Interregional Trade, Structural Changes and Regional Inequality

*Inácio Fernandes de Araújo**
*Eduardo Amaral Haddad**

** Department of Economics, University of Sao Paulo*

Abstract. This paper investigates the drivers of structural change stemming from the reallocation of economic activity across sectors and regions in Brazil. Using interregional input-output analysis, we decompose structural change into contributions from technology, domestic and foreign trade, and consumption. We find that final expenditure (income level) are the dominant force behind structural transformation and the reducing regional inequality. However, domestic trade reinforces regional disparities by shifting growth gains toward more developed areas. Interregional linkages act as shock absorbers, dampening regional convergence and amplifying income leakages from poorer regions. Shifts in technical and preference coefficients toward value-added-intensive sectors supported growth in lagging regions. Foreign trade also contributed to reducing regional inequality. Our findings underscore the critical role of input-output linkages and domestic trade patterns in shaping structural change and regional disparities—highlighting the often-overlooked importance of interregional trade.

Keywords. Domestic trade, Regional disparity, Input-output analysis.

Resumo. Este artigo investiga os fatores que impulsionaram a mudança estrutural decorrente da realocação da atividade econômica entre setores e regiões no Brasil. A partir de uma análise inter-regional de insumo-produto, a mudança estrutural é explicada em contribuições da tecnologia, comércio (doméstico e exterior) e consumo. O estudo mostra que o consumo final é o principal determinante da transformação estrutural e da redução da desigualdade regional. No entanto, o comércio doméstico reforça as disparidades regionais ao direcionar os ganhos de crescimento para regiões mais desenvolvidas. Os encadeamentos produtivos inter-regionais atuam como absorvedores de choques, atenuando a convergência regional e amplificando os vazamentos de renda de regiões mais pobres. Mudanças nos coeficientes técnicos e de preferência em direção a setores intensivos em valor adicionado impulsionaram o crescimento em regiões menos desenvolvidas. O comércio exterior também contribuiu para a redução da desigualdade regional. Os resultados do estudo destacam o papel da interdependência setorial e dos padrões de comércio doméstico na mudança estrutural e das disparidades regionais, evidenciando a importância, muitas vezes subestimada, do comércio inter-regional.

Palavras-chave. Comércio doméstico, Disparidade regional, Análise insumo-produto.

Área de submissão: 4. Crescimento econômico e desenvolvimento regional.

Classificação JEL. R15, C67, F14, O18.

1. Introduction

Structural change, typically defined as the reallocation of economic activity across sectors, has attracted growing attention in the literature (Herrendorf et al., 2013; Neuss, 2019). Most studies, however, adopt a sectoral perspective and give limited attention to shifts in economic activity across regions within countries. In Brazil, concerns about the spatial distribution of economic activity have long fueled debates on regional development (Haddad, 1999; Azzoni and Haddad, 2018, 2021; Barufi and Haddad, 2019). Understanding the forces behind structural change is thus essential for informing policy design aimed at steering the regional and sectoral allocation of activity, with important implications for local growth and regional convergence.

Brazil experienced a prolonged economic stagnation with highly uneven regional impacts from 2011 to 2019—the period covered by our analysis. Real GDP grew by only 2.73% (0.34% annually), while the population expanded by 9.24% (1.11% annually), leading to a 5.96% decline in per capita GDP (–0.76% annually). Over the same period, real GRP growth ranged from –4.7% in Sergipe to 33.6% in Mato Grosso (IBGE, 2023). These disparities reflect differences in regional productive structures, shaped by the geographic concentration of public sector activity and foreign-oriented industries. In addition, interregional integration has influenced the spatial transmission of shocks in Brazil through complex input-output linkages.

This paper examines the forces driving structural change and regional inequality in Brazil during the economic stagnation of the 2010s, focusing on two key mechanisms: shifts in input-output linkages (regional and sectoral interdependence) and changes in domestic trade patterns. While domestic trade has received limited attention in the literature, we show that interregional trade plays a central role in shaping both structural transformation and regional disparities. By combining input-output analysis with structural decomposition techniques, we assess how demand contraction propagated across regions during this period of stagnation.

We use a unique database comprising two interregional input-output tables for Brazil to analyze the regional transmission of shocks between 2011 and 2019. Applying structural decomposition analysis (SDA), we identify the main drivers of change across states during Brazil's so-called "Second Lost Decade"[1]. The analysis explores shifts in regional inequality, heterogeneous adjustment patterns across regions, and the role of domestic trade in shaping these outcomes. Our approach therefore provides a framework to investigate the links between interregional trade, structural transformation, and regional inequality.

Despite extensive research on regional disparities, most studies focus on international integration, while domestic trade remains understudied, mainly due to data limitations. Consistent estimates of intra- and interregional trade flows are rare, especially in large, diverse economies like Brazil. To address this gap, we construct a novel dataset on trade flows among Brazilian states and with the rest of the world. Drawing on the System of National and Regional Accounts and a wide range of sectoral data sources, we develop harmonized interregional input-output tables for 2011 and 2019—filling a critical data void in Brazil, where no official estimates exist.

We combine this dataset with structural decomposition analysis and demographic trends to examine the drivers of regional inequality during Brazil's stagnation. We find that changes in both domestic and international integration played a central role. Less developed areas became increasingly dependent on the rest of the system, exacerbating production leakages. In contrast, richer regions absorbed structural shocks through trade linkages, while poorer regions internalized multipliers through adjustments in technology, preferences, and consumption.

Section 2 discusses the literature related to regional disparities and their interaction with trade and economic structure. Section 3 presents Brazil's regional inequality and its evolution over the period analyzed, as well as the structure of interregional trade in Brazil. Section 4 introduces the methodology, which employs SDA to compare diverse economic structures within partitioned input-output systems. Section 5 presents the results of the SDA at different spatial aggregation levels.

[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.

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

This section reviews the main contributions of the literature related to regional disparities and their interaction with trade and economic structure. We begin by discussing the theoretical foundations and international empirical evidence, highlighting mechanisms behind spatial inequalities. We then turn to studies focused on Brazil and other Latin American economies, which shed light on the role of interregional linkages, spatial regimes, and structural changes in shaping regional inequality.

2.1 Theoretical and International Perspectives

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. 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. 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 include analyses conducted for Indonesia (Sonis et al., 1997), Brazil (Haddad, 1999; Perobelli and Haddad, 2006), Japan (Sonis et al., 2001; Hitomi et al., 2000), Mozambique (Silva, 2007), Colombia (Perobelli et al., 2010 and 2023; Araújo et al., 2023; Pacheco et al., 2023), and Latin America (Haddad and Araújo, 2021). Although not focused specifically on interregional trade and the concentration of economic activity, the findings of Haddad et al. (2020) on the impact of the crisis on the Greek economy, showed that interregional economic structure shape regional cyclical responses reinforcing spatial inequalities.

2.2 The Case of Brazil and Latin America

Previous 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, 2019). 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 first 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 second research group 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 (Haddad et al., 2014). The structural decomposition analysis combines with other approaches based on input-output systems that have attempted to analyze the structure of multi-regional trade flows.

In summary, the literature highlights both the theoretical mechanisms and empirical evidence associated with regional disparities. However, there remains a gap in understanding the role of domestic trade flows and structural linkages across regions, particularly in developing countries. Our study contributes to this literature by leveraging new interregional input-output data for Brazil to examine how domestic integration interacts with global forces to shape regional inequality.

