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INTERREGIONAL TRADE, STRUCTURAL CHANGES AND REGIONAL INEQUALITY

Inácio F. Araújo
Eduardo A. Haddad

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Interregional Trade, Structural Changes and Regional Inequality

Inácio F. Araújo [a], Eduardo A. Haddad [b]

[a] *Post-Doctoral Researcher, Department of Economics at USP and NEREUS. E-mail: inacio.araujo@usp.br*

[b] *Full Professor, Department of Economics at USP and NEREUS, São Paulo, Brazil Senior Fellow, Policy Center for the New South, Rabat, Morocco. E-mail: ehaddad@usp.br*

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, interregional trade was critical to drive changes in regional value-added, acting as an absorber of structural changes for the richer states.

Keywords. Interregional trade, Domestic trade, Regional disparity, Location of economic activities, Economic recession, Input-output analysis.

JEL Codes. R15, C67, F14, O18

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 (Haddad et al., 2010; Haddad and Araujo, 2021). 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. 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, 2021; Barufi and Haddad, 2020). More recently, two complimentary bodies of research have examined the business cycle co-movement in subnational economies over time, and the role of structural changes during periods of both economic 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 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 of analysis using these databases very often falls on the role played by technical change and changes in final demand, the latter reflecting shifts in social preferences (Haddad et al., 2014). The decomposition analysis 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 these input-output analysis frameworks, structure decomposition and feedback loop 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 all 27 states varied from -4.7% in Sergipe to 33.6% in Mato Grosso. The regional productive structures in Brazil 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 interregional integration of the Brazilian economy has also influenced the spatial propagation of the impacts through a complex diffusion of the multiplier effects.

Previous literature has provided several insights into the causes of regional inequalities, mainly related to international integration. However, the effects of intra- and interregional trade within a domestic economy have been less explored in economic models. Furthermore, empirical evidence has primarily focused on analyses for North America and Western Europe. Therefore, our study aims to explain the impact of domestic trade on the evolution of spatial inequalities in Brazil during the 2010s. We focus on intraregional trade changes over time, which, to the best of our knowledge, have never been discussed in the literature about the evolution of spatial inequalities. We also investigate the relevance of interregional trade as a mechanism to reduce or increase regional inequality. Thus, this paper provides new insights into the relationship between intra- and inter-regional trade, regional growth, and spatial inequalities.

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 period from 2011 to 2019. We assess the main driving forces of the changes faced by the Brazilian regions in the so-called "Second Lost Decade"[1] using structural decomposition analysis (SDA) to compare different economic structures in the context of partitioned input-output systems. 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.

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, interregional 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

[1] The 1980s in Brazil are referred to as the "First Lost Decade" due to a severe economic crisis characterized by hyperinflation, increasing public debt, and halted GDP growth.

simultaneously increased their dependence upon the rest of the system, increasing the existing production leakages.

Section 2 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. Section 5 presents the results of the SDA at different spatial aggregation levels. Section 6 outlines the main conclusions as regards the relative importance of structure change in the evolution of regional inequality.

2. Relation to the Literature

Regional inequalities are persistent, and their recent sharp rise has generated growing interest in urban and regional science (Bathelt et al., 2024). To understand the spatial distribution of economic activity and, in particular, the regional inequalities, studies have investigated this issue from different perspectives. Some studies have analyzed economic development stages and the evolution of regional disparities, drawing on the seminal works of Kuznets (1955), Myrdal (1957), Hirschman (1958), and Williamson (1965). Another body of literature has focused on economic geography models emphasizing intra-national and international trade as drivers of agglomeration and dispersion forces that explain the location of economic activities and lead to spatial inequalities. These models have demonstrated that globalization—through increased global economic integration via trade—can lead to regional agglomerations that worsen inequality.

Standard economic geography models suggest that regional inequalities may increase as some regions benefit from the increasing returns from foreign trade while others remain more dependent on domestic trade (Kim, 2008). Thus, these models have shown that regional imbalances at national and internal levels result from imperfect competition, increasing returns, and transportation costs. Building on the new trade theories by Krugman (1979) and Helpman and Krugman (1985), their analyses show that market size is an exogenous comparative advantage amplified by the home market effect. The home-market effect suggests that the interplay of transportation costs and economies of scale imply that the larger market accommodates a disproportionately large share of economic activity. Thus, larger regions attract more firms due to population and purchasing power, with decreased transport costs further amplifying this effect, leading to regional specialization and spatial inequalities (Fujita and Thisse, 2009). In the core-periphery model, Krugman (1991) addresses the mobility of consumers and workers, identifying transport costs as crucial for agglomeration. Low transport costs lead to the concentration of manufacturers in a core region, while high transport costs result in a symmetric regional production pattern; therefore, transport costs allow for both regional convergence and divergence.

In an extension of early economic geography models, vertical linkage models address the limitations of inter-regional migration in explaining agglomeration. This is especially relevant in regions with low labor mobility, where it is more plausible for labor to move within the same geographical region rather than between different regions. Thus, in the vertical linkages models, Krugman and Venables (1995) and Fujita et al. (1999) modify the basic core-periphery model to focus on input-output linkages among firms within a region rather than labor movement across regions. Thus, vertical linkage models explain the mechanisms of agglomeration and the resulting spatial inequalities through input-output relationships between firms in an imperfectly competitive industry. These models provided a comprehensive framework for understanding how vertical linkages drive regional economic integration and spatial dynamics (Baldwin et al., 2003).

Part of the empirical literature has focused on the relationship between increasing foreign trade, the evolution of within-country concentration of economic activity, and spatial inequalities. Paluzie (2001) found evidence of increased interregional disparities after Spain joined the European Union. Rodríguez-Pose (2012) provided evidence that foreign trade openness is positively and significantly associated with regional inequality, particularly in low- and middle-income countries, where internal spatial inequality is often higher, and structural features amplify the trade-inequality effect. Autin et al. (2018) found that regional inequality has grown in the United States over the last four decades. Bathelt et al. (2024) noted a substantial rise in spatial economic inequalities in high-income countries in North America and Western Europe since around 1980.

Regional disparities in developing countries are linked to the natural advantages of certain areas compared to others and the presence of agglomeration forces, which result in the concentration of activities (Venables, 2005). Rodríguez-Pose and Gill (2006) demonstrated that regional disparities increase in developing countries as primary sector goods trade loses importance in the composition of total trade. The findings of Coşar and Fajgelbaum (2016), Fan (2019), and Duan et al. (2023), for instance, demonstrated that international economic integration has uneven regional effects, affecting within-country inequalities in the Chinese economy.

Much of the existing literature, including all the studies cited in this section, has primarily focused on the concentration of economic activity related to international trade. However, there needs to be more evidence examining the relationships between domestic trade and the spatial distribution of activities. The literature in this area has mainly concentrated on assessing how the interregional economic structure contributes to the concentration of activity in major urban centers and reinforces regional inequalities. Examples of such studies in developing countries include analyses conducted for Indonesia (Sonis et al., 1997), Brazil (Haddad, 1999; Perobelli and Haddad, 2006), Mozambique (Silva, 2007), Colombia (Perobelli et al., 2010 and 2023; Araujo et al., 2023; Pacheco et al., 2023), and Latin America (Haddad and Araujo, 2021).

