the parameters determined, the model can be solved numerically. The numerical procedure used is a first-order approximation to the policy function as presented in Schmitt-Grohé and Uribe (2004). The methodology uses Taylor's theorem to find approximations to the equations of the model, and when necessary use the implicit function theorem to evaluate derivatives. One advantage of this numerical strategy is that it uses analytic derivatives which improve the computational efficiency and yield more accurate results to welfare comparisons (Farmer and Hollenhorst, 2006).

4 Results

Using the calibrated model and Brazilian data for the 1995–2017 period, I compute the four wedges described in equations 12–15. Figure 2 plots the output and estimated stochastic process between 2003–2017 relative to the base year 2003. The red line marks the beginning of the slowdown in the growth rate of the Brazilian economy in 2011.

In the growth period (2003–2010), both the efficiency and the labor wedge rise, accounting for essentially all the movements of output. The exception is 2009 when output and productivity contract as a result of the Global Financial Crisis. The labor wedge decrease in 2010, showing a delay to adjust to the output drop. The contraction in the labor wedge is persistent until 2011, which is compatible with The Brazilian rigid formal labor market.

The bond and capital wedges display the opposite fluctuations to what we observed in the output during the growth period. Exhibiting a mild downward trend between 2003–2017, the bond wedge is unable to explain the behavior of output along the analyzed period; the bond wedge in 2016 was 0.3% lower than 2003.

Notice that during the slowdown and recession periods (2011–2016) the efficiency and the labor wedges can account for a significant portion of the downturn. The labor wedge exhibits the sharpest downfall among the wedges after 2014, which suggests that frictions in labor-leisure played a significant role in explaining the 2014–2016 crisis.

Over slowdown and recession periods, the capital wedge fluctuates, but the capital distortion τ_k is smaller between 2014–2016 than in 2003, and the capital wedge plays a minor role in explaining the output fluctuations. The capital wedge pattern suggests that financial frictions models that are mapped from the capital wedge are unable to explain the Brazilian boom to bust cycle. Note that we can map financial frictions from other wedges, for example, we can map financial shocks from labor wedge as in Jermann and Quadrini (2012).

Given the estimated wedges, which wedges better account for the bust and boom that Brazil experienced during the 2000s and 2010s? To answer that question, the wedges by themselves are insufficient to quantify their importance to account for the Brazilian business

[7] World Bank World Development Indicators (WBI)

[8] International Labour Office (ILO) LABORSTA database

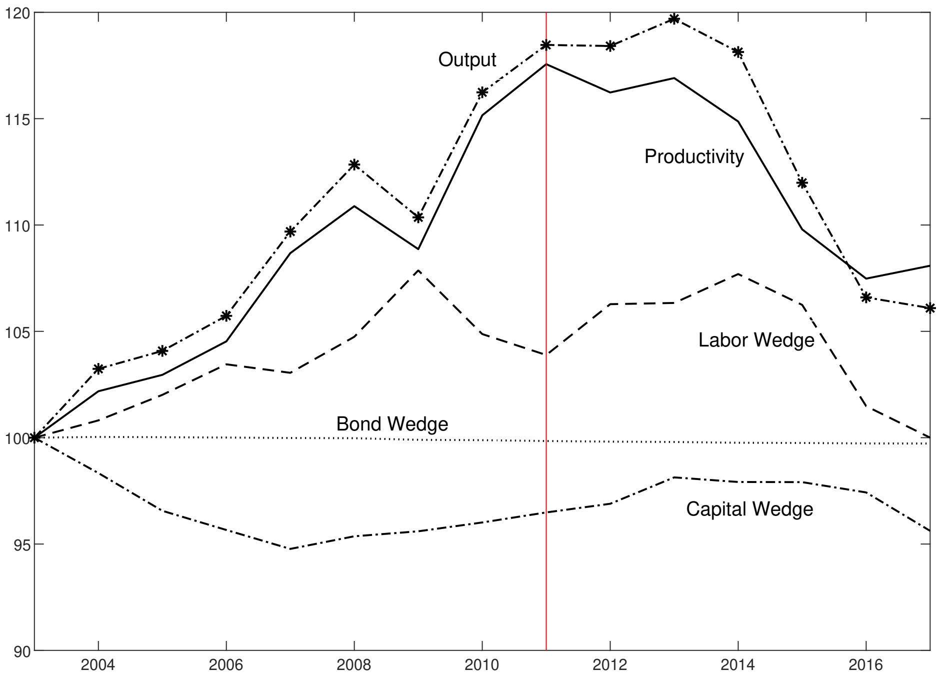


Figure 2: Output and Measured Wedges (annually; normalized to equal 100 in 2003.)
Source: Own Elaboration (2019)

cycle. So, I plot the model predictions for one or more combination of wedges with the observed data from 2003–2017 for Brazil.