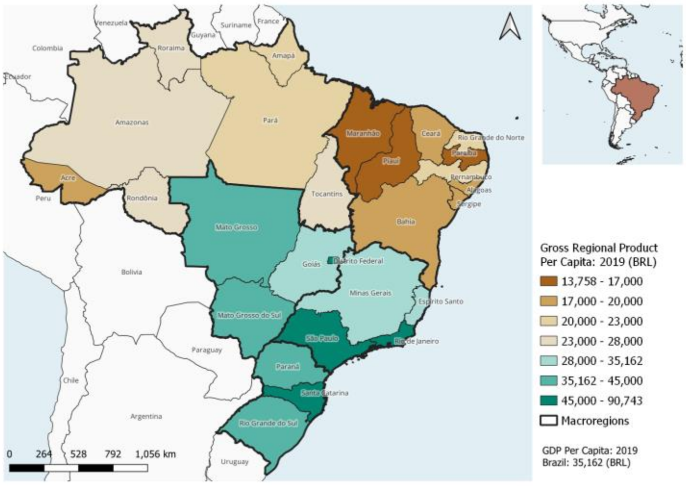
3. Regional Setting

3.1 Regional Inequalities in Brazil

Regional inequalities in Brazil have been examined through different lenses, such as: the influence of regional policies (Resende, 2012; Ribeiro et al., 2018), the relation between income inequality and spatial inequality (Ehrl and Monasterio, 2019), and the impact of interregional trade (Haddad, 1999; Perobelli and Haddad, 2006). Azzoni (2001), analyzing regional inequality in Brazil between 1939 and 1995, identified a general trend of income convergence, though with heterogeneous regional effects: poorer regions exhibited rising internal inequality, while richer regions experienced a decline. Manzi et al. (2023) identified a gradual reduction in regional inequalities in Brazil between 2002 and 2019, marked by σ-convergence at a declining rate. The authors highlight core-periphery dynamics, with states converging within distinct clusters that do not converge with each other. Differences in convergence speed and transitional dynamics are observed across clusters, with faster transitions in poorer states and heterogeneous trajectories within each group.

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).

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

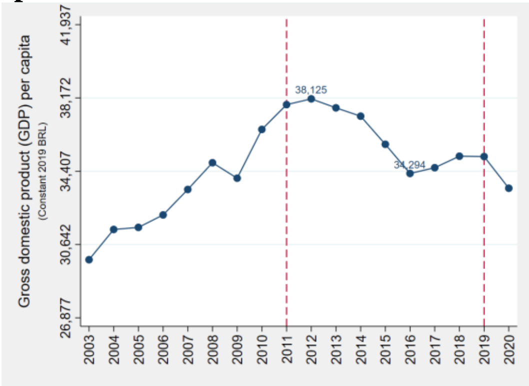


Source: Brazilian Institute of Geography and Statistics (IBGE). Regional Accounts of Brazil (2002-2020).

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. 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%.

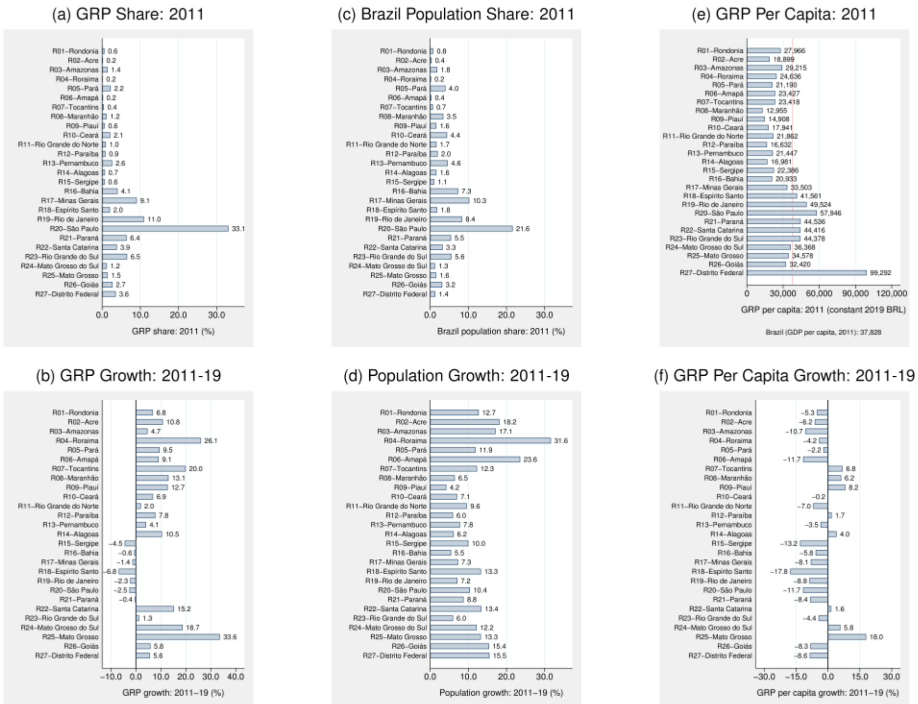
Figure 2. GDP per capita of Brazil between 2003 and 2020 (constant 2019 BRL)



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

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). During this period, only seven states—Sergipe, Bahia, Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, and Paraná—experienced a contraction in real regional income. These states accounted for 63.9% of the national GDP in 2019, underscoring the macroeconomic relevance of this regional downturn. 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. 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.

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. The systemic effects generated through input-output linkages act as a concentrating force that amplifies regional inequalities in Brazil. Figure 4 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 4. Regional distribution of the net value added multiplier in the Brazilian states in 2019

Value added multiplier (columns) / Regional distribution of the net value added multiplier (%) (rows)

	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. 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.

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 domestic trade, result in states located in the central-southern region of the country benefiting from sectoral and regional interdependence along supply chains. Haddad (1999) 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 the relationship between interregional trade and Brazilian regional inequalities.

4. Methodology

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.

The demand for intermediate inputs and final demand determine the production by sector and region in the input-output analysis. Consider an economy with M regions (labelled *r* or *s*) and N sectors (labelled i or *j*) in each region. Then, following Miller and Blair (2022), the standard input-output relationship can be written as

$$\mathbf{x} = \mathbf{LYi}. \tag{1}$$

Where the $(MNx1)$ vector **x** represents the gross output, the $(MNxMN)$ matrix $\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$ is the Leontief inverse. The $(MNxM)$ matrix **Y** represents the final demand, and **i** is a $(Mx1)$ column vector of ones. Here, **I** is the identity matrix, and **A** represents the intermediate inputs (**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:

$$\mathbf{va} = \hat{\mathbf{v}}\mathbf{LYi}. \tag{2}$$

The $(MNx1)$ diagonalized vector **v** in the matrix $\hat{\mathbf{v}}$ represents the value added (**w**) generated per unit of gross output, such as $\mathbf{v}' = \mathbf{w}'(\hat{\mathbf{x}})^{-1}$.

In order to be able to determine to what extent domestic trade has influenced structural change in Brazil, we expand the number of components in the solution of the interregional input-output model following the approach of Oosterhaven and van der Linden (1997) and Oosterhaven (2024).

4.1 Decomposition of the Leontief Effect

We disaggregate the input coefficient matrix **A** into two components, **C** and $\mathbf{A}^*$. Following the Hoekstra et al. (2016) and Araújo et al. (2020), we define the total input requirements of sector *j* in region *s* for output of sector *i* (i.e., the *i*-inputs) as $z_{ij}^{*s} = \sum_r z_{ij}^{rs}$. In (NxN) matrix form, this yields $\mathbf{Z}^{*s} = \begin{bmatrix} z_{11}^{*s} & \cdots & z_{1N}^{*s} \\ \vdots & \ddots & \vdots \\ z_{N1}^{*s} & \cdots & z_{NN}^{*s} \end{bmatrix}$. We then horizontally stack the $\mathbf{Z}^{*s}$ matrices across all s regions, and vertically replicate the result M times to obtain the final structure:

$$\mathbf{Z}^* = \begin{bmatrix} \mathbf{Z}^{*1} & \cdots & \mathbf{Z}^{*\mathrm{M}} \\ \vdots & \ddots & \vdots \\ \mathbf{Z}^{*1} & \cdots & \mathbf{Z}^{*\mathrm{M}} \end{bmatrix}. \tag{3}$$

These represent the total intermediate input requirements, irrespective of the origin region. Based on this, we compute $\mathbf{A}^* = \mathbf{Z}^*\hat{\mathbf{x}}^{-1}$, where $\mathbf{A}^*$ denotes the total technical coefficients that abstract from the geographic origin of inputs, capturing the underlying technological input structure of all industries across all regions. Structurally, $\mathbf{A}^*$ is an $(MNxMN)$ block matrix composed of M identical *NxMN* submatrices. Each submatrix reports the total use of input i from all Brazilian regions per unit of output of sector *j* in region *s*.

