economies

MDPI

Article

Linking Brazilian Regions to Value Chains: Is There a Potential for Regional Development?

Eduardo Rodrigues Sanguinet [1,2,3,*], Miguel Atienza [2], Carlos Roberto Azzoni [3] and Augusto Mussi Alvim [4]

[1] Instituto de Economía Agraria, Facultad de Ciencias Agrarias y Alimentarias, Universidad Austral de Chile, Valdivia 509000, Chile
[2] Departamento de Economía, Facultad de Economía y Administración, Universidad Católica del Norte, Antofagasta 1240000, Chile; matienza@ucn.cl
[3] Departamento de Economia, Faculdade de Economia, Administração, Contabilidade e Atuária, da Universidade de São Paulo, São Paulo 05508-010, Brazil; cazzoni@usp.br
[4] Escola de Negócios, Pontificia Universidade Católica do Rio Grande do Sul, Porto Alegre 90619-900, Brazil; augusto.alvim@pucrs.br
* Correspondence: eduardo.sanguinet@uach.cl

Abstract: This paper examines the subnational dimension of regional value-added transfers in multiscalar value chains in Brazil by analyzing the local content embedded in trade. This study reveals distinct spatial-based connectivity patterns within subnational and global value chains. An input–output model is employed to estimate the trade in value added from different Brazilian regions. The findings demonstrate that economically advanced regions, such as Southeastern Brazil, are both globally and nationally integrated and therefore stand to benefit from both types of integration. Conversely, subnational peripheries in the North and Northeastern states of Brazil play a crucial role in supplying raw materials for both domestic and global flows. These regions exhibit a clear profile of export dependency with low value-added content in trade. Consequently, our trade measures highlight a spatial concentration of development opportunities characterized by a distinct core–periphery pattern within the country. This imbalance in territorial capacity limits the potential for these regions to derive economic development benefits from integration into value chains.

Keywords: trade in value-added (TiVA); domestic value chains (DVC); global value chains (GVC); multiscalar analysis; uneven development

Citation: Sanguinet, Eduardo Rodrigues, Miguel Atienza, Carlos Roberto Azzoni, and Augusto Mussi Alvim. 2023. Linking Brazilian Regions to Value Chains: Is There a Potential for Regional Development?. *Economies* 11: 199. https://doi.org/10.3390/economies11070199

Academic Editor: Ines Kersan-Škabić

Received: 23 May 2023
Revised: 4 July 2023
Accepted: 10 July 2023
Published: 21 July 2023

1. Introduction

Understanding the relationship between uneven development and integration into so-called global value chains (GVC) is one of the main objectives of this framework (Gereffi 1994, 2019a, 2019b). In this regard, our analysis focuses on the implications of governance patterns of multinational companies (MNC) worldwide, evaluating their further development and industrial upgrading paths in a context of increasing fragmentation of production (Gereffi 2019a; Mudambi and Puck 2016; Mudambi et al. 2018; Baldwin 2006, 2008). However, despite the theoretical and analytical advances related to upgrades and development opportunities for local producers (Humphrey and Schmitz 2002), GVC-related evidence still lacks the explicit inclusion of the subnational scale when attempting to understand the potential for regional development and the increase in the quality of linkages across both domestic and global value chains (Mudambi et al. 2018; Verbeke and Asmussen 2016). From this perspective, the mode of regions participating in the value chain does not focus on the production of certain goods and services but focuses on a certain production link in the product value chain based on their respective resource endowments so as to obtain the largest trade gains (Liu et al. 2021).

To deal with this gap, the geographical dimension of Brazilian value chains is explored, providing evidence of the subnational role of regional engagement in different value chains.

For this purpose, we explore two main issues. First, we explore the trade-offs of value-added traded between domestic and global destinations according to the stages of the value chain. We include the subnational component in the theoretical and empirical field of our GVC studies, using trade in value-added (TiVA) statistics and an index of the regional value chain's participation (Koopman et al. 2014) within an input–output framework at a regional level based on the hypothetical extraction method (HEM) (Los et al. 2016; Haddad et al. 2020; Timmer et al. 2019). Second, we define the connectivity patterns of local integration in value chains. We classify the different patterns of integration into both subnational and global value-added trade flows, providing empirical elements to discuss the potential for regional development opportunities in the Brazilian states (Gui and Paolo Russo 2011; Lang et al. 2022).

From this scope, we analyze the hierarchical dimension of the leading roles of Brazilian states regarding the engagement patterns of uneven development and further map the potential benefits or losses when regions integrate into the GVC. Notably, the case of Brazil is adequate for multiscalar analysis due to its characteristics, including its economic geography and subnational disparities. Aspects such as the size of the country (population, area, and GDP) and its diversity in natural resource endowments, including agricultural resources, climate divide, and water and mineral availability, allow the creation of complex chains on a national and global scale (Azzoni and Haddad 2018; Silveira-Neto and Azzoni 2011). These aspects imply a structural divide in regional assets, leading to a clear-cut core–periphery pattern in which the Brazilian states play different roles in production networks both internally and internationally. On the one hand, the domestic architecture of production networks tends to be governed by the southeastern central areas—mainly Sao Paulo and Rio de Janeiro—which coordinate the DVC as suppliers of the highest intensive-value-added levels to the rest of the country. In contrast, the poorer peripheral Northern and Northeastern states tend to be more connected to the GVC as suppliers of natural resources for global nodes, such as Asian, North American, or European production centers (Guilhoto et al. 2015; Lee et al. 2018; Sturgeon 2016).

The importance of the Brazilian domestic market has intensified in recent years, leading to increasing rates of domestic value added (DVA) embedded into Brazilian exports (Montalbano and Nenci 2014; de Araújo et al. 2020; Perobelli et al. 2019). However, no previous research has analyzed how, in this inward-oriented form of integration into international markets, the different subnational regions are participating in value creation, nor how domestic value chains are connected to global value chains. Moreover, this raises doubts as to what extent peripheral areas benefit from the interaction of national and international chains (Duan et al. 2023). Building on this case study, other studies considered the analytical scope of well-known country-level value chains' participation indicators based on trade in value added (TiVA) measures, answering the calls for the incorporation of a multiscalar approach to building a broader picture of spatial value chains (Mudambi and Puck 2016; Timmer et al. 2019; Haddad and Araújo 2020).

Furthermore, to better understand the uneven development opportunities available to the Brazilian regional economy, this paper extends the GVC-related analysis of TiVA, including an explicit subnational dimension and a classification of different forms of integration considering the interaction of national and global scales. We redefine the theoretical–analytical outline of the spatial dimension of value-added flows in the context of both DVC and GVC. We deal with the structural path of both direct and indirect input–output linkages, emphasizing the delimitation of their frontiers and boundaries (Smichowski et al. 2016; Meng et al. 2017). This approach extends the analytical scope of well-known country-level participation in value chain indicators. It responds to the calls to incorporate a multiscalar approach to building a broader picture of spatial value chains (Mudambi and Puck 2016; Mudambi et al. 2018; Timmer et al. 2019; Haddad and Araújo 2020; McCann and Mudambi 2005), thus allowing us to obtain a better understanding of the uneven development opportunities available to the Brazilian regional economies.

It is important to stress that we do not attempt to analyze the evolution of value chains' integration and regional development patterns. Furthermore, we identify structural

features that provide new insights into the theoretical and policy-based issues of uneven development opportunities. We do not explicitly explore the temporal dimensions (Meng et al. 2017; Meng and Yamano 2017), the measurement of value capture (Whitfield et al. 2020; Coe and Yeung 2015), upgrading (Gereffi 2019a), and the feedback's direct and indirect effects on multi-country input–output tables (Hewings and Oosterhaven 2015). Our estimates are based on the mapping of interdependent value-added flows across subnational borders (Haddad and Araújo 2020), which enable us to propose a structural typology of the potential to increase quality linkages.

This article contains five sections. The first analyses how a multiscalar perspective of value chain analysis contributes to a better understanding of uneven development; afterward, the characteristics of Brazil's economic geography are briefly described. The third section presents the methods and data used in the analysis. The fourth section discusses the main results, and finally, we present our conclusions and their implications.

2. Core Dimensions of Spatial Interactions within Value Chains

2.1. From Global to Local

One of the original challenges of our GVC analysis, which was derived from the influence of world–systems theory in this framework, was to explain the uneven patterns of development based on the countries' specialization in different functions or stages of global production (Gereffi 1994). Most recent studies have associated integrating into GVC with different positive outcomes that lead to economic development through different stages of industrial upgrading (World Bank 2020). This approach is generally optimistic and assumes that global integration is beneficial for economic development by creating comparative advantages to incorporate more value added into trade (Baldwin 2006, 2017; Pickles and Smith 2016). This optimism has pushed into the background—when not left aside—the initial interest in understanding the causes of uneven development.

Another dominant characteristic of GVC analysis has been its methodological nationalism, taking nation-states as their main, if not unique, unit of analysis. This type of approach could provide novel results when the inherent multiscalar organization of the GVC is considered. However, the analysis of the subnational characteristics of value chains as part of the explanation of countries and regional positions is still missing (Fold 2014). There is little evidence in the GVC literature of analyses at different scales (Sturgeon and Gereffi 2008; Gereffi et al. 2005; Baldwin and Venables 2013; Los et al. 2015). Some studies in this direction point out that national integration into GVC is associated with a greater spatial concentration within countries (Kelly 2013; Smith 2015) and that benefits from the global integration of peripheral regions are very limited (Scholvin et al. 2019, 2020; Coe et al. 2008). However, evidence is still scarce about the channels that could explain this process and how DVC and GVC interact to promote or constrain regional economic development. In this sense, territorializing GVC analysis is crucial for understanding uneven development both within and across countries.

MNC are essential agents for explaining the organization and coordination of Global Production Networks (GPN) in a context where their location decisions have become increasingly complex and strategic (Iammarino and McCann 2013). These decisions include determining not only sites of production but also networks of suppliers and intra-industry trade and knowledge flows (Markusen 1989; Buckley et al. 1976). In this sense, the locational advantage of MNCs is increasingly defined at a subnational scale (Mudambi et al. 2018; Verbeke and Asmussen 2016; Rugman and Verbeke 2004). They help create hierarchies of places that define how value chains are organized and how each of these places contributes to value creation and, further, can benefit from participation in GVC. Thus, discussing aspects of regional integration within countries and combining them with trade between countries is necessary to identify the determinants of spatial heterogeneity and local capacity differentials (Iammarino and McCann 2013; Beugelsdijk et al. 2010; McCann 2008). The subnational coordination of value chains is based on spatially dependent assets (Teece 1986; Schotter et al. 2017), particularly innovation advantages, which depend on the

combination of local resources and global connections (Bathelt and Li 2014). Consequently, not all regions are equally prepared to participate in and obtain benefits from global integration, and their position can deeply explain their development opportunities within the DVC.

2.2. Local Dimension of Value Chains: Within-Country Value-Added Trade

The global production networks framework (GPN) literature has highlighted the territorial aspects of globally fragmented production (Coe and Yeung 2015). Refs. (Boschma and Frenken 2006; Rodríguez-Pose 2021; Yeung 2021) have stressed the need to combine the contributions of this approach with those of evolutionary economic geography (EEG). These are two of the most influential strands in economic geography and regional studies for the understanding of uneven development. The GVC framework has a relatively narrower approach based on inter-firm relationships and the analysis of trade in value added (TiVA) flows. Territorializing this type of analysis can also play a complementary role in understanding how spatially uneven patterns emerge, including some aspects of the fields of international and development studies that GPN and EEG do not always address.

