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Easing the Effects of Austerity with Reforms: A regional CGE experiment on Brazilian labor productivity

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1. INTRODUCTION

In the current Brazilian public debate, in parallel to the Federal Government's austere measures on the expenditure side and the attempt adopt fiscal consolidations in the Federative Units (states) via the Federal Government's Tax Recovery Plan, there is a discussion regarding the need to approve structural reforms, such as the liberalization of the labor market, increase in the average time for workers' social security contributions and modification of the tax structure.

According to the extensive compilation of theories and empirical evidence presented in Alesina et al. (2019), fiscal consolidations can achieve expansionary results. For OECD countries, Bouis et al. (2012), Alesina et al. (2018) and Annicchiarico et al. (2013) find, to a greater or lesser extent and time to maturity, the achievement of fiscal consolidations in periods of economic stagnancy. This conclusion, supported mainly by the role of expectations, opposes the Keynesian argument that fiscal consolidations would have a contractionary effect on aggregate demand in the short-run. Thus, expansionist austerity (or expansionary fiscal contraction) can be defined as the positive correlation between fiscal adjustment, either through cutting public spending or increasing taxation, and private consumption and investment.

As this literature argues, one of the contexts that would allow expansionary results due to fiscal consolidations is the one marked by accompanying policies. These policies vary from the concomitant adoption of contractionary monetary policy and the liberalization

of the capital market, according to the pioneering analysis of Giavazzi and Pagano (1990), to structural reforms in the labor market and the productive sectors (product market).

For Brazil, the impacts of fiscal austerity are still uncertain, whether at the macroeconomic and sectoral level or on the social spectrum, on the well-being of households and income distribution. Although the implementation of Constitutional Amendment (AC) 95/2016[1] had the goal of anchoring the expectations of economic agents, limiting the growth of public spending in a context of fiscal insolvency, as pointed out by Salto and Barros (2018), some argue on its flexibilization, given the persistence of high idle capacity and unemployment, as well as the lack of public investment in sectors such as health, education and infrastructure (GIAMBIAGI, 2019).

The history of reforms in the Brazilian state is wide and old (COSTA, 2008). These reforms, however, differ considerably from one another. If in the 1950s and 1960s they were marked by developmentalism - from the 1980s and, mainly, 1990s, it was influenced by the global liberalism (CARDOSO, 2021). Currently, reforms are constantly brought to the public debate as an essential agenda for the resumption of Brazilian growth, justified by the fact that they act to liberalize and cooperate to the private sector, in order to mitigate the eventual short-run negative impact on economic activity. due to fiscal consolidation, as part of the literature argues.

According to Anderson, Hunt and Snudden (2014), the reforms positively affect labor productivity and the level of employment through the liberalization of the labor and product market. According to Bouis (2012), flexibilities in labor laws, for example, reduce restrictions on hiring and firing employees, which, in turn, can increase labor productivity, despite the reduction in the bargaining power of the worker and increase, most of the time, precariousness and social costs (RUBERY and PIASNA, 2016; SHIN, 2012). Even social security reforms that promote an increase in the retirement age and actuarial neutrality, raise the labor force participation rate to a new balance in about 10 years according to estimates by Bassanini and Duval (2006; 2009), who, from the point

[1] Constitutional Amendment No. 95 (AC 95), of December 15, 2016, established the New Fiscal Regime (NRF) within the scope of the Federal Government's Fiscal and Social Security Budget, which will be in force for twenty financial years. The NRF sets individual limits for the Executive, for the bodies of the Other Powers, the Public Ministry of the Union - MPU and the Public Defender's Office of the Union (DPU) (MINISTRY OF FINANCE, 2018).

of view of view of the worker, are also liable to adverse effects (BOERI et al., 2002; KODAR, 2004).

Less optimistic arguments regarding the achievement of structural reforms can be found in Rodrik (2017), who highlights the fact that despite the goal of raising the potential output of the economy in the long-run, reallocating factors to more productive sectors, its impacts are usually overestimated. For Bardaka et al. (2020), unless structural reforms are carefully planned to support productive sectors (high value-added), these policies may fail even in the long-run.

Discussions on the effects of austerity and structural reforms are scarce of regional analyzes. This is an important feature, in face of heterogeneities common to space, especially in Brazil, a continental country with great regional, social, economic and structural inequalities. These inequalities mean that the importance of public spending for the economies and well-being of households and the dynamics and productive structure itself vary considerably between regions.

For different countries, Caraveli and Tsionas (2012); Beatty and Fothergill (2013); Cabrera, Lustig and Moran (2015); Pearce (2013); Murphy (2017); Green and Lavery (2015); and Tupy and Toyoshima (2013) highlight the central role of public sector performance and government income transfers to households with regard to interregional income inequalities. The greater dependence of smaller and poorer regions on public sector action, either directly, in the administration and provision of services, or indirectly, via income transfers, is a stylized fact in the literature of regional economics, they are the so-called “economies without production”.

Regarding fiscal consolidations and their regional effects, Cardoso et. al. (2019) assess the direct and indirect impacts of a fiscal austerity agenda of the Brazilian government on the country's regional and sectoral inequalities. The authors project austere scenarios for the growth of public spending in the Brazilian economy, without and with the recovery of private investment (ie, considering the hypothesis of expansionary fiscal austerity) and conclude that, even if the recovery of private investment was sufficient to offset the negative impacts of the spending cutting on economic growth, there would be worsening

macroeconomic and inequality indicators between municipalities and states in the North and Northeast, relative to the rest of Brazil.

Considering the literature favorable to the positive effect of structural reforms, through labor productivity, and the one that discusses the role of the Government in regional inequalities, this article proposes to measure the increase in labor productivity necessary to offset the contractionary effect of the public spending cut on GDP, stemming from the deepening and regional extension of the fiscal austerity agenda in Brazil in the coming years. Still, considering the Brazilian regional structure, it seeks to assess the heterogeneity of eventual productivity gains in the states of the country. For this, a computable general equilibrium model (EGC) with recursive dynamics is used, calibrated for the Brazilian twenty-seven states (Federative Units). The model is based on 2015 data published by the System of National Accounts (SCN) of Brazil (IBGE, 2019) and allows a bottom-up analysis from the state to the national level.

This paper innovates when investigating the regional productivity gain to compensate the contractionary effects of fiscal austerity in Brazil, through the EGC model. Its results are in accordance with the literature on regional convergence in the Brazilian productive structure, as well as regional inequalities. Despite not considering the influence of the pandemic caused by COVID-19, the themes brought here are closely linked to this problem, both in coping with and overcoming the multisystem crisis caused by the virus.

