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REGIONAL AND GLOBAL PATTERNS OF PARTICIPATION IN VALUE CHAINS: EVIDENCE FROM BRAZIL

Inácio Fernandes de Araújo
Fernando Salgueiro Perobelli
Weslem Rodrigues Faria

TD Nereus 03-2021
São Paulo
2021

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Inácio Fernandes de Araújo

Department of Economics, University of São Paulo, Brazil. The University of Sao Paulo Regional and Urban Economics Lab (NEREUS).

E-mail: inacio.araujo@usp.br

Corresponding author

Fernando Salgueiro Perobelli

Department of Economics, Federal University of Juiz de Fora, Brazil. Territorial and Sectorial Analysis Laboratory (LATES).

E-mail: fernando.perobelli@ufjf.edu.br

Weslem Rodrigues Faria

Department of Economics Federal University of Juiz de Fora, Brazil. Territorial and Sectorial Analysis Laboratory (LATES).

E-mail: weslem.faria@ufjf.edu.br

Acknowledgements. This work was supported by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) [Edital nº 42/2014 PGPSE]. Inácio Fernandes de Araújo acknowledges financial support from Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) [Grant 2019/00057-9]. Fernando Salgueiro Perobelli acknowledge financial support from Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) [Grant 304205/2016-8]. Weslem Rodrigues Faria acknowledge financial support from Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) [Grant 302792/2019-8].

This is an accepted manuscript version. The version of record of this manuscript has been published by Elsevier. The definitive version is available at: https://doi.org/10.1016/j.inteco.2020.12.009

Regional and Global Patterns of Participation in Value Chains: Evidence from Brazil

Abstract. This paper focuses on the role played by the Brazilian economy in global value chains with reference to global and regional contexts. For which we calculate downstream and upstream indicators of global and regional integration and fragmentation of global value chains. We use the full Eora Multiregional Input-Output Table for the period from 1990 to 2015. The main results indicate that Brazilian participation in global value chains increased during this period and became more fragmented internationally, mainly in global terms, but its regional insertion has increased more than its global insertion. Although South America has a small share in value-added trade, Brazil operates as a regional hub, as it is a reference for international trade in this region. In the global context, Brazil plays the role of supplier of intermediate inputs, while in the regional context, Brazil serves as the main production center.

Keywords: International fragmentation; Global value chains; Global and regional fragmentation; Input-output; Brazil.

Classification codes: F15; C67; D57.

1. Introduction

Since the 1970s, Brazil's commercial and industrial policies have been oriented towards the formation of a vertically-integrated national industrial park and the establishment of all stages of production. These policies have been formulated to preserve Brazil's limited exposure to imports, with a strong protectionist tendency (Veiga and Rios, 2017). The main instrument of this trade policy is the collection of high import tariffs (Messa and Oliveira, 2017). Tariff barriers have a significant effect on blocking trade in value chains, as intermediate inputs cross national borders many times before they become final products.

The initial and limited trade policies of the Brazilian economy arising since the 1970s were the creation of the Southern Common Market (Mercosur) in 1991 (agreement between Brazil, Argentina, Paraguay and Uruguay), the trade agreement between Mercosur, Chile and Bolivia in 1996 and extended to include Colombia, Ecuador, and Peru in 2003. Since then, Brazil has been relatively closed to new trade agreements (Thorstensen and Ferraz, 2014).

Given this context, commercial opening in Brazil began in the early 1990s, such that changes in the structure of production and international trade in the Brazilian economy necessarily changed its role in global value chains. The growth of the Brazilian economy since then, mainly in the 2000s, has attracted foreign investments and made the Brazilian economy more heterogeneous in terms of sectors compared to prior periods. In fact, the existence of Mercosur had a spillover effect on the development of international trade in other South American countries also. Many companies sought to obtain or expand access to South American markets, which led to an increase of foreign investments in Brazil and the region in recent decades.

The main objective of this paper is to verify Brazil's role in global value chains considering its participation in global and regional trade blocs. The hypothesis is that Brazil has different roles in global value chains and regional value chains. Brazil carries out international trade with several countries, regions and trade blocs. However, the country's trade with the other Mercosur members has a different pattern compared to other countries and trade blocs. Thus, this paper intends to verify the trade pattern differences between Brazil and South America and Brazil and other regions and trade blocs. We also seek to verify the role of Brazil as a reference center for conducting international trade in South American countries, that is, the role of Brazil as a regional hub in international trade (Baldwin and Lopez-Gonzalez, 2015).

To achieve these stated goals, we perform a spatial decomposition of foreign value-added content, by taking into account the upstream and downstream segments of value chains. The regional and global participation patterns in the value chains are analyzed through the geographic extension of the stages of production. These patterns are assessed using indicators of global and regional fragmentation of global value chains. To measure the linkages of global value chains, the value-added content is decomposed using the inter-country input-output model over the period from 1990 to 2015. We use the full Eora Global Supply Chain Database's multiregional input-output table (MRIO), which contains data for 190 countries and specifies 26 activity sectors. The chosen period of investigation allows us to evaluate Brazil's participation in global value chains relative to different scenarios and changes in its commercial and industrial policies. Thus, we assess if Brazil's integration process with internationally fragmented production chains follows a worldwide trend or presents a pattern distinct from other economies.

Some relevant prior studies conducted on the Brazilian economy are focused on discussing value chains based on evidence supported by gross export statistics, even though such statistics are not appropriate in this context (Johnson and Noguera, 2012a; Koopman, Wang and Wei, 2014). Dietzenbacher, Guilhoto and Imori (2013), Guilhoto and Imori (2014), Ferraz, Gutierre and Cabral (2015), Callegari et al. (2018), Magacho et al. (2018), Perobelli et al. (2019), Haddad (2019) and

Haddad and Araújo (2020) analyze the insertion of Brazil into global value chains based on the trade of value-added content. This paper differs from the existing literature in that we analyze the role that Brazil can play in the trade relations of global value chains from two perspectives – global and regional. As such the paper contributes to the literature by explaining the differences that the Brazilian economy plays in relative terms in the international fragmentation of production both globally and regionally – that is, we focus on the geographic extension of its value chains.

Our findings suggest that between 1990 and 2015 Brazil's production became more fragmented internationally and consequently its participation in global value chains increased. However, its regional insertion increased more than its global insertion. Although South America has a small share in value-added trade, it was found that Brazil operates both as a regional hub and serves as a reference for international trade in that region. In the global context, Brazil has the role of supplier of intermediate inputs, while in the regional context, Brazil plays the role of an important production center. This regional production center proved to be well integrated with the principal hubs of the global value chains (United States, China and Germany).

The paper is structured as follows. Section two presents a literature review about vertical specialization and the challenges of measuring the participation of countries in global production chains. Section three presents the vertical specialization measures used in this study. Section four provides the source of the data used in the analysis. Section five presents and discusses the results. Finally, section six provides conclusions and suggestions for policymaking.

2. Literature review

International trade can enable countries to achieve higher levels of production and consumption (Gandolfo, 2014) and stimulate the distribution of resources by outsourcing production to global production chains (Yi, 2003; Grossman and Rossi-Hansberg, 2008). The intensification of international production outsourcing is a global tendency (Grossman and Helpman, 2005) and one of the factors that contribute to competitiveness in the world economy (Timmer et al., 2013).

The international outsourcing of production arises from the decisions of companies to carry out part of their productive stages abroad. These stages may involve the physical production of goods, the acquisition of intermediate inputs, or services performed at a distance, such as information technology and human resources (Yamashita, 2010). This international fragmentation allows countries to specialize in specific stages of vertically integrated value chains (Jones, 2000; Yi, 2003) —referred to as vertical specialization (Hummels, Ishii and Yi, 2001). According to Yamashita

(2010), in general, increased international outsourcing reduces production costs and adds more stages to global value chains. Hummels (2007) indicated that technological progress allowed for the separation of production processes and the continuous reduction of transport costs. Besides this, coordination capacity through governance in value chains and the liberalization of international trade, effected via tariff reduction policies, may have also contributed to the expansion of fragmentation across national boundaries (Yi, 2003; Gereffi et al., 2005).

Zeddies (2011) analyzed the determinants of the international fragmentation of production in European Union countries. According to him, in addition to the prices of the factors of production, the main determinants are transportation costs and delivery time, firm sizes, the number of establishments in the countries that have commercial agreements, investments in research and development, qualification of the workforce, and quality of infrastructure and communication networks. Fort (2013), using US company data, indicated that communication technology tends to facilitate production fragmentation, but high-tech production fragmentation tends to occur between high-tech countries. This result makes it evident that companies tend not to transfer technology capabilities to low-wage countries. Hillberry (2011) argued that many of the factors pointed out, especially theoretically, as the main causes of production fragmentation are difficult to determine due to the lack of data. However, the evidence of these two latter scholars indicates that increased availability of air transport, and the introduction of new trade blocs in Eastern Europe and East Asia may have been sources of increased international production fragmentation.