Figure 3 shows the predictions of the model for the output, feeding one wedge into the model at a time. Figures 4, 5 and 6 shows the predicted movements of the labor, consumption and investment. In all four plots the solid line represents the actual data and the dashed line represents the predictions of the model, simulated by each of the four wedges considered in isolation. By construction, feeding all wedges to the model we replicate the observed data. The predictions by the models with a combination of wedges are display in Figure 7.

4.1 Output

Starting with the top left panel of Figure 3, we can see that movements in the output between 2003–2017 are mainly explained by the productivity. But the productivity model under-predicts the slowdown and downturn in output from 2011 through 2017. Note that the capital wedge (top right) in isolation help to explain the slowdown in the output from the early 2010s.

The labor wedge (bottom left) follows the same pattern as the observed fluctuation in the output, but predict much lower fluctuations. For the 2014 recession, the labor wedge account for a share of the sharp decline in the output. Further, we can see that the output simulated with only bond wedge (bottom right) is unable to explain the fluctuations observed in real output data.

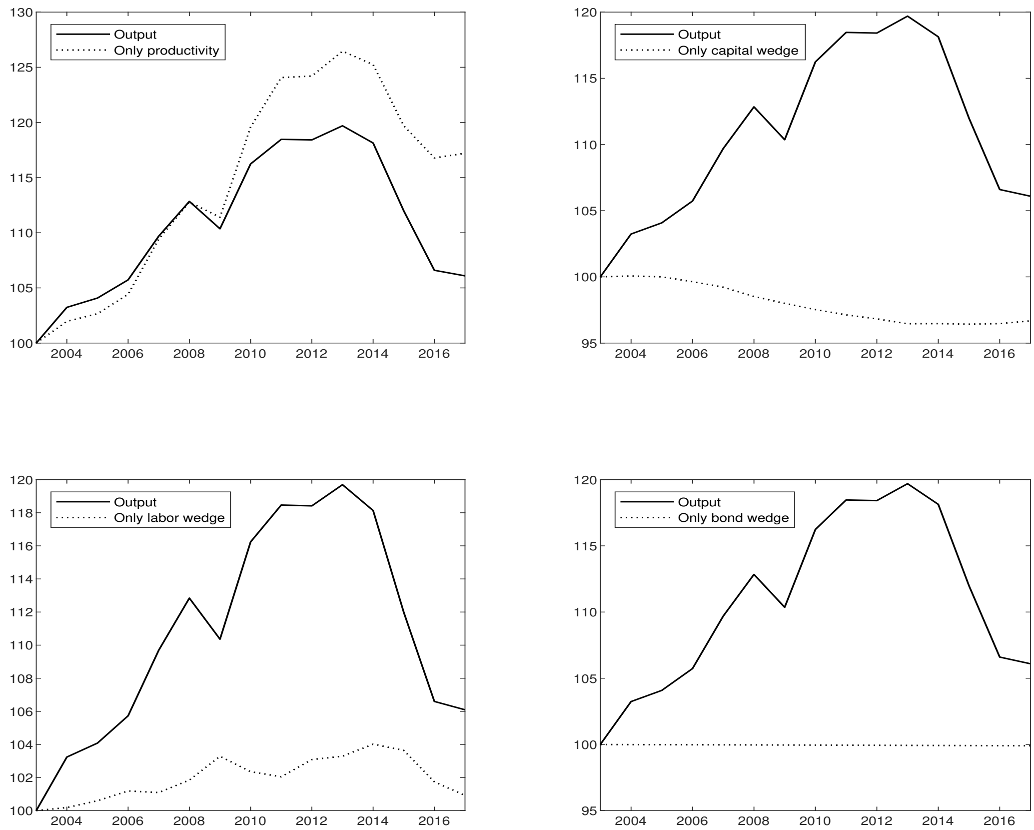


Figure 3: Observed and Simulated Output with a Single Wedge
Source: Own Elaboration (2019)

4.2 Labor

The simulated labor data using only the labor wedge explains most of the fluctuations in hours worked (bottom right panel in Figure 4). But for the recession that started in 2014, all the wedges under-predict the fall in hours worked. The unemployment rate rose from 6.8% in the last quarter of 2015 to 13.7% in the first quarter of 2017, which is reflected in the observed percentage of hours worked.