Instead of gross flows of exports and imports, TiVA statistics, which are generally used in GVC studies, show how much of the added value generated by regions is distributed across the value chain network. From a global perspective, empirical evidence at a national scale suggests that the fragmentation of production has led developing countries to perform low value-added functions/activities, serving mainly as providers of raw materials to the large global nodes. The larger nodes specialize in the sophisticated and upper level of the value-added stages of production (Baldwin and Venables 2013; De Backer et al. 2018; Gereffi et al. 2010; Kowalski et al. 2015). Territorializing GVC implies analyzing to what extent this global trend is also reproduced within countries. It is possible to find some pockets of efficiency and globally competitive regions in developing countries, and the large ones may be able to build their own internal DVC as part of their development process. In this sense, local characteristics, such as access to knowledge, extensive markets, skilled labor, or even natural resources, can promote the heterogeneity of functional roles within these countries and globally (Iammarino and McCann 2013; Atienza et al. 2018), building a complex picture of interactions between DVC and GVC.

The regionalization of value chains involves diverse connectivity patterns across national and international scales, significantly impacting regional economic development opportunities (Atienza et al. 2020). Therefore, as a first approach to understand how the interaction of different spatial scales of trade in value added could affect regional development patterns (and opportunities), we consider some dimensions of subnational trade-based relations along with different value chains.

There are two main aspects to the spatial interdependence of value chains. The first depends on the characteristics of the regional economic structure, with participatory emphasis on the stage along the production chain (industrial pool), which determines the ability to generate, transfer and capture value (Coe and Yeung 2015). The second has to do with the industrial potential of the specialized stage in existing production chains, which can make the region a strategic trade partner in the supply of intermediate inputs, strengthening the levels of connectivity and interaction of the spatial reach of value-added trade flows.

The reach of GVC connectivity has been considered an important economic development strategy, considering the linkage and distribution of value, which may have different spatial boundaries (Lang et al. 2022; Milanovic 2016). Trade in value added through industrial linkages and within country regions provides relevant elements to understand the development potential of participating in chains. Furthermore, to address this shortcoming, we follow Brüntrup and Herrmann (2014) and Gui and Paolo Russo (2011), the authors of which propose some typologies of trade integration, on patterns of integration in value chains to identify connectivity characteristics of value-added flows. Overall, structural elements of local economies; the industrial pool at the sectoral activity level, which relates

to the upgrading potential in proving that local value was added; and the interaction of spatial scales, specifically the geographical reach of trade flows can be used as starting points to analyze connectivity patterns. First, the level of value added in trade depends on the location of assets and endowments in the regions and the level of diversification or productive specialization. Local productive aptitude is relevant to understanding the connectivity profile of value chains and the industrial content incorporated into production and trade (provider of intermediate inputs). Second, interactions at multiple scales (within-region and within-country) are influenced by the role played by regions in orchestrating the functioning of value chains. Regional hierarchies, mainly on the demand side, are essential to explain the direction and content of trade flows.

Figure 1 and Table 1 provide four potential scenarios of regional integration into value chains from this multiscalar perspective associated with different economic development opportunities and outcomes (Gui and Paolo Russo 2011)[1]. The input–output methodology is commonly used to analyze regional integration through value-added flows. The participation of regions in value chains is identified through trade in value added, which depends fundamentally on forward and backward linkages and the structure of the final demand. Therefore, by assessing the level of trade and the extent of flows (local or international demand), it is possible to determine the potential benefits of integration for regional development (Table 1).

Table 1. Main characteristics of a regionalization typology of multiscalar integration.

Type of Connectivity	Level of Value Added in Trade	Degree of Interaction in a Multiscalar Sense	Development Opportunities
Black hole	Intermediate, depending on the shorter-distance linkage requirements	Focused on intraregional (shorten value chains)	Less capacity to improve relations with other subnational and foreign trade partners
Centralized gateway	Highly concentrated in both resource-based and high-tech and intensive knowledge industries	Integrated with a clear governance role in a multiscalar integration	Higher potential to improve quality linkages. This integration profile is able to promote development impulses among hinterland linkages depending on the IO industry-related networks dealing with it
Balanced	Diversified in terms of industry pool	Able to integrate in a multiscalar sense for both local and foreign production networks	Higher opportunities to increase the value added in diversified production and trade structures
Unbalanced	Concentrated on less-intensive value added	Limited to the role of raw material providers, mainly for foreign markets	Fewer opportunities to build complex networks in which regions are able to engage in high-value-added stages among value chains

Given these characteristics, the regional position in domestic value chains (DVC) and global value chains (GVC) is intricately linked to the region's ability to harness advantages from global integration. Consequently, this relationship can help elucidate variations in patterns of uneven development, as outlined in Table 1. In this study, we conduct an empirical analysis focusing on Brazil to shed light on these aspects, as discussed in the following section.

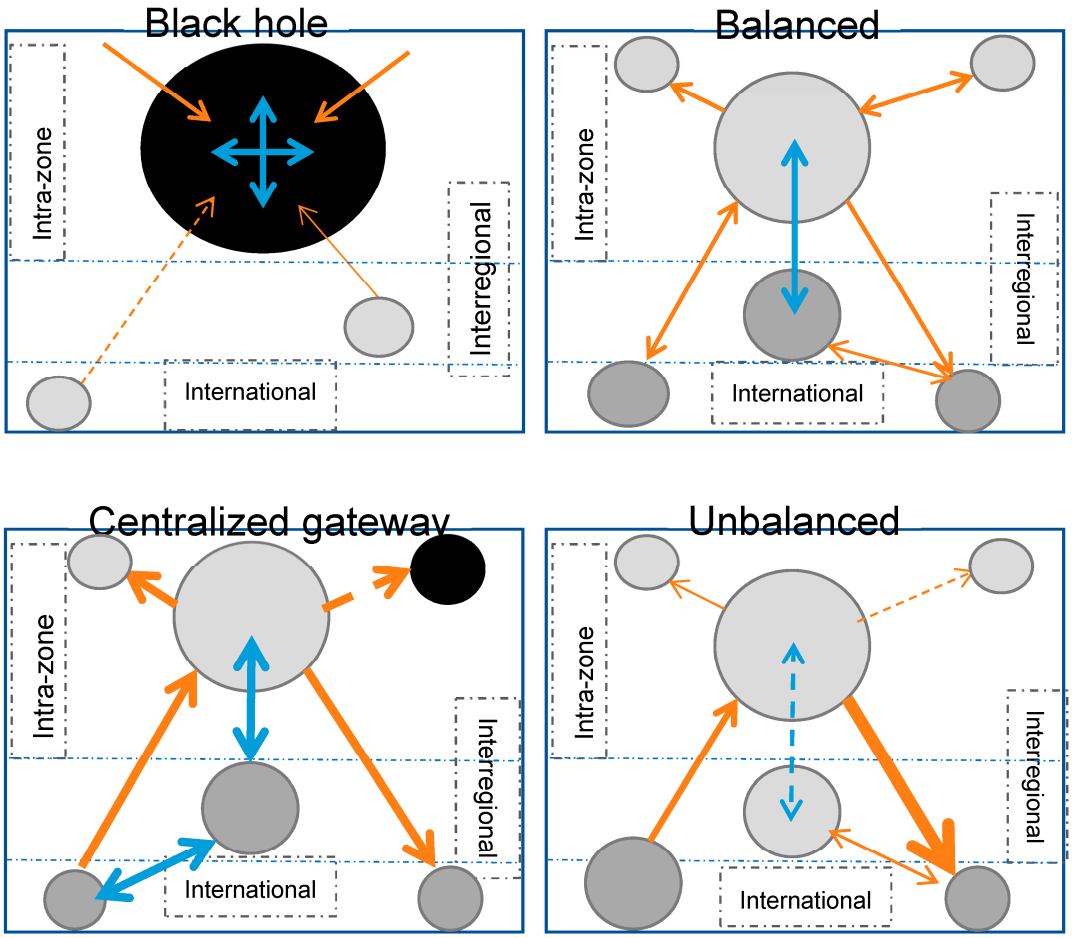

Figure 1. Stylized spatial-defined value chain categories. (1) Black hole: the black circles indicate internal benefits from integration. Links with other areas are weak (dotted and thinner arrows). There is little contribution to building networks outside (thin arrows). (2) Balanced: integration occurs inside, between, and outside the space units. The grey circle indicates that the region benefits and consolidates networks with other spatial levels (thicker and continuous arrows). (3) Centralized gateway: the gains are transmitted along the value chains, with connections at all levels (including black holes) to the hinterland and abroad. Thicker and continuous arrows show the governance potential to build networks at multiple scales. (4) Unbalanced: space units are unequally integrated, with spatial and industrial concentration potential. There are strong global links and a relative domestic disconnection, reducing the potential for internal linkages. Source: Authors based on Gui and Paolo Russo (2011).

3. Brazilian Regional Inequalities

In the context of growing globalization, Brazil has singular characteristics that are useful to understand the interaction of DVCs and GVCs in developing countries and how their architecture can contribute to the persistence of uneven patterns of territorial economic development.

The country of Brazil has a large domestic market and a relatively closed economy, with some level of trade protection in many industries (Sturgeon 2016; de Araújo et al. 2020; De Backer et al. 2018). Furthermore, Brazil's area represents about 85% of Europe—all non-Russian Europe fits into the country—and is larger than the continental U.S. This extensive area shows a substantial diversity in socioeconomic and environmental ways of living. Furthermore, the weather and the availability of natural resource endowments imply pronounced and persistent regional inequalities in terms of the local structure of production (Silveira-Neto and Azzoni 2011; Azzoni and Haddad 2018).

The large economic centers in the Southeast macro-region, including the states of São Paulo, Rio de Janeiro, Minas Gerais, and Espírito Santo, dominate the national economy (Figure 2). This core region represents just 11% of the territory but 53% of the national GDP and 42% of the population as of 2017. These states also have the highest concentrations of the leading educational and R&D hubs, the financial market, the manufacturing industry, and close to 60% of foreign direct investment (FDI) (Barroso 2016). Following the regional hierarchies, the southern Brazilian region has the second greatest regional economic importance, with 14% of the population, 16% of the GDP, and above-average levels of per capita income, education, and labor quality. In contrast, the poor Northeast macro-region covers nine states, 27% of the population, and 15% of the GDP as of 2017. This area could never reach a level of per capita income above half the national average (Azzoni and Haddad 2018). The south region is the second highest in terms of economic importance, with 14% of the population, 16% of the GDP, and above-average levels of per capita income, education, and labor quality. Finally, the large and sparsely populated areas in the North and Mid-West regions specialize in natural resources oriented towards the international markets, with grains and cattle in the Mid-west and mining in the North.

Figure 2 shows the contrast between the core–periphery pattern of the Brazilian economic geography in terms of GDP and the uneven spatial patterns in export orientation, which is strongly concentrated in the peripheral states in the Midwest and North regions. The importance of the domestic market has intensified in recent years, leading to increasing rates of domestic value added (DVA) being embedded into Brazilian exports (Montalbano and Nenci 2014; Perobelli et al. 2019). However, no previous research has analyzed how the different regions of the country participate in value creation, how domestic value chains are connected to global value chains, and to what extent peripheral areas benefit from the interaction of national and international chains.

