Interregional Trade, Structural Changes and Regional Inequality

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Abstract. This study explores changes in regional inequality and examines distinct adjustment patterns among Brazilian states investigating the role played by interregional trade during economic stagnation. We combine structural decomposition analysis with observed demographic changes to identify the main drivers of change in regional inequality. By focusing on different dimensions of integration, we show that changes in intra-regional and international integration were the main drivers of the observed reduction in regional inequality. However, inter-regional trade was critical to drive changes in regional value-added, acting as an absorber of structural changes for the richer states.

Keywords. Interregional trade, Regional inequality, Brazilian economy, Economic recession, Input-output analysis, Structural decomposition analysis.

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1. Introduction

Recent studies have identified three broad spatial regimes associated with regional integration into the global economy in Brazil and other Latin American economies. These include: (i) a dynamic space associated with "primary exporters" in which the connections are easily associated with specific and scattered export activities; (ii) an "intermediate space", which assumes a role of transition in the context of the interface between the country's interregional system with the world economy, more articulated with the domestic markets; and (iii) a denser economic space, more integrated with the world economy, where higher efficiency in manufacturing and services activities plays a crucial role in affecting the country's overall competitiveness (Haddad et al., 2010; Haddad and Araujo, 2021). As these different forms of integration of subnational economies define hierarchies of regional economic structures, one would expect their influence on a region's responsiveness to national business cycles, ultimately affecting the trajectory of regional inequality.

Different strands of research have analyzed regional performance within business cycles. A well-documented empirical fact for Latin American countries is that regional income inequality varies over time, with alternating periods of increase and decrease (Azzoni, 2001; Azzoni and Haddad, 2018, 2020; Barufi and Haddad, 2020). More recently, two complimentary bodies of research have been looking at the business cycle co-movement in subnational economies over time and the role of structural changes during periods of both booms and recessions. The former relates the co-movement with the size of the regional economies, the productive structure similarities, the relative level of development, and the geographical distance (Mejía-Reyes et al., 2019; Aroca and Mejía-Reyes, 2023). The latter relies on historical input-output databases as valuable sources of information for uncovering some of the essential dimensions of structural change in an economy and for unraveling the various sources of growth of national and regional economies (e.g. Feldman et al. 1987; Dewhurst 1993; Sonis et al., 1996; Dietzenbacher and Los 2000; Hitomi et al. 2000; Romero et al. 2009; Haddad et al., 2020). The focus very often falls on the role played by technical change and changes in final demand, the latter reflecting changes in social preferences (Haddad et al., 2014). It combines with other approaches based on input-output systems that have attempted to analyze the structure of multi-regional trade flows. Feedback loop analysis has been used for interregional (Sonis et al., 1995, 2001) and intercountry input-output tables (Sonis et al., 1993) providing an opportunity to examine the hierarchy of intra- and inter-regional trade flows within an integrated economic system.

Combining both frameworks is particularly interesting for assessing the regional propagation of the recent period of economic stagnation in the Brazilian economy. From 2011 to 2019, the period of our analysis, real GDP grew only 2.73% (0.34% a.a.), and population increased by 9.24% (1.11% a.a.) resulting in an overall reduction of per capita GDP equivalent to -5.96% (-0.76% a.a.). In the same period, real GRP from the 27 states varied from -4.7% in Sergipe to 33.6% in Mato Grosso. In the case of Brazil, the regional productive structures have played an important role since the sectoral pattern of the impacts was influenced by the geographical presence of the public sector and foreign export activities. However, when considering indirect effects, the inter-regional integration of the Brazilian economy has also influenced the spatial propagation of the impacts through a complex diffusion of the multiplier effects.

This paper uses a unique database comprising two fully specified interregional input-output tables for Brazil to analyze the regional propagation of the economic stagnation observed in the recent period (2011-2019). The study explores the changes in regional inequality, examines the diverse adjustment patterns among Brazilian states, and investigates the role played by interregional trade during this period. Using techniques of structural decomposition analysis (SDA) for comparing different economic structures in the context of partitioned input-output systems, we assess the main driving forces of the changes faced by the Brazilian regions in the so-called "Second Lost Decade."

We combine the SDA results with observed demographic changes to identify the main drivers of change in regional inequality during this period of economic stagnation. By focusing on the different dimensions of integration, we show that changes in intra-regional and international integration were the main drivers of the observed reduction in regional inequality. However, inter-regional trade was also crucial in driving changes in regional value-added, acting as an absorber of structural changes for the richer states. While poorer regions faced technical coefficients and final demand adjustments through stronger internal linkages that favored the internalization of the multiplier effects, they simultaneously increased their dependence upon the rest of the system, increasing the existing leakages.

In addition to this introductory section, the next part discusses Brazil's regional inequality and its evolution over the analysis period. Section 3 presents the structure of interregional trade in Brazil. Section 4 introduces the methodology, which employs Structural Decomposition Analysis (SDA) to compare diverse economic structures within partitioned input-output systems. This section also details the database for our analysis, established on two interregional input-output tables constructed for Brazil in 2011 and 2019. The results in Section 5 utilize SDA techniques to identify the main driving forces shaping changes in Brazilian regions. We further delve into our analysis in Section 5.1 by examining the diverse adjustment patterns among Brazilian states, while Section 5.2 investigates the changes in interregional trade. The evolution of regional inequality is explored in Section 5.3. In Section 6, we discuss our findings.

2. Regional Setting

Regional inequalities in Brazil have been examined through various lenses, including the impact of regional policies, the dynamics of the labor market, and the structure of interregional trade. Resende (2012) evaluated the effects of regional development funds to mitigate regional inequalities. Ribeiro et al. (2018) analyzed the impact of state activities, particularly investments in infrastructure, on regional disparities. On the hand of the labor market, Ehrl and Monasterio (2019) found evidence suggesting that the composition of skills within the regional occupational structure contributes to persistent regional inequality. Shifting the focus to trade linkages, Haddad (1999) assessed the impact of regional and sectorial interdependence on Brazilian regional inequality, illustrating how the evolution of Brazil's productive structure during the 1990s favored the more developed regions of the country. Additionally, Perobelli and Haddad (2006) demonstrated that the regional disparities intricately shape the trajectory of interregional trade in Brazil.

Azzoni (2001) examined the evolution of regional inequality in Brazil and identified that, while there was regional income convergence between 1939 and 1995, this convergence impacted regions in distinct ways. The author highlighted two distinct economic processes, leading poorer regions to experience increasing internal inequality and richer regions to witness a reduction in inequality. In recent insights into the evolution of regional inequalities in Brazil, Manzi et al. (2023) indicated a gradual tendency to reduce regional inequalities between 2002 and 2019. The authors emphasized the presence of σ-convergence but noted a decrease in convergence speed over the period. They identified the existence of core-periphery dynamics, revealing that Brazilian states tend to converge within specific clusters, but these clusters show no indications of converging with each other. The results exhibit notable differences between groups in terms of their speeds and transitional behavior, with the path tending to be faster in the economically poorer states of Brazil. Furthermore, the relative transition path does not appear uniform for the states within each cluster.

Figure 1 illustrates the distribution of gross domestic product (GDP) per capita across Brazil's 27 Federation Units (or states), providing insight into regional income distribution and the formation of clusters among the states. These clusters include the least developed states, situated in the North (Rondônia, Acre, Amazônia, Roraima, Pará, Amapá, and Tocantins) and Northeast (Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, and Bahia) macro-regions, as well as the wealthier states in the Southeast (Minas Gerais, Espírito Santo, Rio de Janeiro, and São Paulo), South (Paraná, Santa Catarina, and Rio Grande do Sul), and Central-West (Mato Grosso do Sul, Mato Grosso, Goiás, and Distrito Federal), identified in the convergence analysis by Azzoni (2001) and Manzi et al. (2023).

< Figure 1 >

In 2019, while Brazil’s GDP per capita was 35,162 BRL, only São Paulo, Rio de Janeiro, Santa Catarina, and Distrito Federal had a gross regional product (GRP) per capita exceeding the national average. Figure 1 also visually distinguishes the per capita income levels between the North (N) and Northeast (NE) regions in comparison to the Southeast (SE), South (S), and Central-West (CW) regions. The 16 states in the North and Northeast, contributed around 20% to the national GDP, representing 36% of the population, with an average per capita income of 19,446 BRL. In contrast, the 11 states in the Southeast, South, and Central-West comprised 80% of the national GDP, and 64% of the population, and had an average per capita income of 43,975 BRL.

In addition to the regional forces of economic concentration and dispersion, the trajectory of GDP growth rates also shapes the evolution of regional inequalities. Figure 2 depicts the GDP per capita in Brazil from 2003 to 2020. Real GDP exhibited a growth of 2.73% from 2011 to 2019, a period of Brazil’s economic crisis, while the population increased by 9.24%, resulting in an overall reduction of GDP per capita equivalent to -5.96%. Supplementary Figures A1 and A2, found in the Appendix, illustrate the performance of GRP and GRP per capita across the 27 Brazilian states from 2003 to 2020.

< Figure 2 >

The impact of Brazil’s economic crisis on lower levels of GDP per capita, however, exhibits spatial differentiation. Figure 3 illustrates the GRP, population, and GRP per capita in the 27 Brazilian states from 2011 to 2019. In 2011, only the states of São Paulo (33.1%), Rio de Janeiro (11.0%), and Minas Gerais (9.1%) accounted for 53.2% of the GRP (Figure 3a). These states and their neighboring states absorbed the negative impact of the national economic crisis between 2011 and 2019 (Figure 3b). The stronger economic performance of other states is linked to the high government consumption contribution to the GRP in the North and Northeast regions and the boost from foreign exports to the agro-industry situated in the Central-West. The decentralization of productive activities towards the North and Central-West regions, as presented by Araujo et al. (2019), further accounts for the superior performance of states in these regions. Economic growth (Figure 3b) was surpassed by population growth (Figure 3d), especially in the North region, resulting in a decline in its per capita income (Figure 3f).

< Figure 3 >

3. Structure of Interregional Trade

Figure 4 presents the interregional trade flows among the 27 Brazilian states and the rest of the world. The width of each arrow originating from a state relates to its interregional exports to other states and the rest of the world. The width of the arrows pointing towards a state represents its interregional imports from other states (Figure 4a). Figure 4 also depicts the regional distribution of interregional exports (Figure 4b) and imports (Figure 4c), alongside the balance of interregional trade (Figure 4d)—by definition, the sum of interregional trade across all states balances to zero, given that the interregional exports from one state are the interregional imports of another.