Since 2008 the labor wedge over-predict the share of worked hours, a period that coincide with the industrial policies initially adopted by the government to mitigate the Global Financial Crises, that remained in place until 2016.

It is worth noting that the government responded to the crisis with countercyclical policies, similar to several other countries. The government also increase the availability of credit with below-market interest rates, reduced the industrialized products tax, and increase the duration of unemployment insurance. In 2011, the credit expansion was further extended, and the government graded payroll taxes cut for selected industries, which, in turn, affected the labor market.

The simulated labor per-capita data using only the productivity (top right) and only the capital wedge (top left) play a minor role in explaining the labor movements, exhibiting almost stable trends since 2003. The productivity predict a higher fraction of hours worked

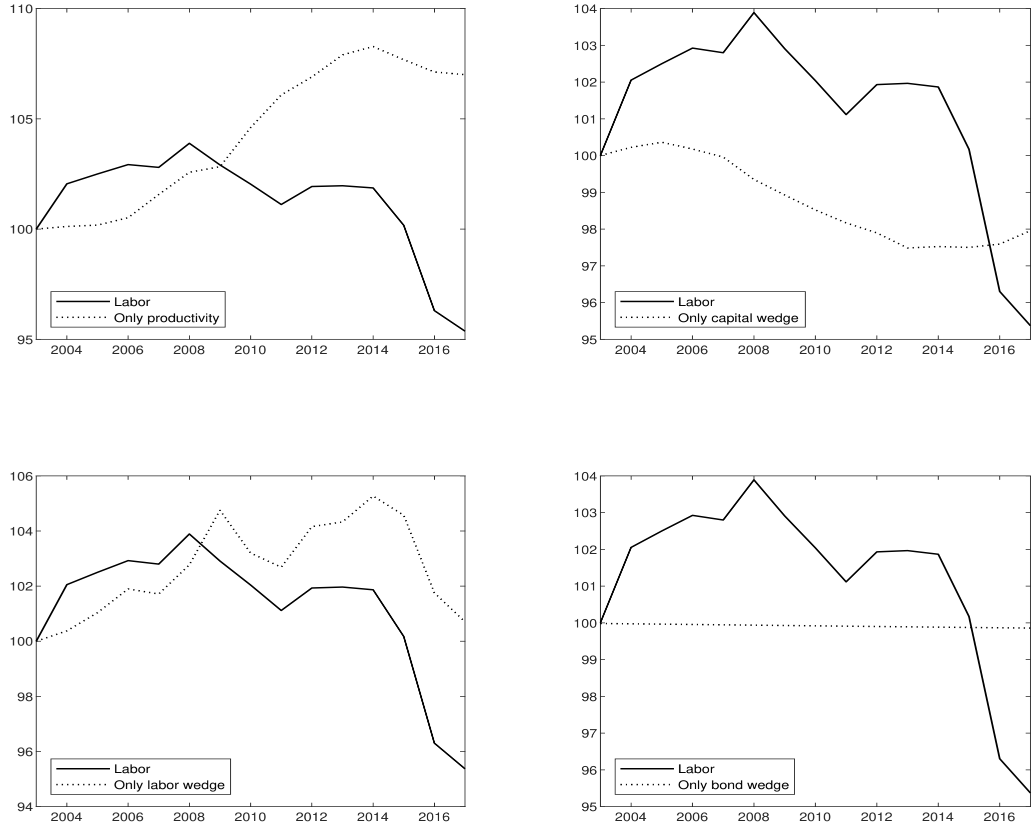


Figure 4: Observed and Simulated Labor with a Single Wedge
Source: Own Elaboration (2019)

after 2008, and the capital wedge a lower fraction of worked hours relative to 2003. The bond wedge (bottom right) is unable to explain the observed labor data.