(**a**) Share of GDP

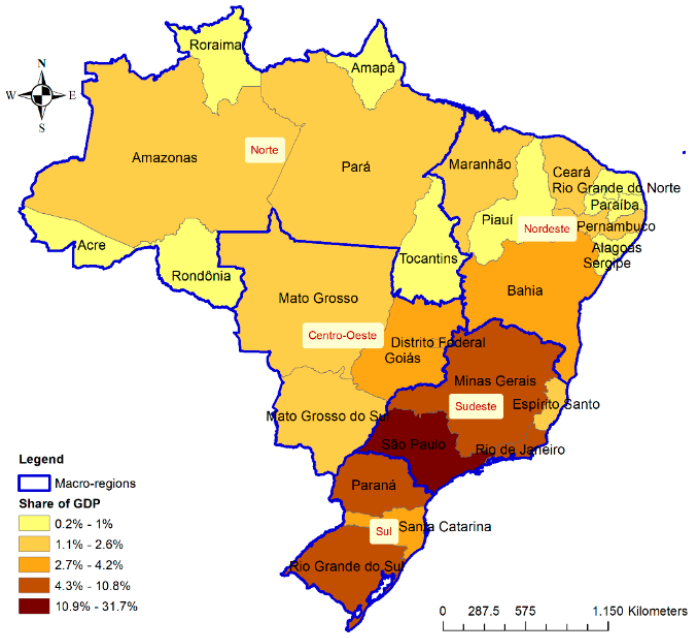

Figure 2. *Cont.*

(**b**) Ratio of total exports by regional GDP

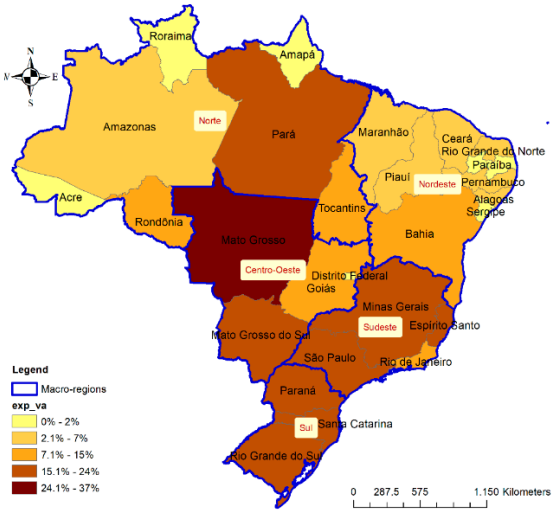

Figure 2. Regional patterns of Brazilian economic geography. Source: Brazilian IRIO.

4. Methodology

We used the 2015 interregional input-output (IRIO) table estimated by the Regional and Urban Economics Lab at the University of São Paulo (NEREUS-USP), covering 27 regions (federative units) and 67 industries[2]. The table is the latest public IRIO available online (the details of the methodological procedure can be found in (Haddad et al. 2017)). Regarding the data and time, evidence on the input and output suggests that tables represent interregional and interindustry dependence on the economic structure, which tends to maintain stability over time. In this regard, (Los et al. 2016) indicates that the fragmentation of production has modest changes over time, thereby allowing the assumption that economic structure can be analyzed from IO tables.

In our application, the DVC accountability regards the interregional VA flows, as it means focusing on the final interregional demand structure, whereas the GVC's integration measures the amount of VA embodied in the exports vector in the final demand (Haddad et al. 2020; Timmer et al. 2019; Meng et al. 2017; Visentin and Guilhoto 2019). Although TiVA accounting has been predominantly used in the GVC approach at the national level (Los et al. 2016; Baldwin and Robert-Nicoud 2014; Johnson and Noguera 2012, 2017; Koopman et al. 2011), this paper innovates by including the role of the interaction between DVCs and GVCs. For this purpose, the hypothetical extraction method (HEM) initially proposed by Los et al. (2016) is extended to an IRIO system covering regions, industries, and exogenous international export destinations, as proposed by Haddad et al. (2020) and Haddad and Araújo (2020).

4.1. Interregional Input–Output System: Trade in Value Added (TiVA)

The basic input–output (IO) of gross output is given by

$$x = (I - A)^{-1}y = By \tag{1}$$

where x is the gross output, $B = (I - A)^{-1}$ is Leontief's inverse, where I is the identity matrix, A is a square matrix of input coefficients, and y is the final demand. In the context of the IRIO model, this system is represented as block matrices given by

$$\begin{bmatrix} x_1 \\ \vdots \\ x_n \end{bmatrix} = \begin{bmatrix} B_{11} & \cdots & B_{1n} \\ \vdots & \ddots & \vdots \\ B_{n1} & \cdots & B_{nn} \end{bmatrix} \begin{bmatrix} y_{11} & \cdots & y_{1n} & \sum y_{1m} \\ \vdots & \ddots & \vdots & \vdots \\ y_{n1} & \cdots & y_{nn} & \sum y_{nm} \end{bmatrix} i \tag{2}$$

where i is a summation vector, and m represents the rest of the world (RoW) export destinations (Haddad et al. 2020). The actual domestic value added (DVA) of region 1 needed to attend to their final demand can be expressed as

$$\mathrm{dva}_1 = \mathrm{v}_1(\mathrm{I} - \mathrm{A})^{-1}\mathrm{y}i \tag{3}$$

where v_1 is a row matrix with the first element equal to the ratio between the VA and gross output of region 1 and zeros elsewhere, as in $\mathrm{v}_1 = \begin{bmatrix}\widetilde{\mathrm{v}_1} & 0 & \cdots & 0\end{bmatrix}$. Other regions are set to zero, while there is a domestic (local) value for 1s in their exchange for different subnational regions or exports (for other countries). To measure the DVA embodied in trade, Los et al. (2016), Chen et al. (2018), and Haddad and Araújo (2020) considered one hypothetical situation where region 1 does not export to region n. Therefore, the counterfactual DVA of 1 is expressed as

$$\mathrm{dva}^*_{1,\mathrm{n}} = \mathrm{v}_1\left(\mathrm{I} - \mathrm{A}^*_{1,\mathrm{n}}\right)^{-1}\mathrm{y}^*_{1,\mathrm{n}}i \tag{4}$$

where the final demand for 1 by n and intermediates inputs are set to zero. As a result, two counterfactual matrices, A and y, are defined as follows:

$$\mathrm{A}^*_{1,\mathrm{n}} = \begin{bmatrix}\mathrm{A}_{11} & \cdots & 0\\ \vdots & \ddots & \vdots\\ \mathrm{A}_{\mathrm{n}1} & \cdots & \mathrm{A}_{\mathrm{nn}}\end{bmatrix} \text{ and } \mathrm{y}^*_{1,\mathrm{n}} = \begin{bmatrix}\mathrm{y}_{11} & \cdots & 0 & \mathrm{y}_{1\mathrm{m}}\\ \vdots & \ddots & \vdots & \vdots\\ \mathrm{y}_{\mathrm{n}1} & \cdots & \mathrm{y}_{\mathrm{nn}} & \mathrm{y}_{\mathrm{nm}}\end{bmatrix} \tag{5}$$

As Haddad et al. (2020) suggested, for an IRIO system, the VA to exports is destined to follow $m = RoW$, which is exogenously defined. It is important to emphasize that this strategy has the limitation of ignoring a relevant part of the direct and indirect feedback effects of each region of the system with the other countries along the value chain by not considering a global IO table explicitly. Following the same logic, this can be expressed as follows:

$$\mathrm{dva}^*_{1,\mathrm{m}} = \mathrm{v}_1\left(\mathrm{I} - \mathrm{A}^*_{1,\mathrm{m}}\right)^{-1}\mathrm{y}^*_{1,\mathrm{m}}i \tag{6}$$

The HEM strategy shows that the trade DVA from region 1 is calculated by the difference between the actual DVA and counterfactual situations. Then, the bilateral TiVA from region 1 to region n, accounting for the DVC (interregional flows), is given by:

$$\mathrm{TiVA}_{1,\mathrm{n}} = \mathrm{dva}_1 - \mathrm{dva}^*_{1,\mathrm{n}} \tag{7}$$

The trade cycle is complete, supposing that VA imports are made with the same Brazilian technology as Haddad et al. (2020) assumed in the absence of a global multiregional IO table. This allows combining foreign markets from the perspective of purchase and also allows the sale of TiVA, while accounting for the DVA embodied towards the GVC. By disaggregating the regional VA by "s" industries, a suitable picture of the industrial VA content is directly and indirectly incorporated into the DVC and GVC. Therefore, the sum of the industrial TiVA equals the sum of the regional VA included in value chains, as follows:

$$\mathrm{TiVA}_{1,\mathrm{n}} = \sum_{\mathrm{s}=1}^{\mathrm{s}} \mathrm{TiVA}^{\mathrm{s}}_{1,\mathrm{n}} \forall\ \mathrm{s} = \{1, \ldots, s\},\ n = \{1, \ldots, r\}\ or\ n = \{RoW\} \tag{8}$$

4.2. Regional Position of a Value Chain: The Koopman Index

In order to provide empirical evidence of uneven patterns of value chain integration, our analysis was extended to include the subnational setting in the well-known Koopman index (Koopman et al. 2014), allowing us to map participation and regional position in value chains and discuss ex ante implications for regional development opportunities. The position index of Koopman et al. (2014) describes the relative position of a given region in the value chains. In an IRIO setting, the amount of DVA transferred to DVCs and GVCs is considered; further, the mentioned index measures the upstream position as the logarithmic

relationship between (1) the sum of intermediates supplied from one region ***r*** used in sales by other regions n and (2) the total of intermediate imports used in their local production. Then, the total VA that the region r delivers to the other regions of the interregional system is computed as the indirect VA use (IVU). Similarly, the total VA that the region receives from other areas, as the foreign VA uses, is the FUV. Therefore, the same logic was applied to account for Koopman's upstream index for DVC and GVC using the VA's measures to outflows and inflows. The indexing measurement is given by:

$$\mathrm{I_n} = \ln\left(1 + \frac{\mathrm{IVU_n}}{\sum \mathrm{TiVA}}\right) - \ln\left(1 + \frac{\mathrm{FUV_n}}{\sum \mathrm{TiVA}}\right) \text{ for } n = \{1, \ldots, r\} \text{ or } n = \{RoW\} \quad (9)$$

where $\sum$TiVA is the total VA traded into a country (across the DVC, $n = \{1, \ldots, 27\}$), and across the GVC, ($m = \{RoW\}$). Positive indices indicate a relatively more upward position; these positions contribute more VA to sell from other regions or countries than other countries to theirs. Indeed, two regions can have an identical position index in the industry while having very different degrees of participation in the DVCs (Koopman et al. 2014; Aslam et al. 2017). Therefore, the position index is assessed for all regions' transactions, indicating their relative importance for the subnational supply chain.

Finally, the results of bilateral TIVA flows were analyzed and discussed in light of the opportunities for uneven regional development. The Supplementary Material provides complementary indices for mapping the integration patterns in terms of revealed regional comparative advantage and cluster analysis results for the consistency of our typology classification. The following section presents the main results of TiVA for DVCs and GVCs in Brazil.

5. Results

This section is divided into three parts. In the first part, Brazil's DVC is analyzed, describing the position and the degree of dominance and governance in the architecture of production chains among the states. In the second part, the main aspects of the interaction between the DVCs and GVCs are discussed. Finally, the third part incorporates a discussion on regional development opportunities.

5.1. Subnational Brazilian DVC

Maps on the left side of Figure 3 show the VA flows among states of DVCs in agriculture, mining, manufacturing, and services, which are all different stages of a value chain, according to Equation (8). Based on the concept of *nodal regions* (Dacey 1960), three hierarchical relationships were defined in the domestic chains: dominant (red circles), intermediate (orange circles), and dominated (yellow circles). We considered that region A is dominated by region B if (1) the most important flow of A originates in B and (2) at least 20% of the total flow received by A comes from B. Thus, the subnational analysis of TiVA indirectly shows the interregional multiplier effects of industrial specialization and governance mechanisms in the DVCs[3].