< Figure 4 >

São Paulo (30.2%), Rio de Janeiro (10.1%), and Minas Gerais (8.1%) emerge as the primary players in interregional exports. The economically disadvantaged regions, specifically the North and Northeast, exhibit a trade deficit in interregional commerce—contributing approximately 19% to interregional exports and 24% to interregional imports. Only Amazonas, Rio de Janeiro, São Paulo, and Distrito Federal maintain a positive trade balance (Figure 4d). The leading foreign exporters include states specializing in manufacturing and knowledge-intensive services—São Paulo (25.6%), Rio de Janeiro (14.9%), and Minas Gerais (10.4%)—followed by states engaged in the production of natural resource-intensive goods, such as mineral exports—Pará (7.1%)—or those with sophisticated agro-industries—Paraná (6.9%), Rio Grande do Sul (6.8%), Mato Grosso do Sul (6.6%), Santa Catarina (3.9%), Goiás (2.7%), and Mato Grosso (2.2%).

The policies aimed at promoting industrialization in Brazil during the second half of the 20th century were not fully aligned with regional strategies to enhance the distribution of economic activity. Consequently, there were incentives for industrialization in the wealthiest regions, particularly in the Southeast. In the early 21st century, the emergence of a technologically intensive industry and the rise of knowledge-intensive services further reinforced the concentration of productive activity in the major urban areas of the country's wealthiest states. These characteristics of the historical process of activity localization, reflected in the concentration of gross trade flows (Figure 4), result in states located in the central-southern region of the country benefiting from sectoral and regional interdependence along supply chains (Haddad, 1999).

The systemic effects generated through input-output linkages, acting as a concentrating force that amplifies regional inequalities in Brazil, can be visualized in Figure 5. This figure illustrates the regional distribution of the value-added multiplier of the Brazilian states. The value-added multiplier and its decomposition into net intra- and inter-regional effects are depicted in the last three lines at the bottom of the figure. The value-added multiplier represents the capacity of a regional economy to generate gross value added (or GRP at basic prices) from final demand shocks. For instance, a demand shock of 1,000 million BRL in final demand in Mato Grosso, which has the highest multiplier (1.63), produces 1,630 million BRL in gross value added in the Brazilian economy. Only 38.0% of the additional 630 million BRL produced to meet the demand shock are absorbed within Mato Grosso (intraregional effect), while 62.0% represent productive leaks generating gross value added in other Brazilian states. São Paulo absorbs most of the productive leakages stemming from a demand shock in the economy of Mato Grosso (24.5%). With a multiplier of 1.58, São Paulo has the highest capacity to absorb shocks from other regional economies. Additionally, São Paulo exhibits the lowest productive leakage of shocks generated within its economy, amounting to 31.6% (interregional effect). The value-added multiplier for foreign exports is 1.97, primarily absorbed by the economy of São Paulo. Despite contributing to 25.6% of gross foreign exports, São Paulo can absorb 32.6% of the gross value added generated in the Brazilian economy due to international demand.

< Figure 5 >

Figure 6 illustrates how interregional input-output linkages serve as a powerful force influencing regional inequalities in the Brazilian economy. This image summarizes the systemic effects at the state level presented in Figure 5, dividing the Brazilian economy into a group of the poorer regions (North and Northeast) and another group of the wealthier regions (Southeast, South, and Central-West). As an illustration, a domestic demand shock is applied, originating from the poorer and wealthier regions, each valued at 1 million BRL. A third shock of foreign demand of the same value is also applied. Due to the multipliers produced by input-output linkages, the North and Northeast regions can generate an additional 0.43 million BRL in gross value added to the Brazilian economy from a demand of 1 million BRL originating in their region. The Southeast, South, and Central-West regions generate 0.55 million BRL, while foreign demand generates 0.97 million BRL. The difference in multiplier effects among the three shocks is explained by the sectoral composition of regional economies and the value-added intensity per unit of output in each sector.

< Figure 6 >

The critical insight from Figure 6 to understand the systemic process reinforcing regional inequalities in Brazil is to comprehend how the poorer and wealthier regions absorb the production generated by these demand shocks. The additional gross value added generated by demand shocks in the North and Northeast regions produces 0.26 million BRL (60.3%) within the region and an additional 0.17 million BRL (39.7%) in the Southeast, South, and Central-West regions. The additional gross value added generated by demand shocks in the Southeast, South, and Central-West regions produces 0.52

million BRL (94.0%) within the region and an additional 0.03 million BRL (6.0%) in the North and Northeast regions. The production structure of the Southeast, South, and Central-West regions has low productive leakage and absorbs a significant portion of the production generated from demand shocks in the North and Northeast regions.

The shock of foreign demand is another significant factor in accelerating regional inequalities in Brazil. The net effect generated by foreign demand concentrates 0.83 million BRL (85.2%) of the gross value added in the Southeast, South, and Central-West regions, while the North and Northeast regions can only absorb 0.14 million BRL (14.8%). Haddad and Araujo (2019) demonstrate that the wealthier regions of Brazil benefit from efficiency in service activities and a denser economic space, exerting pressure on regional inequalities due to their greater integration with the global economy. The authors also emphasize that the "servicification" of production chains tends to favor larger urban agglomerations in more developed regions, reinforcing regional inequality. Therefore, they conclude that although the geography of natural resources may contribute to reducing regional inequality, input-output linkages are likely to act in the opposite direction.

4. Methodology

We assess the main driving forces of the changes faced by the Brazilian regions between 2011 and 2019 using techniques of structural decomposition analysis. Let us define

$$\mathbf{x} = \mathbf{B}\mathbf{y}. \tag{1}$$

Where $\mathbf{x}$ represents the gross output per sector and region and $\mathbf{B} = (\mathbf{I} - \mathbf{A})^{-1}$ is the Leontief inverse. Here, $\mathbf{I}$ is the identity matrix, and $\mathbf{A}$ represents the intermediate inputs ($\mathbf{Z}$) required per unit of gross output, given by $\mathbf{A} = \mathbf{Z}(\hat{\mathbf{x}})^{-1}$.

Since we aim to decompose value-added growth, we need to transform the gross output in Equation (1) into value added:

$$\mathbf{va} = \hat{\mathbf{v}}\mathbf{B}\mathbf{y} \tag{2}$$

Here, $\mathbf{v}$ represents the value added ($\mathbf{w}$) generated per unit of gross output, such as $\mathbf{v}' = \mathbf{w}'(\hat{\mathbf{x}})^{-1}$. Let us consider the following representation of change in gross value added:

$$\Delta\mathbf{va} = \mathbf{va}_1 - \mathbf{va}_0 = \hat{\mathbf{v}}_\mathbf{1}\mathbf{B}_\mathbf{1}\mathbf{y}_\mathbf{1} - \hat{\mathbf{v}}_\mathbf{0}\mathbf{B}_\mathbf{0}\mathbf{y}_\mathbf{0} \tag{3}$$

The change in gross value added between two points in time ($\Delta\mathbf{va} = \mathbf{va}_1 - \mathbf{va}_0$) may be decomposed using the polar decomposition analysis by Dietzenbacher and Los (1998) as follows:

$$\Delta\mathbf{va} = (\Delta\hat{\mathbf{v}})\bar{\mathbf{B}}\bar{\mathbf{y}} + \bar{\hat{\mathbf{v}}}(\Delta\mathbf{B})\bar{\mathbf{y}} + \bar{\hat{\mathbf{v}}}\bar{\mathbf{B}}(\Delta\mathbf{y}) \tag{4}$$

The Δ term represents the subtraction of components between the two analysis periods, i.e., $\Delta\hat{\mathbf{v}} = \hat{\mathbf{v}}_\mathbf{1} - \hat{\mathbf{v}}_\mathbf{0}$, $\Delta\mathbf{B} = \mathbf{B}_\mathbf{1} - \mathbf{B}_\mathbf{0}$, and $\Delta\mathbf{y} = \mathbf{y}_\mathbf{1} - \mathbf{y}_\mathbf{0}$. The remaining components correspond to $\bar{\hat{\mathbf{v}}} = \frac{1}{2}(\hat{\mathbf{v}}_\mathbf{0} + \hat{\mathbf{v}}_\mathbf{1})$, $\bar{\mathbf{B}} = \frac{1}{2}(\mathbf{B}_\mathbf{0} + \mathbf{B}_\mathbf{1})$, and $\bar{\mathbf{y}} = \frac{1}{2}(\mathbf{y}_\mathbf{0} + \mathbf{y}_\mathbf{1})$. Since matrices $\hat{\mathbf{v}}$ e $\mathbf{B}$ are formed by coefficients constructed from $\mathbf{Z}$, $\mathbf{w}$, and $\mathbf{x}$ in the same base year, there is no need to transform nominal prices into real prices before calculating these matrixes. However, $\mathbf{y}$ need to be transformed into real values. To achieve this, we use state-level deflators provided by the regional accounts system (IBGE, 2023). Thus, we can derive $\mathbf{va}_1$ as the gross value added for 2019, and $\mathbf{va}_0$ as the gross value added for 2011, both at 2019 prices.

To decompose the contribution of intra and interregional trade, we made additional partitions in our SDA of Equation (4). We start by partitioning the final demand as follows:

$$\mathbf{y} = \mathbf{Yi} = [\mathbf{Y}_\mathrm{A} + \mathbf{Y}_\mathrm{E} + \mathbf{Y}_\mathrm{F}]\mathbf{i} \tag{5}$$

where $\mathbf{Y}$ represents the final demand in an interregional context, with 27 different Brazilian states. Here, $\mathbf{i}$ is a summation vector. We disaggregate $\mathbf{Y}$ into three components, in which $\mathbf{Y}_\mathrm{A}$ corresponds to intraregional domestic final demand. In this matrix, we retain only the values of final goods consumed and produced within the same region; the other elements of the matrix are defined as zero. $\mathbf{Y}_\mathrm{E}$ denotes the interregional domestic final demand (the elements within the block-diagonal corresponding to intraregional demand are defined as zero). $\mathbf{Y}_\mathrm{F}$ represents the international demand organized in a block-diagonal matrix with the values of foreign exports. Additionally, we decomposed $\mathbf{Y}_\mathrm{A}$ and $\mathbf{Y}_\mathrm{E}$ into investment, household consumption, and government expenditure. The Leontief inverse matrix is also partitioned into intra ($\mathbf{B_A}$) and interregional ($\mathbf{B_E}$) components, where $\mathbf{B} = \mathbf{B_A} + \mathbf{B_E}$.