The vertical specialization of production has posed challenges to the theoretical modeling of international trade (Yi (2003); Grossman and Rossi-Hansberg (2008); Antràs and Chor (2013)), as well as to empirical modeling (Hummels, Ishii and Yi (2001); Koopman, Wang and Wei (2014); Johnson and Noguera (2012a); Los, Timmer and de Vries (2016)). This happens because, in the context of vertical specialization, trade statistics, measured in gross terms, include inputs that are added in the early stages of production in other countries. Thus, the total volume of gross trade differs from the sum of the value added by each country at different stages of production. Johnson and Noguera (2012a), Koopman, Wang and Wei (2014), and Los, Timmer and de Vries (2016) show that the vertical specialization of production requires the use of specific measures to estimate each country's contribution to international trade.

Therefore, the importance of international trade, which is measured by gross exports, may be overestimated because of the double counting of intermediate goods crossing national borders more

than once (Koopman, Wang and Wei, 2014).[1] Analyses to measure participation in global value chains mainly use the input-output methodology derived from the initial work by Hummels, Ishii and Yi (2001), with subsequent contributions made by Johnson and Noguera (2012a), Antràs et al. (2012), Koopman, Wang and Wei (2014), Los, Timmer and de Vries (2015), and Gurgul and Lach (2018). The input-output analysis allows us to track all production chains through the structure of industrial interdependence, and thus to account for the direct and indirect participation of each country in global production, at all stages of the global value chains.

The trade in value-added content measured by the input-output approach takes into account that production involves a sequential chain of trade, which extends across many countries, with each country specializing in a particular stage of production. The first measure proposed by Hummels, Ishii and Yi (2001) estimates the imported content in exports under the assumption that these exports are fully absorbed abroad. This measure of specialization excludes the scenarios in which production incorporates imported goods that countries have produced in the early stages of the value chains. Daudin, Rifflart and Schweisguth (2011), Johnson and Noguera (2012a and 2012b), Timmer et al. (2013), Koopman, Wang and Wei (2014), and Los, Timmer and de Vries (2016), using information for the trade flows specified in interregional input-output tables, extend the vertical specialization measure of Hummels, Ishii and Yi (2001) from the value-added content to different decompositions.

Input-output analysis, in addition to measuring foreign value-added content, allows for the identification of the geographic extent of global value chains and the formation of agglomerations of countries at specific stages of production. The regional agglomeration of activities in value chains is driven by the formation of regional trade blocs, which reduce trade barriers preferably between neighboring countries (Johnson and Noguera, 2017).

The geographical extent of global production chains is analyzed by Johnson and Noguera (2012a), Baldwin and Lopez-Gonzalez (2015), and Los, Timmer and de Vries (2015), who present evidence that vertical specialization has different patterns between countries and sectors. Thus, although some industries locate their assembly activities close to the final markets – with specialized suppliers tending to cluster in their surroundings – other industrial activities are characterized by dispersed production around the world. Thereby, international fragmentation can occur essentially through trade in a regional context, i.e., in groups of geographically close countries, or in a global context, i.e., involving geographically distant countries (Backer, Lombaerde and Iapadre, 2018).

[1] The double counting in the gross trade statistics originates from exports that can return to the country of origin in the form of final goods or intermediate inputs; in the case of intermediate inputs, these can be used at other stages of production and re-exported (Koopman et al., 2014).

In this regard, Baldwin and Lopez-Gonzalez (2015) suggest that vertical specialization in the 1990s was marked by regional trade blocs rather than trade in global value chains. Thus, international fragmentation was concentrated among immediate trading partners, geared to the regional location of trade. In contrast, Los, Timmer and de Vries (2015) show that in the 2000s the extent of the international fragmentation was mainly global, involving countries from outside a given region. The international fragmentation of production, in addition to exhibiting different characteristics in the regional and global contexts, is also diverse when comparing downstream and upstream segments of global value chains – regarding this aspect, countries play different roles at different levels of the value chains (Lejour et al., 2017).

Guilhoto and Imori (2014) and Ferraz, Gutierre and Cabral (2015) identified a trend of greater participation of Brazil in value chains for the period between 1995 and 2011 – they determined that the Brazilian economy is one of the worldwide leaders by share of domestic value added in its exports. Perobelli et al. (2019) found an interesting relationship between the fragmentation of production in the Brazilian regions and the insertion of these regions into global production chains. Haddad (2019) presents a guide explaining the input-output methodology adopted to measure the value-added services in Brazilian exports. However, such works – as well as that of Baldwin and Lopez-Gonzalez (2015) – do not discuss the insertion of Brazil considering the geographic extension of its value chains. This paper differs from these in addressing Brazil's integration at the global and regional levels.

3. Decomposing participation in global production chains

Foreign value-added content is used to evaluate integration into global value chains. The method used in this paper to measure the value-added content of trade follows that of Johnson and Noguera (2012a) and Los, Timmer and de Vries (2016), which is adapted to assess the integration in upstream and downstream segments of supply chains, emphasizing the regional and global participation patterns in these chains.

The contribution of each country in the production chain can be broken down using an inter-country input-output table. This table contains the values of the flows of intermediate inputs and final goods among all the countries' industries – i.e., the s industries ($s = 1, ..., S$) in each of the n countries ($n = 1, ..., N$). By combining information on the values of transactions of intermediate inputs ($\mathbf{Z}$), final demand ($\mathbf{F}$), sectoral production ($\mathbf{x}$), and remuneration of primary production factors ($\mathbf{w}$), it is possible to estimate the value generated in each of the SN industries. The intermediate inputs required

per unit of production are defined in the matrix $\mathbf{A} = \mathbf{Z}(\hat{\mathbf{x}})^{-1}$, and the value added per unit of product is defined in the vector $\mathbf{v} = \mathbf{w}(\mathbf{x})^{-1}$. The term $\hat{\mathbf{x}}$ corresponds to the diagonal matrix formed by the vector **x**.

To produce the good (i, s), a combination of local primary inputs and national and imported intermediary inputs from different sectors and countries is required. Then, the good (i, s) is absorbed in the final demand or used as an intermediate input in production. To break down its value, it is necessary to find the product levels associated with the good (i, s) at each stage of production, measured through inter-country input-output tables. To do so, the value chains are identified by the last stage of production of the final good $f_{ij}(s)$. The participation of each country in the international fragmentation of production is measured by its value-added content inserted in the value chains, following the formulation proposed by Los, Timmer and de Vries (2015). Thus, the value generated in the production of the good (i, s) is derived from the remuneration of capital and labor in the country–industry of production. This is equivalent to identifying the extent to which the country of completion of the final good $f_{ij}(s)$ contributes to the production of that good, which can be decomposed as follows:

$$\mathbf{g} = \hat{\mathbf{v}}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{F} \tag{1}$$

where the matrix $\hat{\mathbf{v}}$ is formed by the diagonalization of the value added per unit of product. The use of the Leontief inverse matrix, $(\mathbf{I} - \mathbf{A})^{-1}$, ensures that value-added contributions at all stages of supply through direct and indirect requirements in the productive chain structure are taken into account. The final demand vector (*SN x 1*) **F** has its real values only in the cells that represent the final demand for the country-industry (*i*, *s*), while all other values in the final demand are set to zero. The vector **F** is equal to the final internal and external demand for the final products $f_{ij}(s)$. The choice of a specific vector **F** by country of origin of the production of final goods determines the value chain being analyzed.

The vector (*SN x* 1) **g** contains the value-added contributions generated in each of the country–industries that can be assigned to the value chains of the final products $f_{ij}(s)$.[2] To obtain the origin of the value added to the final good $f_{ij}(s)$ in the production chain by country, the elements of **g**, which correspond to the industries in each country, are added to each other. Los, Timmer and de Vries (2015) show that the main result of this calculation is the possibility of decomposing the value of a final product by the value-added contributions made in any country.

[2] The final demand for the good (*i*, *j*) includes household and government consumption as well as the demand for investment in domestic and foreign markets.

3.1. Downstream integration into global chains

The integration of countries into global production chains may occur differently when considering the downstream or upstream tracking of such production chains. Therefore, this study measures the downstream integration into global value chains, defined as Sourcing_s. This measure is calculated taking as a starting point the proposed decomposition by Los, Timmer and de Vries (2015).

The Sourcing_s measure is calculated using the vector **g**, defined in Equation (1), from its replication for each country of completion of the final good $f_{ij}(s)$. Value added from the country of completion in vector **g** is set to zero. The sum of the value-added contributions provided by each country *i* for the other completion country *j* is defined as:

$$\text{SVA}_s = \sum_{j \neq i} \text{VA}_{ij}(s), \forall\, j \tag{2}$$

The participation of each country in the supply of value-added content for the global production chains, from Equation (2), is defined as follows:

$$\text{Sourcing}_\text{s} = \frac{\text{SVA}_s}{\sum_i \sum_{j \neq i} \text{VA}_i(s)} \tag{3}$$

where $\sum_i \sum_{j \neq i} \text{VA}_i(s)$ is the sum of the foreign value added in global production. The sum of Sourcing_s for each country *i* belonging to the global production chain is equal to 1.