Following our study, we discuss the regional setting of spatial inequalities in Brazil in the next section. By examining the nature of regional inequalities in this economy, we hope to contribute to the ongoing debate on this issue in Brazil and other countries with similar development characteristics.

3. Regional Setting

3.1 Regional Inequalities in Brazil

Regional inequalities in Brazil have been examined through different lenses, such as: the influence of regional policies, the relation between income inequality and spatial inequality, and the impact of the structure of interregional trade. The first lens, the distribution of public funding by federal and local governments to mitigate regional disparities, was evaluated by studying the allocation of regional development funds (Resende, 2012) and investments in infrastructure (Ribeiro et al., 2018). The second, the relationship between income inequality and spatial inequality is not clear, but Ehrl and

Monasterio (2019) found evidence suggesting that the composition of skills within the regional occupational structure contributes to persistent regional inequality in Brazil. The third, the impact of interregional trade on Brazilian regional inequalities, was analyzed by Haddad (1999). The author showed how the regional and sectorial interdependence affected the evolution of Brazil's productive structure during the 1990s, favoring the more developed regions of the country. In addition, Perobelli and Haddad (2006) demonstrated that the regional disparities shaped the trajectory of interregional trade in Brazil.

The interaction between agglomeration forces and regional growth also helps to understand the changes in the distribution of economic activities that cause regional divergence or convergence over time. 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 transition 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.

To illustrate the regional income distribution and the formation of spatial clusters discussed by Azzoni (2001) and Manzi et al. (2023), Figure 1 plots the distribution of gross domestic product (GDP) per capita across Brazil's 27 Federation Units (or 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, the last year of the "Second Lost Decade", 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.[2] 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, 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

[2] The period from 2003 to 2020 is the most extended period for which data from the Regional Accounts of Brazil are comparable over time (IBGE, 2023).

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 >

3.2. Structure of Interregional Trade

This section explores the impact of domestic trade on regional inequalities, emphasizing how trade linkages contribute to economic growth in the most developed regions of Brazil. Figure 4 illustrates 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 economic 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 act as a concentrating force that amplifies regional inequalities in Brazil. Figure 5 illustrates these effects by showing the regional distribution of the value-added multiplier of the Brazilian states. 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 example, 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 >

The impact of interregional input-output linkages as a significant factor affecting regional inequalities in the Brazilian economy is showed in Figure 6. This figure summarizes the systemic effects outlined in Figure 5, grouping the Brazilian states into poorer regions (North and Northeast) and 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.

Therefore, as seen in Figure 6, production absorption from domestic demand shocks in poorer and wealthier regions perpetuates regional inequalities in Brazil. Moreover, the shock of foreign demand also increases these spatial inequalities. 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 (2021) 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

4.1 Structural Decomposition Analysis

Our analysis aimed to understand how structural changes, particularly trade patterns, have affected regional inequalities in Brazil. Thus, we assessed the main driving forces of the changes faced by the Brazilian regions between 2011 and 2019 using structural decomposition analysis techniques. Decomposition analyses have been used to understand structural economic changes regarding the relative importance of the growth of final demand, technological changes, and trade patterns, as demonstrated by Miller and Blair (2022) and Oosterhaven (2022).

The demand for intermediate inputs and final demand determine the production by sector and region in the input-output analysis. Thus, let us define

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

Where the $(sr\ x\ 1)$ vector $\mathbf{x}$ represents the gross output in s sectors and r regions, the $(sr\ x\ sr)$ matrix $\mathbf{B} = (\mathbf{I} - \mathbf{A})^{-1}$ is the Leontief inverse, and the $(sr\ x\ 1)$ vector $\mathbf{y}$ represents the final demand. 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, the (sr x 1) diagonalized vector $\mathbf{v}$ in the matrix $\hat{\mathbf{v}}$ 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:

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

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 $\hat{\bar{\mathbf{v}}} = \frac{1}{2}(\hat{\mathbf{v}}_\mathbf{0} + \hat{\mathbf{v}}_\mathbf{1})$, $\overline{\mathbf{B}} = \frac{1}{2}(\mathbf{B}_\mathbf{0} + \mathbf{B}_\mathbf{1})$, 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 ($\mathbf{B}_{\mathbf{A}}$) and interregional ($\mathbf{B}_{\mathbf{E}}$) components, where $\mathbf{B} = \mathbf{B}_{\mathbf{A}} + \mathbf{B}_{\mathbf{E}}$.

Thereby, we can decompose 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:

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

4.2 Data

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

The decomposition of the gross value added growth from 2011 to 2019 caused by changes in technology and different components of final demand is shown in Table 1. The variation in gross value added in the Brazilian economy was 168,539 million BRL, representing a growth of 2.72%. This growth was highest 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 area 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).

< Table 1 >

Domestic absorption, specifically household and government consumption, and foreign demand were the most important components of the value-added growth, as illustrated in Figure 7. 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 Brazil's economic crisis between 2011 and 2019. Consumption (5.96%), government expenditure (1.76%), and foreign export (2.17%) contributed to mitigating the impacts of the crisis. Figure 8 distinguishes 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 7 >

< Figure 8 >

The result of the change in domestic trade is shown in Table 2. The variation in intra- and interregional trade accounted for 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 is the most important component of the value-added growth, amounting to 224,877 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 (-39.4% of the total change) toward the Central-West region (23.8% of the total change).

< Table 2 >

The geographical pattern of the change in value added shares is illustrated in Figure 9. We observed that over the period 2011-2019, barely seven states experienced a decreasing trend in value share shares—these states concentrated 63.3 percent of Brazil's value added in 2019. The changes in each component of SDA, such as value added, intraregional and inter-regional trade, and foreign trade, demonstrate how the Brazilian states responded to the economic crisis. Figure 10 shows the changes in value added in the Brazilian states between 2011 and 2019 as a percentage change of the total value added of each state in 2011. The impact of intraregional trade was the primary component for value-added growth in most states, with greater effects in the states of the North and Central-West regions. Meanwhile, the most important changes in inter-regional trade were in 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 the largest exporters of agro-industrial products such as soybeans, corn, beef, and vegetable oils.

< Figure 9 >

< Figure 10 >

The effect of domestic demand shocks on changes in gross value added across Brazilian regions emphasizes the importance of interregional linkages in driving regional economic dynamics and increasing inequalities during the economic crisis. Table 3 illustrates the impact of domestic demand on value-added growth from 2011-19 by the region of origin of the domestic demand shock and the region affected by this demand shock. The total change in gross value added (55,626 million BRL) equals the domestic component (34,471 million BRL) minus the statistical discrepancy (-21,155 million BRL) in Table 1. The change in domestic demand was -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).

< Table 3 >

The wealthier regions absorbed 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 a shock absorber and reducing the impact of structural changes on the wealthier states (Table 3). 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.