4.3 Consumption

The credit availability increased the household consumption in the 2000s until 2014. From 2003 to 2014 the total household debt increased almost five-fold as a result of facilitating repossess collateral by lending institution, new bankruptcy law, and a new law on payroll lending. The consumption rise was also partially caused by government programs targeting low-income households, and subsidized housing programs (Garber et al., 2018).

Figure 5 shows the path of consumption over the course of the growth slowdown and recession. I estimate that consumption was 25 percent above the trend by the mid-2010s and drop sharply after 2014. Both the bond wedge (bottom right) and the capital wedge (top right) cannot account for the movements in the consumption.

The productivity in isolation (top left) provides a reasonable match for the consumption movements for a large part of the decade, however, the productivity over-predicted of the consumption drop in 2009 and under-predict the drop in 2015. The labor wedge (bottom left) o helps account for the rise in consumption in 2009, and the fall in consumption in 2014. This suggests that a combination of the productivity and labor wedge are needed to account for the

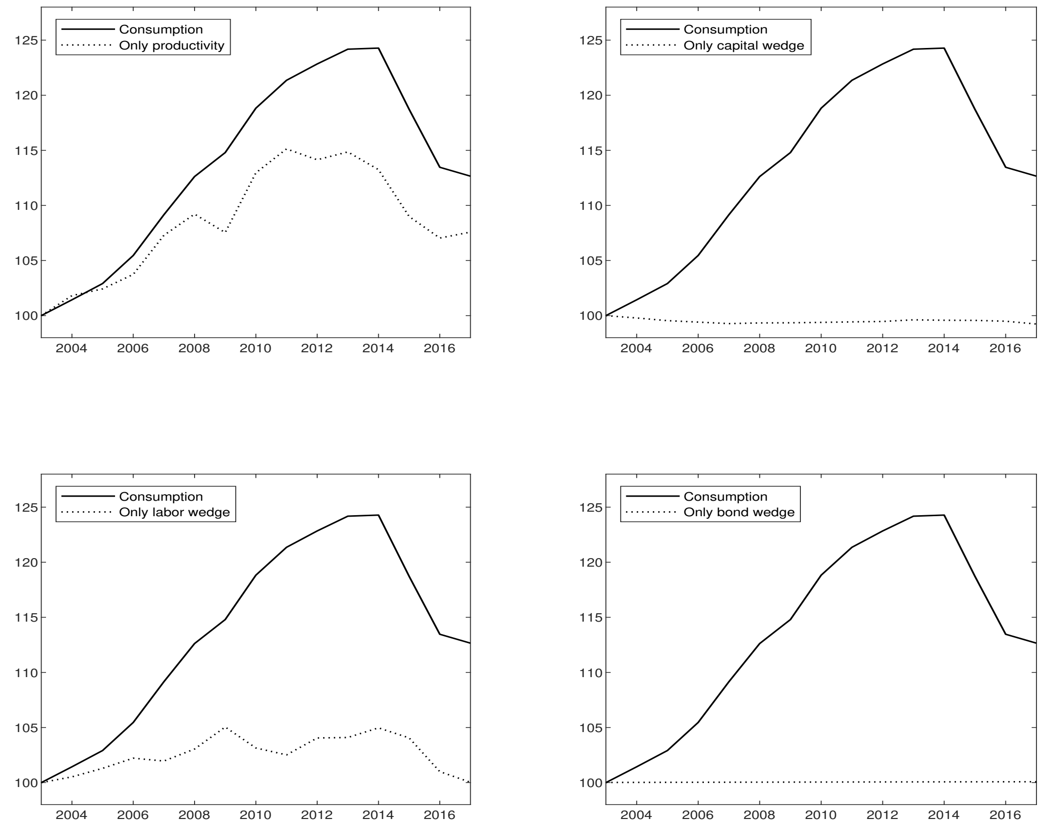


Figure 5: Observed and Simulated Consumption with a Single Wedge
Source: Own Elaboration (2019)

consumption fluctuations.

4.4 Investment

The investment can be accounted for without the bond wedge (bottom right panel in Figure 6). Note also that the capital wedge (top right) cannot account for the downturn in the investment; the capital wedge predicted a boom through the mid-2000s until 2015.

The productivity (top left) predict the observed movements in investment particularly well, but suggest a higher volatility in investment than observed in the data. The labor wedge (bottom left) appear to play some role to explain the investment, although smaller than the role of the productivity. The labor wedge complements the productivity in accounting for the investment movements, specially between 2014–2017.