A clear-cut core–periphery pattern with a hub and spoke morphology emerges, which is strongly dependent on the state of Sao Paulo (SP) in all industries. To identify more details of the architecture of DVCs within the country, the maps on the right side of Figure 3 exclude the exchanges involving SP, representing 32% of the total interregional TiVA. The strategy of excluding SP is not arbitrary. In all supply chains, the interregional flows involving Sao Paulo show dominance, hiding the potential for the integration of non-core regions (both geographically and economically). Furthermore, all maps on the left side of Figure 3 show a consistent central node position of Sao Paulo across different DVCs and an intermediary role of Rio de Janeiro.

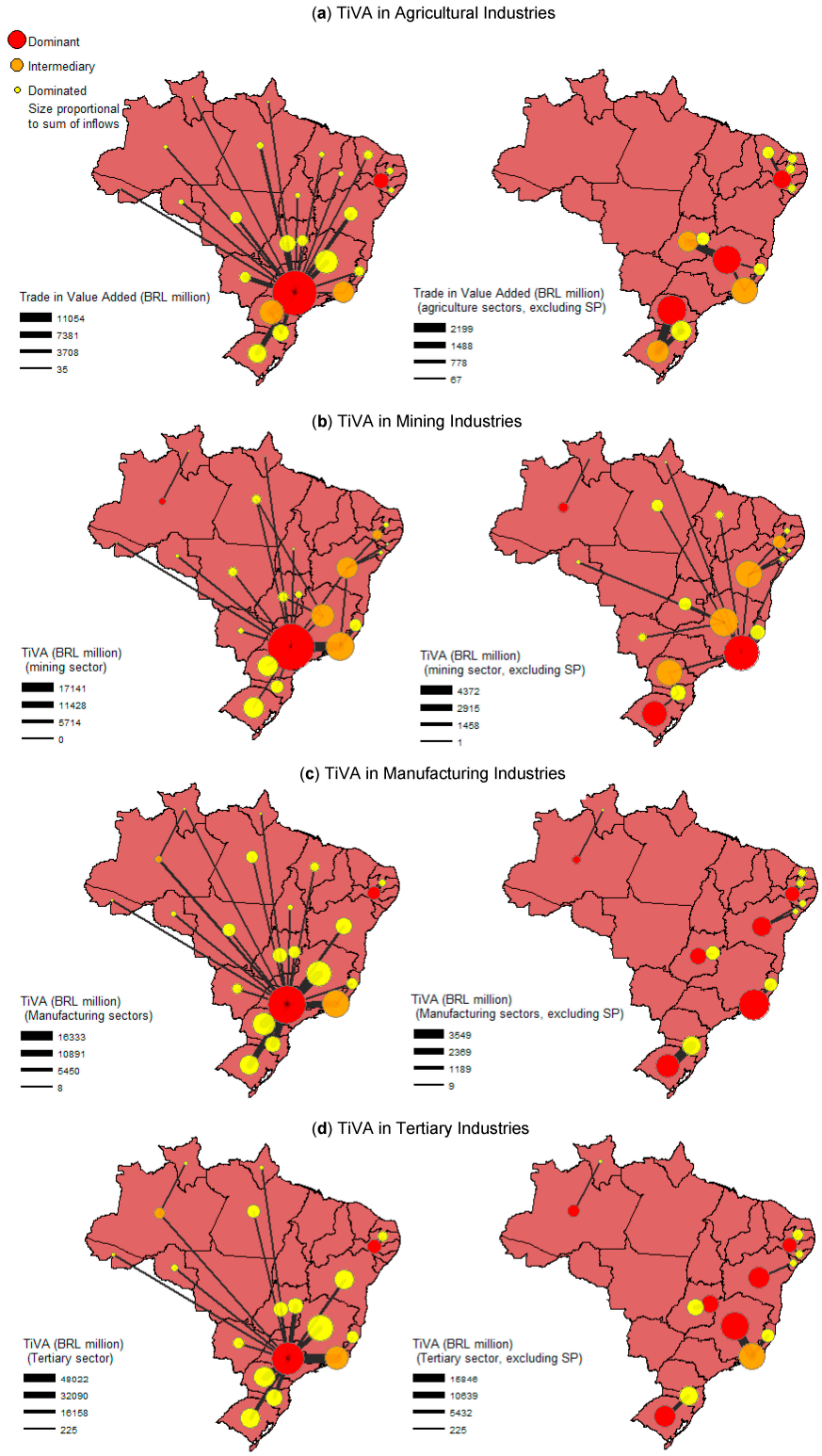

Figure 3. Interregional industry-level hierarchical TiVA. Legend: (**a**) Shows the interregional flows of agricultural industries (with and without Sao Paulo), (**b**) Shows the interregional flows of the mining industries (with and without Sao Paulo), (**c**) Shows the interregional flows of manufacturing industries (with and without Sao Paulo), (**d**) Shows interregional flows of tertiary industries (with and without Sao Paulo). Note: At least 20% of the total inflows and the dominant sales flow were considered to rank regions based on interregional TiVA. In part (**b**), São Paulo's buying and selling flows were dropped. Supplementary Material details bilateral TiVA flows.

In general, the degree of spread through local value chains was assessed by analyzing the industrial vocations within and among Brazilian states. To do so, we considered four large industry groups to understand the DVC's spatial architecture.

For agriculture-related activities, the exclusion of Sao Paulo highlights the dominance of the South and other Southeast states, including Minas Gerais and Rio de Janeiro; the Northern states are dominated by the rest of the country, being disconnected from agricultural supply chains. Three spatial patterns are revealed: (1) South: Paraná dominates due to the importance of land exploitation and the timber industry in the state, whereas Rio Grande do Sul has an intermediary position; (2) Southeast: Minas Gerais assumes dominance, highlighting the role of primary activities to promote connectivity within the country, and; (3) Pernambuco—which was historically the country's first economic center in the exploitation of sugarcane and wood—centralizes the dominance in Northeast. The Northern and Midwestern states are potentially disconnected from this type of supply chain, despite their relevance in terms of production.

This spatial pattern changes considerably in the domestic mining value chain. Excluding Sao Paulo, the dominance moves to the states of Rio Grande do Sul, Rio de Janeiro, and Amazonas. Interregional mining TiVA is concentrated in the South and Southeast macrozones. However, unlike agriculture, it now includes the Northern states in subnational networks. In the South macrozone, Rio Grande do Sul has extensive reserves of mineral coal and limestone, Rio de Janeiro hosts oil extraction and refining, and Amazonas (excluding the capital city, Manaus) exploits minerals such as niobium, kaolin, and sylvanite. The absence of the Sao Paulo hub reveals that the Southeast chain is governed by RJ and that there is a potential for the consolidation of a subnational value chain not dependent on Sao Paulo. This shows that the geography of natural resources can strengthen the position of some peripheral states.

The geography of domestic manufacturing value chains reveals that the most diverse manufacturing zone is concentrated in Sao Paulo, implying a dominant position, while Rio de Janeiro and Amazonas assume an intermediately dominant position. The strong specialization of Sao Paulo in high-technology intensive activities facilitates a relatively more complex architecture in the value chain, with potential for local linkages driven by geographical proximity in different states of the country. There is at least one central manufacturing hub in each macrozone (Rio de Janeiro—Southeast; Distrito Federal—Midwest; Bahia and Pernambuco—Northeast; Rio Grande do Sul—South; and Amazonas—North). A similar type of spatial organization of DVCs is present in the tertiary sector. However, in this case, when Sao Paulo is omitted, the Southeastern dominance moves to Minas Gerais due to its economic size (Haddad and Araújo 2020; Veiga and Rios 2017).

For a better understanding of the centralized hub and spoke morphology of the DVCs, a more detailed characterization of the VA transfers between the peripheral and central areas is shown in Table 2, presenting the industrial net balances across states. The first column shows the industrial share of TiVA incorporated at a national level by each industry (sum of all states). The rest of the columns represent non-core macrozones and the four states of Southeast Brazil (core areas). It is important to note that the sum of each line adds up to zero, allowing the identification of spatial patterns and territorial specialization.

A spatial division of production was found. The economic activities that require specialized knowledge and innovation are positioned at the top of the DVC's regional hierarchy. Accordingly, financial, business, and service activities, together with R&D activities, are highly concentrated in Sao Paulo, and to a lesser extent, in Rio de Janeiro, revealing centralized governance in high-tech DVC. Simultaneously, these states are net importers of electricity, gas, water, public services, and primary products, except mining, which is highly concentrated in Rio de Janeiro, home of the headquarters of Petrobras, the national state petroleum monopolist. This pattern contrasts with the industrial mix of the other macrozones. Only Southern states showed a more balanced result with some surplus in manufacturing trade. In general, however, the peripheral states are fundamentally suppliers of primary and intermediate inputs in DVCs, particularly to Southeastern states.

A clear-cut pattern of spatial divisions of production is found, where economic activities requiring specialized knowledge and innovation are positioned at the top of the DVCs' regional hierarchy. This pattern presents the first feature necessary to understand potential differences in the development opportunities from integrating into the GVC.

Table 2. Industry-level interregional TiVA balances (BRL, millions).

Industry (ISIC Groups)	Non-Core				Core States			
	North	Northeast	Midwest	South	MG	ES	RJ	SP
Accommodation and food	−1277	1475	−1428	−2235	−890	−92	3395	1052
Administrative activities and complementary services	−6641	−7987	−8272	−9844	−3880	−1076	6519	31,181
Agriculture, livestock, forest production, fisheries, and aquaculture	14,449	8954	11,051	11,578	−909	−1398	−9704	−34,021
Arts, culture, sport, and recreation	−368	−927	−281	−373	281	−130	1003	796
Construction	350	−978	−315	473	653	−137	486	−533
Domestic services	−234	−927	288	−1121	302	−196	1136	752
Education	−3441	−10,124	5215	6355	1607	−2586	13,475	−10,500
Electricity and gas	2994	811	1443	2918	−678	−487	1174	−8175
Extractive industries	−2	−3601	−2446	−9527	−1035	7048	26,458	−16,896
Financial, insurance, and related services	−14,866	−33,848	3816	−23,918	−16,747	−4324	−11,743	101,631
Human health and social services	−9859	−14,390	−9879	5587	−2086	−956	826	30,757
Information and communication	−6497	−15,893	−5178	−7505	−5115	−1603	8159	33,633
Manufacturing industries	−3758	−23,170	−18,308	19,145	−2596	−2859	−25,080	56,625
Other service activities	−1512	−1646	441	−1325	−313	−277	1434	3198
Professional, scientific, and technical activities	−6673	−10,485	−4933	−3190	−1198	−1911	3640	24,749
Public administration, defense, and social security	3996	7157	24,760	−13,740	−4217	1528	−7962	−11,521
Real estate activities	−2878	−9332	−1310	−4121	−3165	−297	2345	18,758
Trade; repair of motor vehicles and motorcycles	−5893	−16,280	−847	11,724	−12,246	1733	−8369	30,178
Transport, storage, and mail	−4217	−5691	−2104	1533	−1514	946	4857	6191
Water, sewage, waste management, and decontamination activities	−436	541	−58	−940	82	214	1419	−821
National level	−46,762	−136,341	−8344	−18,528	−53,665	−6860	13,467	257,033

The position of macrozones and core states in the DVCs contrasts when we analyze the aggregate contribution (last line of Table 2). Only the State of Sao Paulo provides more intermediate inputs than all the states in the Northeast and South. In contrast, Rio de Janeiro and Minas Gerais provide more value added to the DVC than all Northern states. The following section shows these relative positions in more detail.

5.2. Multiscalar Interactions between DVC and GVC and Value Chain's Position

Table 3 shows the participation of states in DVC and GVC inflows and outflows both nationally and internationally. Only 19.8% of the national VA is embodied in foreign destination exports, while the remaining 80.2% is oriented to DVCs. However, not all regions are deeply involved in DVCs, reinforcing the opportunities for export-led development in the GVC. Sao Paulo stands out for selling 78% of its VA to the rest of the country and, at the same time, having strong linkages with the GVC—more than 20% of the state VA is export-oriented.