The systemic impact of foreign demand on value-added growth is shown in Table 4. While the North and Northeast absorbed 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 absorbed 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 >

5.1 Effects of structural change on 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, 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:

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

where y_i represents the gross value added per capita in state i (for $i = 1, \ldots, 27$), n is the number of states, 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. Discussion and Conclusion

This article investigates the regional dynamics of the Brazilian economy during the so-called "Second Lost Decade". The methodology employed in this analysis compares diverse economic structures within partitioned input-output systems, using two interregional input-output tables constructed for Brazil in 2011 and 2019. We then apply the structural decomposition method 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 and the impacts of domestic trade on spatial inequality. 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. The study results show that interregional trade played a significant role in driving changes in gross regional product, acting as an absorber of structural changes for wealthier states. Meanwhile, poorer regions faced technical and final demand changes through stronger internal linkages that favored the internalization of multiplier effects. However, the poorer regions also increased their dependence on the rest of the system, amplifying income leakages.

Our article brings new evidence regarding the impact of economic change, particularly during economic recessions, on spatial inequalities. Haddad and Araujo's (2021) findings regarding the distribution of economic activity showed that foreign exports of natural resource-intensive commodities reduce regional inequalities in Latin American countries. Our results complement this study by demonstrating the importance of increased domestic trade in reducing regional inequalities. In fact, intra-regional linkages act as shock absorbers, strengthening the process of regional convergence. These findings are consistent with those of Araujo et al. (2023), who showed that greater interconnectedness within domestic supply chains leads to the highest growth of local economies in Colombia and regional resilience during economic recessions.

Another contribution of our study is highlighting the role of intra- and interregional trade in shaping the evolution of regional inequalities. This area has received less attention than the extensive literature on the effects of foreign trade. Our findings are connected to research conducted by Haddad (1999), Perobelli and Haddad (2006), Haddad and Araujo (2021), Araujo et al. (2023), Pacheco et al. (2022), and Perobelli et al. (2010 and 2023). While these studies did not specifically focus on regional inequalities, except Haddad (1999), they investigated how linkages generated by domestic trade contribute to the concentration of economic activity in major urban areas across Latin American countries, with a particular focus on the economies of Brazil, Chile, Colombia, and Mexico.

Providing further evidence on the nature of regional inequalities in a developing economy is another contribution of this article. Bathelt et al. (2024) demonstrate that spatial economic inequality is now one of the most urgent and challenging issues to study due to its complexity, and most of the empirical evidence is concentrated in studies about North America and Western Europe. The patterns of inequalities differ in developing countries compared to developed countries, for instance, given the high participation of the informal sector in developing economies. However, more evidence is still needed on the nature of informal activity distribution and its effect on regional inequalities. Furthermore, as Kim (2008) highlighted, the standard regional economics models for addressing regional inequality can be inadequate for analyzing developing countries. These models often fail to emphasize the structural shift in economic activities from extractive activities in rural areas to manufacturing and services in cities, a development tendency and characteristic of recently growing regions such as the Central-West and North macro regions in Brazil.

The findings in our study also highlight new challenges related to changes in interregional inequalities. Brazil is undergoing a geographic reallocation of economic activity, with production expanding to the Central-West and North macro-regions, as Araujo et al. (2019) demonstrated. This relocation within the national territory can affect regional convergence processes and is increasingly reflected in policymaking. For instance, Haddad et al. (2023b, c) evaluated the impacts of the tax reform passed in Brazil in 2023. This reform altered several fiscal mechanisms that contributed to the spatial relocation of economic activity. The authors found a trade-off between efficiency and regional inequality, with tax reform potentially concentrating production and increasing inequality across the country.

Additionally, spatial inequalities and regional growth opportunities have led to discussions about the effects of climate change and forest conservation. Haddad et al. (2024) show that domestic trade, by final demand originating from the more developed Brazilian center-south, exerts much stronger pressure on Amazon deforestation than local, within Amazon, and foreign export demand. This result is directly related to our findings on the role of intra- and inter-regional trade in the evolution of regional inequalities. Within the current distribution of economic activity in the national territory, changes in the domestic trade balance between poorer and wealthier regions, which could help reduce regional inequalities, would lead to greater pressure on environmental resources in economically disadvantaged regions. Therefore, regional inequalities and compensation mechanisms related to deforestation accountability and domestic trade are additional factors that could deepen political fissures in Brazil.

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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*
Value-added growth: 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					Brazil
		North	Northeast	Southeast	South	Central–West	
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 total change)							
Intraregional component		*15.56*	*14.78*	*35.26*	*13.03*	*19.44*	*98.07*
Interregional component		*2.19*	*11.18*	*-39.42*	*4.20*	*23.78*	*1.93*
Sub–total		*17.75*	*25.96*	*-4.16*	*17.23*	*43.22*	*100.00*

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 (2011-19)			Gross value added in 2011	Value-added growth: 2019-11 (%)
		N, NE	SE, S, CW	Total		
Region impacted	N, NE	87,940	–22,087	65,853	1,221,443	5.39
by demand shock	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.

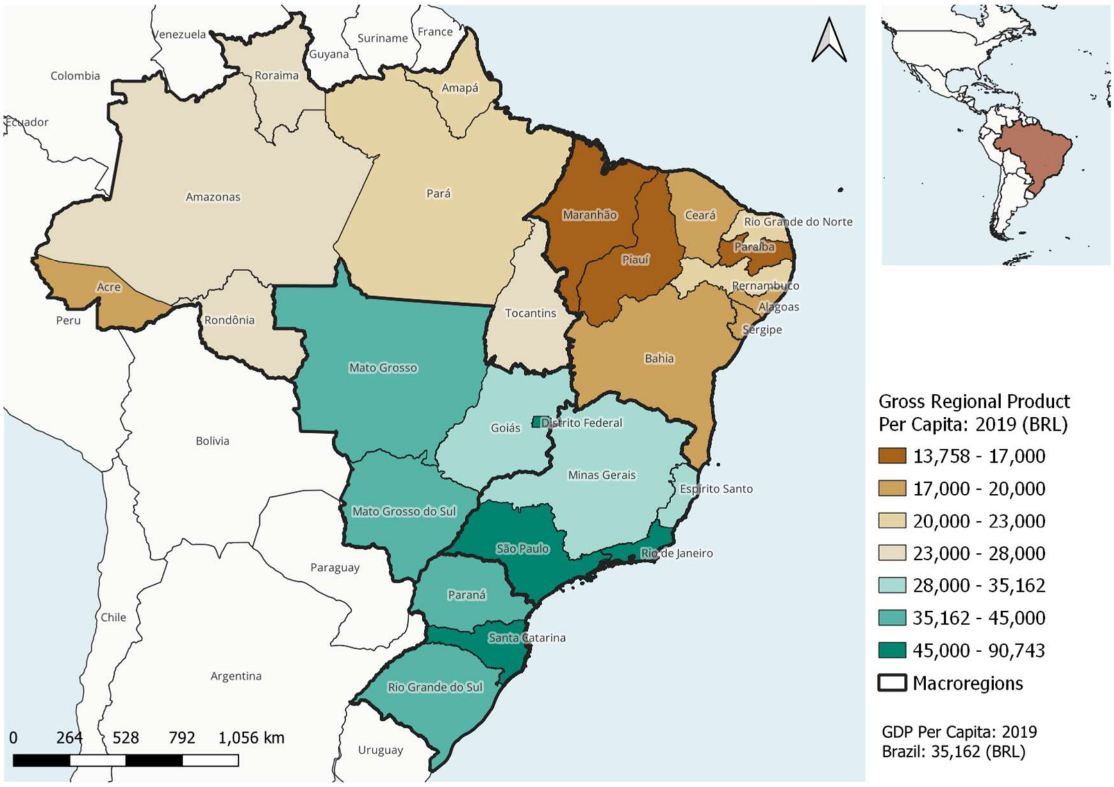
Table 4. The effect of foreign demand in gross value added changes in Brazilian Macroregions: 2011-19 (million, constant 2019 BRL)

		Origin of the foreign demand shock (2011-19)			Gross value added in 2011	Value-added growth: 2019-11 (%)
		N, NE	SE, S, CW	Total		
Region impacted	N, NE	18,515	3,523	22,038	1,221,443	1.80
by demand shock	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).