I summarize the one-wedge models predictions for output, labor, consumption, and investment by presenting the predicted variation in percentage in Table 2. Overall, productivity does the best job predicting the movements in the output, consumption, and investment during the 2000s and 2010s. But, although the productivity tracks the direction of the movements, it over-predicts the output and investment growth between 2003–2010 and under-predicts the recession between 2011–2017. The consumption is under-predicted in the 2000s and the fall is over-predicted in the 2010s.

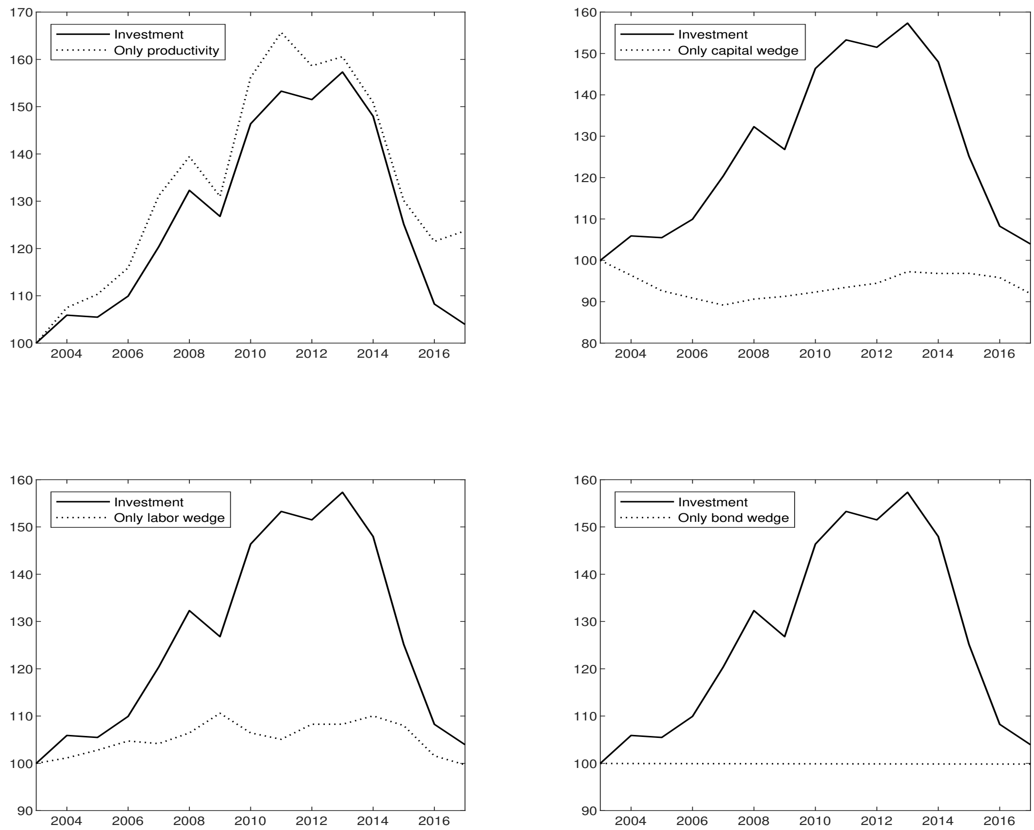


Figure 6: Observed and Simulated Investment with a Single Wedge
Source: Own Elaboration (2019)

The productivity cannot account for the labor variation from 2003 to 2017, being the labor wedge the best predictor of the observed labor movements. The capital and bond wedge have a limited contribution in accounting for the observed data movements for the growth, and the slowdown follow by the recession period. The analysis reinforces that efficiency and labor wedges play a dominant role in explaining the fluctuations in the Brazilian business cycle.

	Output	Labor	Consumption	Investment
		2003–2010		
Productivity	24.07	6.08	15.13	65.70
Labor Wedge	2.05	2.69	2.52	5.08
Capital Wedge	-2.87	-1.83	-0.57	-6.53
Bond Wedge	-0.05	-0.07	0.04	-0.08
Observed	18.47	1.12	21.36	53.28
		2011–2016		
Productivity	-7.28	1.04	-8.09	-44.20
Labor Wedge	-0.31	-0.93	-1.52	-3.50
Capital Wedge	-0.66	-0.58	0.06	2.35
Bond Wedge	-0.04	-0.04	0.02	-0.04
Observed	-11.87	-4.81	-7.89	-45.03

Note: All contributions are expressed in percentage variation between 2013 and 2016 observed data.