3.2. Upstream integration into global chains

The upstream integration in global chains focuses on the provenance of the value added for the last stage of production, that is, the country-of-completion. In this regard, the value added in the final goods produced in Brazil is decomposed, per the approach developed in Los, Timmer and de Vries (2015). Thus, the vector **F** of Equation (1) includes the final demand values only for Brazil, with the other cells specified as zero. The value of the final good produced by industry *s* in Brazil is indicated by FINO_s. The value added from country *j* is defined by $\text{VA}_{(j)}(s)$. The vector **g** contains the corresponding levels $\text{VA}_{(j)}(s)$ for each final good produced in Brazil $f_{ij}(s)$, such that:

$$\mathrm{FINO}_s = \sum_s \mathrm{VA}_{(j)}(s) \tag{4}$$

The contribution of all countries to the value added in the production of (i, s) is equal to the value of the final product (i, s). The FINO_s measure allows for the definition of the value added throughout the production chain in which Brazil is integrated, minus the value-added content produced in Brazil:

$$\mathrm{FVA}_s = \sum_{j \neq Brazil} \mathrm{VA}_{(j)}(s) = \mathrm{FINO}_s - \mathrm{VA}_{(Brazil)}(s) \tag{5}$$

The term FVA_s measures the international fragmentation of production chains.[3] FVA_s, unlike SVA_s, defined in Equation (2), is the sum of the value added from the *N* countries in the production of country *i*. SVA_s, in turn, is the sum of the contribution of country *i* to the value added inserted in the production of the *N* countries belonging to the global production chain. To measure the importance of foreign value added, FVA_s is expressed as the share of value added in the production of *s*:

$$\mathrm{FVAS}_s = \mathrm{FVA}_s / \mathrm{FINO}_s \tag{6}$$

The foreign value-added share (FVAS) is used to measure the extent of the international fragmentation of the value chains in which Brazil is inserted. This share is an index that varies between zero and one. FVAS assumes zero value when all value added is produced internally, assuming larger values as international fragmentation increases.[4] FVAS includes the value added at each stage of production. Thus, this measure does not pose the problem of double counting, defined by Koopman, Wang and Wei, (2014), which is present in the other vertical specialization metrics that use intermediate inputs imported into production.

3.3. Regional and global fragmentation of value chains

Foreign value added, following the proposed decomposition in Los, Timmer and de Vries (2015), is used to define the international fragmentation of production within regional or global blocs of trade. The focus of the analysis is the participation of the Brazilian economy into global value

[3] The approach to international fragmentation measuring from FVA_s is based on tracking the value chain, starting from the final product and tracing the added value, at all stages, needed to produce the final good.

[4] By definition, FVAS cannot be equal to one, because the final stage of production must involve some activity in the country of completion of production.

chains. In this way, FVA_s is decomposed into the foreign value-added share that originates in the region in which Brazil is included, i.e., the regional foreign value added (RFVA_s), and the share of the foreign value added that is produced geographically distant from Brazil, i.e., the global foreign value added (GFVA_s). Because the countries of South America are characterized by common linkages of trade and investment, they are considered Brazil's regional trade bloc.[5]

The regional foreign value added in the final good $f_{ij}(s)$ produced in Brazil is defined as the contribution of the value added of the region to which Brazil belongs minus the contribution of Brazil:

$$\mathrm{RFVA}_s = \sum_{\substack{j \in region \\ of\ Brazil}} \mathrm{VA}_j(s) - \mathrm{VA}_{(Brazil)}(s) \tag{7}$$

Similar to Equation (6), the regional share of FVA_s in Brazil's production chains is defined by:

$$\mathrm{RFVAS}_s = \mathrm{RFVA}_s / \mathrm{FINO}_s \tag{8}$$

The increase over time in the share of RFVA_s indicates a trend of regional fragmentation of the value chain. Similarly, GFVA_s measures the contribution of value added of all countries outside the region of Brazil[6], as follows:

$$\mathrm{GFVA}_s = \sum_{\substack{j \notin region \\ of\ Brazil}} \mathrm{VA}_j(s) \tag{9}$$

The share of the Brazilian production in the global value chain is defined as follows:

$$\mathrm{GFVAS}_s = \mathrm{GFVA}_s / \mathrm{FINO}_s \tag{10}$$

The $\mathrm{Sourcing}_s$ measure can also be decomposed to the value added originated in Brazil and supplied to the regional and global trading blocs. Thus, Brazil's contribution to the production of the countries in the regional value chain is defined by Regional Sourcing (RS_s):

[5] There is no multilateral trade agreement that includes all the countries of South America. Although there are two multilateral agreements, the Union of South American Nations (UNASUR) and the Integration of South American Regional Infrastructure (IIRSA), a free trade area among the countries of the region has not been established. IIRSA is a joint program of the governments of UNASUR countries with the objective of building infrastructure in the continent. UNASUR is comprised of 12 countries and provides for the replacement of the economic cooperation blocs of the Southern Common Market (Mercosur) between Argentina, Brazil, Paraguay, Uruguay and Venezuela, and the Andean Community of Nations (CAN), composed of Ecuador and Peru. The other countries that make up UNASUR are Chile, Guyana and Suriname.

[6] Following the definition of Los, Timmer and Vries (2015), the term global value added is used to define the value added that is geographically distant from the location of the last stage of production. Therefore, this measure should not be interpreted as value added anywhere in the world, as it would, by definition, be equal to the value of the final product.

$$\text{Regional SVA}_s = \sum_{j \neq i} \text{VA}_{ij}(s), \forall\, j \in \text{region of Brazil} \tag{11}$$

$$\text{RS}_s = \frac{\text{Regional SVA}_s}{\sum_i \sum_{j \neq i} \text{VA}_{ij}(s)} \tag{12}$$

Brazil's participation in the supply of value added in the global chain is defined by Global Sourcing (GS_s):

$$\text{Global SVA}_s = \sum_{j \neq i} \text{VA}_{ij}(s), \forall\, j \notin \text{region of Brazil} \tag{13}$$

$$\text{GS}_s = \frac{\text{Global SVA}_s}{\sum_i \sum_{j \neq i} \text{VA}_{ij}(s)} \tag{14}$$

4. Database

The regional and global fragmentation of value chains is analyzed using the data provided by the full Eora MRIO. The construction of this database is described in Lenzen et al. (2012a) and Lenzen et al. (2013a). The full Eora MRIO contains data for 190 regions of the world, specifying 26 sectors of activity,[7] and covers the period from 1990 to 2015.[8] The data for the construction of the Eora MRIO database derive from national statistical offices. Bilateral trade data comes from the UN Comtrade Database and UN Service Trade Database. The Eora database assumes that its regional specification sufficiently covers the global economy.

Changes in the national accounts system may cause interruptions in the continuity of the input-output tables of Brazil estimated by Eora. However, Lenzen et al. (2013b) show that this does not generate imbalances in sectoral aggregated analyses – which are the focus of this study. A detailed description of the price corrections and of all the discontinuities and corrections implemented in the input-output tables for the Brazilian economy, used in the estimation of the full Eora MRIO, is found in Lenzen et al. (2012b) and Lenzen et al. (2013b).

[7] The Eora MRIO provides data from the inter-country input-output table with the breakdown of 56 sectors of activity into the Brazilian economy. However, this matrix does not have a harmonized version for all world economies, making it impossible to aggregate foreign value-added results at the industrial level.

[8] Owen et al. (2016), Steen-Olsen et al. (2016) and Owen (2017) analyzed the results of economic indicators constructed from the Interregional Input-Output Tables of the Global Trade Analysis Project (GTAP), World Input-Output Database (WIOD), Multi-region Input-Output Table (EORA) and Inter-country Input-Output (OECD–ICIO) and found that global added value accounts are similar between these databases, although differences exist at the country and individual sector levels.

The choice of using the Eora other than other databases of inter-country input-output tables is motivated by its complete regional specification for the South American countries. This allows us to measure the geographical origin of all regional trade flows in Brazil. In addition, the historical series of the full Eora MRIO makes it possible to evaluate the evolution of Brazil's participation into global value chains.

5. Results

The measures of foreign value–added share (FVAS) and Sourcing are used to quantify the Brazilian economy participation in regional and global trade blocs. FVAS is a measure of upstream integration into global chains, that is, in terms of the purchase of inputs. The Sourcing measure, defined by the share of value added produced by Brazil in relation to total foreign value added in all value chains, evaluates the downstream integration into production chains.

Table 1 shows the distribution of value added in the final goods produced in Brazil in two groups: for all activity sectors and for the sectors related to agriculture, mining, manufacturing and tradable services.[9] The regional and global foreign value-added share (FVAS) in the final goods produced in Brazil increased from 1990 to 2015. This suggests that production in Brazil became more internationally fragmented. Brazil ranks 157th out of 188 countries[10] in terms of FVAS in final products (Table A1 in the Appendix).[11] South American countries have a small share in the production of final goods in Brazil – the regional trade bloc provided 2.06% (RFVAS) and the global trade bloc contributed 8.98% (GFVAS) of the foreign value added in Brazilian production in 2015.

[9] Non-transactional services are not included in the analysis because their production is not traded internationally. These sectors are characterized by services rendered locally.