The intermediate input requirement matrix $\mathbf{Z}^{\mathrm{rs}}$ representing flows from region *r* and *s* can be expressed as $\mathbf{Z}^{\mathrm{rs}} = \mathbf{C}^{\mathrm{rs}} \otimes \mathbf{Z}^{*s}$ where $\mathbf{C}^{\mathrm{rs}}$ is a (*NxN*) matrix with element c_{ij}^{rs} denoting the share of total *i*-inputs used by industry *j* in region *s* that are sourced from region *r*. When *r*=*s*, $\mathbf{C}^{\mathrm{rs}}$ captures the share of domestically sourced inputs. Stacking all $\mathbf{C}^{\mathrm{rs}}$ matrices into a block matrix, we define $\mathbf{C} = \begin{bmatrix} \mathbf{C}^{11} & \cdots & \mathbf{C}^{1\mathrm{M}} \\ \vdots & \ddots & \vdots \\ \mathbf{C}^{\mathrm{M}1} & \cdots & \mathbf{C}^{\mathrm{MM}} \end{bmatrix}$. The full interregional input coefficient matrix $\mathbf{A}$ can then be constructed as $\mathbf{A} = \mathbf{C} \otimes \mathbf{A}^*$, where the Hadamar product (cell-by-cell matrix multiplication) $\otimes$ distributes the total technical coefficients $\mathbf{A}^*$ according to the regional sourcing structure defined by $\mathbf{C}$. Thus, $\mathbf{A}^*$ is an $(MNxMN)$ matrix with cell-specific trade origin ratios, indicating which fraction of that intermediate demand originates from region *r*. The Leontief inverse matrix can then be rewritten as $\mathbf{L} = (\mathbf{I} - \mathbf{C} \otimes \mathbf{A}^*)^{-1}$.

4.2 Decomposition of Final Demand

Furthermore, we can subdivide final demand in domestic final demand ($\mathbf{Y}^{\mathrm{D}}$) and foreign demand ($\mathbf{Y}^{\mathrm{F}}$), in which $\mathbf{Y} = \mathbf{Y}^{\mathrm{D}} + \mathbf{Y}^{\mathrm{F}}$. Let $\mathbf{Y}^{\mathrm{D}}$ denote the matrix of domestic final demand flows, where element y_i^{rs} represents the domestic final demand in region s for good i produced in region r. Thus, we define the domestic final demand in region s for input i from all source regions as $y_i^{*s} = \sum_r y_i^{rs}$. Gathering these values for all industries i, we construct a column vector $\mathbf{y}^{*s} = [y_1^{*s} \ \cdots \ y_i^{*s} \ \cdots \ y_N^{*s}]^{\mathrm{T}}$, which reflects the industry composition of final demand in region s, irrespective of the geographical source of the goods. Building the $\mathbf{y}^{*s}$ vectors for all $s = 1, \dots, M$, we define the (*MNxM*) matrix $\mathbf{Y}^*$, which contains the industry structure of final demand for each destination region. The matrix $\mathbf{Y}^*$ is the final demand counterpart of the intermediate input requirements matrix $\mathbf{Z}^*$. We then express domestic final demand as $\mathbf{Y}^{\mathrm{D}} = \mathbf{F} \otimes \mathbf{Y}^*$, where $\mathbf{F}$ is a (*MNxM*) matrix of sourcing shares for final demand. Each element $f_i^{rs} = y_i^{rs} / \sum_s y_i^{rs}$ represents the share of final demand in region s for industry i that is sourced from region r. The matrix $\mathbf{F}$ thus encodes cell-specific trade origin ratios, indicating the geographic source composition of final demand by sector and destination region. Let $\mathbf{y}^{\mathbf{F}}$ denote the (*MNx1)* column vector of foreign demand, defined as $\mathbf{y}^{\mathbf{F}} = \mathbf{Y}^{\mathbf{F}}\mathbf{i}$.

The matrix $\mathbf{Y}^*$ can be expressed as the product of two components: a matrix of industry shares of domestic final demand ($\mathbf{B}$) and a vector of total domestic final demand each destination region ($\mathbf{y}$). Specifically, define $\mathbf{B}$ as an (*MNxM*) matrix containing the industry shares of domestic final demand for each destination region, $\mathbf{B} = \begin{bmatrix} \mathbf{b}^1 & \cdots & \mathbf{b}^{\mathrm{M}} \\ \vdots & \ddots & \vdots \\ \mathbf{b}^1 & \cdots & \mathbf{b}^{\mathrm{M}} \end{bmatrix}$. The s-th column of $\mathbf{B}$, denoted $\mathbf{b}^{\mathrm{s}}$, is given by: $\mathbf{b}^{\mathrm{s}} = [b_1^s \dots \ b_i^s \dots \ b_N^s]^{\mathrm{T}}$, where $b_i^s = y_i^{*s} / y_*^{*s}$. Thus, $\mathbf{B}$ is a block matrix, with *M* mutually identical *Nx1* vectors with final demand preference coefficients, indicating the total use of input i from all over the Brazilian regions per unit of final demand in region s. Next, let $\mathbf{y}$ be an (*Mx1)* column vector whose element $y_*^{*s} = \sum_i y_i^{*s}$ represents the total demand in region s; that is, $\mathbf{y} = [y_*^{*1} \ \cdots \ y_*^{*s} \ \cdots \ y_*^{*M}]^{\mathrm{T}}$. Thus, $\mathbf{y}$ is a $(Mx1)$ column vector with consumption or income levels of final demand per region s. Then, $\mathbf{Y}^* = \mathbf{By}$.

4.3 Structural Decomposition Analysis

The solution of the model, from Equation (2), is now as follows:

$$\mathbf{va} = \hat{\mathbf{v}}(\mathbf{I} - \mathbf{C} \otimes \mathbf{A}^*)^{-1}(\mathbf{F} \otimes \mathbf{By} + \mathbf{y}^{\mathbf{F}}). \quad (4)$$

The change in gross value added between two points in time ($\Delta\mathbf{va} = \mathbf{va}_1 - \mathbf{va}_0$), from Equation (4), can distinguishes change in value added coefficients ($\hat{\mathbf{v}}$); technical ($\mathbf{A}^*$) and preference ($\mathbf{B}$)

coefficients; domestic trade patterns for intermediate ($\mathbf{C}$) and final ($\mathbf{F}$) demand; income or consumption level ($\mathbf{y}$); and foreign trade ($\mathbf{y^F}$).

Building on the approach of Oosterhaven and Van der Linden (1997), Hoekstra et al. (2016), and Araújo et al. (2020), and adapting it to the interregional input-output framework—where different domestic regions serve as alternative sourcing origins. Changes in production technology refer to the amount and composition of inputs used in the production process, regardless of their geographic origin, is captured by changes in $\mathbf{A}^*$. In contrast, the geographic sourcing of inputs is captured by the $\mathbf{C}$ matrix. Each element of a $\mathbf{C}$ matrix represents the share of input i used by sector j in region s that is sourced from region r. By construction, the column sums of the full $\mathbf{C}$ matrix equal N, the number of industries. Therefore, changes in $\mathbf{C}$ reflect shifts in the origin of inputs—not in the production technology itself—and thus sum to zero; that is, an increase in the share of imported inputs necessarily implies a decrease in the share of domestically sourced ones. Analogously, we apply the same decomposition framework to final demand.