Thereby, we can decomposition of value-added growth by distinguishing the value added per unit of output, technology (intra- and interregional), and trade (intra- and interregional and foreign). This gives the following decomposition of $\Delta\mathbf{va}$ into six separate components:

$$\begin{array}{lll} \Delta\mathbf{va} & = (\Delta\hat{\mathbf{v}})\bar{\mathbf{B}}\bar{\mathbf{y}} & \text{value added per unit of output} \\ & +\hat{\bar{\mathbf{v}}}(\Delta\mathbf{B_A})\bar{\mathbf{y}} & \text{intraregional technology} \\ & +\hat{\bar{\mathbf{v}}}(\Delta\mathbf{B_E})\bar{\mathbf{y}} & \text{interregional technology} \\ & +\hat{\bar{\mathbf{v}}}\bar{\mathbf{B}}[(\Delta\mathbf{Y}_\mathrm{A}) + \bar{\mathbf{Y}}_\mathrm{E} + \bar{\mathbf{Y}}_\mathrm{F}]\mathrm{i} & \text{intraregional trade} \\ & +\hat{\bar{\mathbf{v}}}\bar{\mathbf{B}}[\bar{\mathbf{Y}}_\mathrm{A} + (\Delta\mathbf{Y}_\mathrm{E}) + \bar{\mathbf{Y}}_\mathrm{F}]\mathrm{i} & \text{interregional trade} \\ & +\hat{\bar{\mathbf{v}}}\bar{\mathbf{B}}[\bar{\mathbf{Y}}_\mathrm{A} + \bar{\mathbf{Y}}_\mathrm{E} + (\Delta\mathbf{Y}_\mathrm{F})]\mathrm{i} & \text{foreign trade} \end{array} \tag{6}$$

4.1 Data

We conduct the structural decomposition analysis using the interregional input-output tables (IIOT) for Brazil in 2011 and 2019. Haddad et al. (2017) detail the construction of the IIOT for 2011, and for 2019, refer to Haddad et al. (2023). These tables are developed utilizing the Interregional Input-Output Adjustment System (IIOAS) method[1], which was developed to estimate interregional input-output systems under conditions of partial

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[1] This approach has been applied for distinct interregional systems: interisland model for the Azores (Haddad et al., 2015), interregional models for Brazil (Haddad et al., 2017), Colombia (Haddad et al., 2018, 2023), Egypt (Haddad et al., 2016), Greece (Haddad et al., 2020), Lebanon (Haddad, 2014), Mexico (Haddad et al., 2020b), Morocco (Haddad et al., 2020c), Paraguay (Haddad et al. 2021), and Ukraine (Haddad et al., 2022).

information.[2] Primary data sources include the Supply and Use Tables (SUT) at national-level provided by the Brazilian Institute of Geography and Statistics (IBGE) available through the System of National Accounts. National data are regionally disaggregated using regional-level surveys made available by IBGE, such as the Regional Accounts of Brazil, Annual Surveys for Industry, Services, and Trade, and National Household Sample Survey. In addition to the databases provided by IBGE, the IIOAS method incorporates the most reliable information at the sectoral and regional levels from official institutions, such as the Brazilian Foreign Trade of Foreign Ministers and Annual Report of Social Information (RAIS) of the Ministry of Labor. Interregional disaggregation was performed to ensure consistency between spatial disaggregation and the aggregate macro version, in addition to maintaining consistency across the 2011 and 2019 information. The IIOT specification covers 68 sectors and all 27 Federal Units.

5. Results

Table 1 illustrates the gross value added (GVA) growth from 2011-19. The variation in gross value added in the Brazilian economy was 168,539 million BRL, representing a growth of 2.72%, with emphasis performance in the North (9.1%) and Central-West (15.0%) regions. The Southeast region, which contributes 54.3% to the Brazilian value added, was the only one to decrease its activity level. This region experienced a loss of -37,339 million BRL, accounting for -22.2% of the total change in value added and -1.11% relative to the size of its economy in 2011. Table 1 also displays the decomposition of the value-added growth rates into six domestic components (value added per unit of output, technology, investment, consumption, government, and statistical discrepancy) and one foreign component (foreign export). The domestic components contributed 20.5% to the value-added growth (34,471 million BRL), while the foreign component contributed 79.5% (134,068 million BRL).

Figure 7 presents the decomposition of value-added growth between 2011 and 2019. The negative variation in value added per unit of output of -134,068 million BRL (-2.81%) and investment of -265,297 million BRL (-4.29%) concentrated most of the impact of

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[2] For surveys on recent approaches to non-survey estimation of inter-regional trade systems, refer to Gabela (2020) and Hewings & Oosterhaven (2021).

Brazil’s economic crisis during this period. Consumption (5.96%), government expenditure (1.76%), and foreign export (2.17%) contributed to mitigating the impacts of the crisis.

< Table 1 >

< Figure 7 >

Table 2 presents the decomposition of the results from our analysis into intra- and interregional trade (229,307 million BRL). The change in technology (16,832 million BRL) and domestic final demand (the sum of investment, consumption, and government, amounting to 212,475 million BRL) components are aggregated within these two trade categories. The effect of intraregional trade change in final goods is the most significant component of the value-added growth, amounting to 227,444 million BRL. The change in interregional trade contributed only 4,429 million BRL (2.6%) to the overall change in gross value added (168,539 million BRL). However, the interregional trade component stands out from the others as it reveals a significant shift in the pattern of interregional trade, moving from the Southeast region (-53.6% of the overall change) toward the Central-West region (32.4% of the overall change).

< Table 2 >

Figure 8 illustrates the impact of the change in all SDA components on the value-added growth in the Brazilian Macroregions. The negative effects on value added per unit of output are explained by a decrease in the value-added coefficient due to an increase in import penetration or an increase in intermediate input coefficients. Intraregional trade of final goods and foreign exports are the most critical factors for value-added growth.

< Figure 8 >

5.1 Have Brazilian states adjusted to the crisis in different ways?

Figure 9 shows the changes in value added in the Brazilian states as a percentage change of the total value added of each state in 2011. Figure 10 depicts the decomposition of changes in gross value added as a percentage of the total change. The impact of intraregional trade was the primary component for value-added growth in most states, with more significant effects in the states of the North and Central-West regions. Meanwhile, changes in inter-regional trade were significant primarily for the states in the Northeast and Central-West regions. Foreign trade drove growth, especially in Pará, a mineral exporter, and in the states of Mato Grosso, Mato Grosso do Sul, and Tocantins, which are significant exporters of agro-industrial products such as soybeans, corn, beef, and vegetable oils.

< Figure 9 >

< Figure 10 >

5.2 What role did interregional trade play?

Table 3 illustrates the impact of observed domestic demand on the change in value added from 2011-19 by the region of origin of the domestic demand shock and the region affected by this demand shock. The total value change of value added (55,626 million BRL) equals the domestic component (34,471 million BRL) in Table 1 minus the statistical discrepancy (-21,155 million BRL). The change in domestic demand is -0.21% on the value-added growth in the wealthier regions (SE, S, and CW) and 5.39% in the less developed regions (N and NE). However, the wealthier regions absorb 26.9% (32,442 million BRL) of the final demand originating in the poorer states, highlighting the importance of inter-regional trade in driving changes in regional value-added, acting as an absorber of structural changes for the wealthier states. Thus, during Brazil's economic crisis, states with higher production density alleviated the negative pressure on their GRP by importing fewer products, given their crisis, and selling more to the poorer regions experiencing growth. The trade structure diminishes the ability of economic growth in the less developed regions to reduce regional inequalities. The importance of input-output linkages and interregional dependence for economic growth and mitigating the impacts of GRP growth volatility during the crisis was also found in Araujo et al. (2023) in a study on Colombian regional economies.

< Table 3 >

Table 4 shows the systemic impact of foreign demand on gross value added. While the North and Northeast absorb 82.2% (18,515 million BRL) of the change in the value added from the original demand shock within their region, the Southeast, South, and Central-West absorb 96.8% (108,194 million BRL) of the impacts. The regionally disparate effects of the change in foreign demand highlight the dependence of the North and Northeast on trade with the Southeast, South, and Central-West regions. Tables A1 and A2 in the Appendix present the results from Tables 3 and 4 across the five Brazilian Macroregions.

< Table 4 >

5.3 What has happened to regional inequality?

We combine the structural decomposition results with observed demographic shifts to identify the main drivers of change in regional inequality during this period of economic stagnation. To achieve this, we employ the Williamson index (Williamson, 1965), a population-weighted metric, to quantify each SDA component's contribution to regional inequality. The Williamson coefficient of variation (CV_w) is computed as follows:

$$CV_w = \frac{\sqrt{\sum_{i=1}^{27}(y_i - \bar{y})^2/27}}{\bar{y}} \tag{7}$$

where y_i represents the gross value added per capita in state i (for $i = 1, \dots, 27$), and $\bar{y}$ is the arithmetic average of regional per capita incomes. To comprehend the effects of each component of the change in value added on inequalities, we shift the y_i element in Equation (7):

$$y_i = y_i^{2011} + \Delta SDA_i^{2011-19} \tag{8}$$

where $\Delta SDA_i^{2011-19}$ represents the change in each component of the structural decomposition analysis (i.e., value added per unit of output, intra- and inter-regional trade, and foreign trade), the sum of y_i^{2011} and the four components of the SDA equals y_i^{2019}. Additionally, we calculate the contribution of the change in population distribution to regional inequalities. To achieve this, we compute the value added per capita using the gross value added in 2019 and the population of 2011. Thus, we evaluate what the CV_w would be if there were no changes in the regional population distribution. The results of CV_w are presented in Figure 11.

< Figure 11 >

The CV_w in 2019 (0.474) was marginally lower than in 2011 (0.477), suggesting that the changes in per capita income between the two periods favored a reduction in regional inequalities. The contribution of the variation in value added per unit of output to the change in gross value added from 2011-19 would have exacerbated regional disparities (0.492). Given that more developed regions, specializing in knowledge-intensive services, with higher value-added content per unit of output, benefited from this component's change in the SDA. Figure 11 also shows that change in intraregional (0.452) and foreign (0.474) trade were the main drivers of the observed reduction in regional inequality. However, interregional (0.513) trade was also essential to drive changes in regional value-added, acting as an absorber of structural changes for the wealthier states. The simulation to assess the contribution of the change in population distribution highlights that the observed shift in regional population distribution helped reduce per capita income inequalities. If there had been no change in regional distribution between 2011 and 2019, the CV_w would have been 0.491 instead of the observed actual value of 0.474.

6. Final Remarks

This article investigates the regional dynamics of the Brazilian economy during the so-called “Second Lost Decade” The methodology employs structural decomposition analysis to compare diverse economic structures within partitioned input-output systems. The foundation of our study is based on two interregional input-output tables constructed for Brazil in 2011 and 2019. We then combine the SDA results with observed demographic changes to identify the main drivers of change in regional inequality during this period of economic stagnation.

The study focused on different dimensions of regional integration in Brazil. It allowed us to identify that intra-regional and international integration changes were the main drivers of the observed reduction in regional inequality in the 2010s. However, inter-regional trade also played a significant role in driving changes in regional value-added, acting as an absorber of structural changes for the wealthier states. While poorer regions faced technical coefficients and final demand adjustments through stronger internal linkages that favored the internalization of multiplier effects, they simultaneously increased their dependence on the rest of the system, amplifying existing leakages.