[10] The Eora MRIO database has information on 190 regions, including one called "statistical discrepancy" and another for the former USSR. Thus, the ranking has information on 188 countries.

[11] One of the reasons for the low FVAS in the Brazilian economy is the high import tariffs practiced in the country. They have been aimed at intensifying the protection of the national industry (Veiga and Rios, 2017a) and increasing domestic content in production. However, we cannot merely analyze the FVAS to assess participation in value chains. For example, the United States and Japan also have low FVAS. The FVAS is influenced by the stage of technological development and its dependence on imports of foreign technologies, and the linkages of the industrial structure with the rest of the world—that is, the industrial specialization in the country and the stages of production that are outsourced abroad.

Table 1. Origin of value added in final goods produced in Brazil (%)

	All sectors		Agriculture, mining, manufacturing and tradable services	
	1990	2015	1990	2015
Domestic value added	93.731	92.014	92.004	88.957
Foreign value added (FVAS),	6.269	7.986	7.996	11.043
of which				
Regional (RFVAS)	0.646	1.476	0.858	2.059
Global (GFVAS)	5.623	6.510	7.138	8.985

Source: Authors' calculations.

The downstream integration of Brazil into value chains in regional and global trade blocs is measured by Regional Sourcing and Global Sourcing. The Sourcing measure assesses the importance of the Brazilian economy for the production chains, that is, the value added with origin in Brazil in relation to the foreign value added included in the final goods produced anywhere in the world. Table 2 shows Brazil's share in world exports of value added and its regional and global participation between 1990 and 2015. In 2015, Brazil contributed 1.39% of foreign value added in the final products of all production chains – 0.24% for the production of South American countries (Regional Sourcing) and 1.14% for the production in the rest of the world (Global Sourcing). Brazil is 20th of 188 countries in a ranking which assesses shares in the supply of value added for global production chains, (Table A2 in the Appendix).

Table 2. Share of value added with origin in Brazil in relation to total foreign value added in all value chains (%)

	All sectors		Agriculture, mining, manufacturing and tradable services	
	1990	2015	1990	2015
Sourcing,	0.963	1.373	0.985	1.386
of which				
Regional Sourcing (RS)	0.096	0.240	0.099	0.244
Global Sourcing (GS)	0.867	1.133	0.886	1.142

Source: Authors' calculations.

Table 3 shows the patterns of participation of the Brazilian economy in regional and global value chains. Columns (1) and (2) show the origin of the foreign value-added share of final goods

produced in Brazil. The Regional FVAS represents 2.06% of the foreign value added in 2015, of which 1.09% originates from Argentina. NAFTA (2.19%) and Europe (3.39%) are the sources of most of the 8.96% of the Global FVAS. Columns (4) and (5) show the destination of the value added produced in Brazil. In the regional production chain, Brazil contributes 0.24% of the value added in final products, of which 0.12% is concentrated in Argentina. Columns (3) and (6) show the growth of the FVAS and Sourcing between 1990 and 2015. Bolivia has grown the share in FVA, driven mainly by Brazil's importation of natural gas. In turn, China has increased its trade with Brazil in both the upstream (FVAS) and downstream (Sourcing) segments of the value chains.

Table 3. Trade in value added: Brazil

	FVAS			Sourcing		
	1990	2015	2015 / 1990	1990	2015	2015 / 1990
	(1)	(2)	(3)	(4)	(5)	(6)
Regional						
Argentina	0.492	1.091	2.217	0.038	0.124	3.225
Bolivia	0.012	0.266	22.557	0.002	0.005	1.946
Chile	0.059	0.178	3.040	0.014	0.034	2.356
Colombia	0.022	0.106	4.899	0.007	0.013	1.836
Ecuador	0.003	0.007	2.236	0.002	0.005	2.503
Guyana	0.000	0.000	1.694	0.006	0.010	1.643
Paraguay	0.043	0.112	2.580	0.006	0.009	1.547
Peru	0.020	0.046	2.319	0.004	0.011	2.417
Suriname	0.000	0.000	0.779	0.000	0.000	1.430
Uruguay	0.060	0.065	1.095	0.008	0.014	1.814
Venezuela	0.148	0.187	1.265	0.011	0.020	1.869
Total (Regional)	**0.858**	**2.059**	**2.398**	**0.099**	**0.244**	**2.463**
Global						
NAFTA	2.487	2.190	0.881	0.221	0.359	1.621
Europe	2.240	3.388	1.512	0.317	0.348	1.098
China	0.168	1.004	5.959	0.019	0.170	8.768
Asia and Oceania	1.886	1.595	0.846	0.299	0.221	0.739
Rest of the World	0.357	0.807	2.264	0.029	0.045	1.525
Total (Global)	**7.138**	**8.985**	**1.259**	**0.886**	**1.142**	**1.289**

Source: Authors' calculations.

Table 4 shows Brazil's regional and global patterns of participation in value chains through the decomposition of the geographical origin of the value-added trade by industry. The participation of the Brazilian economy in international trade is marked by distinct characteristics when considering its global or regional integration. Agriculture (13.56%) and mining (17.49%) make up 31.05% of the regional foreign value added (RFVAS), while manufacturing represents 46.8% of global foreign value added (GFVAS) in 2015. Brazilian value-added exports to South America (Regional Sourcing) consisted mainly of manufacture (44.49%) and services (46.36%), whereas Global Sourcing has become resource-intensive and agriculture and mining increased participation from 12.82% in 1990 to 16.70% in 2015. Table 4 also shows the importance of services in value-added exports in both Regional Sourcing (46.36%) and Global Sourcing (45.22%). Haddad and Araújo (2020) found that the value added to services in exports account for 48.23% of Brazilian exports of value added, despite the fact that services represent only 17.39% of total gross exports in 2015.

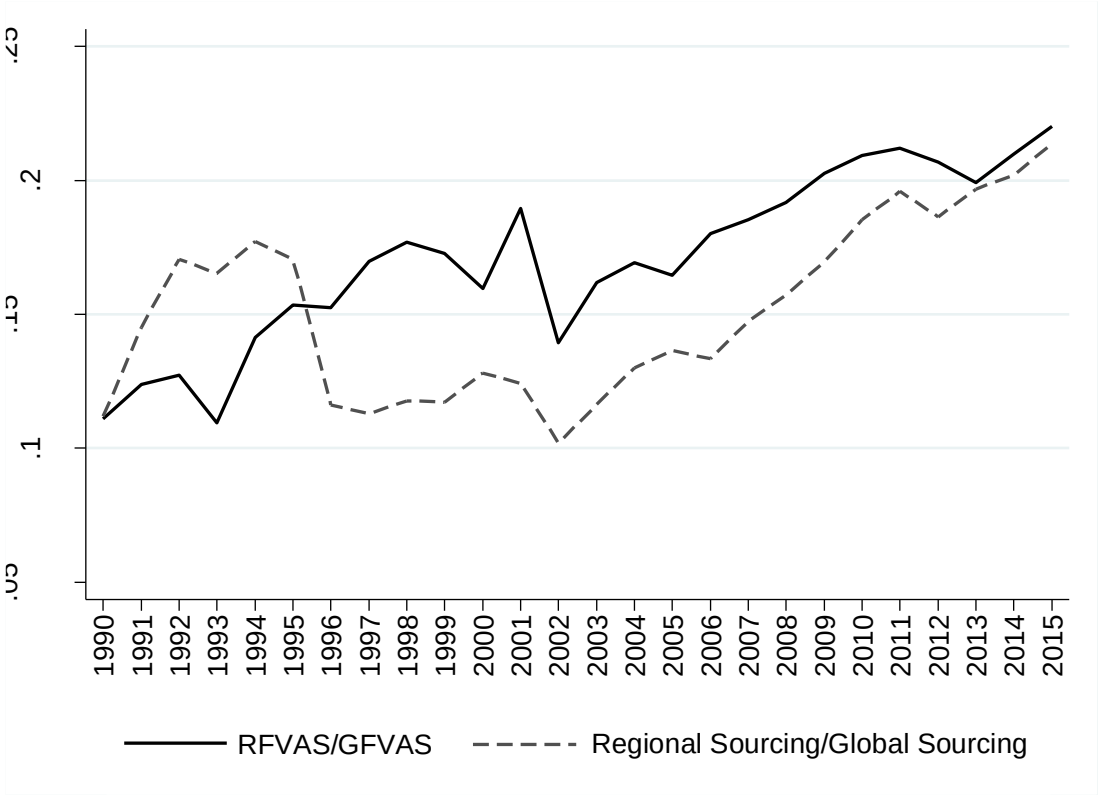
Table 4. Regional and global patterns of participation in value chains: Brazil

		Year	Agriculture	Mining	Manufacture	Services	Total
Foreign Value Added	Regional	1990	15.317	12.554	27.524	44.605	100.000
		2015	13.560	17.495	28.238	40.706	100.000
	Global	1990	1.806	4.403	35.218	58.574	100.000
		2015	1.798	8.472	46.938	42.791	100.000
Sourcing	Regional	1990	4.168	5.844	35.701	54.287	100.000
		2015	3.499	5.650	44.492	46.358	100.000
	Global	1990	7.012	5.807	26.995	60.187	100.000
		2015	6.722	9.980	38.079	45.219	100.000

Source: Authors' calculations.