Our analysis therefore focuses on changes in gross value added in each region that can be attributed to shifts in trade patterns—that is, the combined effects of changes in the sourcing structure of intermediate and final demand. Since the elements of the $\mathbf{C}$- and $\mathbf{F}$-matrices sum to zero, the net effect of these trade pattern changes on gross value added arises from differences in the value-added intensity of production across source regions. A positive (negative) trade pattern effect indicates a shift in sourcing toward regions with more (less) value-added-intensive production technologies.
The SDA of these changes reads as follows:

$$\Delta\mathbf{va} = 0.5\ \Delta\hat{\mathbf{v}}(\mathbf{L_0}(\mathbf{F_0}\otimes\mathbf{B_0})\mathbf{y_0} + \mathbf{L_1}(\mathbf{F_1}\otimes\mathbf{B_1})\mathbf{y_1}) + \quad (5a)$$
$$0.25\ [\hat{\mathbf{v}}_0\mathbf{L}_1\Delta\mathbf{C}\otimes(\mathbf{A_0^*} + \mathbf{A_1^*})\mathbf{L_0}(\mathbf{F_1}\otimes\mathbf{B_1})\mathbf{y_1} + \hat{\mathbf{v}}_1\mathbf{L}_1\Delta\mathbf{C}\otimes(\mathbf{A_0^*} + \mathbf{A_1^*})\mathbf{L_0}(\mathbf{F_0}\otimes\mathbf{B_0})\mathbf{y_0}] + \quad (5b)$$
$$0.25\ [\hat{\mathbf{v}}_0\mathbf{L}_1(\mathbf{C_0} + \mathbf{C_1})\otimes\Delta\mathbf{A}^*\mathbf{L_0}(\mathbf{F_1}\otimes\mathbf{B_1})\mathbf{y_1} + \hat{\mathbf{v}}_1\mathbf{L}_1(\mathbf{C_0} + \mathbf{C_1})\otimes\Delta\mathbf{A}^*\mathbf{L_0}(\mathbf{F_0}\otimes\mathbf{B_0})\mathbf{y_0}] + \quad (5c)$$
$$0.25\ [\hat{\mathbf{v}}_0\mathbf{L_0}\Delta\mathbf{F}\otimes(\mathbf{B_0} + \mathbf{B_1})\mathbf{y_1} + \hat{\mathbf{v}}_1\mathbf{L}_1\Delta\mathbf{F}\otimes(\mathbf{B_0} + \mathbf{B_1})\mathbf{y_0}] + \quad (5d)$$
$$0.25\ [\hat{\mathbf{v}}_0\mathbf{L_0}(\mathbf{F_0} + \mathbf{F_1})\otimes\Delta\mathbf{B}\mathbf{y_1} + \hat{\mathbf{v}}_1\mathbf{L_1}(\mathbf{F_0} + \mathbf{F_1})\otimes\Delta\mathbf{B}\mathbf{y_0}] + \quad (5e)$$
$$0.5\ [\hat{\mathbf{v}}_0\mathbf{L_0}(\mathbf{F_0}\otimes\mathbf{B_0}) + \hat{\mathbf{v}}_1\mathbf{L_1}(\mathbf{F_1}\otimes\mathbf{B_1})]\Delta\mathbf{y} + \quad (5f)$$
$$0.5\ (\hat{\mathbf{v}}_0\mathbf{L_0} + \hat{\mathbf{v}}_1\mathbf{L_1})\ \Delta\mathbf{y^F} \quad (5g)$$

The SDA in Equation (5), following Dietzenbacher and Los (1998), takes the average of two so-called polar decompositions. The changes in gross value added therefore comprise changes in value added intensities (Eq. 5a), changes in technology (Eq. 5c), changes in domestic trade patterns for intermediates (Eq. 5b) or final demand (Eq. 5d), changes in the industry composition of final demand (Eq. 5e), changes in the income or consumption level (Eq. 5f), and change in foreign trade (Eq. 5g). Dietzenbacher and Los (2000) suggest that a key assumption of structural decomposition analysis—the independence of the variables being decomposed—is likely violated in expressions such as Equation (5), where, for instance, changes in value-added intensity (Eq. 5a) may occur alongside changes in production technology (Eq. 5c). However, given the purpose of our analysis, we choose not to follow their suggested decomposition in this study. Since we can group the results of components 5a and 5c together under the label of "technical changes," this choice does not compromise the validity of our approach, which is primarily concerned with understanding shifts in domestic and foreign trade patterns.

4.4 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 Haddad and Araújo (2021) 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 National Accounts System. 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 the 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. We deflated the 2011 IIOT to 2019 prices for the application of structural decomposition analysis techniques, using the deflator provided by the National Accounts System (IBGE, 2023). The IIOT specification covers 68 sectors and all 27 Federal Units (states).

5. Results

The gross value added (GVA) in the Brazilian economy increased by BRL 175 billion between 2011 and 2019, representing a modest 2.82% growth relative to its 2011 level. This stagnant performance reflects the prolonged economic crisis Brazil faced during this period. As illustrated in Figure 5, the service sectors accounted for a significant share of this growth, expanding by BRL 475 billion, primarily driven by business services. In contrast, the manufacturing, which accounted for 13.9% of GVA in 2011, contracted by 11% over the period. The Southeast, responsible for 55.3% of total GVA in 2011, was the only region to lose share in national economic activity, declining by 2.7%.

Figure 5. Decomposition of changes in the gross value added by Brazilian sectors and Macro-regions: 2011-19 (billion, constant 2019 BRL)

Industry	Macroregions: North	Northeast	Southeast	South	Central-West	Brazil	% to GVA in 2011
Agriculture	1,025	449	-20,312	5,054	8,513	-5,270	-1.67
Mining and quarrying	-6,625	-12,434	-66,118	-598	-1,498	-87,274	-32.31
Manufacturing	-7,786	11,629	-91,145	-7,171	410	-94,063	-10.97
Electricity and construction	-1,172	-17,591	-78,323	-8,361	-8,387	-113,834	-20.57
Trade	4,690	-49	10,159	9,940	2,715	27,455	3.45
Business services	8,817	36,329	85,641	60,581	35,139	226,507	11.19
Public administration	15,492	30,704	14,751	26,571	24,081	111,601	11.22
Other service activities	3,068	18,735	51,660	23,381	12,629	109,473	29.44
Total	17,510	67,772	-93,688	109,398	73,603	174,595	2.82
% relative to GVA in 2011	4.92	7.98	-2.74	11.11	12.77	2.82	

Source: SDA results.

The decomposition of the gross value added growth from 2011 to 2019 into six domestic components, value-added coefficients ($\Delta\hat{\mathbf{v}}$), intermediate trade ($\Delta\mathbf{C}$), technology ($\Delta\mathbf{A}$), final demand trade ($\Delta\mathbf{F}$), consumption patterns ($\Delta\mathbf{B}$), and consumption level ($\Delta\mathbf{y}$), Equations (5a)-(5f), and one foreign component, capturing by foreign trade ($\Delta\mathbf{y}^{\mathbf{F}}$), Equation (5g), is shown in Table 1. The domestic components contributed 26.3% to the value-added growth (BRL 46 billion), while the foreign demand contributed 73.7% (BRL 129 billion). Domestic absorption, through change in consumption patterns and consumption level, was the most important component of the value-added growth. We can explore the results in Table 1 in more detail:

- The negative variation in value added per unit of output ($\Delta\hat{\mathbf{v}}$) of BRL -176 billion (-2.8%) is partially explained by a decrease in the value-added coefficient due to an increase in import penetration or an increase in intermediate input coefficients.
- The negative effect of $\Delta\hat{\mathbf{v}}$ is partially offset by a structural shift toward sectors with higher value-added coefficients, captured by the change in technical coefficients ($\Delta\mathbf{A}$), amounting to BRL 18.3 billion. This component reflects technological and structural transformations in production processes that alter input composition. Such changes may originate from

efficiency gains (using fewer inputs per unit of output), increased reliance on specific industries due to substitution or adoption of new inputs, or outsourcing of activities (e.g., greater use of services by manufacturing sectors).