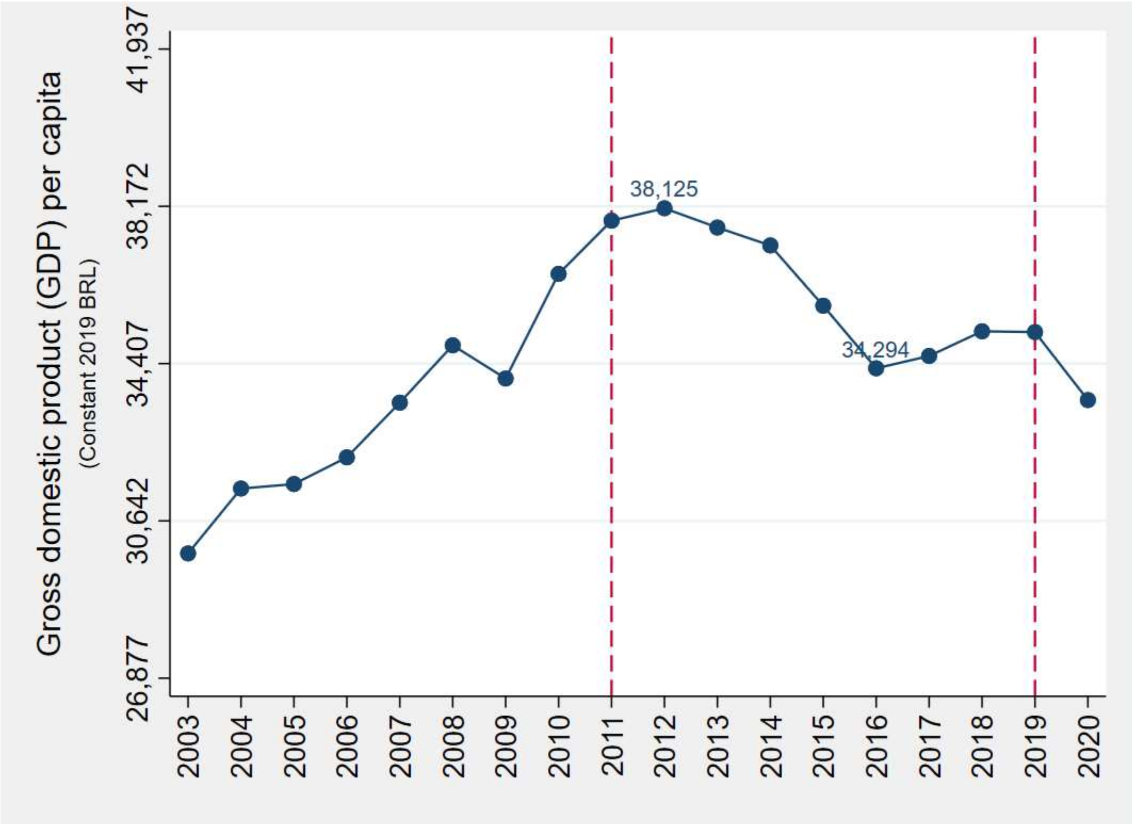
Source: SDA results.

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



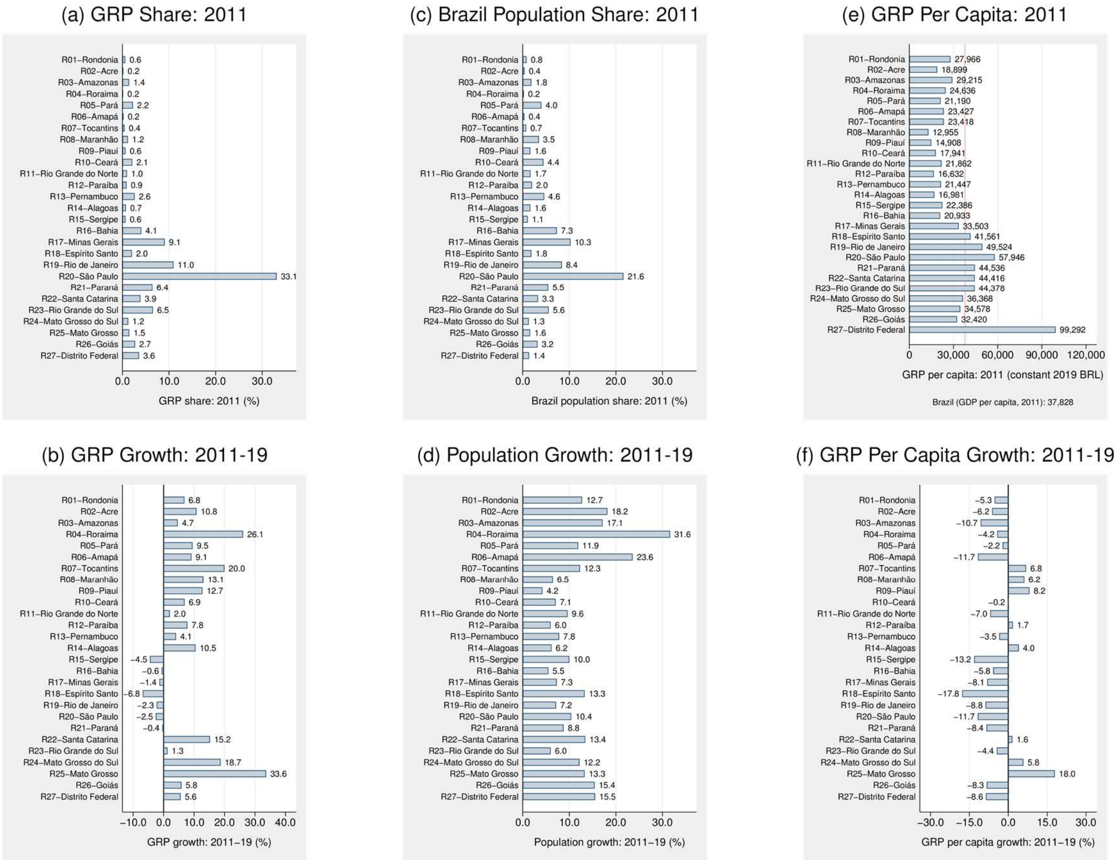
Source: Brazilian Institute of Geography and Statistics (IBGE). Regional Accounts of Brazil (2002-2020). Estimated resident population.