Interestingly, the Southeastern states' role as a global nexus is relatively more extensive than their role in DVCs, with Sao Paulo and Rio de Janeiro acting as the leading "gateway states" connecting peripheral states to GVCs through DVCs (Scholvin et al. 2019). The neighboring states of Sao Paulo in the Southeastern regions—Rio de Janeiro, Minas Gerais, and Espírito Santo—provide around 24.7% of their local VA content to GVCs, representing altogether 62.7% of the national exports of VA (Table 3).

In the last decades, Brazil increased its participation in GVCs to meet its growing demand, mainly from the "Asian Factory". This process of international integration reveals substantial subnational differences. There is a core–periphery pattern in DVC and GVC integration, leading to uneven opportunities for industrial upgrading. Some remote places

specialized in supplying raw materials for GVCs are not fully integrated into DVCs, while diversified regions with stronger linkages with DVCs are also connected to GVCs. Two contrasting cases stand out in the North macrozone: Amazonas—where Zona Franca takes place—provides a higher level of VA to DVCs, while Pará supplies mining to GVCs. The rest of this macrozone has small regional economies that are relatively disconnected from DVCs.

Table 3. Multiscalar TiVA across DVCs and GVCs by the state of origin (BRL millions).

State		Domestic				Foreign				Composition	
		Inflows	(%)	Outflows	(%)	Imports	(%)	Exports	(%)	Domestic	Foreign
North	RO	16,319	0.9	8698	0.5	1503	0.4	1954	0.4	81.7	18.3
	AC	4585	0.3	2521	0.1	395	0.1	81	0.0	96.9	3.1
	AM	30,049	1.7	29,933	1.7	10,479	2.6	1856	0.4	94.2	5.8
	RR	4245	0.2	1387	0.1	258	0.1	30	0.0	97.9	2.1
	PA	46,783	2.6	23,557	1.3	6082	1.5	17,392	4.0	57.5	42.5
	AP	6429	0.4	1563	0.1	304	0.1	128	0.0	92.4	7.6
	TO	13,802	0.8	7791	0.4	1224	0.3	1583	0.4	83.1	16.9
	Total	122,211	6.9	75,449	4.2	20,245	5.0	23,024	5.2	76.6	23.4
Northeast	MA	37,802	2.1	19,381	1.1	3484	0.9	3101	0.7	86.2	13.8
	PI	18,739	1.1	8616	0.5	1343	0.3	981	0.2	89.8	10.2
	CE	42,458	2.4	25,593	1.4	5437	1.3	2783	0.6	90.2	9.8
	RN	23,132	1.3	12,915	0.7	2641	0.6	719	0.2	94.7	5.3
	PB	28,496	1.6	12,990	0.7	1865	0.5	314	0.1	97.6	2.4
	PE	57,096	3.2	40,141	2.3	7745	1.9	1756	0.4	95.8	4.2
	AL	16,653	0.9	14,297	0.8	1976	0.5	1076	0.2	93.0	7.0
	SE	14,099	0.8	9893	0.6	1988	0.5	269	0.1	97.4	2.6
	BA	103,962	5.8	62,269	3.5	16,264	4.0	11,214	2.6	84.7	15.3
	Total	342,437	19.2	206,096	11.6	42,744	10.5	22,212	5.1	90.3	9.7
Southeast	MG	185,240	10.4	131,575	7.4	34,742	8.5	44,337	10.1	74.8	25.2
	ES	42,329	2.4	35,468	2.0	10,019	2.5	12,887	2.9	73.3	26.7
	RJ	171,174	9.6	184,641	10.4	50,759	12.5	52,549	12.0	77.8	22.2
	SP	368,926	20.7	625,959	35.2	146,358	36.0	165,216	37.7	79.1	20.9
	Total	767,668	43.2	977,643	55.0	241,878	59.4	274,990	62.7	78.0	22.0
South	PR	136,663	7.7	130,230	7.3	27,314	6.7	30,801	7.0	80.9	19.1
	SC	81,062	4.6	75,004	4.2	16,788	4.1	18,851	4.3	79.9	20.1
	RS	111,276	6.3	105,239	5.9	26,350	6.5	36,198	8.3	74.4	25.6
	Total	329,001	18.5	310,473	17.5	70,452	17.3	85,850	19.6	78.3	21.7
Midwest	MS	36,575	2.1	29,802	1.7	5085	1.2	6747	1.5	81.5	18.5
	MT	45,087	2.5	35,681	2.0	7803	1.9	16,989	3.9	67.7	32.3
	GO	69,348	3.9	57,187	3.2	10,448	2.6	8345	1.9	87.3	12.7
	DF	66,740	3.8	86,737	4.9	8246	2.0	546	0.1	99.4	0.6
	Total	217,750	12.2	209,407	11.8	31,582	7.8	32,627	7.4	86.5	13.5
Brazil		1,779,068	100.0	1,779,068	100.0	406,902	100.0	438,703	100.0	80.2	19.8

In contrast, there is a solid subnational orientation in the northeastern macrozone. There are, however, three exceptions that are worth mentioning: Maranhão and Piaui, due to the availability of minerals in these locations, and Bahia, due to its recent industrialization driven by the automotive sector. The remaining states comprise more than 90% of the VA that is retained within the country. Finally, despite having smaller national representativeness, a more balanced integration is found in the Southern's macrozone. On average, all the states of this area follow the national distribution of VA to DVCs and GVCs in the primary and manufacturing industries.

Figure 4 combines the Brazilian states' position in DVCs and GVCs according to the Koopman upstream index presented in Equation (9). This measure describes the relative position of each Brazilian state within DVCs or GVCs. The index increases as

regions are relatively upstream, contributing with more VA for other regions rather than absorbing VA from abroad in their production. The horizontal axis represents the position in DVCs—the relative position of each state according to the total TiVA traded across interregional exchanges. The vertical axis plots each state's relative position, considering the VA embedded in exports and VA imports from abroad. Therefore, combining DVC and GVC assessments provides a clearer view of how Brazilian states become involved at different spatial scales[4].

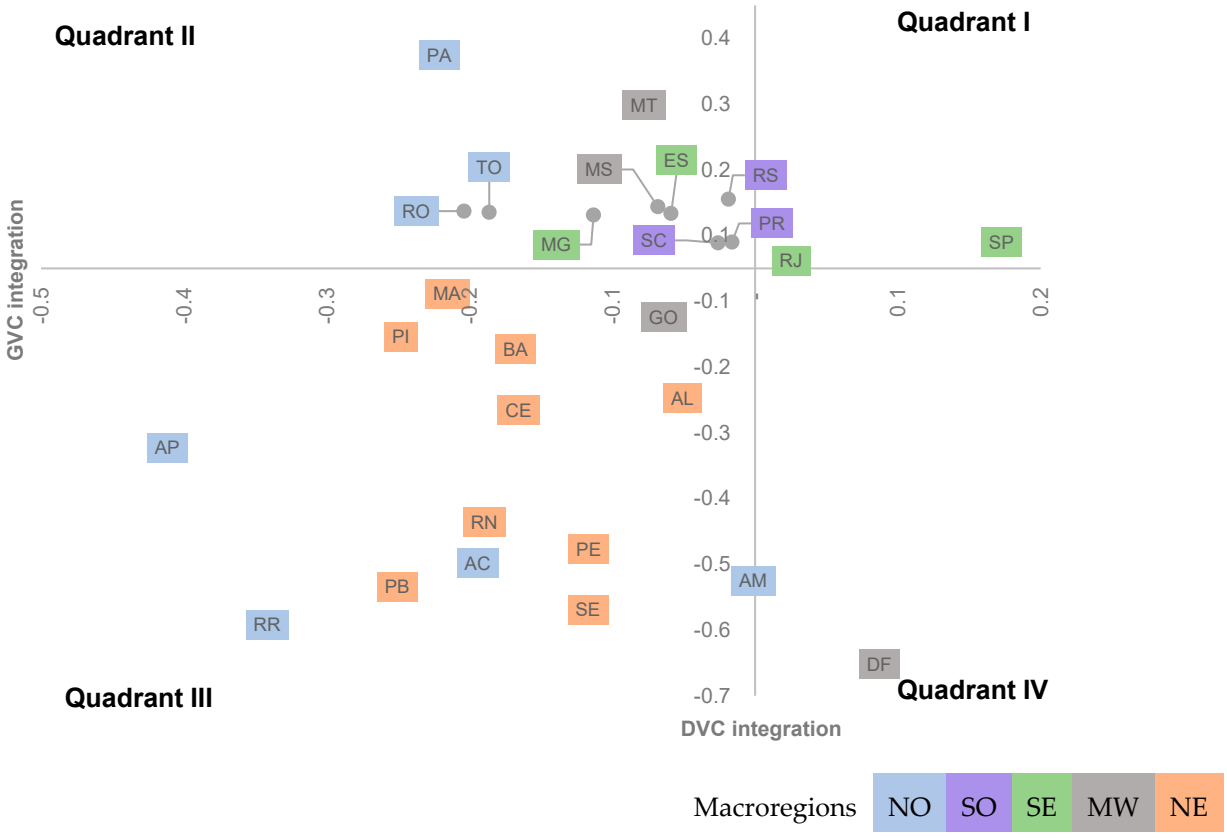

Figure 4. Relative position in value chains (Koopman index of DVCs and GVCs).

Quadrant I encompasses states that are the most connected to both DVCs and GVCs. The wealthiest and most industrialized states of Brazil—Sao Paulo and Rio de Janeiro—are relatively integrated into both levels, with indices above one. The other two Southeastern states—Minas Gerais and Espírito Santo—are in Quadrant II, with other states primarily oriented towards GVCs. Important mining and agricultural GVC suppliers are together in Quadrant II. Most Midwestern agriculture exporters are in this quadrant as well. Both states of this macrozone (Mato Grosso and Mato Grosso do Sul) specialize in commodities and livestock exports. Interestingly, all Southern states also have an export orientation, and their indices are very close to each other. However, these states have more diverse export-oriented baskets at a national and international scale, including goods from primary and secondary industries and providing VA to advanced value chains.

Quadrant III shows states potentially disconnected from the value chains, with Koopman indices below one in DVCs and GVCs. All Northeastern states belong there, revealing that their network articulation has only an intraregional character. Small northern economies also show a relative disconnection from networks. Finally, Quadrant IV includes states oriented toward DVCs, with two structurally differentiated cases. The first is Amazonas, the core state in the northern macroregion, which has an upstream position in the manufacturing sector's DVCs and is a net importer in GVCs due to its tax-free importing manufacturing zone. We also find in this quadrant the Distrito Federal, a net

global importer and a domestic supplier of public services due to Brasilia, the country's capital city.

5.3. Is There a Regional Case for Participation in Multiscalar Value Chains?

The regionalization of value chains has shown distinctive connectivity patterns across space that can significantly impact regional economic development opportunities. In Figure 5, we considered the connectivity patterns shown in Section 2 to propose core characteristics of Brazilian macrozones in terms of value chain integration. Three value chains' integration levels are considered (represented by the pie graphs in each state), including intrazone trade (within each macrozone), interregional trade (between macrozones' states), and international trade (from the macrozone to GVCs). The classification considers decompositions of TiVA (intrastate VA consumption, absorbed VA within macrozones, DVC transfers, and VA to GVCs) and industrial variety (the gap between the resource industries and industrial manufacturing and services)[5].