- We aggregate changes in intermediate inputs ($\Delta\mathbf{C}$) and final demand ($\Delta\mathbf{F}$) into a single component capturing shifts in domestic trade patterns. The overall negative effect (BRL -1.4 billion) reflects a reallocation of demand toward goods and services produced in states and sectors with lower value-added intensity.
- The negative variation in consumption patterns ($\Delta\mathbf{B}$), amounting to BRL 62 billion, reflects changes in the sectorial structure of final demand—by households, government, and investment. This preference shift is primarily driven by a relative decline in the consumption of agricultural and manufactured goods in favor of services, which are more value-added intensive.
- Changes in consumption levels ($\Delta\mathbf{y}$) represent the most significant driver of GVA growth in Brazil, accounting for an increase of BRL 142 billion (2.3% of 2011 GVA). This component captures shifts in the absolute level of domestic final demand, unlike the other domestic components, which reflect changes in coefficients. The expansion in domestic demand primarily stemmed from increased household and government consumption, while investment demand contracted due to the economic downturn during 2011–2019. Therefore, final expenditure (income level) are the dominant force behind structural transformation.
- Growth in foreign trade ($\Delta\mathbf{y}^{\mathbf{F}}$) accounted for BRL 129 billion, or 2.1% of the total variation in GVA over the period.

Therefore, the negative effect of declining value-added coefficients (−100.5%) was fully offset by increases in intermediate demand (+10.5%) and final demand (+35.0%) coefficients, as well as by growth in income/consumption levels (+81.4%) and foreign trade (+73.7%). The net contribution of changes in domestic trade structure was close to zero (−0.7% and −0.1%).

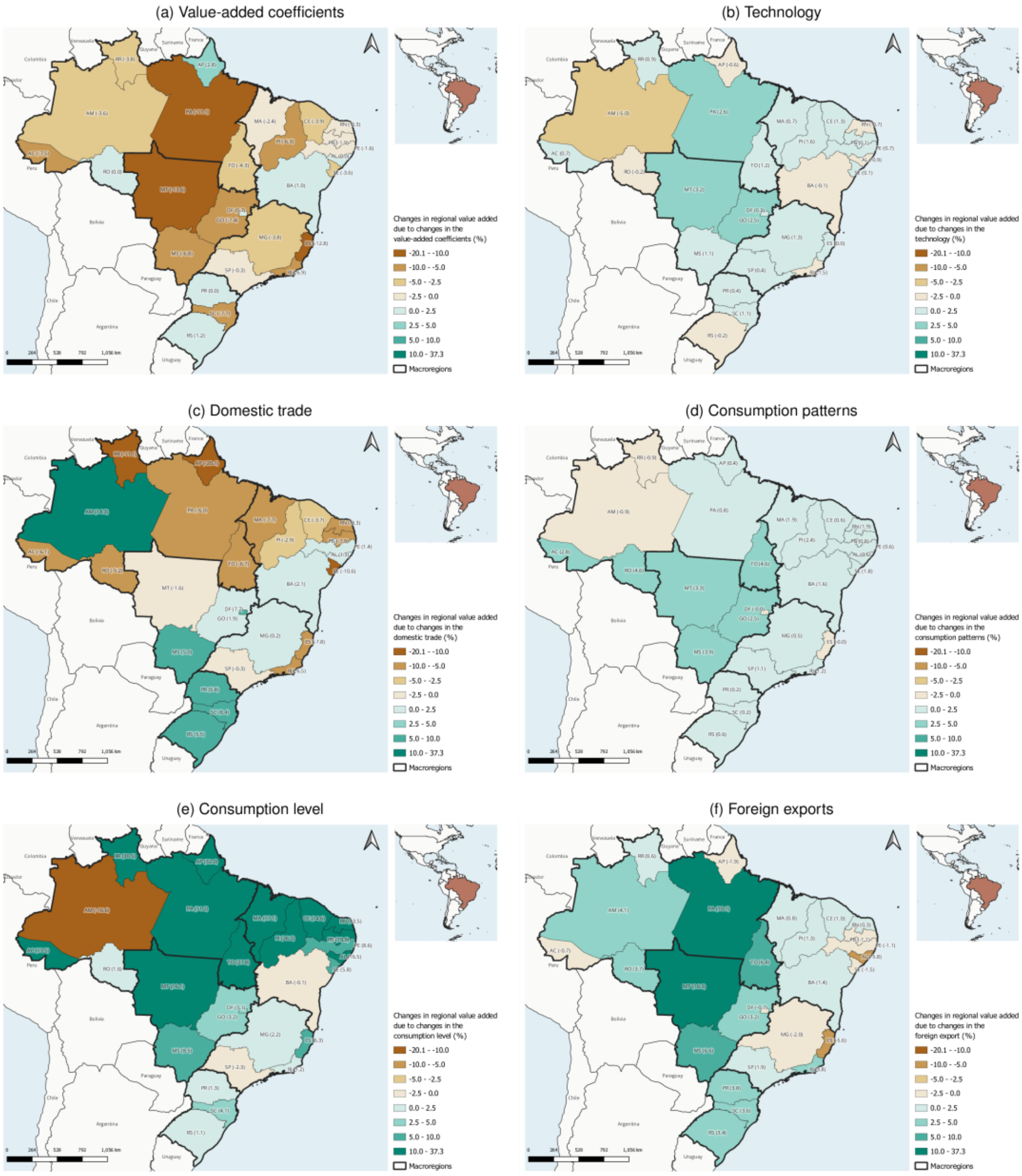
Table 1. Decomposition of changes in the gross value added in Brazil: 2011-19 (billion, constant 2019 BRL)

SDA components	Change in gross value added between 2011 and 2019		
	BRL billion	% of total change	% relative to GVA in 2011
Value-added coefficients	-175.5	-100.5	-2.8
Intermediate trade	-1.2	-0.7	0.0
Technology	18.3	10.5	0.3
Final demand trade	-0.2	-0.1	0.0
Consumption patterns	62.4	35.8	1.0
Consumption level	142.1	81.4	2.3
Foreign trade	128.7	73.7	2.1
Change in GVA, 2011-19	174.6	100.0	2.8

Note: Gross value added was BRL 6,182,089 million in 2011 and BRL 6,356,684 million in 2019. Official exchange rate, BRL per USD, 2019 average: 3.94 BRL/USD (Source: IMF).
Source: SDA results.

As discussed in Section 3.1, Brazil experienced economic stagnation between 2011 and 2019. The SDA components help reveal how individual Federal Units (states) responded to this crisis. Figure 6 shows the contribution of each component to changes in value added across Brazilian states, expressed as a percentage of each state's GVA in 2011. The state of Amazonas (AM) displays a distinct profile compared to other states in the North macro-region, with differences across nearly all SDA components. This divergence reflects the influence of the Manaus Free Trade Zone (Zona Franca de Manaus), an industrial hub supported by tax incentives designed to promote regional economic development and, indirectly, contribute to the preservation of the Amazon rainforest.

Figure 6. Decomposition of changes in gross value added between 2011 and 2019 for major groups of effects in the Brazilian states (in %)



Source: SDA results.