Declaration of interest statement.

No potential conflict of interest was reported by the authors.

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Table 1. Decomposition of changes in the gross value added at basic prices in Brazil: 2011-19 (million, constant 2019 BRL)

	Macroregions					Brazil
	North	Northeast	Southeast	South	Central–West	
Change in the gross value added: 2011–19						
Value added per unit of output	–22,566	–11,819	–94,884	–13,672	–30,740	–173,681
Technology	1,125	–1,213	–27,749	21,983	22,686	16,832
Investment	–15,080	–45,204	–155,652	–36,789	–12,572	–265,297
Consumption	32,603	74,154	165,821	35,009	61,137	368,724
Government	22,058	31,796	8,035	19,310	27,850	109,048
Foreign export	23,147	–1,109	53,391	30,981	27,658	134,068
Statistical discrepancy	–10,144	–8,673	13,700	–4,915	–11,123	–21,155
Domestic components	7,997	39,040	–90,730	20,926	57,238	34,471
Foreign component	23,147	–1,109	53,391	30,981	27,658	134,068
Total change: 2011–19	**31,144**	**37,930**	**–37,339**	**51,907**	**84,896**	**168,539**
Total share (in %)	*18.48*	*22.51*	*–22.15*	*30.80*	*50.37*	*100.00*
Gross value added: 2011	**342,367**	**879,077**	**3,359,726**	**1,041,687**	**565,065**	**6,187,922**
Gross value added share (in %)	*5.53*	*14.21*	*54.29*	*16.83*	*9.13*	*100.00*
Gross value added: 2011–19 (in %)	*9.10*	*4.31*	*–1.11*	*4.98*	*15.02*	*2.72*

Source: SDA results.

Table 2. The effect of intra- and interregional trade in the value-added growth in Brazil: 2011-19

		Macroregions					
		North	Northeast	Southeast	South	Central–West	Brazil
Change in the gross value added: 2011–19 (million, BRL)							
Technology	Intraregional	2,735	–3,809	–1,709	–105	321	–2,567
	Interregional	–1,610	2,595	–26,040	22,088	22,366	19,398
Domestic final demand	Intraregional	32,951	37,702	82,560	29,983	44,247	227,444
	Interregional	6,630	23,043	–64,357	–12,453	32,168	–14,969
Intraregional component		35,686	33,893	80,852	29,878	44,568	224,877
Interregional component		5,020	25,639	–90,398	9,635	54,533	4,429
Sub–total		40,706	59,532	–9,546	39,513	99,101	229,307
Change in the gross value added: 2011–19 (in % of overall change)							
Intraregional component		*21.17*	*20.11*	*47.97*	*17.73*	*26.44*	*133.43*
Interregional component		*2.98*	*15.21*	*–53.64*	*5.72*	*32.36*	*2.63*
Sub–total		*24.15*	*35.32*	*–5.66*	*23.44*	*58.80*	*136.06*

Source: SDA results.

Table 3. The effect of domestic demand in gross value added changes in Brazilian Macroregions: 2011-19 (million, constant 2019 BRL)

		Origin of the domestic demand shock			GVA in 2011	Total impact on GVA in 2011 (%)
		N, NE	SE, S, CW	Total		
Region impacted by demand shock	N, NE	87,940	–22,087	65,853	1,221,443	5.39
	SE, S, CW	32,442	–42,670	–10,227	4,966,479	–0.21
	Brazil	120,383	–64,757	55,626	6,187,922	0.90

Note: N (North), NE (Northeast), SE (Southeast), S (South), and CW (Central-West).

Source: SDA results.

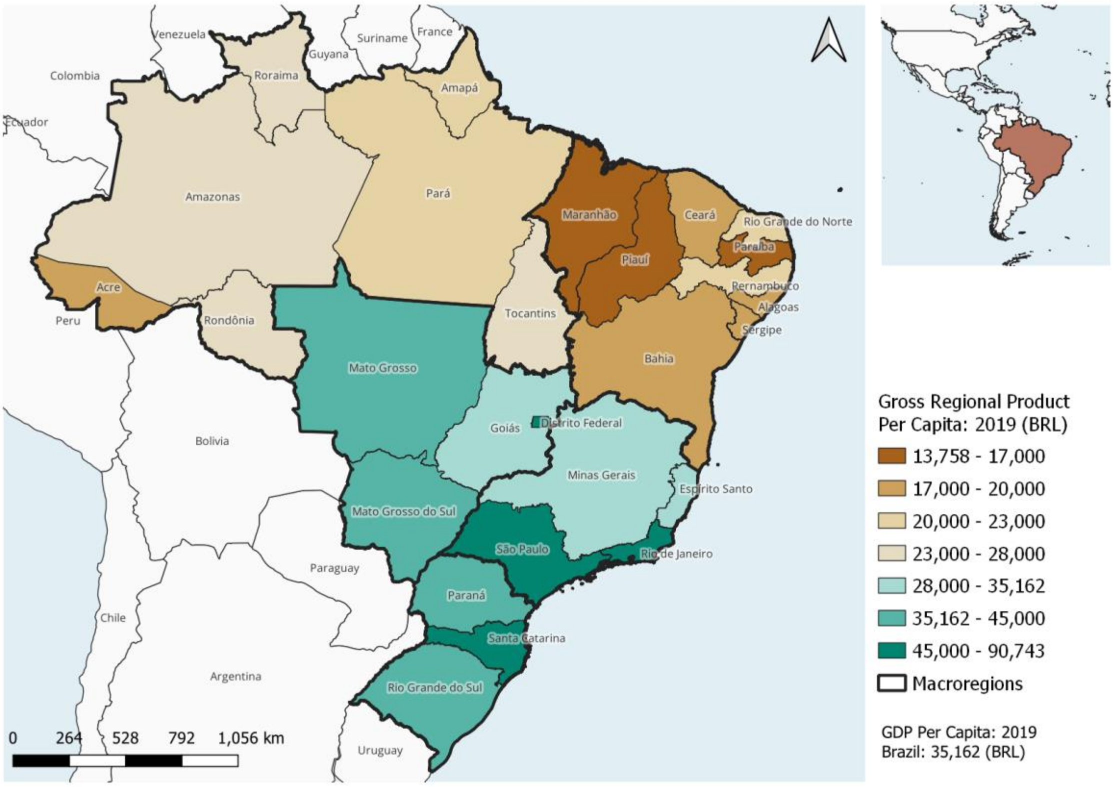
Table 4. The effect of foreign demand in gross value added changes in Brazilian Macroregions: 2011-19 (million, constant 2019 BRL)

		Origin of the foreign demand shock			GVA in 2011	Total impact on GVA in 2011 (%)
		N, NE	SE, S, CW	Total		
Region impacted by demand shock	N, NE	18,515	3,523	22,038	1,221,443	1.80
	SE, S, CW	3,836	108,194	112,030	4,966,479	2.26
	Brazil	22,351	111,717	134,068	6,187,922	2.17

Note: N (North), NE (Northeast), SE (Southeast), S (South), and CW (Central-West).

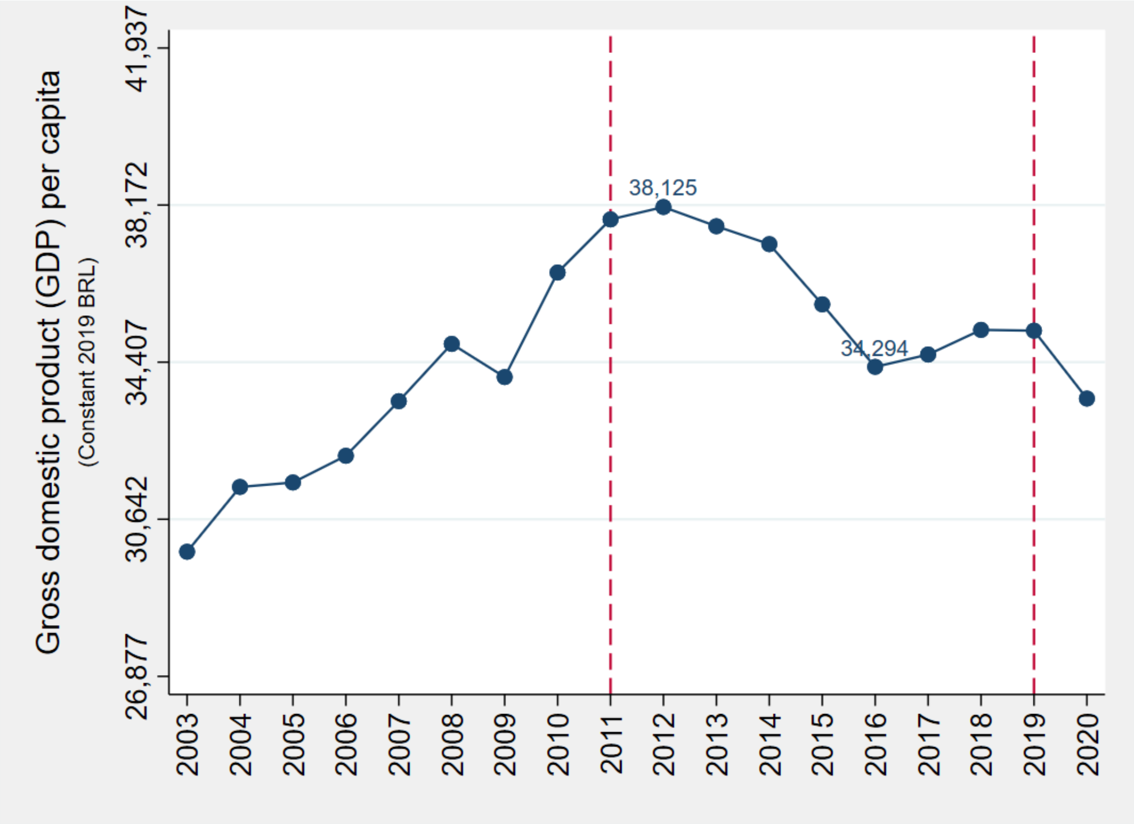
Source: SDA results.