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



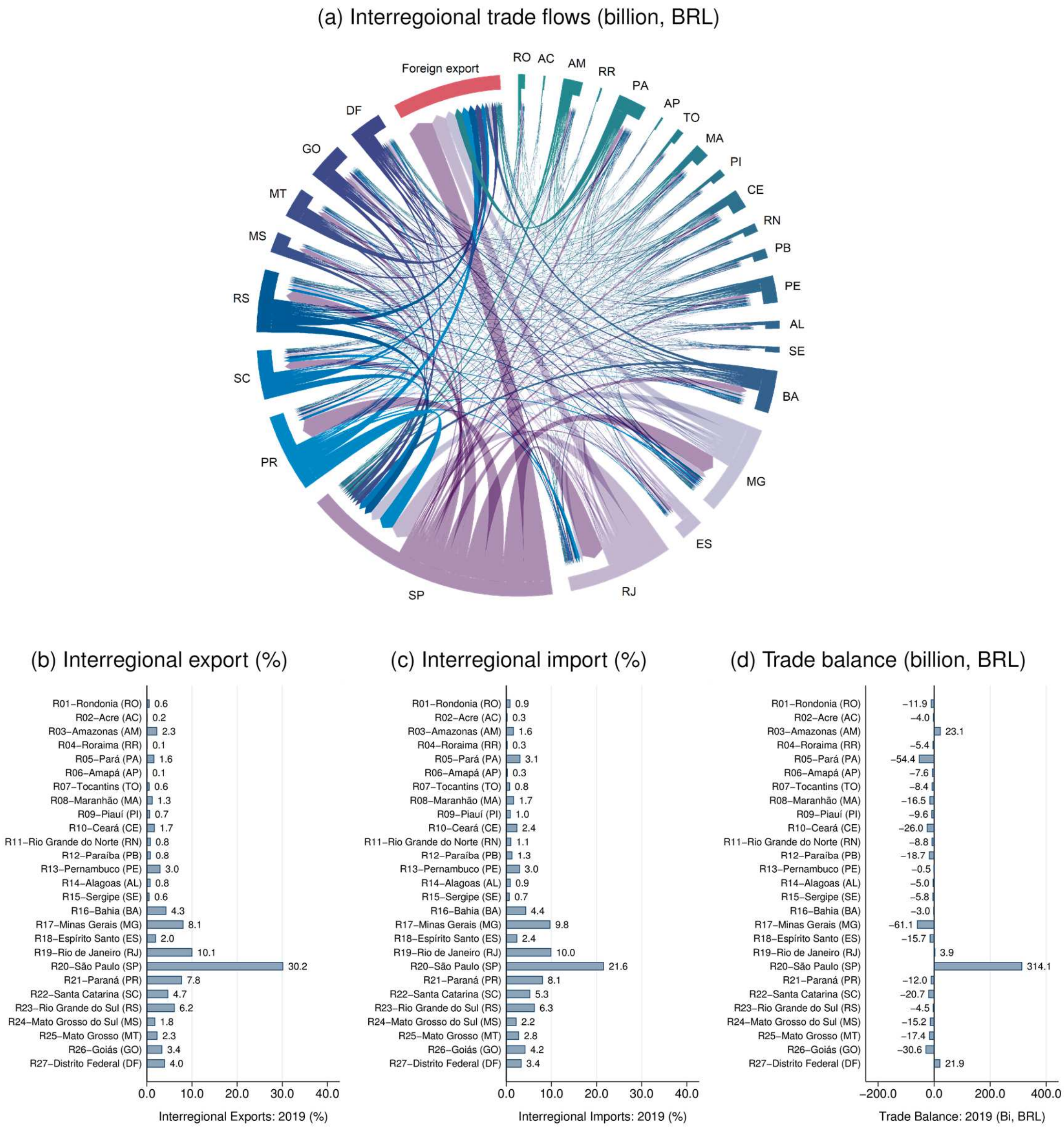
Source: Brazilian Institute of Geography and Statistics (IBGE). Regional Accounts of Brazil (2002-2020). Estimated resident population.

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



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)



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

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

Value added multiplier

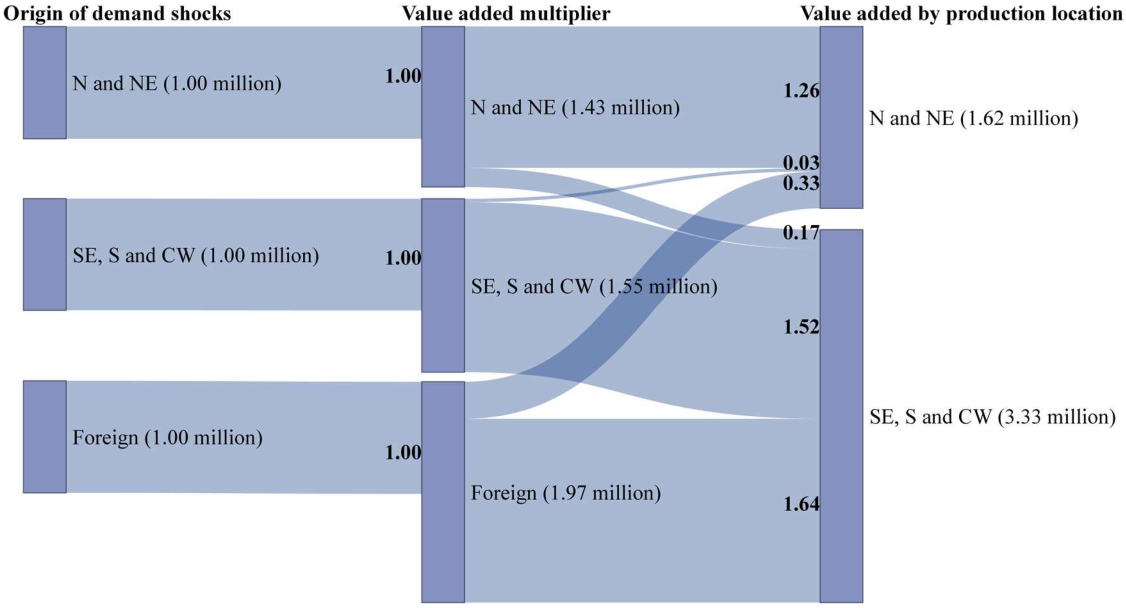
Regional distribution of the net value added multiplier (%)

	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		29.56	20.76	18.73	[illegible]	24.48	16.60	11.10	[illegible]
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. 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.