Figure 1 shows the relative importance of regional insertion in relation to global insertion for the tradable activity sectors between 1990 and 2015. These results allow us to identify the change in the pattern of international fragmentation over time. The RFVAS and Regional Sourcing have increased in relation to the global share. Therefore, although Brazil’s participation in the value chains has been driven mainly by the global fragmentation of production, its regional insertion has increased more than its global insertion. This result may have been driven by trade agreements signed during this period, which Brazil prioritized to conclude with neighboring countries. Johnson and Noguera (2017) show that participation in bilateral free trade agreements positively affects countries' vertical specialization.

Figure 1. Trend of regional and global fragmentation of Brazilian production



Source: Authors' calculations.

5.1 Country clusters by value-added trade proximities

In order to provide an overview of the country clusters that are identified by the FVAS and Sourcing measures, we provide a diagram generated by a so-called multi-dimensional scaling (MDS) algorithm. The MDS technique organizes a set of variables in a few dimensions using the similarities (or distances) between every pair of observation.[12] For the application of the MDS technique, we derive the distance between two countries from the measures of trade value-added (FVAS or Sourcing).

Figure 2 presents the two-dimensional "map" of country clusters, resulting from MDS applied to the trade value added, for 26 industries, focusing on the Brazilian economy. Hence, we distinguish the origin of foreign value added in the Brazilian final products (FVAS) and the destination of the Brazilian value-added exports (Sourcing) by country clusters.

[12] For details on MDS, see Johnson and Wichern (2007).

Figure 2a shows the upstream integration into production chains – that is, the origin of foreign value added in Brazilian final products. Quadrant I shows the countries that provide value-added principally from mineral products to Brazil; quadrant II shows the countries that supply value added in agricultural, mining, textile, food, and wood industries; quadrant III shows the countries that are not representative in the supply of value added for Brazil; and quadrant IV shows the main value added suppliers concentrated in technology-intensive industries.

Figure 2b shows the destination of the Brazilian value-added exports – that is, the value added that is used in the last stage of production in other countries within the value chains. Quadrants I and III show the countries that are not traditional trade partners of Brazil. Quadrant II shows the destination countries of value-added exports in agricultural products, mining, textile, food, and wood industries. Quadrant IV presents the destinations for value-added exports in goods that are technology-intensive and closer to the last stages of production in value chains – such as machinery and electrical equipment, metal products, the petrochemical industry, and transport equipment.

Geographical proximity is still important in international trade (Johnson and Noguera, 2012b). In a context of international fragmentation of production, the connectivity of value chains is marked by geographical proximity of the main production countries, which are the center of globally connected regional chains – such as the regional chains centered on the United States, the European Union and Southeast Asia (Lejour et al., 2017). Figure 2 shows that Brazil's main trading partners in terms of FVAS and Sourcing are geographically distant, except for Argentina. This may be a restrictive factor for Brazil to take advantage of the benefits of greater trade integration and international fragmentation of production. In addition, the results shown in Figure 2 show that the participation of Brazil within the value chains presents different industrial standards, relative to its main trading partners and the downstream and upstream stages of the production chains.

Figure 2. Brazilian integration in the upstream and downstream stages of global value chains for 2015

Fig. 2.a – Origin of foreign value-added share (FVAS) in Brazilian final products by country groups

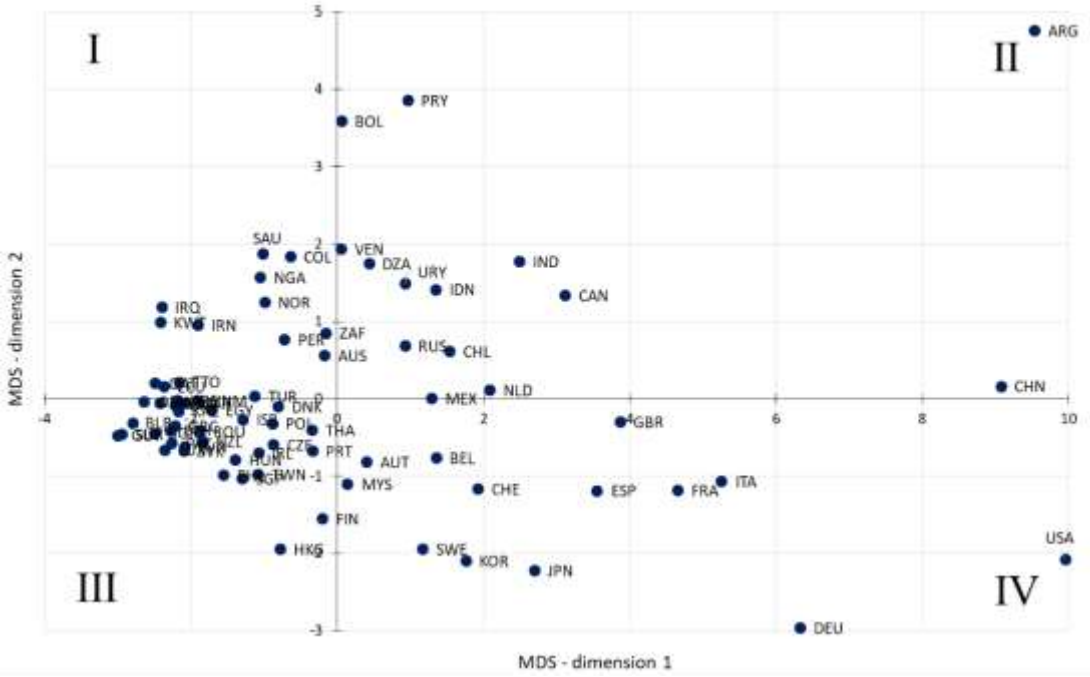
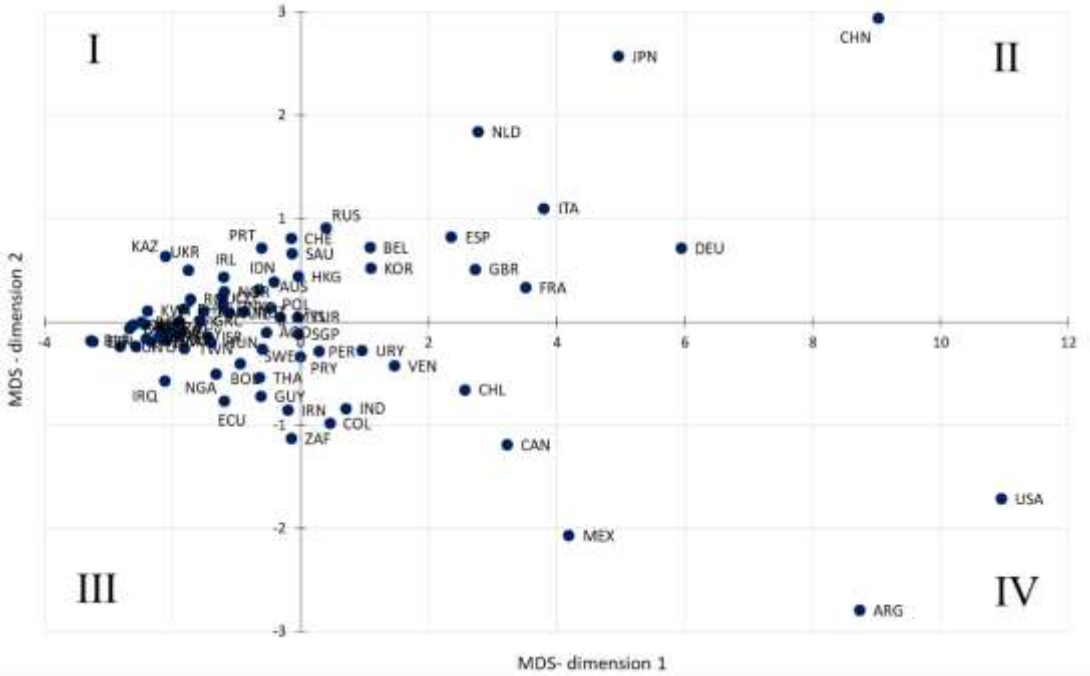


Fig. 2.b – Destination of the Brazilian value-added exports (Sourcing) by country groups