Figure 1. GRP per capita in the Brazilian states: 2019 (constant 2019 BRL)



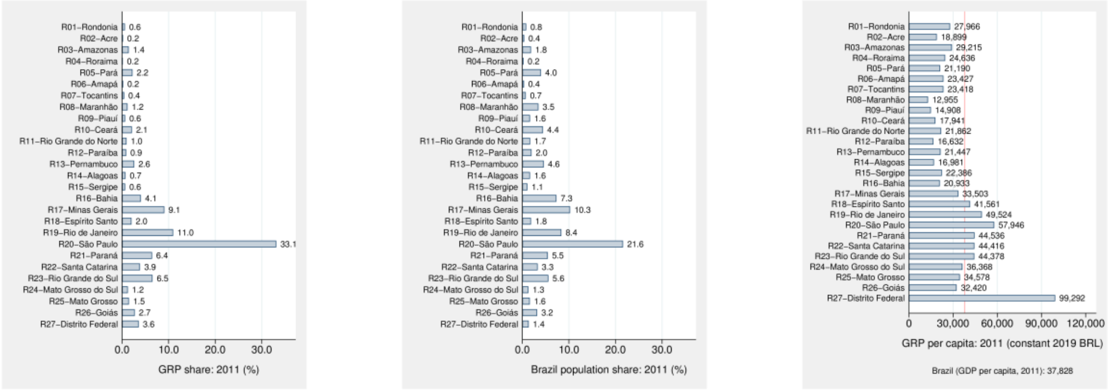
Source: Brazilian Institute of Geography and Statistics (IBGE). Regional Accounts of Brazil (2002-2020). Estimated resident population.

Figure 2. GDP per capita of Brazil between 2003 and 2020 (constant 2019 BRL)



Source: Brazilian Institute of Geography and Statistics (IBGE). Regional Accounts of Brazil (2002-2020). Estimated resident population.

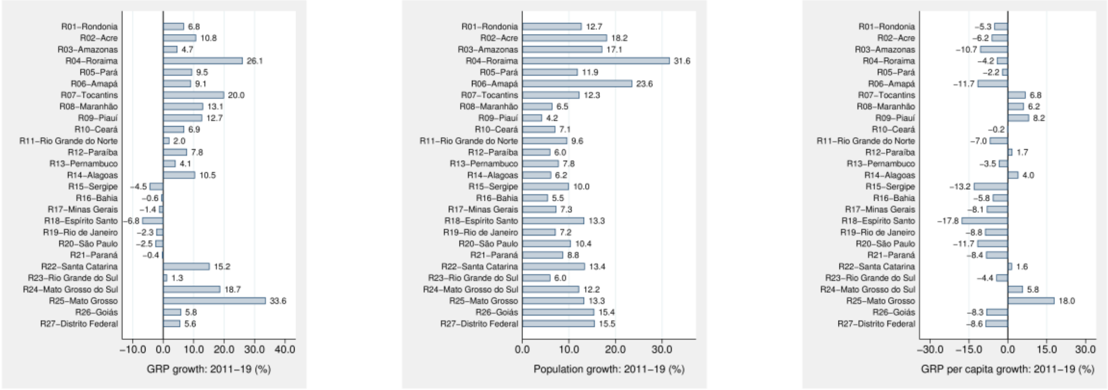
Figure 3. GRP, population, and GRP per capita in the Brazilian states between 2011 and 2019



(a) GRP Share: 2011

(c) Brazil Population Share: 2011

(e) GRP Per Capita: 2011



(b) GRP Growth: 2011-19

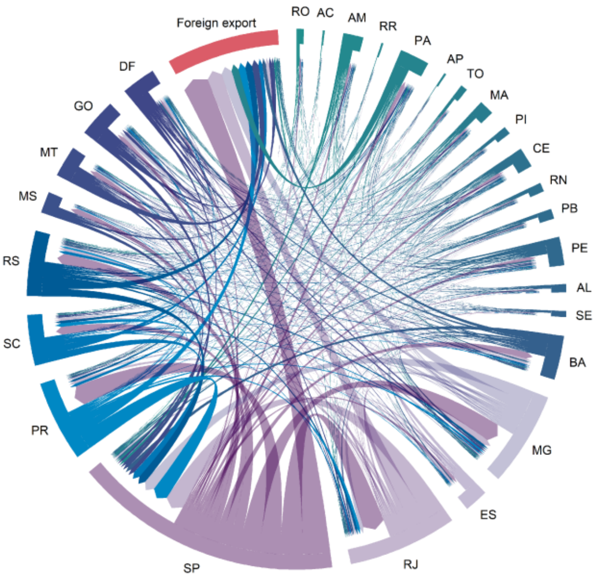
(d) Population Growth: 2011-19

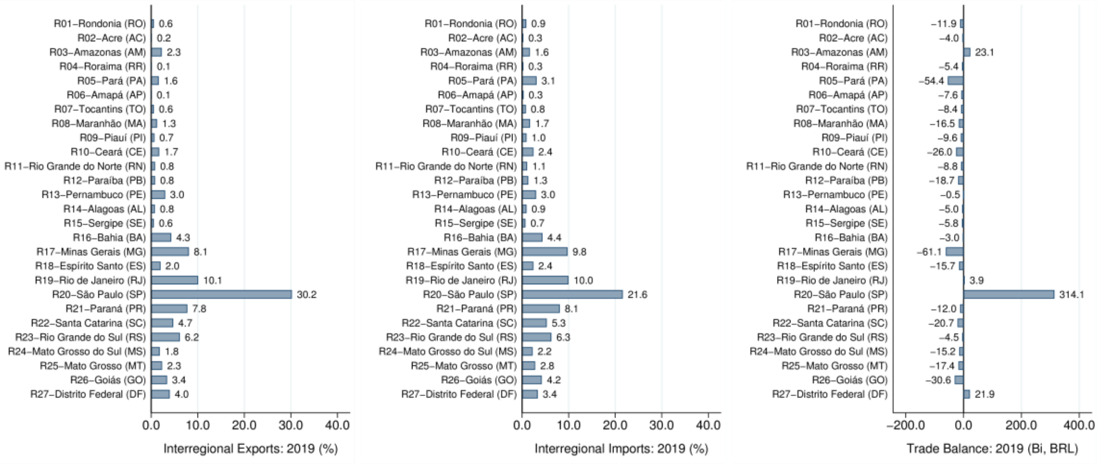
(f) GRP Per Capita Growth: 2011-19

Source: Brazilian Institute of Geography and Statistics (IBGE). Regional Accounts of Brazil (2002-2020). Estimated resident population.

Figure 4. Interregional trade flows in the Brazilian states in 2019 (billion, constant 2019 BRL)

(a) Interregoional trade flows (billion, BRL)





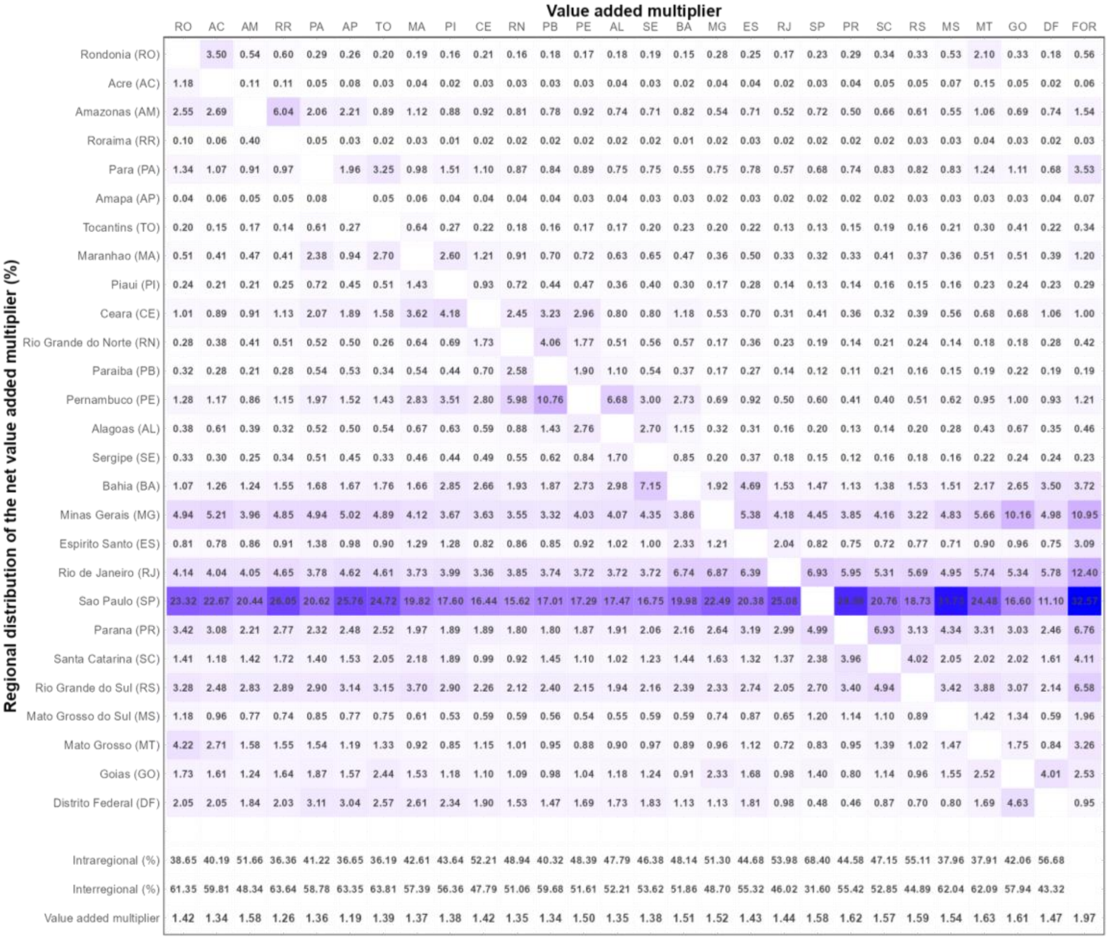
(b) Interregional export (%)

(c) Interregional import (%)

(d) Trade balance (billion, BRL)

Source: Interregional Input-Output Table for Brazil, 2019.