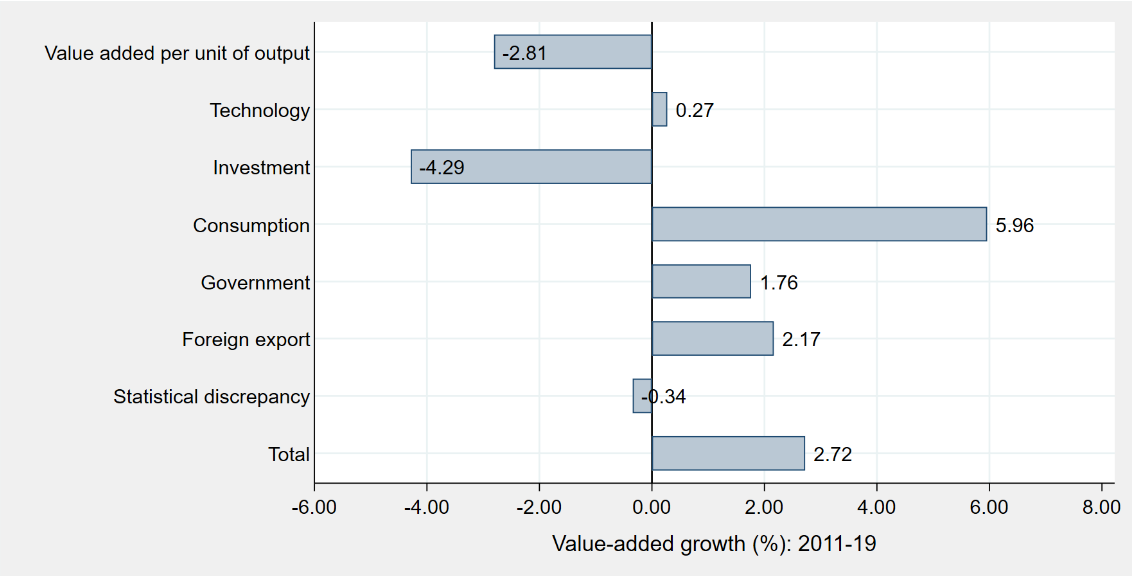
Source: Interregional Input-Output Table for Brazil, 2019.

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



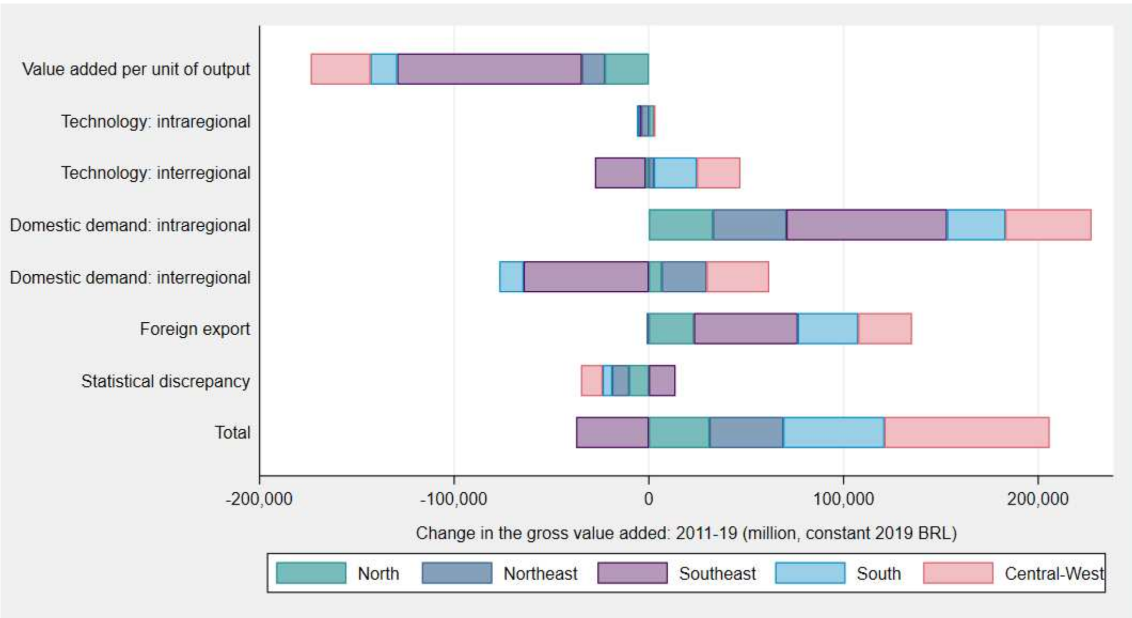
Source: Interregional Input-Output Table for Brazil, 2019.

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



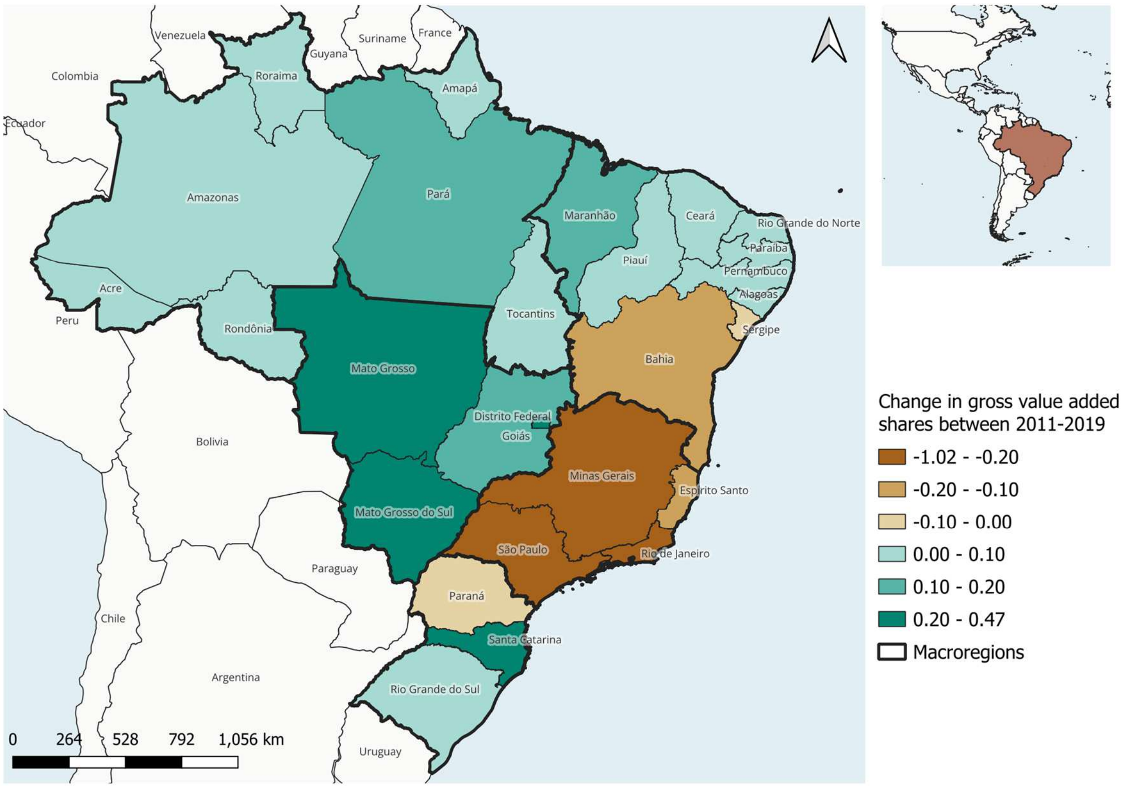
Source: SDA results.