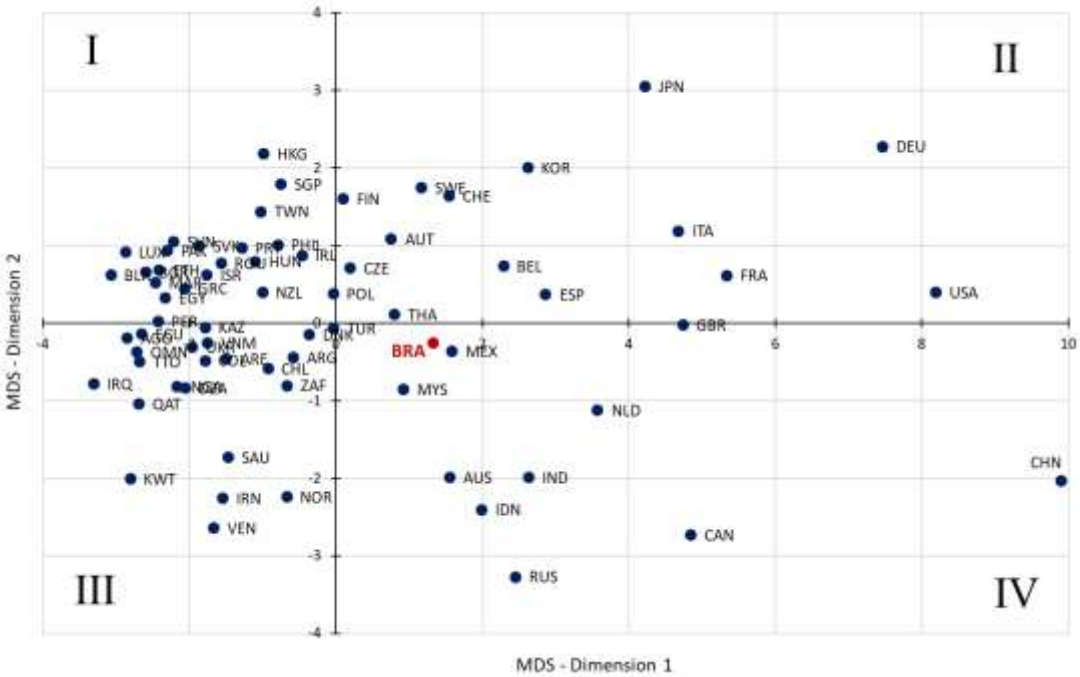


Note: For the application of the MDS technique, the measures of value-added trade were used for each country by activity sector. MDS configuration: method (modern MDS), loss criterion (stress), transformation (identity).

Source: Authors' calculations.

The share of value-added provision in global value chains (Sourcing), per Equation (2), is calculated for 26 country-industries specified in the Eora MRIO database. The MDS technique is used to identify groups of countries with similar patterns of downstream integration in global value chains (Figure 3). In quadrants I and II, the focus is on technology-intensive and specialized countries in the final stages of production of global value chains. Quadrant III reflects resource-intensive countries that contribute principally to early stages of global value chains. Quadrant IV shows countries specialized in the production of agricultural goods, mining, and food, wood, and petrochemical products. Brazil is in an intermediary position in the global production chain; i.e., despite having a comparative advantage in the production of natural resource-intensive goods, the Brazilian industrial structure enables the country to participate in some advanced production stages in value chains, where a country group specialized in technology-intensive industries is concentrated.

Figure 3. Value added in global production chains by country groups for 2015



Note: For the application of the MDS technique, the Sourcing measure is used for each country by sector. MDS configuration: method (modern MDS), loss criterion (stress), transformation (identity). Only the first 70 countries ranked by share in total exports is included in the Figure.

Source: Authors' calculations.

5.2 Comparison between Brazil and other economies

The fragmentation of production occurs differently at the regional or global level of value chains. In this context, Baldwin and Lopez-Gonzalez (2015), Lejour et al. (2017) and Li et al. (2019) identify the hubs in the global trading system. Lejour et al. (2017) show that value-added trade follows supply lines between groups of regions specialized in specific stages of global value chains. These supply lines are formed by groups of geographically close and highly integrated regions that provide value-added to other groups of regions defined as global production centers.

To identify the main regional value chains and global production hubs, the value-added trade flow, measured using Equation (4), is shown in Figure 4. The size of the circle represents the amount of foreign value added in the production of final goods. The width of the arrows represents the flow of value added between countries. The colors represent the regional production chains: South America (orange), North America (dark green), Asia-Pacific region[13] (blue), Europe (light green) and the rest of the world (lilac). The link arrow shows the direction of the value-added flow. The figure shows only the main value-added flows. This figure allows for visualization of the supply chains highlighting the main production hubs.

The structural pattern of the production chains is maintained between 1990 (Fig. 4a) and 2015 (Fig. 4b). Production chains have become more integrated, reflected in the increased share of foreign added value in production. Li et al. (2019) also show that value chains still remain largely regional; China is increasingly playing a relevant role as a hub in simple global value chain networks, although the United States and Germany are still the main hubs in complex global value chain networks.

Even though they are poorly integrated, South American countries act as a regional production center for Brazil, which in turn is more interconnected with the main hubs of the global value chains. Brazil is the main trade reference for these countries. This regional production center mainly supplies the production chain in North America and Europe, which serve as global production centers. Brazil at the global level plays a role as a supplier of intermediate inputs, while at the regional level it plays a role as a main production center. We should note that Brazil has the potential to significantly affect the economies of neighboring countries, assuming a position of regional leadership (Adler and Sosa, 2014).

[13] The Asia-Pacific region includes China, East Asia and Southeast Asia.

Figure 4. Main value-added trade flows in production chains

Fig. 4.a. 1990

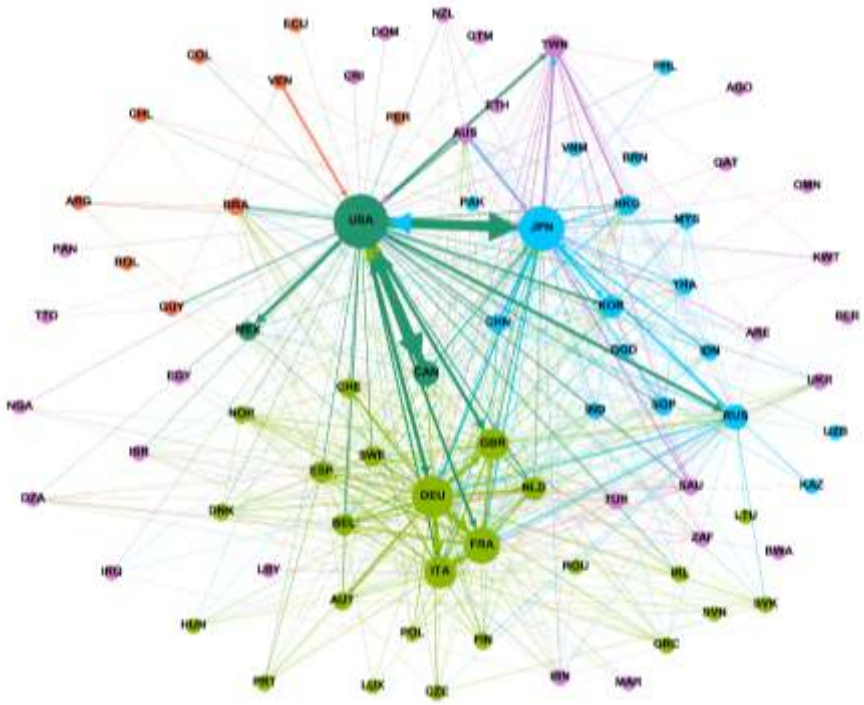
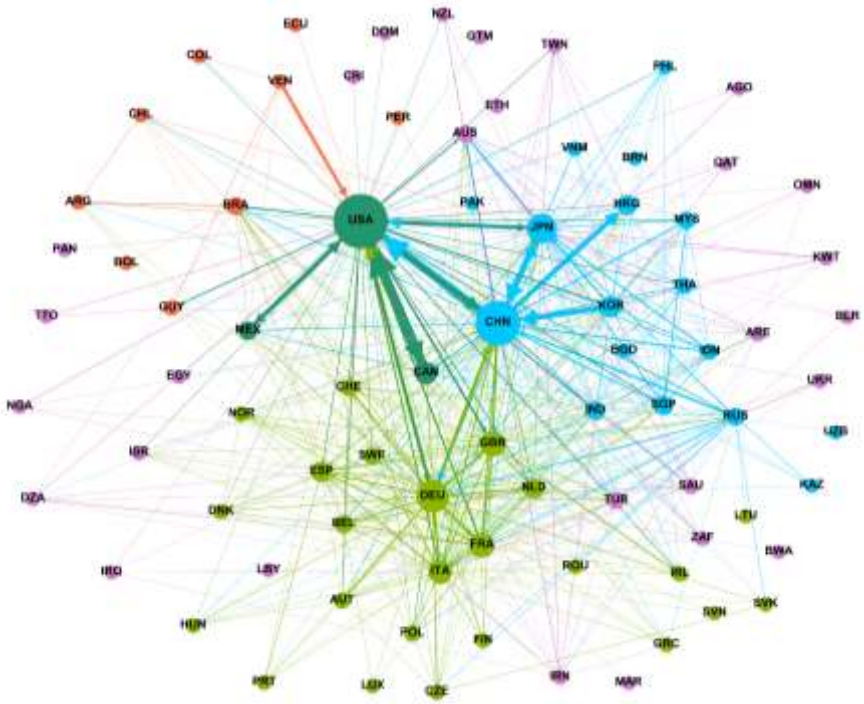


Fig. 4.b. 2015



Note: The circle size represents the amount of foreign added value used in the production of final goods. The width of the arrows represents the flow of added value between countries. The colors represent the regional production chains: South America (orange), North America (dark green), Asia-Pacific region (blue), Europe (light green) and rest of the world (lilac). The link arrow shows the direction of the value-added flow.