Figure 5. Regional distribution of the net value added multiplier in the Brazilian states in 2019

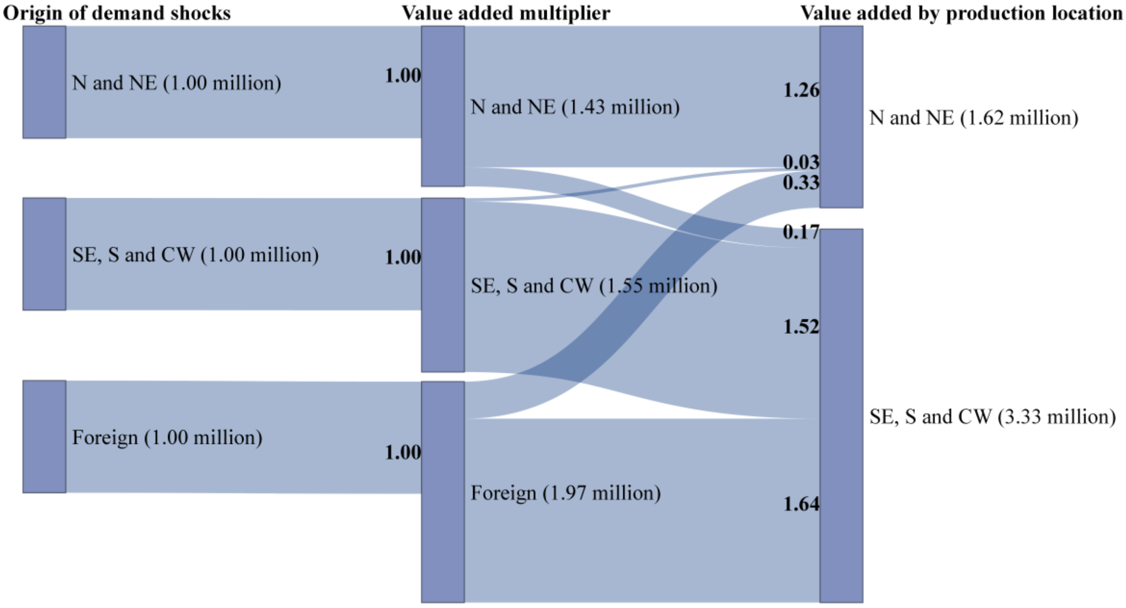


	RO	AC	AM	RR	PA	AP	TO	MA	PI	CE	RN	PB	PE	AL	SE	BA	MG	ES	RJ	SP	PR	SC	RS	MS	MT	GO	DF	FOR
Rondonia (RO)		3.50	0.54	0.60	0.29	0.26	0.20	0.19	0.16	0.21	0.16	0.18	0.17	0.18	0.19	0.15	0.28	0.25	0.17	0.23	0.29	0.34	0.33	0.53	2.10	0.33	0.18	0.56
Acre (AC)	1.18		0.11	0.11	0.05	0.08	0.03	0.04	0.02	0.03	0.03	0.03	0.03	0.04	0.03	0.02	0.04	0.04	0.02	0.03	0.04	0.05	0.05	0.07	0.15	0.05	0.02	0.06
Amazonas (AM)	2.55	2.69		6.04	2.06	2.21	0.89	1.12	0.88	0.92	0.81	0.78	0.92	0.74	0.71	0.82	0.54	0.71	0.52	0.72	0.50	0.66	0.61	0.55	1.06	0.69	0.74	1.54
Roraima (RR)	0.10	0.06	0.40		0.05	0.03	0.02	0.03	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.03	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.03	0.02	0.03
Para (PA)	1.34	1.07	0.91	0.97		1.96	3.25	0.98	1.51	1.10	0.87	0.84	0.89	0.75	0.75	0.55	0.75	0.78	0.57	0.68	0.74	0.83	0.82	0.83	1.24	1.11	0.68	3.53
Amapa (AP)	0.04	0.06	0.05	0.05	0.08		0.05	0.06	0.04	0.04	0.04	0.04	0.03	0.04	0.03	0.03	0.02	0.03	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.07
Tocantins (TO)	0.20	0.15	0.17	0.14	0.61	0.27		0.64	0.27	0.22	0.18	0.16	0.17	0.17	0.20	0.23	0.20	0.22	0.13	0.13	0.15	0.19	0.16	0.21	0.30	0.41	0.22	0.34
Maranhao (MA)	0.51	0.41	0.47	0.41	2.38	0.94	2.70		2.60	1.21	0.91	0.70	0.72	0.63	0.65	0.47	0.36	0.50	0.33	0.32	0.33	0.41	0.37	0.36	0.51	0.51	0.39	1.20
Piaui (PI)	0.24	0.21	0.21	0.25	0.72	0.45	0.51	1.43		0.93	0.72	0.44	0.47	0.36	0.40	0.30	0.17	0.28	0.14	0.13	0.14	0.16	0.15	0.16	0.23	0.24	0.23	0.29
Ceara (CE)	1.01	0.89	0.91	1.13	2.07	1.89	1.58	3.62	4.18		2.45	3.23	2.96	0.80	0.80	1.18	0.53	0.70	0.31	0.41	0.36	0.32	0.39	0.56	0.68	0.68	1.06	1.00
Rio Grande do Norte (RN)	0.28	0.38	0.41	0.51	0.52	0.50	0.26	0.64	0.69	1.73		4.06	1.77	0.51	0.56	0.57	0.17	0.36	0.23	0.19	0.14	0.21	0.24	0.14	0.18	0.18	0.28	0.42
Paraiba (PB)	0.32	0.28	0.21	0.28	0.54	0.53	0.34	0.54	0.44	0.70	2.58		1.90	1.10	0.54	0.37	0.17	0.27	0.14	0.12	0.11	0.21	0.16	0.15	0.19	0.22	0.19	0.19
Pernambuco (PE)	1.28	1.17	0.86	1.15	1.97	1.52	1.43	2.83	3.51	2.80	5.98	10.76		6.68	3.00	2.73	0.69	0.92	0.50	0.60	0.41	0.40	0.51	0.62	0.95	1.00	0.93	1.21
Alagoas (AL)	0.38	0.61	0.39	0.32	0.52	0.50	0.54	0.67	0.63	0.59	0.88	1.43	2.76		2.70	1.15	0.32	0.31	0.16	0.20	0.13	0.14	0.20	0.28	0.43	0.67	0.35	0.46
Sergipe (SE)	0.33	0.30	0.25	0.34	0.51	0.45	0.33	0.46	0.44	0.49	0.55	0.62	0.84	1.70		0.85	0.20	0.37	0.18	0.15	0.12	0.16	0.18	0.16	0.22	0.24	0.24	0.23
Bahia (BA)	1.07	1.26	1.24	1.55	1.68	1.67	1.76	1.66	2.85	2.66	1.93	1.87	2.73	2.98	7.15		1.92	4.69	1.53	1.47	1.13	1.38	1.53	1.51	2.17	2.65	3.50	3.72
Minas Gerais (MG)	4.94	5.21	3.96	4.85	4.94	5.02	4.89	4.12	3.67	3.63	3.55	3.32	4.03	4.07	4.35	3.86		5.38	4.18	4.45	3.85	4.16	3.22	4.83	5.66	10.16	4.98	10.95
Espirito Santo (ES)	0.81	0.78	0.86	0.91	1.38	0.98	0.90	1.29	1.28	0.82	0.86	0.85	0.92	1.02	1.00	2.33	1.21		2.04	0.82	0.75	0.72	0.77	0.71	0.90	0.96	0.75	3.09
Rio de Janeiro (RJ)	4.14	4.04	4.05	4.65	3.78	4.62	4.61	3.73	3.99	3.36	3.85	3.74	3.72	3.72	3.72	6.74	6.87	6.39		6.93	5.95	5.31	5.69	4.95	5.74	5.34	5.78	12.40
Sao Paulo (SP)	23.32	22.67	20.44	26.05	20.62	25.76	24.72	19.82	17.60	16.44	15.62	17.01	17.29	17.47	16.75	19.98	22.49	20.38	25.08		[illegible]	20.76	18.73	[illegible]	24.48	16.60	11.10	32.57
Parana (PR)	3.42	3.08	2.21	2.77	2.32	2.48	2.52	1.97	1.89	1.89	1.80	1.80	1.87	1.91	2.06	2.16	2.64	3.19	2.99	4.99		6.93	3.13	4.34	3.31	3.03	2.46	6.76
Santa Catarina (SC)	1.41	1.18	1.42	1.72	1.40	1.53	2.05	2.18	1.89	0.99	0.92	1.45	1.10	1.02	1.23	1.44	1.63	1.32	1.37	2.38	3.96		4.02	2.05	2.02	2.02	1.61	4.11
Rio Grande do Sul (RS)	3.28	2.48	2.83	2.89	2.90	3.14	3.15	3.70	2.90	2.26	2.12	2.40	2.15	1.94	2.16	2.39	2.33	2.74	2.05	2.70	3.40	4.94		3.42	3.88	3.07	2.14	6.58
Mato Grosso do Sul (MS)	1.18	0.96	0.77	0.74	0.85	0.77	0.75	0.61	0.53	0.59	0.59	0.56	0.54	0.55	0.59	0.59	0.74	0.87	0.65	1.20	1.14	1.10	0.89		1.42	1.34	0.59	1.96
Mato Grosso (MT)	4.22	2.71	1.58	1.55	1.54	1.19	1.33	0.92	0.85	1.15	1.01	0.95	0.88	0.90	0.97	0.89	0.96	1.12	0.72	0.83	0.95	1.39	1.02	1.47		1.75	0.84	3.26
Goias (GO)	1.73	1.61	1.24	1.64	1.87	1.57	2.44	1.53	1.18	1.10	1.09	0.98	1.04	1.18	1.24	0.91	2.33	1.68	0.98	1.40	0.80	1.14	0.96	1.55	2.52		4.01	2.53
Distrito Federal (DF)	2.05	2.05	1.84	2.03	3.11	3.04	2.57	2.61	2.34	1.90	1.53	1.47	1.69	1.73	1.83	1.13	1.13	1.81	0.98	0.48	0.46	0.87	0.70	0.80	1.69	4.63		0.95
Intraregional (%)	38.65	40.19	51.66	36.36	41.22	36.65	36.19	42.61	43.64	52.21	48.94	40.32	48.39	47.79	46.38	48.14	51.30	44.68	53.98	68.40	44.58	47.15	55.11	37.96	37.91	42.06	56.68	
Interregional (%)	61.35	59.81	48.34	63.64	58.78	63.35	63.81	57.39	56.36	47.79	51.06	59.68	51.61	52.21	53.62	51.86	48.70	55.32	46.02	31.60	55.42	52.85	44.89	62.04	62.09	57.94	43.32	
Value added multiplier	1.42	1.34	1.58	1.26	1.36	1.19	1.39	1.37	1.38	1.42	1.35	1.34	1.50	1.35	1.38	1.51	1.52	1.43	1.44	1.58	1.62	1.57	1.59	1.54	1.63	1.61	1.47	1.97

Note: The total of the initial 27 lines in each column corresponds to the portion representing the interregional impact of the value-added multiplier, as indicated in the second-to-last line of the figure. The value added multiplier is aggregated regionally weighted by sectorial final demand in each state.