In addition to the present introduction, the work is divided into four more sections: the first, presents the main studies related to structural reforms and their consequences on labor productivity and regional inequalities as well as the recent literature on the Brazilian productivity; then, we describe the methodology, which presents the structure of the model applied to this work, its database and the simulation strategy. In section 4 we present the results and, at last, the final remarks.

2. LITERARUTE REVIEW

Assessments of the relation between structural reforms, labor productivity and regional inequalities are also scarce and lack consensus. For Colombia, Eslava et al. (2004) investigate the effects of product market reforms, such as removing import restrictions and foreign direct investment, introduced in Colombia in the early 1990s. Based on longitudinal data at the firm level for the period 1982-1998, they find evidence that the reforms are associated with an increase in general productivity, largely driven by the

reallocation of low- and high-productivity companies. These changes had no effect on the persistent history of regional inequality in the country, as assessed by Fergusson et al. (2017). In this sense, for India, Unni, Lalitha and Rani (2001) find that liberal reforms in industry and international trade throughout the 1980s and 1990s only benefited the Gujarat region, which was already the most industrialized in the country before the reforms, in terms of value added, employment, capital and productivity. The authors also observe a general post-reform worsening in the informal sector in relation to the formal sector across the country.

To understand the recent evolution of labor productivity in Brazil, in sectorial and regional terms, as well as an international comparison, we present the following references.

Silva et al. (2016) present an international comparison of the evolution of total productivity in the period from 1965 to 2010 between Brazil, South Korea, the United States and other countries in Latin America, considering the technological effects and structural changes. According to the authors' explanation, this decomposition reveals to us whether the growth of a given economy was due to structural changes - the reallocation of labor from less productive sectors to more productive ones - or technological advances, that is, the fact that the economy is able to produce more with the same amount of inputs. The authors note that, despite the huge total discrepancy between South Korea and other countries, this evolution presents different trajectories when analyzed in shorter periods. If, until 1980, Brazil and South Korea had similar productivity growth, they find that, from the 1980s on, the technological effect was largely responsible for the fall in Brazilian productivity. In the Korean economy, on the other hand, there was a growth of 65.7% in productivity, guided by the outstanding technological effect. For the United States, they observed very low growth in the period 1965-1980, compared to other countries (7%); relative increase in the 1980s (12%); and a considerable recovery in the years extending from 1990 to 2010 (28%).

At the sectoral level, based on data from the National Accounts and the National Household Sample Survey, Veloso et al. (2015) updates the trajectory of the evolution of labor productivity in Brazil over the 1990s and 2000s. The authors show that the average labor productivity grew at a rate of 1.3% a.a. (1995-2013), with a considerable difference

between the three main sectors of the economy: Agriculture (6.1% a.a.); Industry (-0.4% p.a.); and Services (0.6% p.a.).

Regionally, Galeano and Feijó (2013) analyze the decomposition of the evolution of labor productivity in industry between 1996 and 2007, considering its participation in national employment using the shift-share method. Of interest to the present study, the regional rates are: Southeast, -12.4%; South, 14.6%; North, 58.3%; Northeast, 23.9%; and Midwest, 55.5%. According to the authors, the general results show that there was a certain rearrangement of some sectors of industry between regions. However, less developed regions are still unable to absorb that portion of the declining sectors in the Southeast region, due to the low representativeness of industrial activities in the regions. With the exception of the Southeast region, the authors argue that the growth in labor productivity in the analyzed years was due more to the residual regional component, that is, to the competitiveness of the sectors themselves in the regions, than to structural changes in the sectoral composition.

In this way, Cruz and Santos (2011) analyze the dynamics of Brazilian industrial employment between 1990 and 2009 and highlight that, despite the regional spillover of industrial employment, the regions that had a relevant industrial base have moved towards specialization in industrial sectors with greater technological content, as a consequence of the externalities of these places, which, according to the authors, was more important than the tax incentives offered for the dispersion. Mendes et al. (2019) evaluate the spatial reorganization of the Brazilian manufacturing industry after 2008 and suggest a spillover of the activity towards low quality jobs, with a greater dispersion of sectors with less technological intensity and jobs with lower educational levels. The authors assume a strong correlation between sectorial technological intensity and the labor level of education and observe the prominence of the Southeast region, mainly in the state of São Paulo, with regard to employment generation of masters and doctors, in sectors of higher technological intensity. In addition to the sectorial issue, the results still suggest a possible productive transition in seek of lower labor costs.

It is important to emphasize that the dynamics of labor productivity over time, in general, was closely related to the countries' growth of product and income. For Brazil, it is worth remembering that this regional convergence has historically resulted from factors related to the action of economic policy and the economic logic of competition and location. As Ferreira and Diniz (1995) point out, the convergence of per capita income between

Brazilian states in the 1970s and 1980s, the period of greatest effectiveness for industrial decentralization in the country, was associated with the development and expansion of basic infrastructure; the movement of agricultural and mineral borders; the direct action of the State in terms of investments and the granting of subsidies and tax incentives; the crises and reversals of industrial polarization in large urban centers like Rio de Janeiro and São Paulo; and migratory movements and changes in the regional distribution of the population. These conditions are in line with the investigations made, more recently, for the Brazilian industry, as indicated by the previously mentioned works.

3. METHODOLOGY, DATABASE AND SIMULATION STRATEGY

The model used for the simulations is a dynamic recursive CGE model calibrated for Brazil. It follows the theoretical structure of The Enormous Regional Model (TERM), which is a model developed by the Center of Policy Studies (CoPS), in Australia, with several applications for the Brazilian economy such as Ferreira Filho and Horridge (2014); Carvalho et al. (2017); Ribeiro et al. (2018); Cardoso et. al. (2019). As the following discussion present, this method differs by the version of the database and by the regional details of technological change, improving its analytical potential at the regional level.

3.1 The Enormous Regional Model (TERM)

TERM is a bottom-up Computable General Equilibrium model, which means that each region in the model is considered as a separate economy and the results at the national level are aggregations of regional results. Although demand, supply, price and quantity are computed for each region separately, spatial interdependence is considered in the model through interregional trade. Therefore, the TERM approach is appropriate for analyzes in which the industrial and regional details have a relevant role. The theoretical structure of TERM follows basic neoclassical assumptions. For each Federative Unit (state), a representative household chooses a consumption basket that maximizes the Stone-Geary utility function subject to a budget constraint. Consumption is allowed to be divided between the subsistence and luxury component (supernumerary), in which only expenditures above the subsistence level affect the per capita utility (PETER et al., 1996; STONE, 1954). All economic agents (households, firms, government and investors) are allowed to choose between domestic goods (from different regional sources) and

imported goods using a CES specification (Armington hypothesis), based on the differences in the purchase price of each source. The market-clearing condition is valid for all markets in all periods, adjusting prices and quantities each year.