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



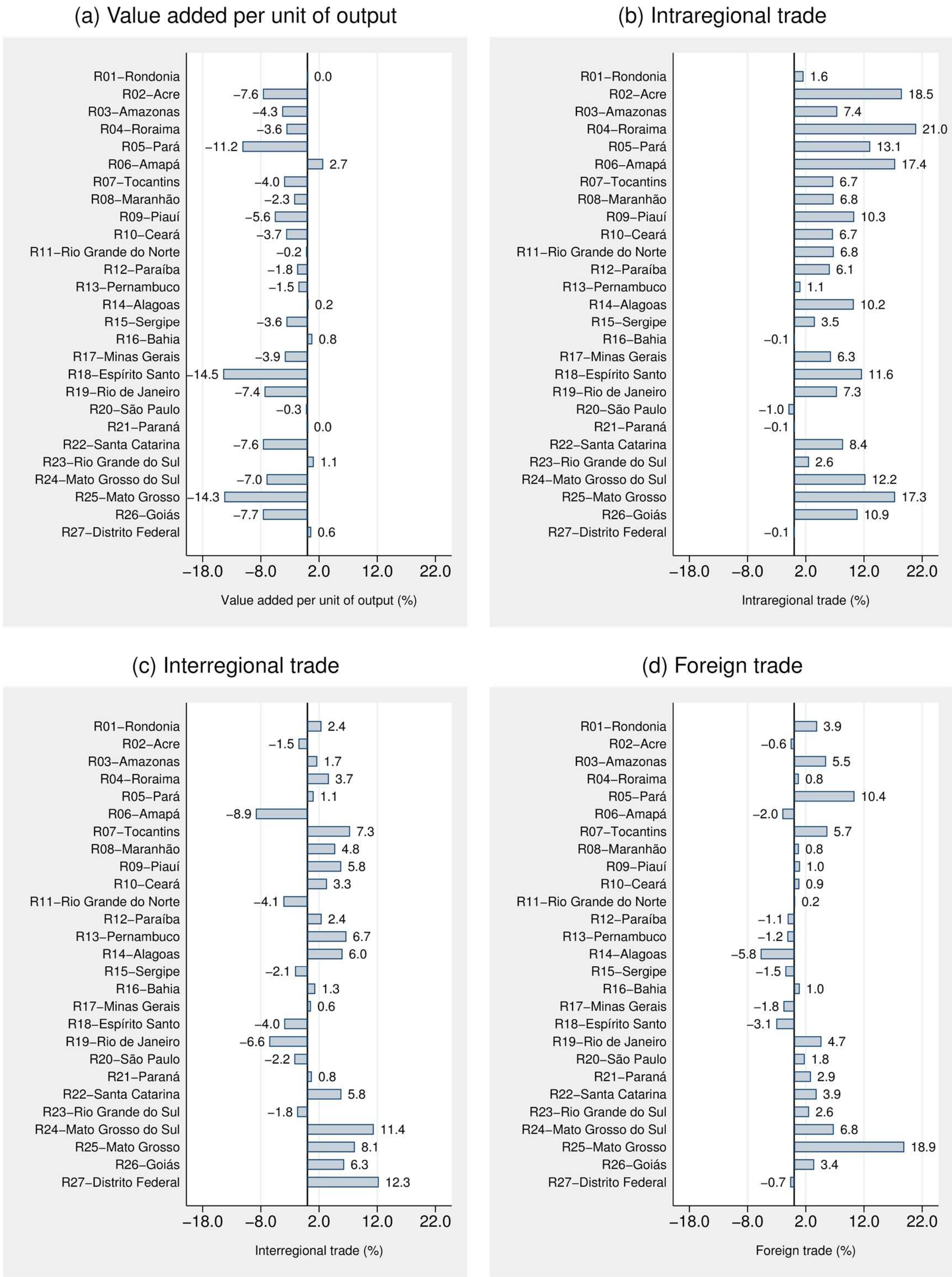
Source: SDA results.

Figure 9. Changes in gross value added shares between 2011 and 2019 in the Brazilian states



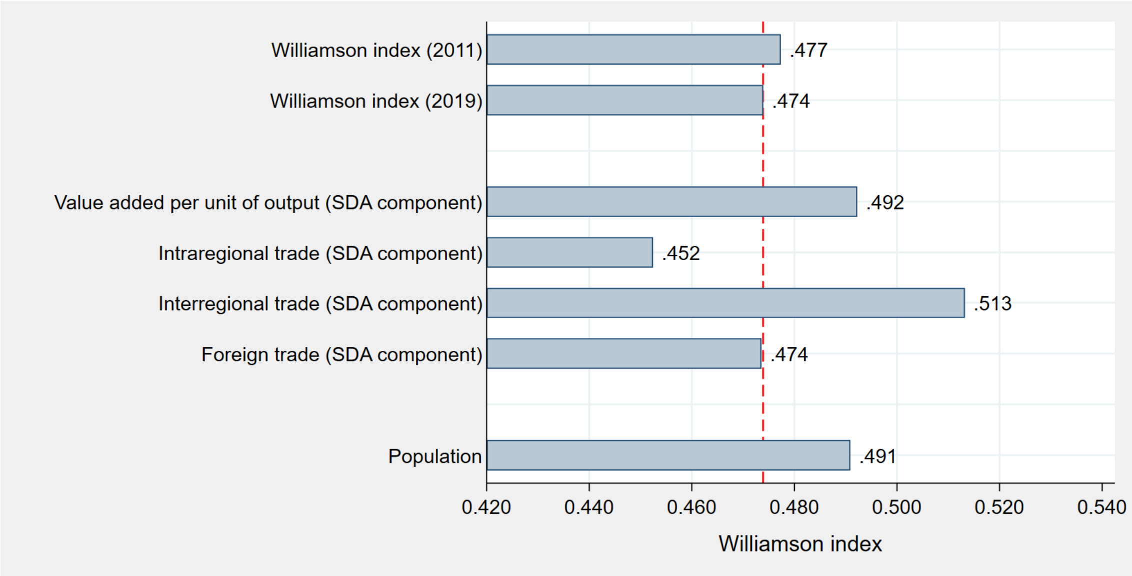
Source: SDA results.

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



Source: SDA results.

Figure 11. Williamson index



Source: Our calculation.