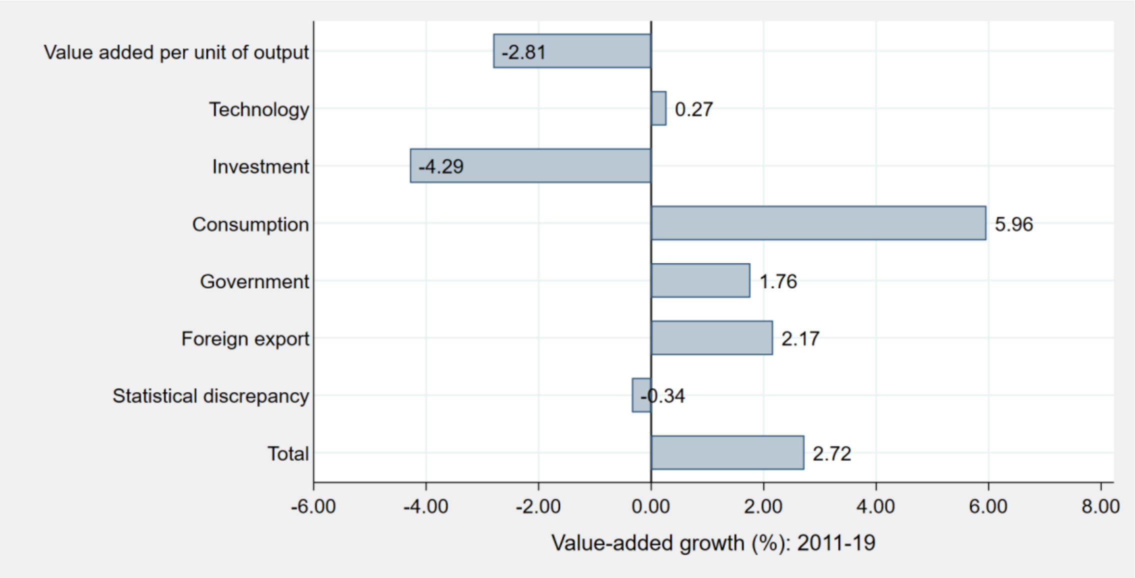
Source: Interregional Input-Output Table for Brazil, 2019.

Figure 6. Gross value added by origin of demand and production location of Brazilian Macroregions in 2019



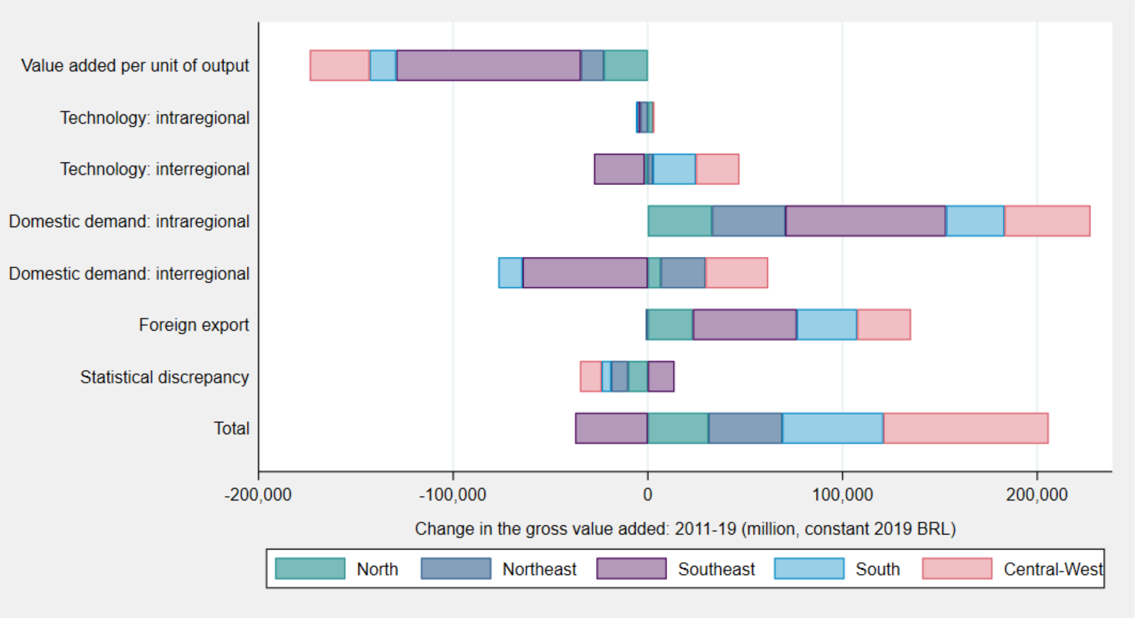
Source: Interregional Input-Output Table for Brazil, 2019.

Figure 7. Decomposition of value-added growth in Brazil: 2011-19 (%)



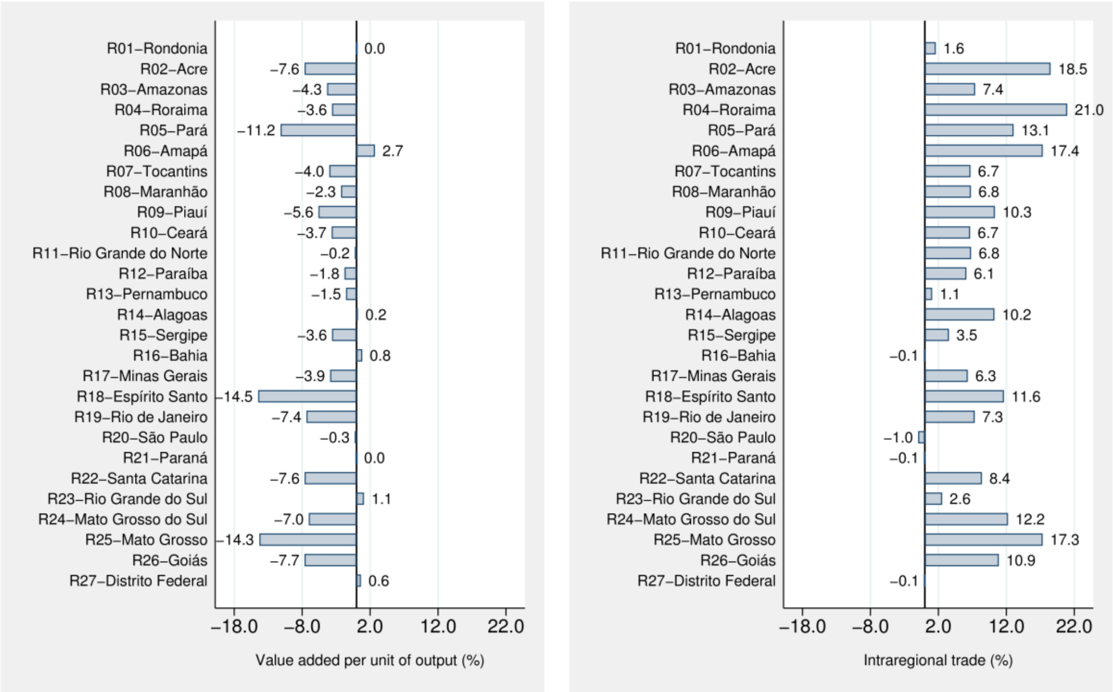
Source: SDA results.

Figure 8. Changes in the gross value added at basic prices per Brazilian Macroregions: 2011-19 (million, constant 2019 BRL)



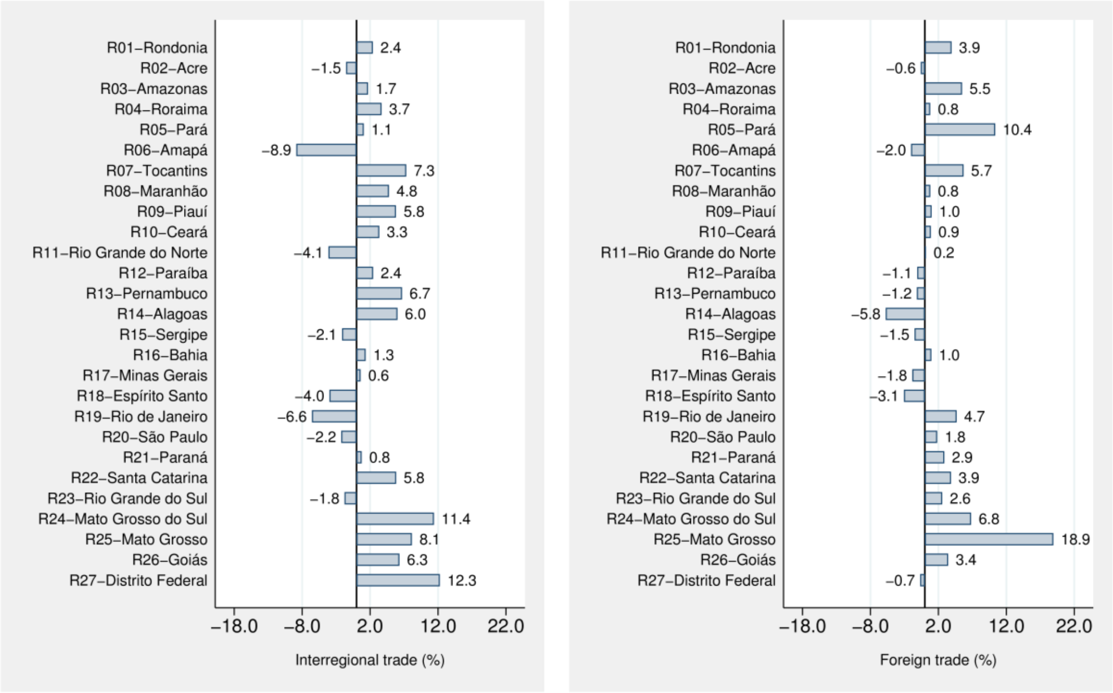
Source: SDA results.

Figure 9. Changes in gross value added in the Brazilian states between 2011 and 2019 (in %)



(a) Value added per unit of output

(b) Intraregional trade



(c) Interregional trade

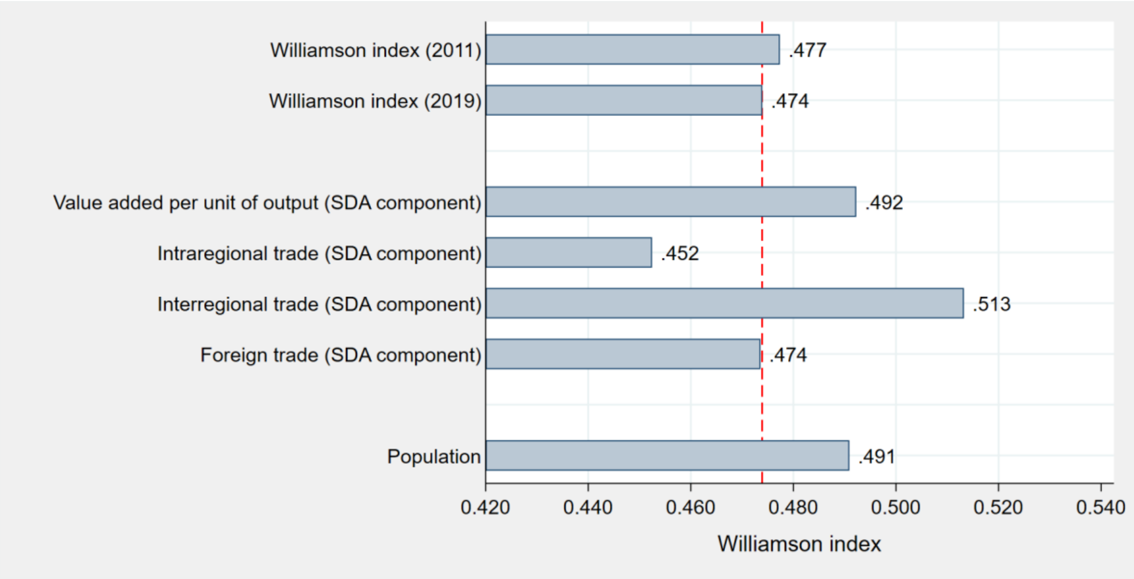
(d) Foreign trade

Source: SDA results.