The equation that models the production technology is the main transmission mechanism of the exercise presented in this study. Its structure defines the production of each industry and region by minimizing the production costs, following a production function in fixed proportions (Leontief type), which establishes the use of intermediate inputs and primary factors (1). Hierarchically combined with the production function, a function of constant elasticity of substitution (CES) defines the composition of the primary factors, labor and capital, employed in production (2). Associated with the inputs, intermediate or primary factors, the variables of technological change are the ones that make it possible to capture the effects of gains or losses in productivity. In this sense, productivity gains can be understood as savers of inputs / factors.

$$tot_{ir}^{q} = \frac{1}{tot_{ir}^{t}} \times MIN\left\{\frac{int_{ir}^{q}}{int_{ir}^{t}}, \frac{prim_{ir}^{q}}{prim_{ir}^{t}}, \frac{oth_{ir}^{q}}{oth_{ir}^{t}}\right\} \quad (1)$$

$$prim_{ir}^{q} = CES\left\{\frac{lab_{ir}^{q}}{lab_{ir}^{t}}, \frac{cap_{ir}^{q}}{cap_{ir}^{t}}\right\} \quad (2)$$

Where *q* is for quantity; *t*, for technology; *i*, for industy and *r*, for region. *int*, *prim*, and *oth* indicates the intermediate inputs, primary factors and other production costs, respectively; *lab* and *cap* indicate the use of labor and capital factors, respectively; tot_{ir}^{q} denotes the total production of industry *i*, in region *r*; and tot_{ir}^{t} is the technological variation in the total use of inputs in industry *i* in region *r*.

The dynamics adjustment is based on the accumulation of investments and capital stock at the regional and industry levels. According to Dixon and Rimmer (2002), for each year of the simulation, it is assumed that the rates of capital growth are determined by the willingness of investors to invest resources in an industry based on the expected rate of return. Basically, if the rate of return expected by investors is higher than the pre-

established normal rate of return, the capital accumulation will be above the normal rate (Dixon and Rimmer 2002).

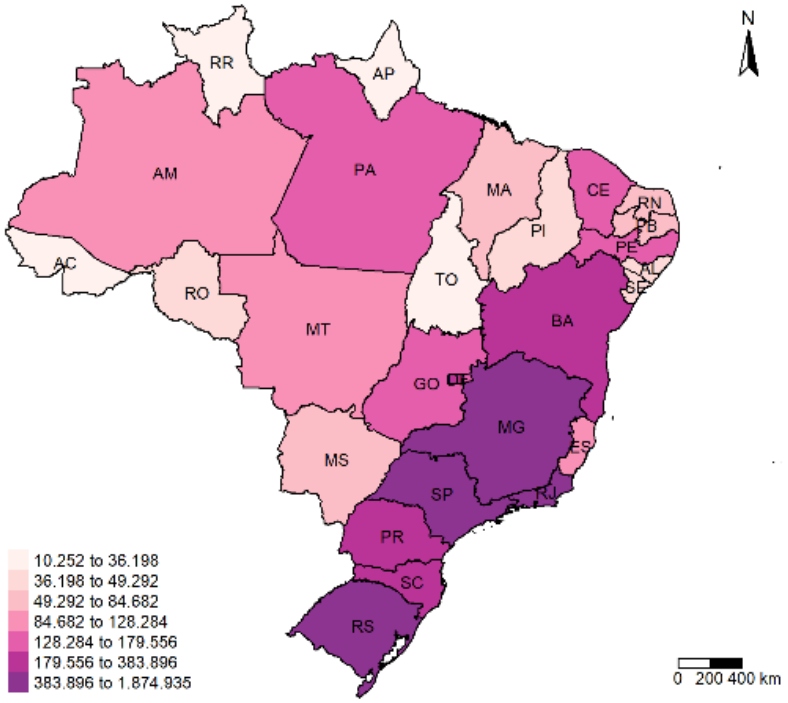
In this sense, the proposed exercise is favored by the ability of the method to capture, over the time, the effects of differentiated technological changes at the regional level on the economic system, as well as by the possibility of decomposing its effects among the main macroeconomic aggregates such as consumption, investment, employment, exports and imports.

3.2 Database

The model's database is made up of 27 regions, corresponding to the Brazilian's states, and 127 sectors, listed in the Input-Output Matrix of 2015 released by the Brazilian Institute of Geography and Statistics (IBGE) (IBGE, 2018). The model's database was regionalized through a method developed by Horridge (2012), in addition to information from the System of National Accounts (SNA) of Brazil. Information on consumption is from the Brazilian 2008–2009 Household Budget Survey (IBGE, 2011); on employment, from the Annual Report of Social Information (RAIS) (BRASIL, 2020); and on international trade, from the Comex Stat (2019), from the Foreign Trade System (SISCOMEX).

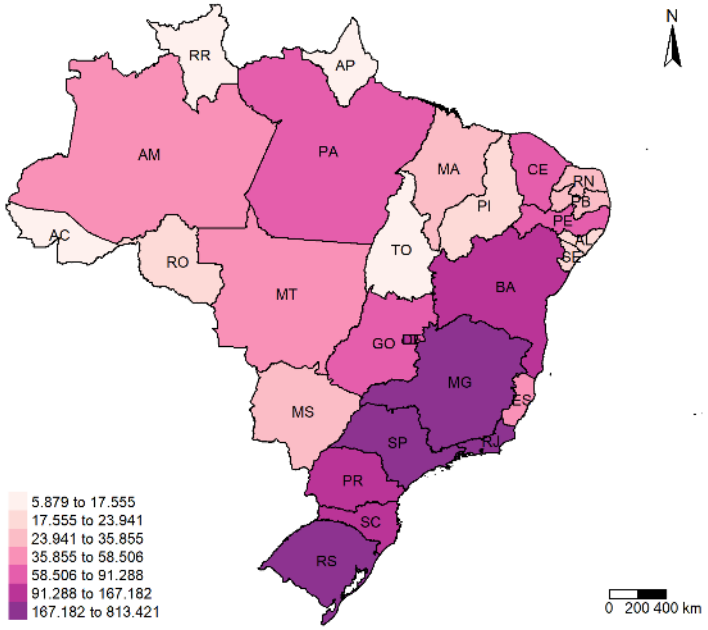
Next, we exhibit some variables from the database that are important for this study: the Gross Regional Product (GRP), by state (Figure 1), the wage bill of the labor factor in the states (Figure 2) and the representativeness of Government expenditure, by government sector, in relation to GRP in each state (Figures 3 and 4).