Source: Authors' calculations.

Table 7 shows FVAS and Sourcing in product value chains for Brazil and the major global manufacturing hubs (United States, China, and Germany).[14] Columns (3) and (6) present the difference between 2015 and 1990. All countries increased their foreign value-added share (FVAS). Meanwhile, the United States and Germany have lost share in Sourcing (column 6). In the 1990s and 2000s, there was a relocation of global manufacturing from the United States, Europe, and Japan toward Southeast Asia (Baldwin and Lopez-Gonzalez, 2015); column (6) shows that the main beneficiary of this process is China (7.82%).

Table 7. FVAS and Sourcing in product value chains by country, 1990 and 2015

	FVAS			Sourcing		
	1990	2015	2015–1990	1990	2015	2015–1990
	(1)	(2)	(3)	(4)	(5)	(6)
Brazil	7.996	11.043	3.047	0.985	1.386	0.401
United States	6.593	11.932	5.339	15.435	9.799	−5.637
China	8.093	12.629	4.536	2.635	10.460	7.825
Germany	13.575	21.894	8.319	10.475	7.880	−2.595

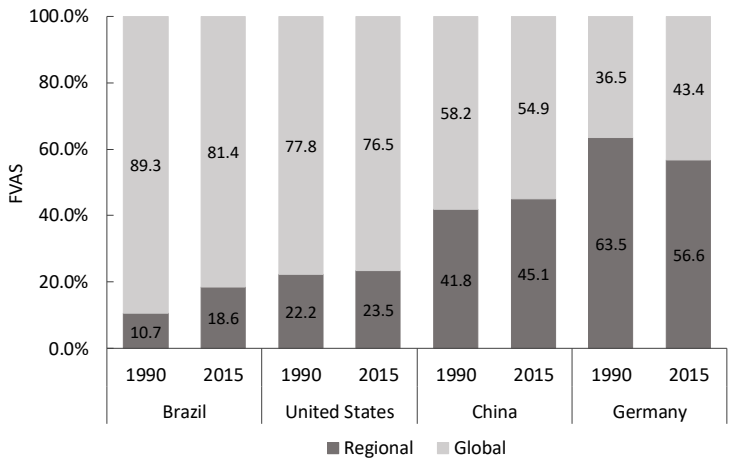
Source: Authors' calculations.

Brazil's participation in value-added trade occurs mainly through global fragmentation (Tables 1 and 2). However, the regional share has increased faster than the global share (Figure 1). This characteristic for the Brazilian economy differs from the result found by Los, Timmer and de Vries (2015) for the production chains ending in NAFTA, Europe, and East Asia countries between 1995 and 2011. For these countries, the growing international fragmentation of production is mainly due to increases in global shares rather than increases in regional shares. That is, the global fragmentation of value chains has progressed much faster than their regional fragmentation. To assess whether the increase in regional share is unique to the Brazilian economy, we analyze the global and regional fragmentation for the major hub of the global production chain (Figures 5 and 6).

[14] Tables A1 and A2 in the Appendix present FVAS and Sourcing in product value chains by country of completion for the 188 countries specified in the Eora MRIO database.

Figure 5 shows the foreign value-added share for the production chains ending in each country of completion.[15] Our results for Germany reinforce the evidence found by Los, Timmer and de Vries (2015), i.e., the value chains appear to have become less regionally fragmented (Figure 4). However, for Brazil, the United States, and China, we found that the regional fragmentation of value chains has progressed more than the global fragmentation between 1990 and 2015. Johnson and Noguera (2017) and Lejour et al. (2017) suggest that trade in production chains occurs in a highly integrated production system within production networks between geographically close economies. This result is partially reinforced with the evidence presented by Baldwin and Lopez-Gonzalez (2015), who interpreted the international fragmentation of production occurring mainly within regional trade blocs. Figure 6 also shows that the value added embedded in exports in 2015, increased regional participation for Brazil and the United States.

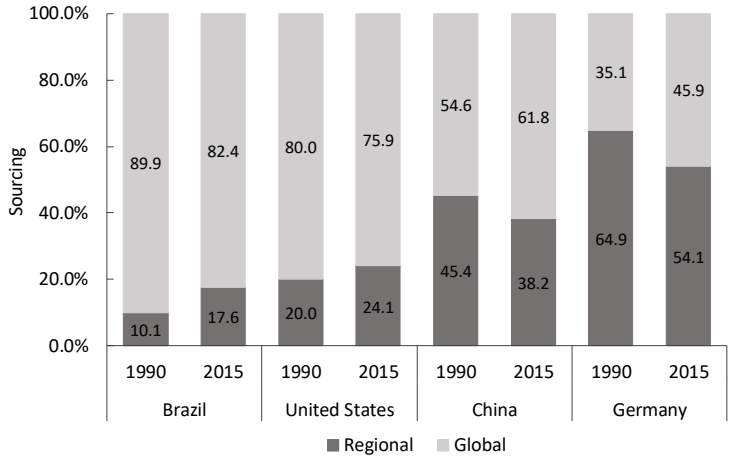
Figure 5. Foreign value-added share (FVAS): regional and global



Source: Authors' calculations.

[15] Our results are comparable to those shown by Los, Timmer and de Vries (2015) only for Mexico, Canada, and the Netherlands in Figure 4. They analyze the following regional trade blocs: the European Union (i.e., the 27 countries that were members in 2011), NAFTA (Canada, Mexico, and the United States), and East Asia (China, Japan, South Korea, and Taiwan).

Figure 6. Sourcing: regional and global

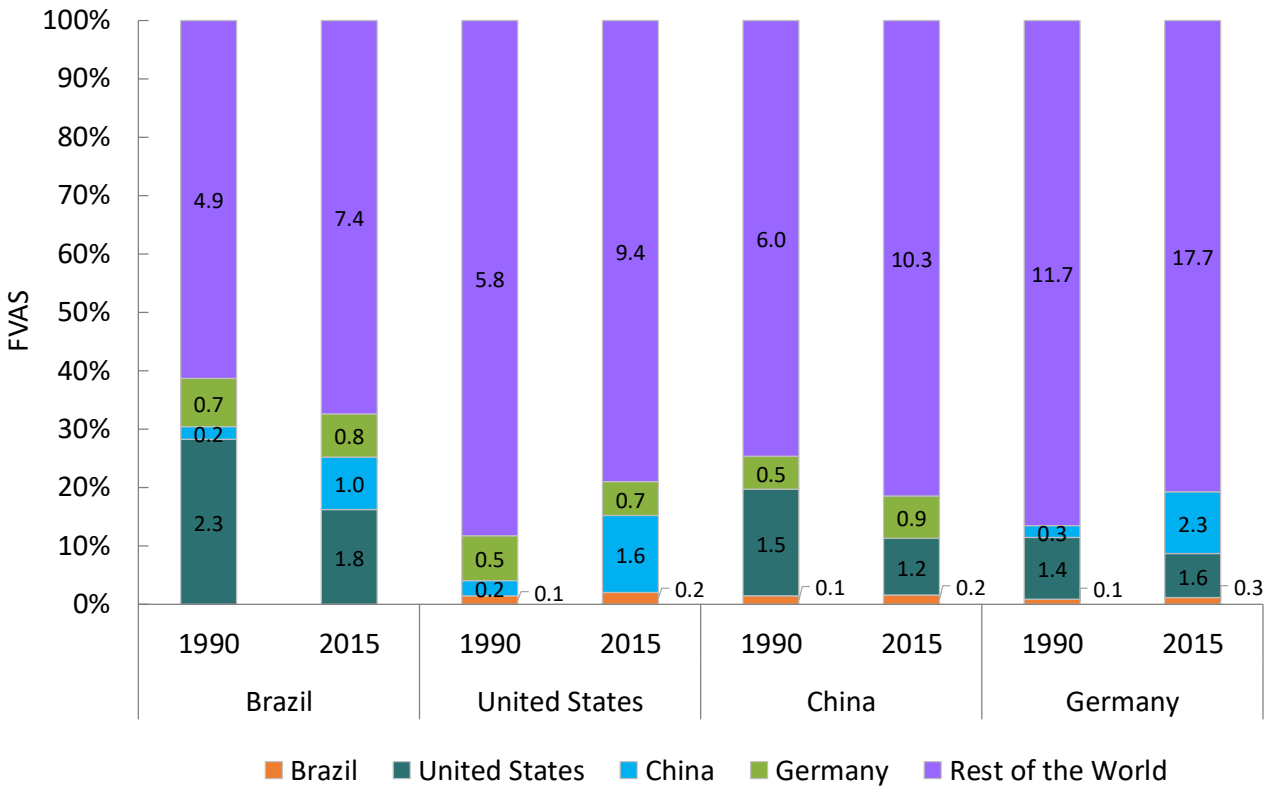


Source: Authors' calculations.