The sharpest decreases in value-added coefficients (Figure 6a) occurred in states located in Brazil's deforestation arc—particularly Mato Grosso (-13.6%) and Pará (-11.1%). In recent years, these states have undergone structural transformations, initially driven by the expansion of natural resource–based activities such as livestock, grain production, and mining following deforestation. This was followed by a transition toward service-oriented economic activities—such as retail, transport, and personal services—linked to urban growth.

Increases in intermediate input coefficients (Figure 6b) and shifts in preferences (Figure 7d) are observed relatively uniformly across the country. The negative effect of changes in domestic trade structure (Figure 6c) is greater in the North and Northeast macro-regions. Thus, interindustry and interregional linkages within the supply chain have fostered strong dependence on domestic trade from the more industrialized regions of the Center-South, shaping the country's pattern of economic expansion.

The domestic consumption-led growth observed at the national level (BRL 142 billion) was accompanied by significant regional variation. Growth in local income (Figure 6e) accounts for the largest share of value-added growth in Brazil, particularly in lower-income states in the North and Northeast. São Paulo (SP) was the only state in the Center-South to experience a decline in local consumption demand; due to its economic weight, the Southeast region as a whole recorded a BRL 15.6 billion reduction in consumption.

Foreign export performance in 2019 was dominated by 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%)—and 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%). Changes in foreign trade (Figure 6f) play a key role in explaining value-added growth in Pará (PA), a major mineral exporter, and in Mato Grosso (MT), Mato Grosso do Sul (MS), and Tocantins (TO), which are leading exporters of agro-industrial commodities such as soybeans, corn, beef, and vegetable oils.

Table 2 summarizes the decomposition results presented in Figure 6 for Brazil's five macro-regions. The Southeast region accounted for the largest decline in GVA, contributing 53.7% of the overall reduction, or a 2.7% decrease relative to its 2011 level. Despite the weak performance of the country's richest region, economic activity grew 2.8% in Brazil over the period, driven by gains in the North (4.9%), Northeast (8.0%), South (11.1%), and Central-West (12.8%) regions. The overall change in domestic trade structure accounted for BRL -1.4 billion, with a shift in trade patterns away from the Southeast region (BRL -64.1 billion) toward the South (BRL 62.6 billion) and Central-West (BRL 22.6 billion).

Table 2. Decomposition of changes in the gross value added by Brazilian macro-regions: 2011-19 (billion, constant 2019 BRL)

	Macroregions					Brazil
	North	Northeast	Southeast	South	Central -West	
GVA in 2011	356.0	849.2	3,416.3	984.3	576.3	6,182.1
GVA in 2019	373.5	917.0	3,322.6	1,093.7	649.9	6,356.7
SDA components						
Value-added coefficients	-22.5	-12.1	-96.1	-14.1	-30.8	-175.5
Intermediate trade	1.6	-4.4	-30.9	18.9	13.6	-1.2
Technology	-0.6	3.2	3.3	3.3	9.2	18.3
Final demand trade	-5.6	-14.1	-33.3	43.7	9.1	-0.2
Consumption patterns	3.7	10.4	34.0	3.4	10.8	62.4
Consumption level	18.7	84.5	-15.6	18.8	35.6	142.1
Foreign trade	22.2	0.2	44.9	35.4	26.1	128.7
Domestic trade						
Intermediate and final demand trade	-4.0	-18.5	-64.1	62.6	22.6	-1.4
% relative to GVA in 2011	-1.1	-2.2	-1.9	6.4	3.9	0.0
Change in GVA, 2011-19	17.5	67.8	-93.7	109.4	73.6	174.6
% of total change	10.0	38.8	-53.7	62.7	42.2	100.0
% relative to GVA in 2011	4.9	8.0	-2.7	11.1	12.8	2.8

Note: Official exchange rate, BRL per USD, 2019 average: 3.94 BRL/USD (Source: IMF).
Source: SDA results.

According to the 2019 IIOT, the North and Northeast regions ran interregional trade deficits—accounting for approximately 19% of exports but 24% of imports. Table 3 presents the changes in GVA resulting from shifts in domestic trade patterns. The origin of demand is shown in the columns, while the location of production is shown in the rows. Between 2011 and 2019, the shift in trade patterns from these less developed regions reduced local production by BRL 19.4 billion (–1.6% of their 2011 GVA), while increasing output in the wealthier South and Central-West regions by BRL

34.3 billion (+2.2% of their 2011 GVA). The increase in GVA in the South (BRL 62.6 billion) and Central-West (BRL 22.6 billion) regions was primarily driven by rising demand from other regions. These findings underscore how domestic trade can reinforce structural disparities by redirecting growth benefits away from less developed regions. These findings are consistent with those of Araújo et al. (2023), who showed that interconnectedness within domestic supply chains influences the performance of local economies in Colombia and improves regional resilience during economic recessions.

Table 3. Change in GVA due to changes in domestic trade patterns between Brazilian macro-regions: 2011–19 (billion, constant 2019 BRL)

	Region	Origin of the domestic demand					Total
		North	Northeast	Southeast	South	Central–West	
Region affected by changes in domestic demand	North	-8.4	1.8	-0.7	0.0	3.3	-4.0
	Northeast	1.3	-14.0	-9.1	-4.8	8.2	-18.5
	Southeast	-5.5	-10.3	-7.1	-30.4	-10.9	-64.1
	South	3.5	5.6	14.4	39.2	-0.1	62.6
	Central–West	8.7	16.5	2.1	-3.5	-1.2	22.6
	Brazil	-0.4	-0.4	-0.3	0.4	-0.7	-1.4

Source: SDA results.

The impact of interregional input-output linkages from foreign trade also contributes to regional inequalities in the Brazilian economy. The systemic effects of foreign demand on value-added growth is shown in Table 4. The North and Northeast absorbed 82.5% (BRL 19.1 billion) of the value added generated by their own foreign demand, while the Southeast, South, and Central-West absorbed 96.9% (BRL 102.3 billion) of the value added generated by foreign exports. These regionally disparate effects underscore the dependence of the North and Northeast on trade linkages with the more industrialized Southeast, South, and Central-West regions.

Table 4. The effect of foreign demand on changes in GVA in Brazilian macro-regions: 2011–19 (billion, constant 2019 BRL)

	Region	Origin of the foreign demand					Total
		North	Northeast	Southeast	South	Central–West	
Region affected by changes in foreign demand	North	20.3	0.3	0.5	0.5	0.6	22.2
	Northeast	0.7	-2.3	-0.2	0.7	1.2	0.2
	Southeast	2.6	0.3	27.8	6.3	8.0	44.9
	South	0.5	0.2	-0.4	33.5	1.7	35.4
	Central–West	0.5	0.0	-0.5	0.7	25.3	26.1
	Brazil	24.6	-1.5	27.1	41.7	36.7	128.7

Source: SDA results.

Tables 3 and 4 illustrate the systemic process that reinforces regional inequalities in Brazil, showing how poorer and wealthier regions absorb the production generated by changes in demand between 2011 and 2019. The production structure of the Southeast, South, and Central-West regions exhibit low productive leakage and absorbs a substantial share of the output resulting from demand originating in the North and Northeast. As a result, the pattern of production absorption in response to changes in domestic demand contributes to the persistence of regional disparities. In addition, shifts in foreign demand further increase these spatial inequalities. Haddad and Araujo (2021) demonstrate that the wealthier regions of Brazil benefit from the existence of 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.