Figure 1 - Gross Regional Product (R$ million), Brazil, 2015.



Source: Model's database.
Average exchange rate in 2015:1 US$ = 3,33 R$.

Figure 2 - Labor force remuneration on each state (R$ million), Brazil, 2015

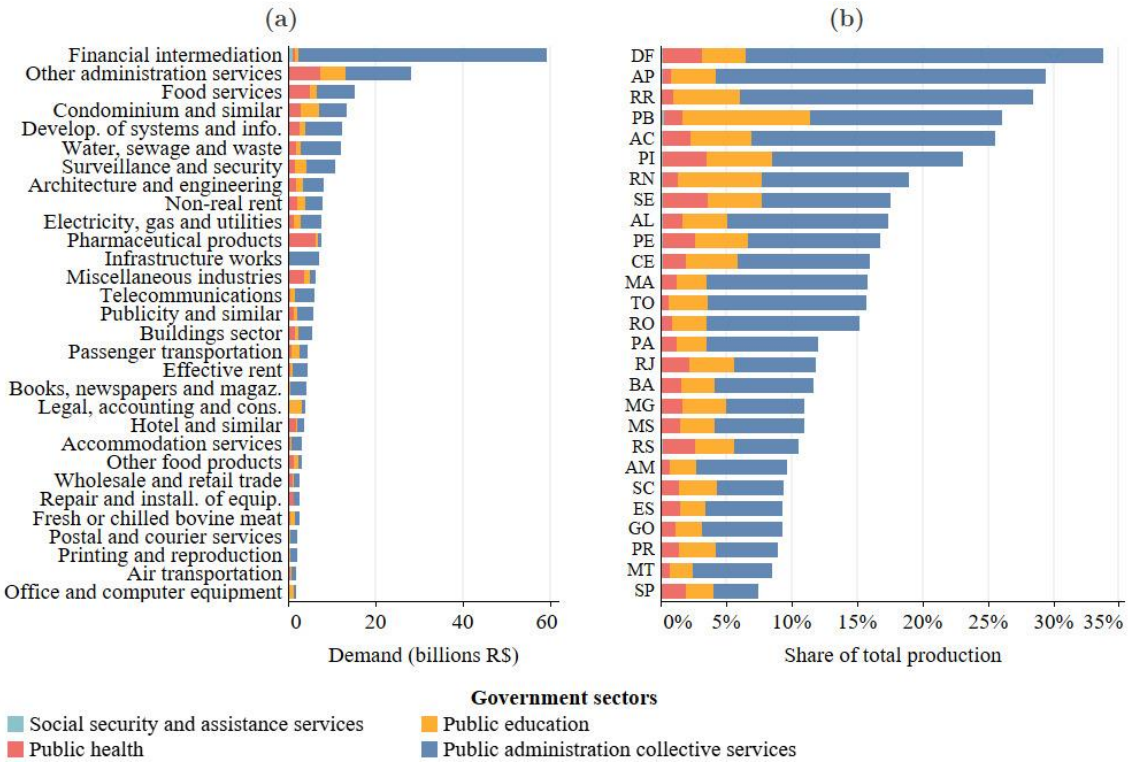


Source: Model's database.

Average exchange rate in 2015:1 US$ = 3,33 R$.

Figure 3 provides an overview of the Government's general role. In our model, public expenditure is taken under the concept of General Government, that is, it represents the total expenditure at the Federal, State and Municipal levels. Part (a) illustrates the composition of the main purchasing flows of the government sectors; in (b), we show the weight of spending on GRP of each, by sector.

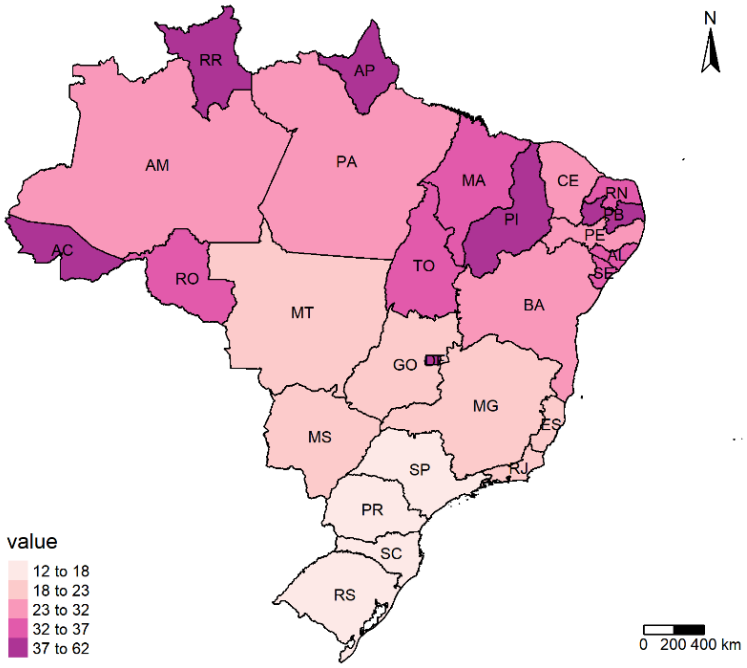
Figure 3 - Main demands of Government sectors for products (a) and the share of Government sectors expenditures in the total production of the states (b).



Source: Model's database.

It is notable that, while Government spending has a greater share in the total production of the North and Northeast of the country the wage bill is concentrated in the states with the highest GDP, mainly in the South and Southeast regions. Figure 4 illustrates the share of the General Government expenditure component in the GRP of each state.

Figure 4 - Representativeness of General Government expenditure on each Federative Unit (% of GRP), Brazil, 2015.



Source: Model's database.

In general, the illustrations indicate that the greater share of public sector consumption (spending on goods and services) in these regions makes their economic dynamics more dependent on this component of final demand. In addition, the Government sector has a high influence in employment and consequently in the wage bill of these regions, which also affects the dynamics of the economy of these states.

3.3 Simulation Strategy

In order to assess the response of labor productivity required to offset the contractionary impact of the Government's shrinkage, influenced by the lasting fiscal austerity agenda currently adopted in the country, the simulation is divided into a base scenario (baseline) and a policy scenario. The simulation of the baseline updates the database as follows: for the observed period (2016–2019), we use the main official macroeconomic data for real GDP, investment, household consumption, government spending, exports, import prices and consumer price index. For the 2020-2021 period, we used a homogeneous scenario of growth at 1% and 1.5%, for these years, respectively, and, from 2022 onwards, we

assumed a scenario of stationary growth of 2.5% per year. From 2020, the hypothesis that the growth of government spending follows the growth rate of household consumption is also adopted in the base scenario.