Appendix A

Table A1. 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					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

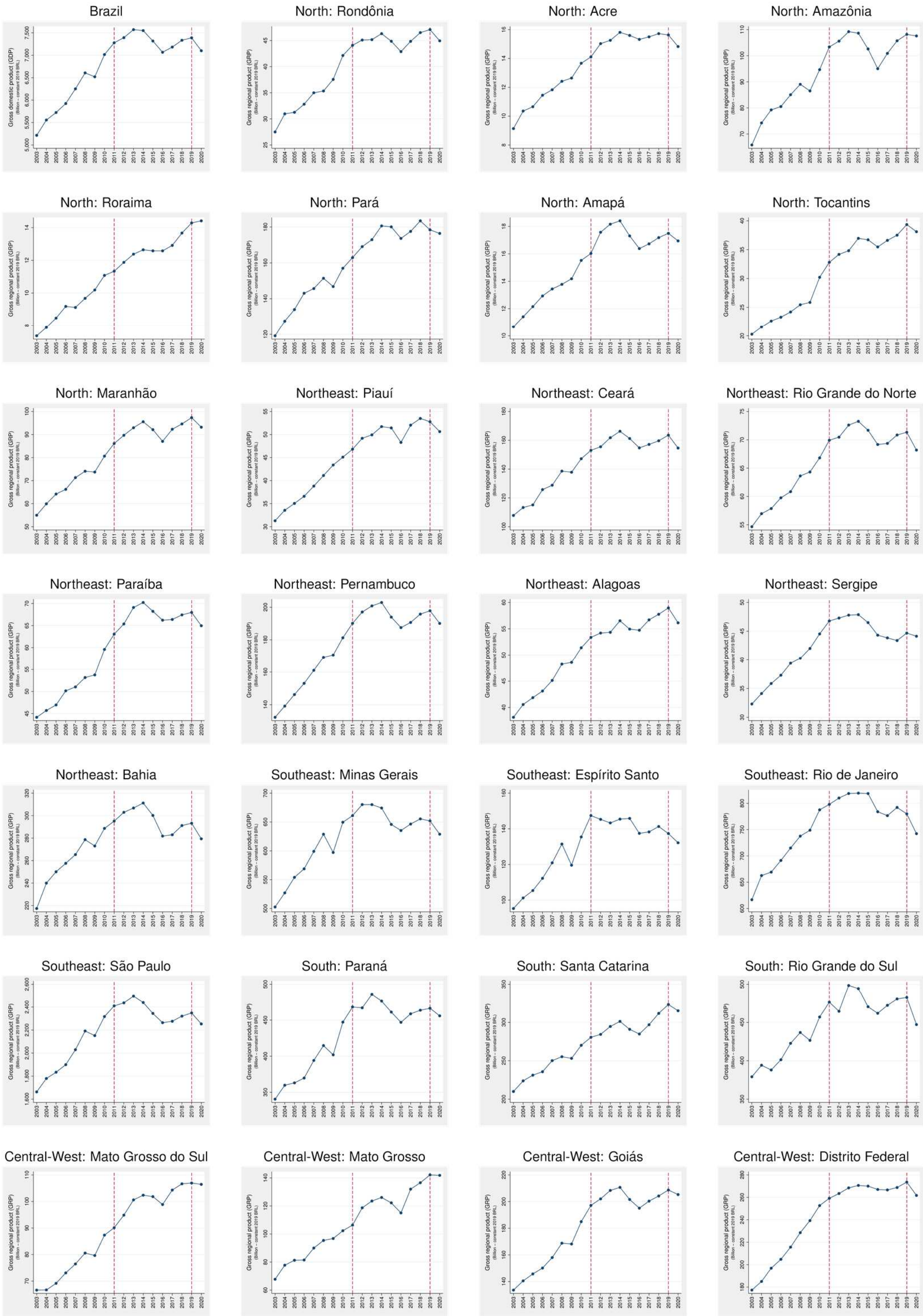
Source: SDA results.

Table A2. The effect of foreign demand in gross value added 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

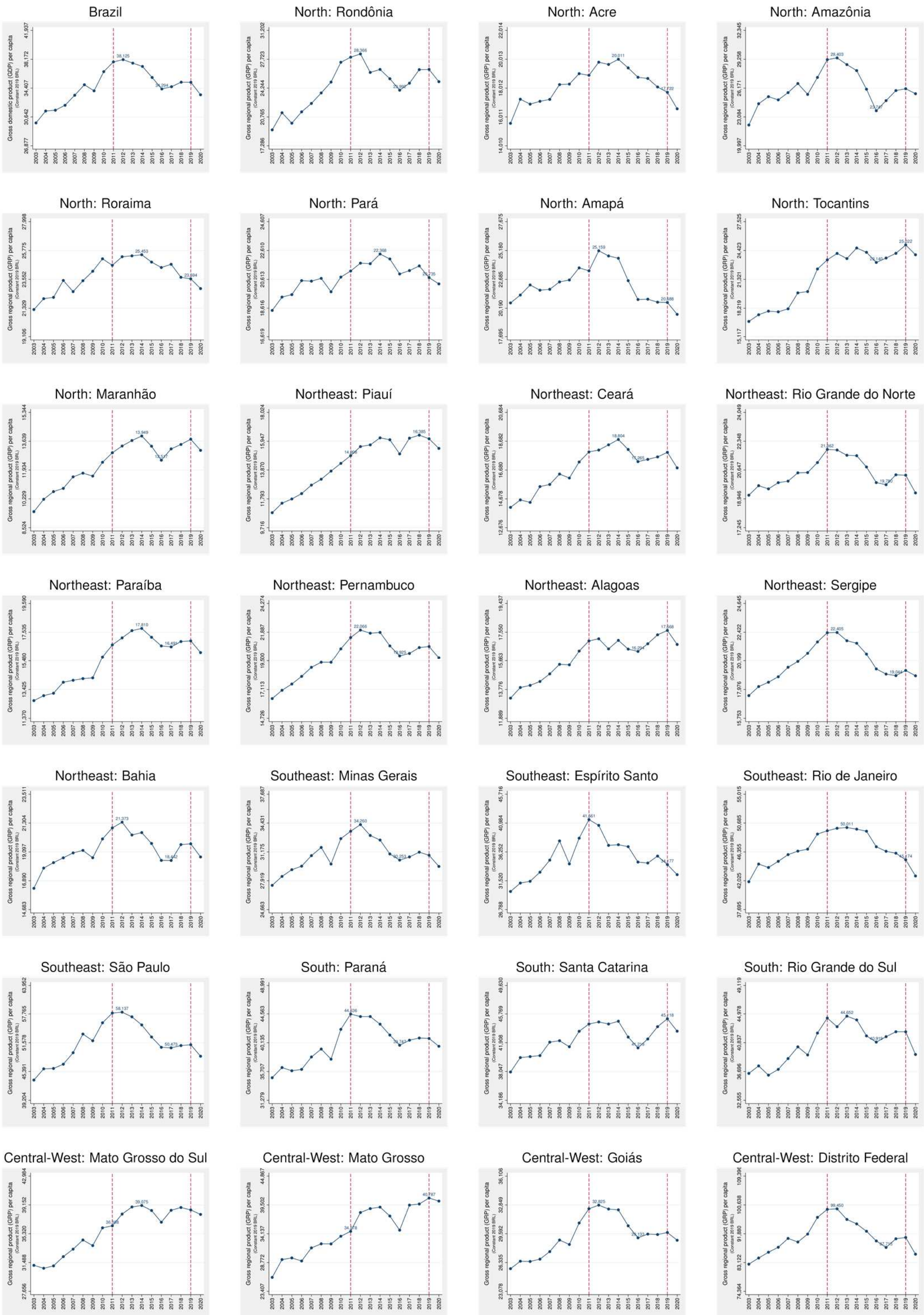
Source: SDA results.

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.