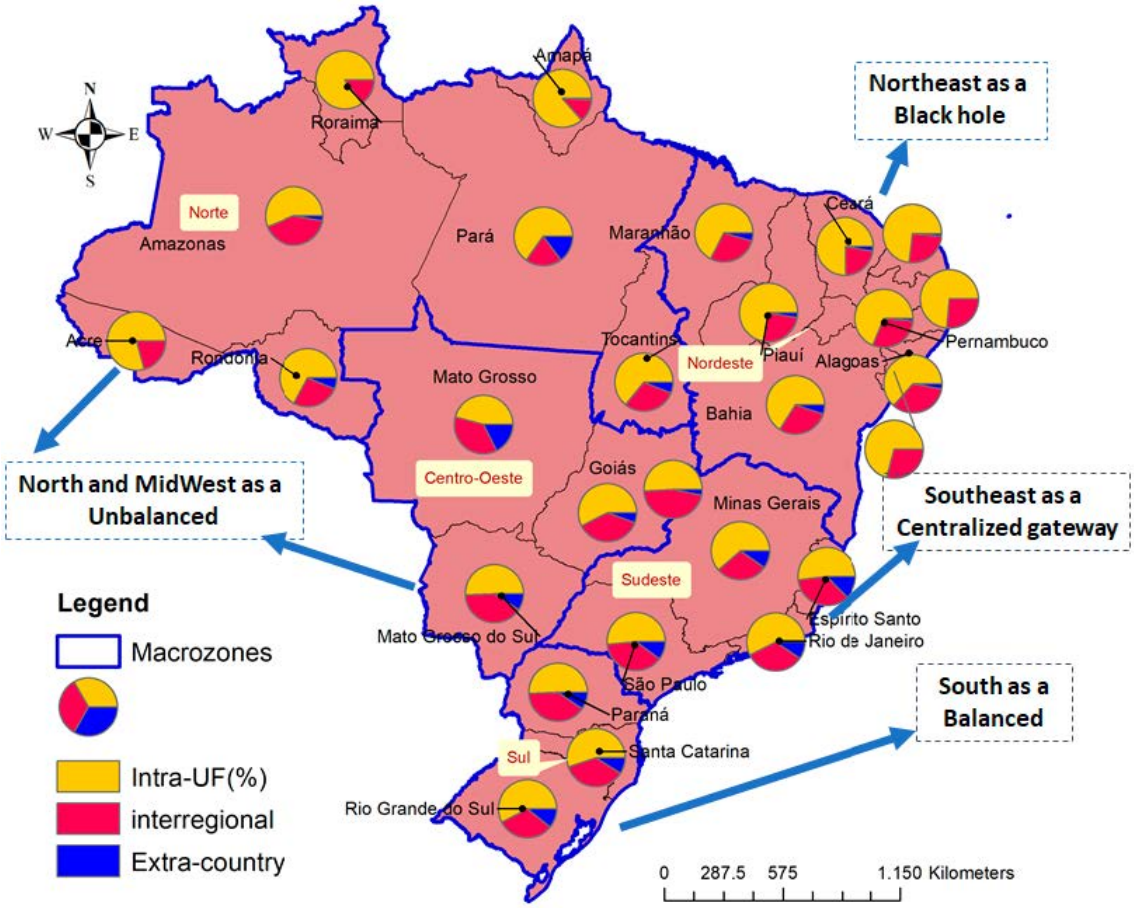

Figure 5. Regionalization of Brazilian value chains. Source: Authors (2023).

In this regard, we consider the interactions between different spatial patterns of connectivity, the intensity, and the quality of local content transferred to value chain networks (Markusen 1989; Beugelsdijk et al. 2010; McCann and Acs 2011). The subnational coordination of value chains is spatially based on regional assets (Teece 1986, 2010; Schotter et al. 2017). Combining the DVC and the GVC linkage architecture provides innovation and upgrading opportunities that directly affect economic development. According to these criteria, we can define four types of spatial-based connectivity patterns, as shown in Table 4.

Table 4. Spatial dimension of connectivity patterns in value chains.

Type of Connectivity	Characteristics and Development Potential
Black hole regions	These spatial units do not exploit regional assets for DVC or GVC integration. These regions have international production networks but possess weak connections both nationally and globally. The reduced degree of economic integration with external areas leads to the formation of short value chains. Geography acts as a facilitator of linkages with close neighbors, restricting the upstream opportunities to develop advanced stages (upgrading process) through national or international integration. Consequently, these spatial units have less capacity to participate in architecturally complex value chains than other areas inside the country and abroad. Their existence is similar to a black hole in the integration strategy of production networks. In addition, these regions tend to have poor asset endowments that make them unlikely to obtain benefits from integration, potentially reducing their ability to compete and thus restricting opportunities for more intense connectivity with broader value chains.
Centralized gateways	These spatial units are connected to the national hinterland through value chains and are potentially able to capture most of the value created in peripheral areas. Furthermore, these regions can extend their value chains through international links centralized at gateway cities (economic hubs). There has been general robust connectivity from a multiscalar perspective through DVCs and GVCs that depends on the installed local capacities in these areas. The local creation, adaptation, and dissemination of knowledge increase the ability of these areas for inter-regional value absorption and benefit from extra-regional connections. These local characteristics are attractive to national and international large companies, which can benefit from the existing links with peripheral areas of the country and with foreign markets.
Balanced regions	These spatial units take benefits of comparative advantages to integrate multiple geographic scales, which are not central nodes on a national scale. In this case, the intra-regional areas are articulated and balanced in terms of foreign and domestic orientation, creating bases that benefit from economic integration. The local content embedded in the value chains is balanced in technological and knowledge intensity, not feeding back an export-based model or a purely financial industry. The development opportunities from integration are broad as they allow regions to exploit territorial advantages and be empowered to perform various functions in both DVCs and GVCs.
Unbalanced regions	The potential for these spatial units to integrate into DVCs or GVCs is unbalanced in favor of global markets. Few of these regions are integrated into advanced stages of the value chain, reproducing export-based models (raw materials exports). The links with foreign trade act as facilitators of connectivity in the GVC but restrict the potential for a broader integration in DVCs. Development opportunities become dependent on external demand, generating territorial enclaves that transfer most local value added to extra-regional partners.

A mapping of these spatial patterns can be identified in Figure 5, and the details of the spatial dimension of connectivity patterns are as follows.

- North and Midwest: Both macrozones present cases of interregional disconnection. Most states show an unbalanced profile of integration. The DVAs are captured outside by centralized gateways or other trade partners, and this transfer does reduce the capacity for building a more robust Northern/Midwestern network. At least one central hub in each macrozone is a leading primary source of VA creation (either by local production or imports), which can benefit from DVC integration. However, the development opportunities fail to achieve the expected benefits from integration. In the North, the central node is only the Amazonas state, while in the Midwest, it is Distrito Federal. In both cases, the connectivity is made through major hubs; the rest of the states are disconnected or specialize in providing raw materials to agricultural or mining GVCs. In these situations, sustainable economic development opportunities coming from integration in GVCs are reduced since capture occurs either inside or outside the country.
- Northeast: While this area could develop strong linkages, it acts as a black hole. Industrial diversification of TiVA indicates a potential to have a competitive macrozone; however, the most outstanding share of DVAs is retained within the Northeast territories. On the one hand, this can result from high self-reliance levels in intra-zone

value chain management. However, on the other hand, it reduces the opportunities for promoting potential industrial upgrading through integration in the largest DVC, the GVC.

- Southeast: There is a potential for promoting sub-national integration to supply DVCs and manage national production for GVCs, which encompass a centralized gateway. Southeastern territories are essential nodes of transferring VA across networks and deal with the redistribution of VA. The network's central node is Sao Paulo, which is integrated into different DVC and GVC stages. Most of the high-tech and business services and headquarters are concentrated in Sao Paulo and Rio de Janeiro. The macrozone orchestrates supply–demand flows within Brazil and the Southeast, revealing a spatial concentration of win–win linkages. The Southeastern development costs depend on their installed regional capacities. In the meantime, there is a potential for spillover effects from gateways into the hinterlands. Although the hinterland basically supplies primary inputs to the Southeast, this domestic integration could be improved to allow different forms of upgrading.
- South: This macrozone has a balanced composition of TiVA to DVC and GVC, as both provide benefits for southern states. Regional endowments allow a broad integration into either the first stages of value chains (resource industries) or advanced fragmentation steps (manufacturing and service-related industries). This VA decomposition is shared by all southern states, indicating development coming from integration into DVCs and GVCs, potentially increasing vertical integration within southern states. The geographical proximity to the Southeast and coastal areas further reveals an advantage for obtaining development benefits from integration.

6. Final Remarks

This article brings a multiscalar perspective to GVC studies by including the subnational dimension in the analysis. The relevance of this extension is twofold: first, it incorporates a deeper understanding of the different structures that combine DVCs and GVCs and include national integration as an essential element for discussing regional development opportunities. In combining DVCs and GVCs, we have considered the methodological core structure applied globally within input–output modelling. Second, it puts at the forefront the relevance of regional structures, territorial capacities and assets, and industrial specialization as crucial elements for regions to develop through integration into GVCs. These latest elements are embedded in regional economic structures considering the backward and forward linkages and the interregional structure of final demand.

Regional results show that the northern and mid-western states of Brazil specialize in agriculture and mining and have limited subnational integration, contributing more to global value chain integration. This integration profile puts these regions as raw material global providers. At the same time, the net value added in these areas is exported to the rest of the world. Northeastern Brazil is integrated among itself but has lower connectivity with both the rest of the country and the globe. The generated value added tends to be absorbed within these regional spaces, indicating a specific trade profile acting as a black hole in value chains. In the southeastern states, an important economic core of the country, interregional demand is concentrated, inducing imports from other subnational areas. Consequently, the concentration of production and wealth acts as a driver of linkages, reinforcing the role of the southeastern region as a gateway and further important productive node. The manufacturing and services industries located in these states can serve as a mechanism to promote subnational development through spillover effects within value chains. Additionally, the southeastern economic area serves as a crucial link to the rest of the world, particularly in sectors with more advanced stages of the value chain (such as manufacturing and services). Finally, the southern states of Brazil show greater integration through both subnational and global demand. This macro-zone also specializes in primary sectors and industries, suggesting the potential to gain economic benefits from integration in multiscalar value chains.

As claimed by the literature on GVCs, trade in value added drives regional development and creates opportunities for growth and job generation. As local companies engage in higher value-added activities, such as research and development, design, and marketing, they tend to employ more skilled labor and pay higher wages. This drives economic growth and improves the standard of living for people in the involved regions. In this regard, as regions specialize in different sectors and activities, they become less dependent on a single economic sector. This reduces vulnerability to economic shocks and increases regional resilience.

Empirically, the findings reveal a core–periphery organization of DVCs, with the economic core of the country (Southeastern states) globally and nationally integrated, obtaining benefits from both types of integration. Thus, at the intra-regional level, backward linkages represent monetary flows and induced investment in the home production of inputs, including the use of local factors of production such as labor and capital goods. In the case of less integrated economic areas, such as the states in the northeast, the results suggest that linkages occur with neighboring regions to supply the regional economies. Linkages with international markets mainly occur through the export of raw materials (natural resources). At the inter-regional level, the stronger demand structure is driven by industrialized zones in the country, such as São Paulo, which attracts a considerable amount of the valueadded produced in the subnational peripheries. This production profile indicates that the country has the potential to strengthen domestic connections; however, it should focus on enhancing the value added in the country's economically poor areas. Thus, the model was able to explain fundamental structural aspects such as the size of the home economy (and other subnational regions), income distribution, import and export structures, private investments, and government policies.

Furthermore, the development impulses from value chain integration are uneven in space, and it is important to consider the diversity of regional capabilities for economic integration. Particularly, the spatial patterns revealed that more sophisticated manufacturing or service sectors benefit the more developed subnational regions, including those from Southeastern Brazil, requiring policies that ensure subnational peripheries diversify and reduce their export-based dependence on lower value-added natural resources. Most regions outside the South and Southeast macro-zones of Brazil are strongly oriented toward international trade in low-value-added industries.