For the policy simulation, the growth in real Government consumption, exogenous, was set at a zero-percentage change, exactly representing the commitment of the fiscal adjustments initiated in 2017, according to the Constitutional Amendment (CA) 95/2016. In other words, there is no real growth in government spending on the policy scene. This assumption is kept constant throughout the simulation period (2019 to 2030). The policy scenario does not intend to strictly simulate the performance of the CA 95/2016, but of a hypothetical austerity agenda, represented by the absence of real growth in General Government spending. This implies that the General Government institutional sector loses its share in the regions' GRP over the simulation period.

The fiscal concept of the General Government gathers the intermediate consumption expenditures of the Government and personnel from the Federal, State and Municipal spheres. The policy scenario therefore represents an illustrative scenario for reducing the size of the state in relation to the economy, since states and municipalities are not, at first, under the expenditure ceiling.[2]

In addition to the database, the operation of CGE models depends on a large system of equations, which stablishes the behavior of the variables and their interrelations. The main equation involved in the policy shock to be studied is simple:

$$GRP_r = C_r + G_r + I_r + X_r - M_r \quad (3)$$

As previously explained, the simulation consists of a relative reduction in Government spending (G) compared to the baseline, for each region *r*. However, to assess the reaction of labor productivity in face of such a contraction, we modify the closure of the model.

[2] There was pressure for States to adhere to the ceiling in exchange for the postponement of payment of debt maturities with the Union. The Tax Recovery Plan, for example, was being proposed by the Union to States in exchange for negotiations regarding federal aid to the fiscal situation of the States. This plan basically followed the CA 95/2016 strategies, such as the zero real growth of the expenses. However, given the difficulty of decision by the States' legislature and the arrival of the Covid-19 pandemic crisis, nothing concrete has been established. On March 3rd of 2021, Proposal of Constitutional Amendment 189 (Emergency PCA) was approved, which sets out austerity rules for States and municipalities, which must be taken if the current expenses of this entity in relation to current revenues exceed 95%.

The closure is the set of hypotheses of the model, in which is defined the exogenous and endogenous variables of the system of equations. In order to simulate the expected effect of the structural reforms adopted in parallel to the fiscal consolidation, we modify the closure of the policy scenario in order to exchange the real GDP of each state, exogenous, with the respective labor productivity, endogenous, while we kept the growth of the first variable unchanged (in relation to that observed in the baseline).

In other words – we avoid an ad hoc definition by endogenously calculating the labor productivity necessary to maintain GDP growth as projected in the baseline. So, according to equation 3, the policy scenario establishes zero growth in Government spending (G) and zero deviation of GDP in relation to the baseline, supported by the other components of the equation that adjust to the expected increase in productivity described in equations 1 and 2.[3]

It is important to emphasize that, intrinsic to this methodology, the details of the dynamics of the labor market and real wages, referring to the recursive dynamics of the model, indicate that the intertemporal adjustment of real wages responds to fluctuations in current employment, in face of an employment trend defined by projections of the workforce growth, present in the baseline. Another important issue is that, in this CGE model, the mere announcement of this policy has only the effect of changing aggregate demand, but not expectations regarding interest and investment rates. Therefore, it can be said that our policy scenario simulates what would happen if the government maintained its commitment to zero growth in real spending, but families and companies, however, did not change their expectations regarding the future.

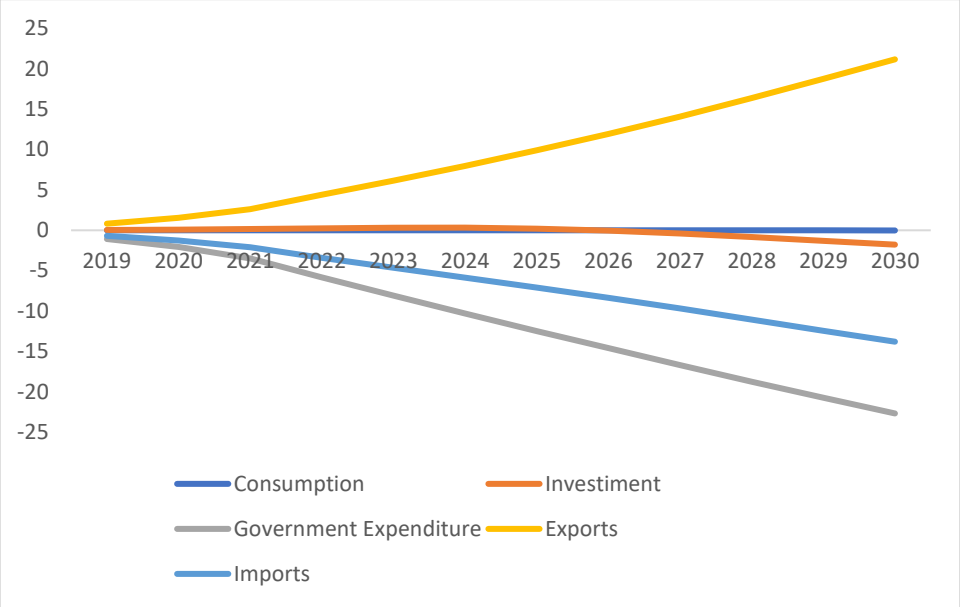
4. RESULTS

In this section, we organize the results from three perspectives: i) at the national and regional macroeconomic level, showing the cumulative impact on the final demand and employment (2019-2030); ii) labor productivity at the state level; and iii) sectoral results at the state level. All the results are exhibited as the accumulated percentage deviation from the baseline scenario, in which the policy of austerity is not applied. Graph 1 shows the results of the national GDP and its components over the projection. Graph 2 shows

[3] According to Cardoso (2019) and Cardoso et al. (2019), due to the relative contraction of aggregate demand, a policy scenario with Government spending growing below that projected in a baseline leads to the negative deviation of GDP and its components, with the exception of Exports, in a long-run result. In the baseline, the Government's expenditure component follows the GDP dynamics in each region.