Table 2: Predicted Percentage Change by Wedge
Source: Own Elaboration (2019)

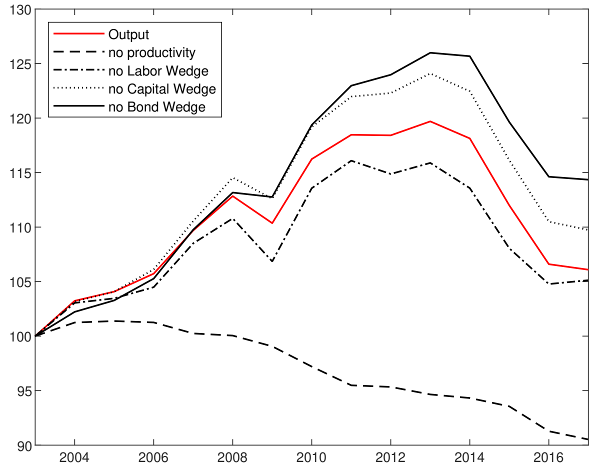
4.5 One-wedge-off economy

To ensure the robustness of a wedge in the model prediction, we can hold one wedge fixed at a time, and assesses the importance of that particular wedge to reproducing the observed dynamics. The counterfactual exercise also helps determine which frictions must be included in a model to account for the boom to bust cycle of 2003-2016 in Brazil. Figure 7 shows the path of output, labor, investment, and consumption from 2003 to 2017, along with the paths predicted by the model with three wedges, holding one wedge constant to its steady-state level.

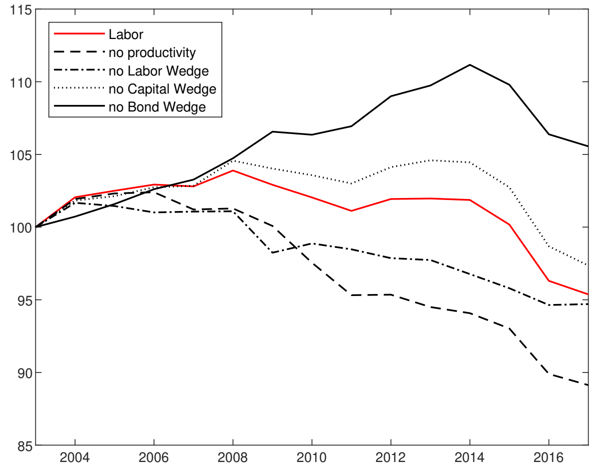
The top left panel shows that holding fixed productivity generates the opposite dynamics to those observed in the Brazilian output. The movements predicted in the output by the model without productivity have an almost linear downward trend even for the growth period between 2003–2010. The output predicted by the model without labor, capital, and bond wedges match the movements in the observed data but fail to explain the amplitude of the slowdown and recession cycles. Both models without bond and capital wedge over-predict the output after 2009 and the model without the labor wedge under-predicts the output since the mid-2000s.

The explanatory power of the different wedge combinations for investment (bottom left) are similar to those for the output. The predictions by the model without capital, labor, and bonds match the movements in the observed data. In the growth period (2003–2010) the model without the bond wedge gives a better prediction for the investment, and in the slowdown and recession period (2011–2016) the model without the capital wedge yields the most accurate prediction.

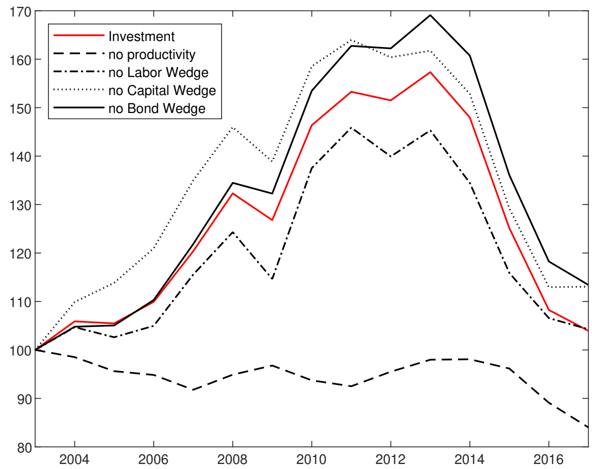
The predictions for the consumption (bottom right) without the capital wedge are essentially along the observed trend over 2003–2017. For the labor, all different wedge combinations are unable to explain the observed labor trend after 2008, we can see in the top right panel that all models predicted labor growth below trend. So, note that productivity is the main wedge accounting for the behavior of the observed data, especially during the growth period, and the capital and bond wedges were less relevant in explaining the economic fluctuations.