The significance of the domestic value chains' (DVC) structure becomes even more apparent in a large country such as Brazil, where nearly 80% of the value added is traded within the country. Our findings have important implications for policymakers, suggesting that national development strategies should not solely focus on integration into global value chains (GVCs) but also consider the potential of developing more sophisticated DVCs. This entails coordinating production stages and expanding opportunities for hinterland regions to establish upstream and downstream linkages.

In this context, it is crucial to explore the role of national core regions as gateways for connecting peripheral regions to GVCs, moving beyond the traditional resource extraction focus. The DVC landscape in Brazil appears to replicate the core–periphery pattern observed in international trade, limiting the capacity of many states to fully capitalize on the benefits of global integration. Therefore, policymakers should recognize the untapped potential of DVCs and strive to foster their development, as they can offer alternative avenues for economic growth and regional development. By diversifying production and strengthening intra-regional connections, Brazil can enhance its position within both domestic and global markets, leading to a more balanced and inclusive development path.

In conclusion, our research underscores the importance of harnessing the opportunities provided by DVCs alongside GVC integration in shaping effective and comprehensive national development strategies. By embracing a multi-dimensional approach that fosters domestic coordination and connectivity, Brazil can unlock its regions' potential and pave the way for a more equitable and prosperous future. For peripheral states in Brazil, we observe distinct positions within domestic value chains (DVCs) and global value chains

(GVCs). Southern states demonstrate a more balanced integration profile, indicating their potential to benefit from multiscalar network connectivity. Conversely, Northeastern states appear disconnected from both DVCs and GVCs and are characterized by limited internal relationships. The North and Midwest regions primarily rely on natural resource exports and serve as economic engines. However, it remains uncertain whether significant opportunities for upgrading will arise for these states through global integration.

Our analysis of the interactions between domestic value chains (DVCs) and global value chains (GVCs) and their implications for regional development opens up several avenues for further research. Firstly, incorporating the asset content of value-added flows, specifically labor, can provide a deeper understanding of development opportunities. Examining the functional divisions of labor within DVCs and GVCs helps explain these opportunities more comprehensively by considering the capabilities present in each region. Additionally, exploring the role of non-economic actors in building local capacities can complement this research. This approach would involve combining qualitative and quantitative methods to uncover the non-economic relationships that underlie integration. Lastly, it is crucial, especially in developing countries, to delve into the analysis of the "left-behind" regions that remain disconnected from national and global chains. Understanding the conditions at the national and international levels that can promote the benefits of integration is essential in these contexts.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/economies11070199/s1, Table S1. Bilateral TiVA flows (BRL millions), Table S2. Decomposition of VA (selected indicators), Table S3. Distribution of VA to GVC, Table S4. Distribution of interregional TiVA by macrozones' destinations, Table S5. Large industry level interregional TiVA, Table S6. Revealed Comparative Advantage (RCA) for specialized industries to foreign markets, Table S7. Clustering results (K-means method), Table S8. Variables considered in cluster analysis; Table S9. Regional setting of IRIO model; Table S10. Industrial classification of IRIO model. Figure S1. Interregional industry-level hierarchical TiVA (agriculture, all regions), Figure S2. Interregional industry-level hierarchical TiVA (agriculture, excluding Sao Paulo), Figure S3. Interregional industry-level hierarchical TiVA (mining, all regions), Figure S4. Interregional industry-level hierarchical TiVA (mining, excluding Sao Paulo), Figure S5. Interregional industry-level hierarchical TiVA (manufacturing, all regions), Figure S6. Interregional industry-level hierarchical TiVA (manufacturing, excluding Sao Paulo), Figure S7. Interregional industry-level hierarchical TiVA (tertiary, all regions), Figure S8. Interregional industry-level hierarchical TiVA (tertiary, excluding Sao Paulo). Figure S9. Connectivity trade levels by Brazilian region. Moineddin et al. (2003) is cited in the Supplementary Material.

Author Contributions: Conceptualization, E.R.S. and M.A.; methodology, C.R.A.; software, E.R.S.; validation, A.M.A., C.R.A. and M.A; formal analysis, E.R.S.; investigation, E.R.S.; resources, A.M.A.; data curation, C.R.A.; writing—original draft preparation, E.R.S.; writing—review and editing, C.R.A.; visualization, A.M.A.; supervision, M.A.; project administration, E.R.S.; funding acquisition, E.R.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), grant number 001, and the APC was funded by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) grant number (88881.710318/2022-01) under the project (PUC/RS—ECONOMIA—42005019027P0).

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: We greatly appreciate the collaboration of the Regional and Urban Economics Lab at the University of São Paulo (NEREUS-USP) for sharing the updated database of the interregional input-output table for the Brazilian economy.

Conflicts of Interest: The authors declare no conflict of interest.

Notes

[1] (Gui and Paolo Russo 2011) introduces an analytic framework that connects the global structure of cruise value chains to the regional articulation, discussing some strategies to generated local value within territories.

[2] Supplementary Material details bilateral TiVA for both DVC and GVC, from Brazilian regional source (origin and destination regions). Also details the regional and industrial classification. Haddad et al. (2017) describe the regionalization procedures.

[3] In the Supplementary Material, the results of the comparative advantage index are available, following Meng et al. (2017), in which it is possible to emphasize the industrial position and uneven governance pattern among Brazilian regions in terms of TiVA.

[4] In order to guarantee the consistency of this classification, the Supplementary Material provides the results of the cluster analysis considering these value-added disaggregation measures. Moreover, it shows the decomposition of value-adde trade.

[5] In order to guarantee the consistency of this classification, the Supplementary Material provides the results of the cluster analysis considering these value-added disaggregation measures. Moreover, it shows the decomposition of value-adde trade.

References

Aslam, Aqib, Natalija Novta, and Fabiano Rodrigues-Bastos. 2017. *Calculating Trade in Value Added*. IMF Working Papers. Washington, DC: International Monetary Fund (IMG). [CrossRef]

Atienza, Miguel, Marcelo Lufin, and Juan Soto. 2018. Mining linkages in the Chilean copper supply network and regional economic development. *Resources Policy* 70: 101154. [CrossRef]

Atienza, Miguel, Martín Arias-Loyola, and Nicholas Phelps. 2020. Gateways or backdoors to development? Filtering mechanisms and territorial embeddedness in the Chilean copper GPN's urban system. *Growth Change* 52: 88–110. [CrossRef]

Azzoni, Carlos Roberto, and Eduardo Amaral Haddad. 2018. Regional Disparities in Edmund Amann. In *Oxford Handbooks Online Regional Disparities*. Edited by Carlos R. Azzoni and Werner Baer. New York: Oxford University Press, pp. 1–27. [CrossRef]

Baldwin, Richard. 2017. *The Great Convergence: The Great Convergence: Information Technology and the New Globalization*. Cambridge: Harvard University Press.

Baldwin, Richard, and Anthony J. Venables. 2013. Spiders and snakes: Offshoring and agglomeration in the global economy. *Journal of International Economics* 90: 245–54. [CrossRef]

Baldwin, Richard, and Frédéric Robert-Nicoud. 2014. Trade-in-goods and trade-in-tasks: An integrating framework. *Journal of international Economics* 92: 51–62. [CrossRef]

Baldwin, Richard E. 2006. Sequencing and depth of regional economic integration: Lessons for the Americas from Europe. *World Economy* 31: 5–30. [CrossRef]

Baldwin, Richard E. 2008. Managing the Noodle Bowl: The fragility of East Asian Regionalism. *The Singapore Economic Review* 53: 449–78. [CrossRef]

Barroso, Liliane Cordeiro. 2016. Investimento Direto Estrangeiro nos Estados do Brasil. Fortaleza: Banco do Nordeste do Brasil, ano 1, n.1, out. 2016. (Informe Etene). Available online: https://www.bnb.gov.br/s482-dspace/bitstream/123456789/745/1/2016_INET_01.pdf (accessed on 15 February 2022).

Bathelt, Harald, and Peng-Fei Li. 2014. Global cluster networks-foreign direct investment flows from Canada to China. *Journal of Economic Geography* 14: 45–71. [CrossRef]

Beugelsdijk, Sjoerd, Philip McCann, and Ram Mudambi. 2010. Introduction: Place, space and organization-economic geography and the multinational enterprise. *Journal of Economic Geography* 10: 485–93. [CrossRef]

Boschma, Ron A., and Koen Frenken. 2006. Why is economic geography not an evolutionary science? Towards an evolutionary economic geography. *Journal of Economic Geography* 6: 273–302. [CrossRef]

Buckley, Peter J., Mark Casson, Peter J. Buckley, and Mark Casson. 1976. A Long-run Theory of the Multinational Enterprise. In *The Future of the Multinational Enterprise*. London: Palgrave Macmillan, pp. 32–65. [CrossRef]

Brüntrup, Michael, and Raoul Herrmann. 2014. Bush-to-Energy Value Chains in Namibia: Institutional Challenges for Pro-Poor Rural Development. In *Global Value Chains: Linking Local Producers from Developing Countries to International Markets*. Edited by Meine Pieter van Dijk and Jacques Trienekens. Amsterdam: Amsterdam University Press, pp. 89–116.

Chen, Wen, Bart Los, Philip McCann, Raquel Ortega-Argilés, Mark Thissen, and Frank Van Oort. 2018. The continental divide? Economic exposure to Brexit in regions and countries on both sides of The Channel. *Papers in Regional Science* 97: 25–54. [CrossRef]

Coe, Neil M., and Henry Wai-Chung Yeung. 2015. *Global Production Networks: Theorizing Economic Development in an Interconnected World*. New York: Oxford University Press. [CrossRef]

Coe, Neil M., Peter Dicken, and Martin Hess. 2008. Global production networks: Realizing the potential. *Journal of Economic Geography* 8: 271–95. [CrossRef]

Dacey, Michael F. 1960. A note on the derivation of nearest neighbor distances. *Journal of Regional Science* 2: 81–88. [CrossRef]

de Araújo, Inácio Fernandes, Randall W. Jackson, Amir B. Ferreira Neto, and Fernando S. Perobelli. 2020. European union membership and CO_2 emissions: A structural decomposition analysis. *Structural Change and Economic Dynamics* 55: 190–203. [CrossRef]

De Backer, Koen, Philippe De Lombaerde, and Lelio Iapadre. 2018. Analyzing Global and Regional Value Chains. *International Economics* 153: 3–10. [CrossRef]