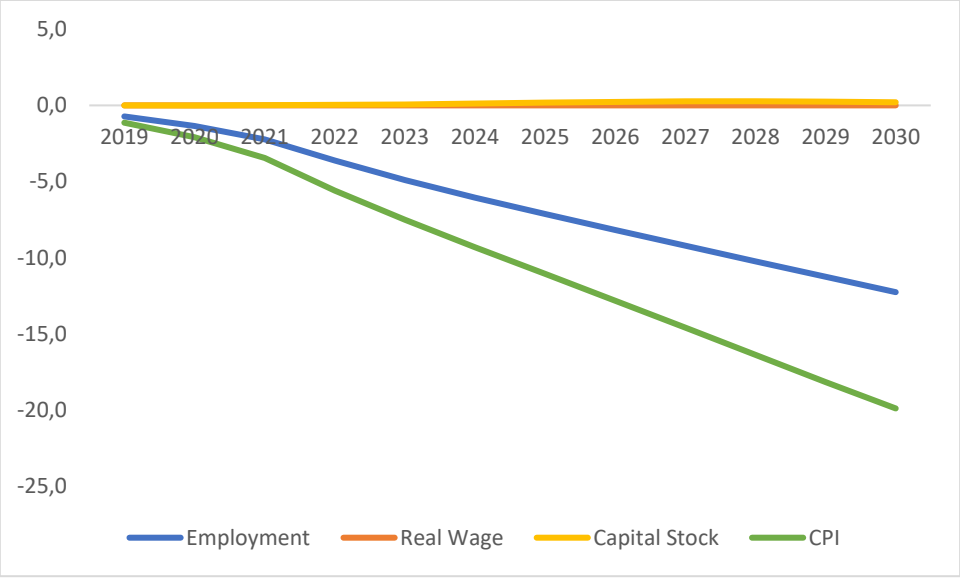
the evolution of other macroeconomic variables, important for the interpretation of the results of Graph 1.

Graph 1 - Macroeconomic Results - Policy Scenario - Accumulated deviation (%) to the Baseline (2019-2030)



Source: Own elaboration based on the simulation results.

Graph 2 - Other macroeconomic results - Policy Scenario - Accumulated deviation (%) to the Baseline (2019-2030)



Source: Own elaboration based on the simulation results.

As shown in the previous graphs, a shock of retraction of total government demand (Graph 1) would contribute to the fall in aggregate demand. To adjust to this fall, domestic prices adjust. This reduction in prices has two consequences: On the one hand, there is a

reduction in the remuneration of factors, which generates a reduction in household consumption, contributing to amplify the contractionary effect of the cut in public spending and, on the other hand, given that international prices do not change and that exports demand responds negatively to the exchange rate (local currency/$world), there is a change in relative prices favorable to Brazilian exports, leading to an increase in this aggregate in GDP. Here, it is assumed that the country has no influence on the global market prices, this means that Brazil has a terms of trade decline, which leads to export growth relative to imports and a trade surplus. To this condition, it is also added the fact that the increase in labor productivity contributes to the reduction of production costs.

As we can observe in Graph 1, however, household consumption remains almost equivalent to that projected in the baseline (final accumulated deviation of -0.02%), despite the employment fall (Graph 2). This result is due to the fact that the gain in labor productivity sustains the average level of wages each year, detaching them from the level of domestic prices (Graph 2).

The real constraint of the public expenditure with a positive response of the labor productivity also does not drive significant growth in investment (Graph 1). Thus, even with cheaper inputs and growth in exporting sectors, the levels of income and consumption influence the rate of return on capital and contribute to keeping investment at levels similar to the base scenario, although there is a small negative deviation in the final years of the simulation. The state level results in Table 1 show that the variables vary considerably between them.

Table 1 - Macroeconomic Results by Federative Unit - Policy Scenario - Accumulated Deviation (%) from the Baseline (2030)

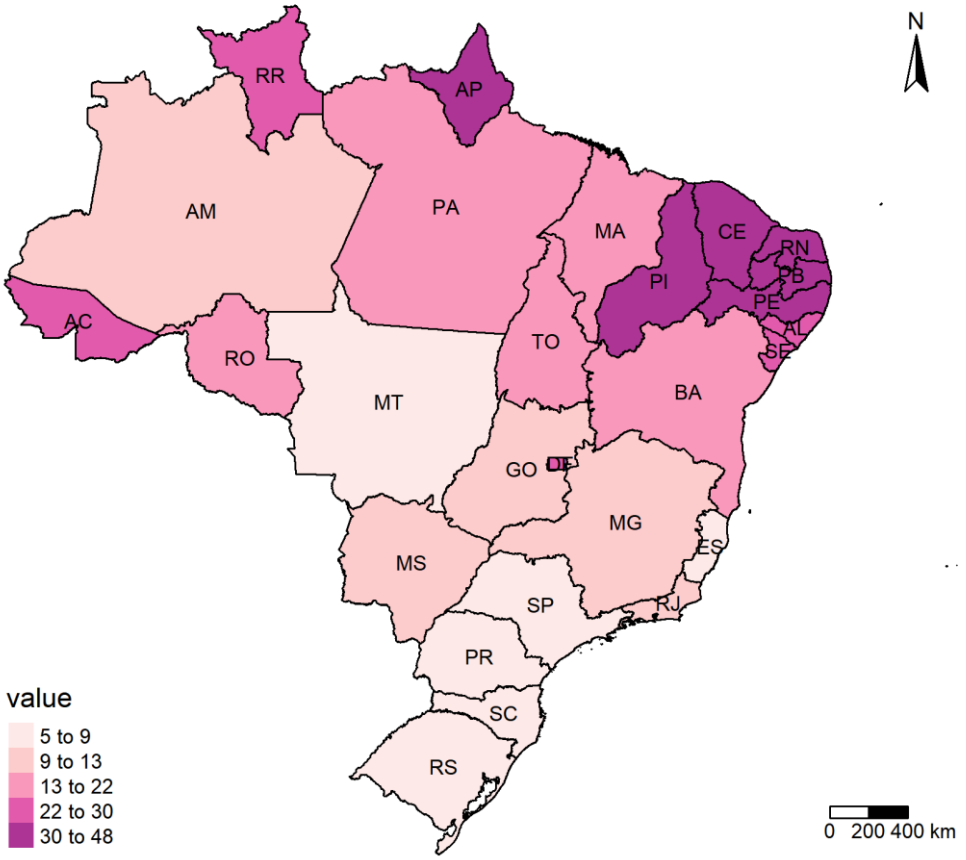
Federal Unit	C	I	G	X	M	Employment
1 RO	0	-8	-23	28	-18	-12
2 AC	-12	-14	-23	29	-24	-23
3 AM	1	-1	-23	21	-10	-11
4 RR	-9	-13	-23	31	-21	-20
5 PA	-4	-3	-23	25	-17	-16
6 AP	-15	-14	-23	31	-24	-26
7 TO	-3	-10	-23	26	-20	-15
8 MA	-9	-8	-23	24	-20	-20
9 PI	-19	-15	-23	31	-26	-29
10 CE	-15	-16	-23	41	-25	-25
11 RN	-20	-23	-23	44	-29	-30
12 PB	-31	-33	-23	56	-36	-40
13 PE	-24	-26	-23	42	-31	-34