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 quantify the contribution of each SDA component to regional disparities, we employ the Williamson index—a population-weighted coefficient of variation widely used in regional economics (Williamson, 1965). This index captures the extent of income disparities across regions while accounting for differences in population size. One of the main advantages of the Williamson index is its intuitive interpretation: it measures the dispersion of regional per capita income around the national average, weighted by population, making it particularly suitable for analyzing inequality across administrative units such as states. The Williamson coefficient of variation (CV_w) is computed as follows:

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

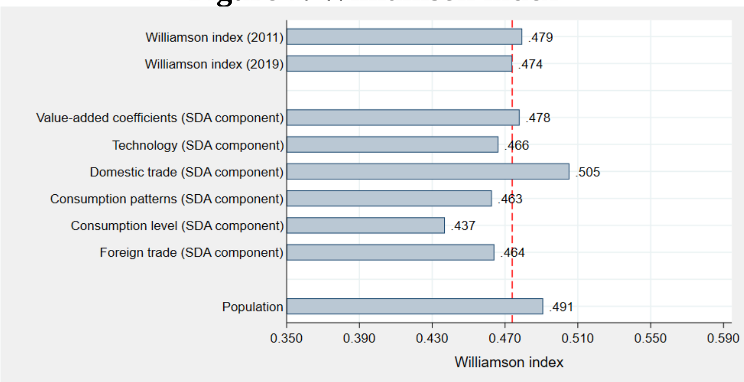
where y_i represents the gross value added per capita in state i (for $i = 1, \dots, 27$), n is the number of states, and $\bar{y}$ is the gross value added per capita in Brazil. To comprehend the effects of each component of the change in value added on inequalities, we shift the y_i element in Equation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

$$y_i = y_i^{2011} + \Delta SDA_i^{2011-19} \quad (8)$$

where $\Delta SDA_i^{2011-19}$ represents the change in each component of the structural decomposition analysis (value-added coefficients, technology, domestic trade, consumption patterns, consumption level, 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 construction of these counterfactual scenarios aims to evaluate how structural changes in gross value added and demographic composition over 2011–2019 shaped the evolution of regional disparities in Brazil. The results of CV_w are presented in Figure 7.

Figure 7. Williamson index



Source: Our calculation.

The CV_w in 2011 (0.479) was marginally higher than in 2019 (0.474), 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 worsen regional disparities (0.478)—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. The change in technology (0.466), consumption patterns (0.463), consumption level (0.437) and foreign trade (0.464) were the main drivers of the observed reduction in regional inequality. However, domestic trade (0.505) exacerbates regional disparities by reducing the effect of structural changes and benefiting the wealthier states. The alternative scenario of changing population distribution increases regional inequality (0.491).

To assess the robustness of our findings, we replicate the decomposition using the Theil index, a commonly used alternative in studies of spatial inequality. Both measures lead to consistent conclusions: increases in local income, captured by consumption levels, are the main factor behind declining regional disparities. In contrast, shifts in domestic trade patterns contribute to growing inequality across regions.

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 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 interregional and international integration changes were important for the observed variation in regional inequality in the 2010s. We find that final expenditure (income level) are the dominant force behind structural transformation and the reducing regional inequality. However, domestic trade reinforces regional disparities by shifting growth gains toward more developed areas. Interregional linkages act as shock absorbers, dampening regional convergence and amplifying income leakages from poorer regions. Shifts in technical and preference coefficients toward value-added-intensive sectors supported growth in lagging regions. Foreign trade also contributed to reducing regional inequality. Our findings underscore the critical role of input-output linkages and domestic trade patterns in shaping structural change and regional disparities—highlighting the often-overlooked importance of interregional trade.

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 increasing regional inequalities. In fact, interregional input-output linkages act as shock absorbers, weakening the process of regional convergence.

Another contribution of our study is highlighting the role of domestic 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 Araújo (2021), Araújo 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 regional inequalities. Brazil is undergoing a geographic reallocation of economic activity, with production expanding into the Central-West and North macro-regions, as previously shown by Araújo et al. (2019). This relocation within the national territory can affect regional convergence processes and is increasingly reflected in policymaking. For instance, Haddad et al. (2023a, b) evaluated the impacts of the tax reform passed in Brazil in 2023. The reform modified several fiscal mechanisms that previously influenced the spatial distribution of economic activity. Their findings suggest a trade-off between efficiency and regional equity, as the reform may lead to a concentration of production and an increase in regional disparities.

Additionally, spatial inequalities and regional growth opportunities have led to discussions about the effects of climate change and natural resource 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 domestic 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.

References

Araújo, I. F., Gomes, A. L., Ricciulli, D., & Haddad, E. A. (2023). *Economic Base and Regional Specialization in Colombia: A Note on Input-Output Linkages*. In: E. A. Haddad, J. Bonet, & G. J. D. Hewings (Eds.) The Colombian Economy and Its Regional Structural Challenges: A Linkages Approach. Springer.

Araújo, I. F., Gonçalves, E., & Almeida, E. (2019). Effects of Dynamic and Spatial Externalities on Local Growth: Evidence from Brazil. *Papers in Regional Science*, 98(2), 1239-1259.

Araújo, I. F., Jackson, R. W., Ferreira Neto, A. B., Perobelli, F. S. (2020). European Union Membership and CO2 Emissions: A Structural Decomposition Analysis. *Structural Change and Economic Dynamics*, 55:190-203.

Aroca, P., & Reyes, P. M. (2023). *Regional Business Cycles in Latin America*. Springer.

Austin, B., Glaeser, E., & Summers L. H. (2018). *Saving the Heartland: Place-Based Policies in 21st Century America*. Brookings Papers on Economic Activity, Spring.

Azzoni, C. R. (2001). Economic Growth and Regional Income Inequality in Brazil. *The Annals of Regional Science*, 35, 133-152.

Azzoni, C. R., & Haddad, E. A. (2018). *Regional Disparities*. In: E. Amann, C. Azzoni, & W. Baer (Eds.) The Oxford Handbook of the Brazilian Economy. Oxford University Press, pp. 422-445.

Azzoni, C. R., & Haddad, E. A. (2021). *The Case for Regional Policy: Design and Evaluation*. In: M. M. Fischer, & P. Nijkamp (Eds.) Handbook of Regional Science. Berlin, Heidelberg: Springer Berlin Heidelberg.

Baldwin, R., Forslid, R., Martin, P., Ottaviano, G., & Robert-Nicoud, F. (2003). *Economic Geography and Public Policy*. Princeton University Press.

Barufi, A. M., & Haddad, E. A. (2019). *Regional Policy Models: A Review*. In: R. Capello, R. & P. Nijkamp (Eds.) Handbook of Regional Growth and Development Theories: Revised and Extended Second Edition. Edward Elgar, pp. 573-587.

Bathelt, H., Buchholz, M., & Storper, M. (2024). The Nature, Causes, and Consequences of Inter-Regional Inequality. *Journal of Economic Geography*, lbae005.

Coşar, A. K., & Fajgelbaum, P. D. (2016). Internal Geography, International Trade, and Regional Specialization. *American Economic Journal: Microeconomics*, 8(1), 24-56.

Dietzenbacher, E., & Los, B. (1998). Structural Decomposition Techniques: Sense and Sensitivity. *Economic Systems Research*, 10(4), 307-324.