Duan, Yuwan, Erik Dietzenbacher, Bart Los, and Ruochen Dai. 2023. Regional inequality in China during its rise as a giant exporter: A value chain analysis. *Journal of Regional Science* 63: 148–72. [CrossRef]
Fold, Niels. 2014. Value Chain Dynamics, Settlement Trajectories and Regional Development. *Regional Studies* 48: 778–90. [CrossRef]
Gereffi, Gary. 1994. The organization of buyer-driven global commodity chains: How U.S. retailers shape overseas production networks. In *Commodity Chains and Global Capitalism*. London: Praeger, pp. 95–122. [CrossRef]
Gereffi, Gary. 2019a. Economic upgrading in global value chains. In *Handbook on Global Value Chains*. London: Edward Elgar Publishing, pp. 240–54. [CrossRef]
Gereffi, Gary. 2019b. Global value chains and international development policy: Bringing firms, networks and policy-engaged scholarship back in. *Journal of International Business Policy* 2: 195–210. [CrossRef]
Gereffi, Gary, John Humphrey, and Timothy Sturgeon. 2005. The governance of global value chains. *Review of International Political Economy* 78: 78–104. [CrossRef]
Gereffi, Gary, Karina Fernandez-Stark, and Gary Gereffi. 2010. *The Offshore Services Value Chain: Developing Countries and the Crisis*. Policy Research Working Papers. Washington, DC: The World Bank. [CrossRef]
Gui, Lorenzo, and Antonio Paolo Russo. 2011. Cruise ports: A strategic nexus between regions and global lines-evidence from the mediterranean. *Maritime Policy and Management* 38: 129–50. [CrossRef]
Guilhoto, Joaquim, Jean-Marc Siroën, and Ayçil Yücer. 2015. The Gravity model, Global Value Chain and the Brazilian States. *Document de travail UMR DIAL* DT/2015-02: 1–20. Available online: https://dial.ird.fr/wp-content/uploads/2021/10/2015-02-The-gravity-model-global-value-chain-and-the-brazilian-states.pdf (accessed on 15 February 2022).
Haddad, Eduardo Amara, Carlos Alberto Gonçalves Júnior, and Thiago Oliveira Nascimento. 2017. Matriz Interestadual De Insumo-Produto Para O Brasil: Uma Aplicação Do Método IIOAS. *Revista Brasileira de Estudos Regionais e Urbanos* 11: 424–46. Available online: http://www.revistaaber.org.br (accessed on 15 February 2022).
Haddad, Eduardo A., and Inácio F. Araújo. 2020. The Internal Geography of Services Value-Added in Exports: A Latin American Perspective. *Papers in Regional Science* 100: 713–44. [CrossRef]
Haddad, Eduardo A., Fatima Ezzahra Mengoub, and Vinicius A. Vale. 2020. Water content in trade: A regional analysis for Morocco. *Economic Systems Research* 5314: 1–20. [CrossRef]
Hewings, Geoffrey J. D., and Jan Oosterhaven. 2015. Interregional input–output modeling: Spillover effects, feedback loops and intra-industry trade. In *Handbook of Research Methods and Applications in Economic Geography*. Cheltenham: Edward Elgar Publishing Ltd., pp. 369–90. [CrossRef]
Humphrey, John, and Hubert Schmitz. 2002. How does insertion in global value chains affect upgrading in industrial clusters? *Regional Studies* 36: 1017–27. [CrossRef]
Iammarino, Simona, and Philip McCann. 2013. *Multinationals and Economic Geography*. Cheltenham: Edward Elgar Publishing. [CrossRef]
Johnson, Robert C., and Guillermo Noguera. 2012. Accounting for intermediates: Production sharing and trade in value added. *Journal of International Economics* 86: 224–36. [CrossRef]
Johnson, Robert C., and Guillermo Noguera. 2017. A Portrait of Trade in Value-Added over Four Decades. *Review of Economics and Statistics* 99: 896–911. [CrossRef]
Kelly, Philip F. 2013. Production networks, place and development: Thinking through Global Production Networks in Cavite, Philippines. *Geoforum* 44: 82–92. [CrossRef]
Koopman, Robert B., Zhi Wang, and Shang-jin Wei. 2011. How much of Chinese exports is really made in China?: Assessing foreign and domestic value-added in gross exports. *Vertical Specialization and Value-Added Trade*, 39–79.
Koopman, Robert, Zhi Wang, and Shang-Jin Wei. 2014. Tracing Value-Added and Double Counting in Gross Exports. *American Economic Review* 104: 459–94. [CrossRef]
Kowalski, Przemyslaw, Javier Lopez Gonzalez, Alexandros Ragoussis, and Cristian Ugarte. 2015. Participation of Developing Countries in Global Value Chains: Implications for Trade and Trade-Related Policies. In *OECD Trade Policy Papers*. Paris: OECD, pp. 1–166. [CrossRef]
Lang, J., Stefano Ponte, and Thando Vilakazi. 2022. Linking power and inequality in global value chains. *Global Networks*, 1–17. [CrossRef]
Lee, Keun, Marina Szapiro, and Zhuqing Mao. 2018. Special Issue Article From Global Value Chains (GVC) to Innovation Systems for Local Value Chains and Knowledge Creation. *The European Journal of Development Research* 30: 424–41. [CrossRef]
Liu, Ziwen, Qingxu Huang, Chunyang He, Changbo Wang, Yihang Wang, and Kaixin Li. 2021. Water-energy nexus within urban agglomeration: An assessment framework combining the multiregional input-output model, virtual water, and embodied energy. *Resources, Conservation and Recycling* 164: 105113. [CrossRef]
Los, Bart, Marcel P. Timmer, and Gaaitzen J. De Vries. 2015. How global are global value chains? A new approach to measure international fragmentation. *Journal of Regional Science* 55: 66–92. [CrossRef]
Los, Bart, Marcel P. Timmer, and Gaaitzen J. De Vries. 2016. Tracing value-added and double counting in gross exports: Comment. *American Economic Review* 106: 1958–66. [CrossRef]
Markusen, James R. 1989. Trade in producer services and in other specialized intermediate inputs. *American Economic Review* 79: 85–95. [CrossRef]

McCann, Philip. 2008. Globalization and economic geography: The world is curved, not flat. *Cambridge Journal of Regions, Economy and Society* 1: 351–70. [CrossRef]
McCann, Philip, and Ram Mudambi. 2005. Analytical differences in the economics of geography: The case of the multinational firm. *Environment and Planning* 37: 1857–77. [CrossRef]
McCann, Philip, and Zoltan J. Acs. 2011. Globalization: Countries, cities and multinationals. *Regional Studies* 45: 17–32. [CrossRef]
Meng, Bo, and Norihoko Yamano. 2017. Compilation of a regionally extended inter-country input–output table and its application to global value chain analyses. *Journal of Economic Structures* 6: 1–38. [CrossRef]
Meng, Bo, Yong Fang, Jiemin Guo, and Yaxiong Zhang. 2017. Measuring China's domestic production networks through Trade in Value-added perspectives. *Economic Systems Research* 29: 48–65. [CrossRef]
Milanovic, Branko. 2016. *Global Inequality: A New Approach for the Age of Globalization*. Cambridge: Harvard University Press.
Moineddin, Rahim, Joseph Beyene, and Eleanor Boyle. 2003. On the Location Quotient Confidence Interval. *Geographical Analysis* 35: 249–56. [CrossRef]
Montalbano, Pierluigi, and Silvia Nenci. 2014. The trade competitiveness of southern emerging economies: A multidimensional approach through cluster analysis. *World Economy* 37: 783–810. [CrossRef]
Mudambi, Ram, and Jonas Puck. 2016. A Global Value Chain Analysis of the 'Regional Strategy' Perspective. *Journal of Management Studies* 53: 1076–93. [CrossRef]
Mudambi, Ram, Lee Li, Xufei Ma, Shige Makino, Gongming Qian, and Ron Boschma. 2018. Zoom in, zoom out: Geographic scale and multinational activity. *Journal of International Business Studies* 49: 929–41. [CrossRef]
Perobelli, Fernando Salgueiro, Inácio Fernandes De Araújo, V. de A. Vale, and M. de M. Pires. 2019. Inserção produtiva internacional e inter-regional: Uma análise a partir das cadeias globais de valor. *Pesquisa e Planejamento Econômico* 49: 163–95.
Pickles, John, and Adrian Smith. 2016. *Articulations of Capital: Global Production Networks and Regional Transformations*. Hoboken: John Wiley & Sons.
Rodríguez-Pose, Andrés. 2021. Costs, incentives, and institutions in bridging evolutionary economic geography and global production networks. *Regional Studies* 55: 1011–14. [CrossRef]
Rugman, Alan M., and Alain Verbeke. 2004. A perspective on regional and global strategies of multinational enterprises. *Journal of International Business Studies* 35: 3–18. [CrossRef]
Scholvin, Sören, Moritz Breul, and Javier Revilla Diez. 2019. Revisiting gateway cities: Connecting hubs in global networks to their hinterlands. *Urban Geography* 40: 1291–309. [CrossRef]
Scholvin, Sören, Moritz Breul, and Javier Revilla Diez. 2020. A magic formula for economic development? Global market integration and spatial polarization in extractive industries. *Area Development and Policy* 6: 337–46. [CrossRef]
Schotter, Andreas P. J., Ram Mudambi, Yves L. Doz, and Ajai Gaur. 2017. Boundary Spanning in Global Organizations. *Journal of Management Studies* 54: 403–21. [CrossRef]
Silveira-Neto, Raul M., and Carlos R. Azzoni. 2011. Social policy as regional policy: Market and nonmarket factors determining regional inequality. *Journal of Regional Science* 51: 433–50. [CrossRef]
Smichowski, Bruno Carballa, Cédric Durand, and Steven Knauss. 2016. Uneven Development Patterns in Global Value Chains: An Empirical Inquiry Based on a Conceptualization of GVCs as a Specific Form of the Division of Labor, CEPN Working Papers 2016-06, Centre d'Economie de l'Université de Paris Nord. Available online: https://cepn.univ-paris13.fr/working-paper-n2016-06-uneven-development-patterns-in-global-value-chains-an-empirical-inquiry-based-on-a-conceptualization-of-gvcs-as-a-specific-form-of-the-division-of-labor-bruno-carballa/ (accessed on 15 February 2022).
Smith, Adrian. 2015. Economic (in)security and global value chains: The dynamics of industrial and trade integration in the Euro-Mediterranean macro-region. *Cambridge Journal of Regions, Economy and Society* 8: 439–58. [CrossRef]
Sturgeon, Tim, and Gary Gereffi. 2008. The Challenge of Global Value Chains: Why Integrative Trade Requires New Thinking and New Data Prepared for Industry Canada. Available online: http://www.globalvaluechains.org (accessed on 11 April 2021).
Sturgeon, Timothy J. 2016. Brazil in Global Value Chains. *MIT Industrial Perfomance Center Working Paper Series*. vol. 16-001, pp. 1–16. Available online: http://www.cggc.duke.edu/pdfs/2013-05-22_Sturgeon_et_al_Funcex_article_submitted.pdf (accessed on 30 December 2021).
Teece, David J. 1986. Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy* 15: 285–305. [CrossRef]
Teece, David J. 2010. Business models, business strategy and innovation. *Long Range Planning* 43: 172–94. [CrossRef]
Timmer, Marcel P., Sébastien Miroudot, and Gaaitzen J. de Vries. 2019. Functional specialisation in trade. *Journal of Economic Geography* 19: 1–30. [CrossRef]
Veiga, Pedro da Motta, and Sandra Polónia Rios. 2017. Inserção em Cadeias Globais de Valor e Políticas Públicas: O Caso do Brasil. In *Cadeias Globais de Valor, Políticas Públicas e Desenvolvimento*. Brasilia: Instituto Brasileiro de Pesquisas Economicas, pp. 399–434.
Verbeke, Alain, and Christian Geisler Asmussen. 2016. Global, Local, or Regional? The Locus of MNE Strategies. *Journal of Management Studies* 53: 1051–75. [CrossRef]
Visentin, Jaqueline Coelho, and Joaquim Jose Martins Guilhoto. 2019. The role of interregional trade in virtual water on the blue water footprint and the water exploitation index in Brazil. *Review of Regional Studies* 49: 299–322. [CrossRef]
Whitfield, Lindsay, Cornelia Staritz, Ayelech T. Melese, and Sameer Azizi. 2020. Floriculture Firms in Sub-Saharan Africa Local Apparel and Floriculture Firms in Sub-Saharan Africa abstract. *Economic Geography* 96: 195–218. [CrossRef]

World Bank. 2020. World Development Report 2020. In *World Development Report 2020: Trading for Development in the Age of Global Value Chains*. Washington, DC: The World Bank. [CrossRef]

Yeung, Henry Wai-chung. 2021. Regional worlds: From related variety in regional diversification to strategic coupling in global production networks. *Regional Studies* 55: 989–1010. [CrossRef]