14 AL	-15	-14	-23	38	-24	-26
15 SE	-15	-10	-23	23	-19	-26
16 BA	-3	-3	-23	25	-14	-15
17 MG	2	1	-23	22	-13	-10
18 ES	3	0	-23	20	-12	-10
19 RJ	-1	0	-23	21	-13	-13
20 SP	6	2	-23	20	-11	-7
21 PR	4	1	-23	21	-12	-8
22 SC	4	0	-23	22	-12	-9
23 RS	3	1	-23	20	-12	-9
24 MS	0	1	-23	23	-15	-12
25 MT	2	1	-23	22	-14	-10
26 GO	1	-4	-23	25	-17	-11
27 DF	-14	-17	-23	29	-25	-25

Source: Own elaboration based on the simulation results.
Sections: North; Northeast; Southeast; South and Center-West.

At the state level, the results in Table 1 indicate a significant worsening in household consumption and investment in states in the North region, such as Acre (AC), Roraima (RO) and Amapá (AP), and in the Northeast, which, with the exception of Bahia (BA), have significant numbers below 9% of accumulated negative deviation from the baseline. As can be seen, the real stagnation of Government expenditure is of equal magnitude between states; however, its impacts are different given the different share of the public sectors (public education, public health and public administration and social security) in each one, as indicated in the previous section. Exports grow more in the states most affected by the policy, in which unemployment and the fall in consumption and investment are also greater, inducing a fall in domestic prices and, therefore, in export prices. The regional heterogeneities of the results imply that the response of the labor productivity necessary to keep GDP constant is also heterogeneous in the country's states, as shown in Figure 5.

Figure 5- Labor productivity accumulated growth, by Federative Unit (%) - Policy scenario (2030).



Source: Own elaboration based on the simulation results.

In the model structure, the increase in productivity is given in negative values, which implies the need for less work to produce a certain quantity of product. In a similar way, we can interpret the positive values as an increase in the quantity of product that the same number of workers will be able to produce.

As can be seen in Figure 5, the results of the simulation show that the labor productivity necessary to sustain GDP in the face of reduced government spending is heterogeneous in the country. The low magnitude of accumulated growth in the states of the South, Southeast and Center-West (with the exception of the Federal District - DF) and high in most of the North and especially the Northeast regions, points out that, in relative terms, the limitation of the real growth in Government expenditure in São Paulo (SP) and Piauí (PI), for example, it is more expressive in the second, because the representativeness of Government expenditure in its GDP is much higher than in the former, in order to demand

even greater growth in labor productivity in those regions most affected by fiscal austerity.

As described in the mechanisms of the shock, the positive impacts in terms of variation in production, employment and investment must occur in the sectors whose production is mainly export-oriented, especially commodities sectors. Thus, another justification for the regional heterogeneity of the results is supported by the regional distribution of the industries.

Table 2 highlights the 20 industries with the highest and lowest accumulated growth after the implementation of the policy. The list of industries that have benefited the most from the policy is more diversified and presents sectors predominantly oriented to the foreign market, with the majority belonging to the extractive and processing industries. The industries with the worst accumulated result, on the other hand, have activities aimed at the domestic market, such as public services, infrastructure, rents and other services and supply goods.

Table 2 – Industrial Results - Policy scenario - Accumulated deviation (%) compared to the baseline (2030)

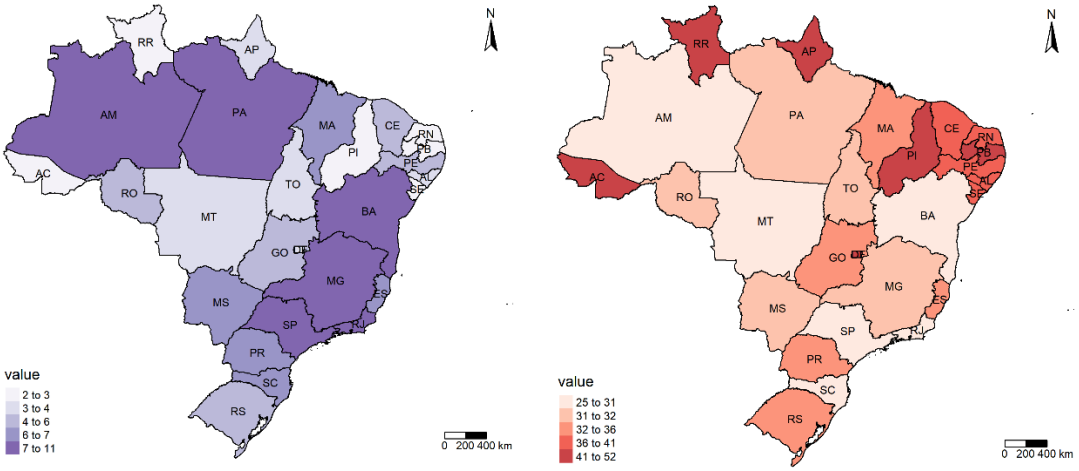
Top 20 Industries		Bottom 20 Industries	
Non-ferrous metal minerals	28,3	Public administration collective services	-21,6
Hotel and similar accommodation services	28,3	Public education	-17,7
Non-ferrous metallurgy products	28,1	Social Security and Assistance Services	-16,6
Naphtha for petrochemicals	26,9	Public health	-13,6
Mineral coal	25,5	Buildings sector	-5,4
Cellulose	25,4	Infrastructure works	-4,2
Iron ore	24,7	Private health	-3,8
Pesticides and household disinfectants	24,6	Imputed rent	-3,5
Organic chemicals	24,2	Research and Development	-2
Fabrics	23,7	Employers' organizations, trade unions and other membership	-1,7
Electronic components	23,3	Gasoalcohol	-0,7
Pig iron and ferroalloys	22,6	Trucks and buses, including cabins, bodies and trailers	-0,6
Inorganic chemicals	22,1	Water transportation	-0,3
Non-real estate rentals and management of intellectual property assets	21,4	Other dairy products	-0,1

Motor vehicle parts and accessories	21,2	Other food products	-0,1
Resins, elastomers and artificial and synthetic fibers	20,9	Food services	0
Machinery for mineral extraction and construction	20,8	Furniture	0,5
Legal, accounting and consulting services	20,7	Other products and services of temporary crops	0,9
Aviation fuels	20,5	Specialized construction services	1
Storage and auxiliary transport services	19,9	Products derived from wheat, cassava or maize	1,1

Source: Own elaboration based on the simulation results.