Duan, Y., Dietzenbacher, E., Los, B., & Dai, R. (2023). Regional Inequality in China during its Rise as a Giant Exporter: A Value Chain Analysis. *Journal of Regional Science*, 63(1), 148-172.
Ehrl, P., & Monasterio, L. (2019). Skill Concentration and Persistence in Brazil. *Regional Studies*, 53(11), 1544-1554.
Fan, J. (2019). Internal Geography, Labor Mobility, and the Distributional Impacts of Trade. *American Economic Journal: Macroeconomics*, 11(3), 252-288.
Fujita, M., & Thisse, J. F. (2009). New Economic Geography: An Appraisal on the Occasion of Paul Krugman's 2008 Nobel Prize in Economic Sciences. *Regional Science and Urban Economics*, 39(2), 109-119.
Fujita, M., Krugman, P. R., & Venables, A. (1999). *The Spatial Economy: Cities, Regions, and International Trade*. MIT Press.
Haddad, E. A. (1999). *Regional Inequality and Structural Changes: Lessons from the Brazilian Experience*. Routledge.
Haddad, E. A., & Araújo, I. F. (2021). The Internal Geography of Services Value-Added in Exports: A Latin American Perspective. *Papers in Regional Science*, 100(3), 713-744.
Haddad, E. A., Araújo, I. F., & Sacco, J. G. (2023a). *Reforma Tributária no Brasil: Impactos Regionais da PEC 45/2019*. Working Paper, n. 8-2023. Núcleo de Economia Regional e Urbana da Universidade de São Paulo.
Haddad, E. A., Araújo, I. F., & Sacco, J. G. (2023b). *Reforma Tributária no Brasil (2): Impactos Econômicos Regionais do FNDR*. Working Paper, n. 10-2023. Núcleo de Economia Regional e Urbana da Universidade de São Paulo.
Haddad, E. A., Cotarelli, N., Simonato, T. C., Vale, V. A., & Visentin, J. C. (2020). The Grand Tour: Keynes and Goodwin Go to Greece. *Journal of Economic Structures*, 9(1), 1-21.
Haddad, E. A., Faria, W. R., & Guilhoto, J. J. M. (2014). A Typology of Propagation of Technology and Social Preferences in the Process of Economic Development: An Input-Output Approach. *Journal of Economic Studies*, 41(4), 569-585.
Haddad, E. A., Gonçalves, C. A., & Nascimento, T. (2017). Matriz Interestadual de Insumo-Produto para o Brasil: Uma Aplicação do Método IIOAS. *Revista Brasileira de Estudos Regionais e Urbanos*, 11(4), 424-446.
Haddad, E. A., Hewings, G. J., Perobelli, F. S., & Santos, R. A. (2010). Regional Effects of Port Infrastructure: A Spatial CGE Application to Brazil. *International Regional Science Review*, 33(3), 239-263.
Haddad, E. A.; Araújo, I. F.; Feltran-Barbieri, R.; Perobelli, F. S.; Rocha A.; Sass, K. S.; & Nobrea, C. A. (2024). Economic Drivers of Deforestation in the Brazilian Legal Amazon. *Nature Sustainability*, 7, 1141-1148.
Herrendorf, B., Rogerson, R., & Valentinyi, A. (2013). Two Perspectives on Preferences and Structural Transformation. *American Economic Review*, 103(7), 2752-2789.
Hirschman A. O. (1958). *The Strategy of Development*. Yale University Press, New Haven, CN.
Hitomi, K., Okuyama, Y., Hewings, G. J. D. & Sonis, M. (2000). The Role of Interregional Trade in Generatin Change in Regional Economies of Japan, 1980-1990. *Economic Systems Research*, 12(4), 515-537.
Hoekstra, R., Michel, B., Suh, S. (2016). The Emission Cost of International Sourcing: using Structural Decomposition Analysis to Calculate the Contribution of International Sourcing to CO2–Emission Growth. *Economic Systems Research*, 28(2): 151-167.
IBGE (2023). Brazilian Institute of Geography and Statistics. *Regional Accounts of Brazil (2002-2020)*. Available at: https://www.ibge.gov.br.
Kim, S. (2008). *Spatial Inequality and Economic Development: Theories, Facts, and Policies*. In: Spence, M., Annez, P. C., & Buckley, R. M. (Eds.). Urbanization and growth. Washington, DC: World Bank Publications.
Krugman, P. (1991). Increasing Returns and Economic Geography. *Journal of Political Economy*, 99(3), 483-499.

Krugman, P., & Venables, A. J. (1995). Globalization and the Inequality of Nations. *The Quarterly Journal of Economics*, 110(4), 857-880.

Kuznets, S. (1955). Economic Growth and Income Inequality. *American Economic Review*, 45(10): 1-28.

Manzi, G., Alsayed, A., Martins, H., & Saibene, G. (2023). Regional Economic Convergence in Federation Contexts: A Comparative Analysis of Brazil and the European Union. *Regional Studies*, 57(11), 2269-2284.

Mejía-Reyes, P., Díaz-Carreño, M. Á. & Aroca, P. (2019). Mexican States' Business Cycles Co-movement over the Period 2000-2014: A Panel Data Model Estimation. *Growth and Change*, 50(4), 1532-1567.

Miller, R. E., & Blair, P. D. (2022). *Input-Output Analysis: Foundations and Extensions*. Cambridge University Press.

Myrdal, G. (1957). *Economic Theory and Underdeveloped Regions*. Duckworth, London.

Neuss, L. (2019). The Drivers of Structural Change. *Journal of Economic Surveys*, 33(1), 309-349.

Oosterhaven, J. (2024). A Decomposition of Economic Growth Decompositions. *The Annals of Regional Science*, 73:1395-1408.

Oosterhaven J., van der Linden J. A. (1997) European technology, trade and income changes for 1975-85: an intercountry input-output decomposition. *Economic Systems Research*, 9:393-411.

Pacheco, R., Fernandes, R. P., Araújo, I. F., & Haddad, E. A. (2023). *Trade in Value-Added: Does MFN Status Matter for Colombian Regions?*. In: E. A. Haddad, J. Bonet, & G. J. D. Hewings (Eds.) The Colombian Economy and Its Regional Structural Challenges: A Linkages Approach. Springer, Advances in Spatial Science.

Paluzie, E. (2001). Trade Policy and Regional Inequalities. *Papers in Regional Science*, 80(1), 67-85.

Perobelli, F. S., & Haddad, E. A. (2006). Padrões de Comércio Interestadual no Brasil, 1985 e 1997. *Revista de Economia Contemporânea*, 10(1), 61-88.

Perobelli, F. S., & Hewings, G. J. (2023). *Revisiting the Structural Interdependence among Colombian Departments*. In: E. A. Haddad, J. Bonet, & G. J. D. Hewings (Eds.) The Colombian Economy and Its Regional Structural Challenges: A Linkages Approach. Springer, Advances in Spatial Science.

Perobelli, F. S., Haddad, E. A., Moron, J. B., & Hewings, G. J. (2010). Structural Interdependence among Colombian Departments. *Economic Systems Research*, 22(3), 279-300.

Resende, G. M. (2014). Measuring Micro-and Macro-Impacts of Regional Development Policies: The Case of the Northeast Regional Fund (FNE) Industrial Loans in Brazil, 2000–2006. *Regional Studies*, 48(4), 646-664.

Ribeiro, L. C. S., Domingues, E. P., Perobelli, F. S., & Hewings, G. J. D. (2018). Structuring Investment and Regional Inequalities in the Brazilian Northeast. *Regional Studies*, 52(5), 727-739.

Rodríguez-Pose, A. (2012). Trade and Regional Inequality. *Economic Geography*, 88(2), 109-136.

Rodríguez-Pose, A., & Gill, N. (2006). How Does Trade Affect Regional Disparities?. *World Development*, 34(7), 1201-1222.

Silva, J. A. (2007). Trade and Income Inequality in a Less Developed Country: The Case of Mozambique. *Economic Geography*, 83(2), 111-136.

Sonis, M., Hewings, G. J., Guo, J., & Hulu, E. (1997). Interpreting Spatial Economic Structure: Feedback Loops in the Indonesian Interregional Economy, 1980, 1985. *Regional Science and Urban Economics*, 27(3), 325-342.

Sonis, M., Hewings, G. J. D., & Okuyama, Y. (2001). Feedback Loops Analysis of Japanese Interregional Trade, 1980–85–90. *Journal of Economic Geography*, 1(3), 341-362.

Venables, A. J. (2005). Spatial Disparities in Developing Countries: Cities, Regions, and International Trade. *Journal of Economic Geography*, 5(1), 3-21.

Williamson, J. G. (1965): Regional Inequality and the Process of National Development: A Description of the Patterns. *Economic Development and Cultural Change*, 13(4/2), 1-84.