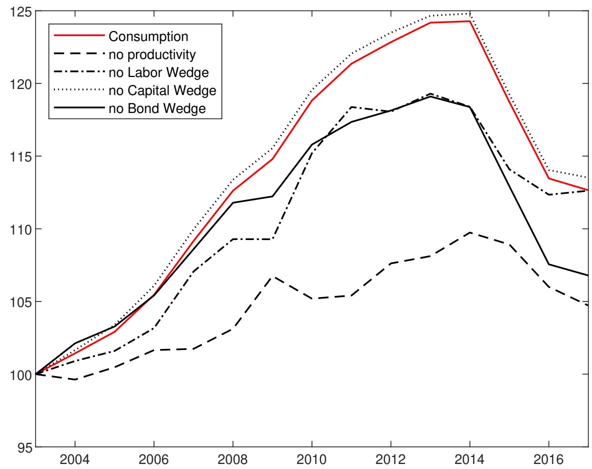
(a) Output



(b) Labor



(c) Investment



(d) Consumption

Figure 7: Observed and Simulated Endogenous Variables Without One Wedge
Source: Own Elaboration (2019)

5 Conclusions and Policy Recommendations

Between 2003–2010, economic growth in Brazil averaged about 4 percent a year—a respectable rate compared to the 2.5 percent average growth in the mid-1990s. By 2011 GDP growth was falling, and in 2014 the country experienced a recession of historic proportions. From 2014 to 2016, Brazil's GDP was shrinking 2.1 percent a year, and the unemployment rate rose from 6.8% in the last quarter of 2015 to 13.7% in the first quarter of 2017.

To identify the main friction responsible for the boom-to-bust cycle in the Brazilian economy, I decompose the business cycle from 1995 to 2017 into its contributing factors. Specifically, I estimate the wedges in a business cycle model using the neoclassical growth model for a small open economy of Lama (2011). Based on the model predictions, I identify which frictions to the business cycle model need to be included to replicate the output, consumption, labor, and investment growth during the economic boom and the following sharp decline during the 2014–2016 economic recession.

By measuring the wedges' paths and the simulated aggregates that they predicted over time, we have a quantitative estimate of the wedges' influence in a given period. The predictions are a guide to identify the underline mechanism that leads to the fluctuations in the business cycle. When we select frictions and shocks that can be mapped to the wedge that are the main drivers in the business cycle, we enhance the potential of a model to explain the specific mechanism that results in the 2000s and 2010s business cycle.

Three results can be learned from the paper. First, productivity is the main wedge accounting for the behavior of the observed investment, consumption, and output, especially until 2009. After the Global Financial Crisis and mainly during the 2014–2016 recession, the labor wedge gradually gained importance in accounting for the movements in the observed data, although the labor wedge never surpasses the productivity in explaining the business cycle. Second, the labor wedge is the best predictor of the observed labor movements throughout the 2000s and 2010s. Last, the capital and bond wedges have a limited contribution in explaining the Brazilian business cycle between 2003–2017.

But the hallmark of the business cycle accounting is helping mapped wedges to shocks and frictions and identify current inefficiencies that enhance the business cycle volatility, not only shed light on the possible explanations of what happened in Brazil during the 2000s and 2010s. In that aspect, my results suggest that policymakers should promote policies that stimulate productivity and mitigate labor market rigidities.

Policies to reduce state intervention in credit markets, promote privatizations, increase trade liberalization, and prioritize horizontal instead of vertical industrial policies are an example of actions that help to tackle structural impediments and boosting productivity. Pin down the specific policy recommendations requires a richer model of the Brazilian economy, that incorporates frictions that manifest themselves as productivity and labor to explain the business cycle. In summary, I conclude that the Brazilian economic recovery and future growth may well require ambitious structural reforms to increase productivity and improve the labor market flexibility since the country no longer relies on a substantial expansion of the labor force or commodity demand growth as in the 2000s.

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