The representativeness of the production of these selected sectors in each state before the implementation of the policy is an important indicator to justify the different levels of labor productivity necessary to sustain economic activity, as shown in the previous result. Figure 6 shows the share of the two groups of sectors in the matrix that considers the entire production of the economy, in the model database, for each state (highest growth and lowest growth, respectively).

Figure 6 - Representativeness of the post-policy 20 Top/Bottom industries on each Federal Unit (% of the total Output) – 2015.



Source: Model's database, own elaboration.

As can be seen, the distribution of the participation of the two groups has some important differences. While the activities that benefited most after the policy simulation were already relatively more important in the states of São Paulo (SP), Rio de Janeiro (RJ), Minas Gerais (MG), Bahia (BA), Amazonas (AM) and Pará (PA), the most affected industries appear with greater representation in the Federal District (DF), Piauí (PI), Rio Grande do Norte (RN), Paraíba (PB), Acre (AC), Amapá (AP) and Roraima (RO). While

the group of industries most benefited from the policy scenario reaches up to 10% of production in some states, those less benefited can reach representativeness of up to 50% - a representative result of the inequality of diversification between the economies of the states.

Overall, the results are consistent with the literature. Since the 1970s, a convergence of income and productive activities can be observed in parallel with the increase in labor productivity in the North, Northeast and, mainly, Midwest regions above that observed for the South and Southeast regions, the most industrialized ones. This result can be explained by the rearrangement of some industrial sectors between regions. However, as authors such as Galeano and Feijó (2013) and Mendes et al., (2019) argue, the less developed regions would not be able to absorb the share of the declining sectors in the Southeast region, due to the low representativeness of the most technological activities in these regions, once the dispersion of activities has occurred in search of lower labor costs in the country.

In the current scenario, as demonstrated in this exercise, the level of labor productivity required to supply fiscal consolidation is relatively more feasible for regions where Government expenditure is less relevant and the productive structure is more diversified and more abundant, in terms of job creation; or more benefited by the fall in relative prices (or both). However, such a gain in productivity does not seem feasible in regions where the opposite occurs: the states of the North and Northeast regions, along with the Federal District, are the ones that suffer most from the cumulative drop in household consumption, unemployment and, mainly, investment - key factor in the history of convergence of production and income between the country's regions.

5. FINAL REMARKS

The present work aimed to measure the increase in labor productivity necessary to offset the contraction of public spending in Brazil arising from the current agenda of fiscal austerity and structural reforms. The objective is supported by the hypothesis that structural reforms can mitigate the effect of austerity by increasing labor productivity. On the other hand, there was a need to consider Brazilian regionalities, since the productive structure - quite uneven in the country - plays an important role in the reaction and

recovery of economies in the face of multidimensional shocks such as those seen in fiscal consolidations.

The economic literature is permeated by arguments in favor of and against the achievement of structural reforms in terms of labor productivity and the level of production in the economy. Factors such as the difficulty in planning and orienting reforms, as well as the slow process of resuming growth in periods of austerity, are the main obstacles listed in the literature. At the regional level, there are also arguments that value the State's development and investment strategies with regard to the convergence of production and productivity. In Brazil, these were the factors that marked the industrialization of historically less developed regions, such as the North, Northeast and Center-West of the country. In this sense, the ability to sustain convergence is a common alert among the authors, who highlight the low infrastructure and education necessary to consolidate the high-tech industry in these emerging regions.

The results of the simulation strategy are consistent with the literature. The labor productivity required to sustain GDP in face of the reduced government spending is spatially heterogeneous in the country.

In the macroeconomic scope, there was a relative fall in prices, investment, employment and imports, while exports were stimulated by the policy. Household consumption remained comparable to the baseline, because, despite the fall in the level of employment, the gain in labor productivity contributed to sustain the average level of wages, detaching them from the level of domestic prices. At the state level, however, there was a marked reduction in consumption in most states in the North, Northeast and the Federal District. The fall in investment and employment was also much greater in these regions.

In addition to the justification supported by the heterogeneity of the representativeness of Government spending in the GDP of each state and the distribution of labor in the country, sectoral performance is also an important factor for the uneven results of the productivity response in each state. The list of sectors that would most benefit from the simulated policy is more diversified, with most activities belonging to the extractive and manufacturing industry, and most representative in the states where the need for compensating labor productivity is less. As for the sectors with the worst accumulated performance, which presents, in general, activities more directed to the domestic market, they are more representative in the states most affected, negatively, by politics.

The rearrangement of production and labor between the regions of the country has been historically related to the action of economic policy and the economic logic of competition and location. More recently, for the Brazilian industry, it can be said that the economies of pre-existing agglomerations and industrial bases were fundamental for its expansion, biasing possible deconcentrations of the productive activity to jobs of worse quality. Therefore, the low perspective of household consumption coupled with the combination of lack of investment and high unemployment in a sectoral composition that has little benefit from the austerity and reforms agenda makes such an increase in labor productivity in some of the states unviable, suggesting a worsening of Brazilian regional inequality.

To the extent that austerity has an effect on variables such as interest rates, inflation and debt control, according to part of the literature, the results presented here show regional vulnerability due mainly to the productive structure - combined with high unemployment and falling consumption of families. Thus, the conclusions of the present study join those of those who defend the flexibility of austerity policies due to public investment aimed at sectoral diversification and expansion of infrastructure, especially in the North and Northeast regions of the country. In addition, it suggests the need to maintain income generation policies through social assistance and formal jobs.

It is worth mentioning some limitations of the work. The CGE model used does not have a fiscal module. Therefore, we do not have transfers between governments and institutions (such as households) and local governments. In addition, there is no direct connection between tax revenues and public expenditure, which are determined exogenously. Due to the specificities of the statistics of the System of National Accounts, the model also does not capture the direct effects of cuts in public services in the household consumption basket, only the indirect effects, via economic activity. Therefore, it is not considered an extended income concept, as proposed in Atkinson (2016), in which the consumption of public goods is counted in the families' income. This can be a starting point for future work.

Finally, we emphasize the fact that the current crisis caused by the pandemic COVID-19 has exposed the vulnerabilities of countries whose role of the State has been mitigated by austerity policies is highlighted. The effects of the pandemic are systemic, but require special attention in relation to the already fragile labor market and labor productivity in

some peripheral economies, as well as access to basic health services and public policies to deal with adverse situations.

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