Figure 10. Decomposition of changes in gross value added (in % of total change) between 2011 and 2019 for major groups of effects in the Brazilian states

Source: SDA results.

Figure 11. Williamson index



Source: Our calculation.

Appendix A

Table A1. The effect of domestic demand in gross value added (GVA) changes in Brazilian Macroregions: 2011-19 (million, constant 2019 BRL)

		Origin of the domestic demand shock					Total
		North	Northeast	Southeast	South	Central–West	
Region impacted by demand shock	North	23,533	1,517	–8,565	–1,982	3,637	18,140
	Northeast	2,184	60,706	–17,996	–6,851	9,670	47,713
	Southeast	–1,846	–6,227	–43,880	–50,780	–1,696	–104,430
	South	3,190	5,741	–19,288	34,962	1,236	25,841
	Central–West	11,181	20,403	–3,731	–4,967	45,475	68,362
	Brazil	38,242	82,141	–93,460	–29,619	58,323	55,626

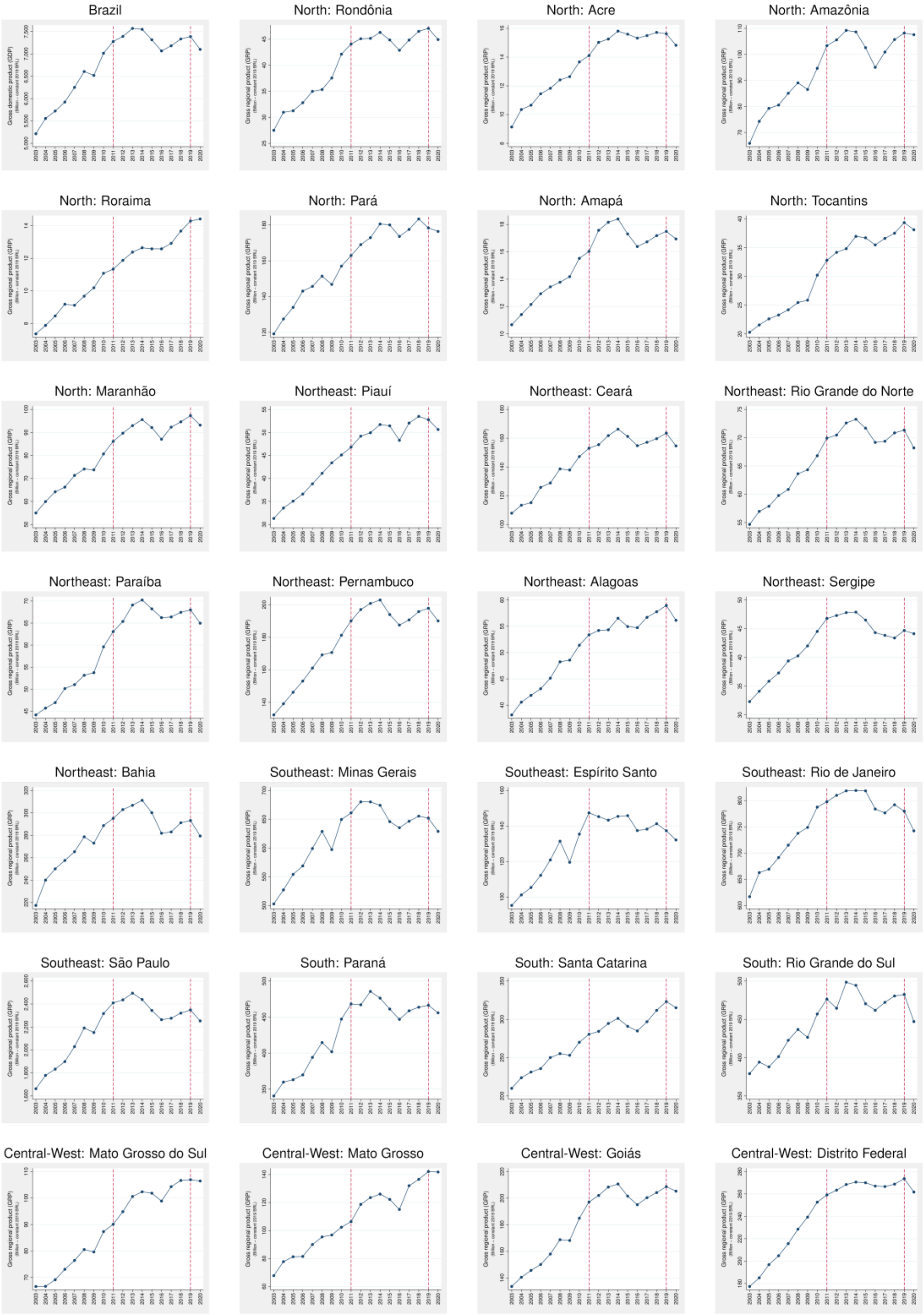
Source: SDA results.

Table A2. The effect of foreign demand in gross value added (GVA) changes in Brazilian Macroregions: 2011-19 (million, constant 2019 BRL)

		Origin of the foreign demand shock					Total
		North	Northeast	Southeast	South	Central–West	
Region impacted by demand shock	North	21,231	309	586	423	598	23,147
	Northeast	736	–3,761	60	585	1,271	–1,109
	Southeast	2,778	–111	37,258	5,009	8,458	53,391
	South	567	99	–190	28,738	1,767	30,981
	Central–West	512	–9	–372	616	26,910	27,658
	Brazil	25,824	–3,473	37,342	35,371	39,003	134,068

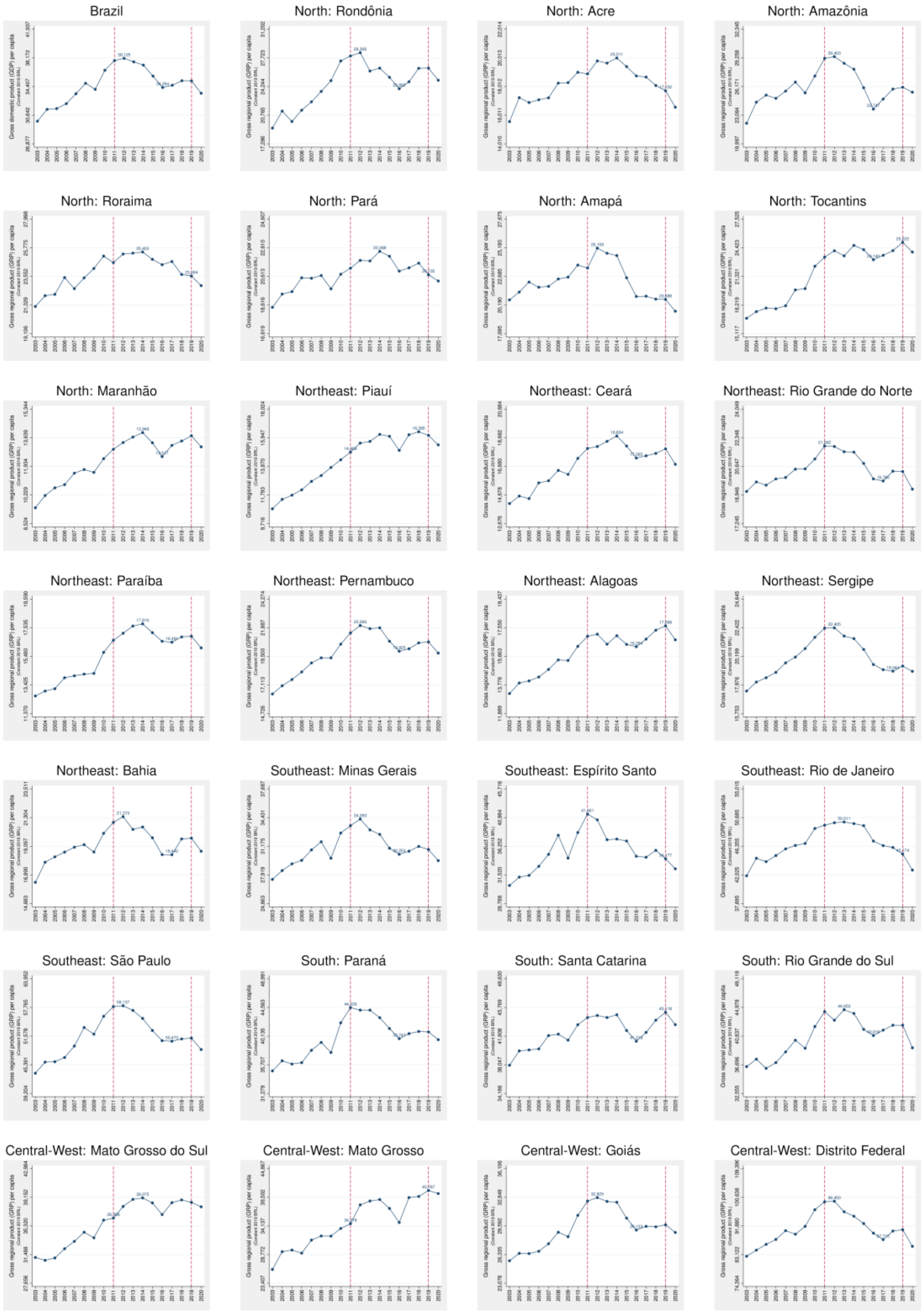
Source: SDA results.

Figure A1. Brazil's GDP and GRP in the Brazilian states (billion, constant 2019 BRL) between 2003 and 2020



Source: Brazilian Institute of Geography and Statistics (IBGE). Regional Accounts of Brazil (2002-2020).

Figure A2. GDP per capita in the Brazilian states and Brazil (billion, constant 2019 BRL) between 2003 and 2020



Source: Brazilian Institute of Geography and Statistics (IBGE). Regional Accounts of Brazil (2002-2020). Estimated resident population.