Geographic proximity is crucial in global value chains because the trade is intensified between economies that share a border. Brazilian participation in global value chains occurs mainly by trade with geographically distant countries. China and Germany mostly have regional trade. These countries are hubs in the global value chain and have a trade pattern for hub-and-spoke networks with their neighboring countries (Baldwin, Lopez-Gonzalez, 2015). Thus, there is an intense trade of intermediate inputs in regional production chain, with Chinese and German firms performing some intermediate stages of production in neighboring countries.

Figure 7 shows the origin of the foreign value added in the final products of Brazil as well as for the major production hubs (United States, China, and Germany). Brazil's share of total value-added exports increased from 0.98% in 1990 to 1.38% in 2015. Although the Brazilian economy occupies a prominent position in South America, its participation in global production chains is still discreet. Brazil contributes only a small share of the foreign value added in the final products of global hubs. Between 1990 and 2015, there was an increase in the interdependence between global hubs, although this interdependence has remained small. Baldwin (2020) also shows that the interdependence of the three global manufacturing hubs – China, Germany and the US – has increased with respect to international supply chains.

Figure 7. Global manufacturing hubs' interdependence



Source: Authors' calculations.

The value-added originating in South America represented 4.22% (1.38% only in Brazil) of the global trade in 2015. The small size of the economy of the countries in the region justifies Brazil's greater dependence on foreign value added with global origin. Brazil and other South American countries depend heavily on trade with countries that are geographically distant. Poor integration between South American countries potentially reduces the benefits that they could obtain from global trade, since the geographic distance still matters in globally fragmented production (Li et al., 2019).

6. Conclusions

This study has undertaken a spatial decomposition of foreign value added in the downstream and upstream segments of value chains. The focus of the analysis is the Brazilian economy, since its pattern of participation in international trade has distinct characteristics with reference to its global or regional integration. This analysis presents evidence with respect to the position that Brazil occupies in the value chains and the spatial extent of this productive fragmentation.

The main results show that the participation of the Brazilian economy in value chains occurs differently when considering their geographic scope and downstream and upstream production stages. We find that the downstream and upstream participation of Brazil in value chains is driven mainly by the global fragmentation of production. However, its regional insertion has increased more than its global insertion. The results also suggest that Brazil operates as a regional hub, as it is a reference for international trade in in this region. This regional production center proved to be more integrated with the main hubs of the global value chains (United States, China and Germany). Additionally, in the global context, Brazil plays the role of supplier of intermediate inputs, while in the regional context, Brazil plays the role of an important production center.

The Brazilian economy is relatively closed to international trade and minimally inserted in value chains. Protectionist policies have been directed for all stages of production in the national territory. Thus, Brazilian industry has remained minimally integrated into the international fragmentation of production. Additionally, the reduced number of trade agreements hinders the country's participation into value chains. However, the results also indicate that Brazil plays a strategic role in the fragmentation of South American production. This role, if well explored, could be a strategic mechanism to increase its participation in global fragmentation.

One of Brazil's greatest challenges in the context of international trade, as well as with reference to some developing countries, is to break the prevailing policy of protecting domestic industry. A greater integration with international trade through openness, trade agreements, and other measures that reduce tariffs and barriers, in the short term can be expected to cause a reduction in the level of activity, employment and income generated by some sectors of the economy. However, over the long term the same sectors are expected to achieve gains in industrial competitiveness. In the context of growing international outsourcing, the formulation of policies should take into account that the production processes are increasingly fragmented in different territories. Mapping the dimensions of value chains is crucial to an increased understanding of Brazil’s participation in the international fragmentation of production, which can be useful for the formulation of external and industrial policies. Hence, the evaluation of the productive structure considering the geographic extension of the value chain may bring objective elements to support the discussion of new trade agreements. The results of this study provide information that can be considered in planning policies that aim to increase Brazil's participation in global value chains. A strategy that could be used for this would be via greater regional insertion considering the negotiation of unilateral agreements (via Mercosur or not) with other countries in South and Central America.

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Appendix

Table A1. Ranking FVAS (2015)

Rank	País	(%)	Rank	País	(%)	Rank	País	(%)	Rank	País	(%)
1	Hong Kong	62,4746	48	Spain	24,6054	95	South Africa	18,2164	142	Senegal	12,4226
2	Singapore	55,8317	49	Iceland	24,3007	96	Gambia	17,5564	143	Burundi	12,3854
3	Luxembourg	48,0784	50	Bahamas	24,1387	97	Oman	17,2723	144	Mali	12,2423
4	Ireland	44,5272	51	Thailand	23,6202	98	UAE	16,7125	145	Cuba	12,1373
5	Tanzania	43,9097	52	Israel	23,2692	99	New Zealand	16,6532	146	Zambia	12,1141
6	Hungary	42,1964	53	Switzerland	23,2536	100	Malawi	16,4027	147	Syria	11,9514
7	Slovakia	41,7480	54	Namibia	23,2454	101	Bermuda	16,0992	148	USA	11,9321
8	San Marino	40,8655	55	Cyprus	23,0629	102	Mexico	16,0799	149	New Caledonia	11,6138
9	Viet Nam	39,7862	56	Cape Verde	22,9706	103	Costa Rica	15,9878	150	Venezuela	11,6100
10	Swaziland	39,1934	57	Fiji	22,8284	104	Madagascar	15,8174	151	Peru	11,4997
11	Estonia	38,3935	58	Croatia	22,3932	105	Bolivia	15,7029	152	Gabon	11,4744
12	Malaysia	38,1140	59	Poland	22,3794	106	Serbia	15,5769	153	Yemen	11,2273
13	Belgium	38,0820	60	Tajikistan	21,9751	107	Bosnia and Herzegovi	15,5706	154	Haiti	11,1290
14	Lithuania	36,0448	61	Romania	21,9642	108	Cayman Islands	15,2909	155	Algeria	11,1225
15	Lesotho	35,8693	62	Norway	21,9466	109	Nepal	14,9618	156	Colombia	11,1002
16	Guyana	35,6643	63	Germany	21,8944	110	Rwanda	14,8044	157	Brazil	11,0432
17	Belarus	35,2303	64	Vanuatu	21,8567	111	Guinea	14,7703	158	Indonesia	10,8760
18	Czech Republic	34,0214	65	Albania	21,8174	112	Sierra Leone	14,6916	159	India	10,7146
19	Slovenia	33,9289	66	Georgia	21,7822	113	Uruguay	14,5868	160	Russia	10,0894
20	Aruba	33,7258	67	Bulgaria	21,7527	114	Philippines	14,4571	161	Sri Lanka	9,9839
21	Netherlands	32,9623	68	Taiwan	21,6339	115	Saudi Arabia	14,2925	162	Cameroon	9,7763
22	Malta	32,9248	69	Tunisia	21,6080	116	Central African Repub	14,1022	163	Afghanistan	9,5831
23	Mauritius	32,3819	70	Jamaica	21,4119	117	Burkina Faso	14,0994	164	Ghana	9,5242
24	South Korea	31,2372	71	El Salvador	21,3357	118	Iran	13,9347	165	Mozambique	9,2337
25	Kyrgyzstan	30,4968	72	Lebanon	21,0326	119	Congo	13,8252	166	Kuwait	8,6262
26	TFYR Macedonia	30,3707	73	Italy	21,0249	120	Armenia	13,7845	167	Laos	8,5702
27	Greenland	30,2611	74	Honduras	20,9108	121	Uganda	13,6779	168	Bangladesh	8,1029
28	Austria	29,4678	75	Mauritania	20,4582	122	Paraguay	13,6156	169	Azerbaijan	8,0946
29	Netherlands Antilles	28,6986	76	Chile	20,4445	123	Australia	13,5600	170	Cote dIvoire	8,0756
30	Ukraine	28,4747	77	French Polynesia	20,0236	124	Kazakhstan	13,4868	171	Angola	7,5910
31	Sweden	28,4685	78	Jordan	20,0194	125	DR Congo	13,4160	172	Moldova	7,5204
32	Denmark	27,7024	79	Togo	19,7880	126	Liberia	13,4087	173	Egypt	7,4569
33	Montenegro	27,5477	80	Cambodia	19,6142	127	Libya	13,2897	174	Eritrea	7,4156
34	Antigua	27,5445	81	France	19,5850	128	Japan	13,2698	175	Somalia	7,2876
35	Latvia	27,3713	82	Turkey	19,5761	129	Ecuador	13,2312	176	North Korea	7,1714
36	British Virgin Islands	27,3319	83	Panama	19,2137	130	Benin	13,2293	177	Nigeria	6,9859
37	Bhutan	27,3211	84	Macao SAR	19,2095	131	Argentina	13,1738	178	Uzbekistan	6,9109
38	Seychelles	26,7272	85	Gaza Strip	19,1807	132	Guatemala	13,1506	179	Ethiopia	5,7589
39	Portugal	26,4452	86	UK	19,1274	133	Bahrain	13,1007	180	Iraq	5,6442
40	Belize	26,1862	87	Andorra	19,1011	134	Brunei	13,0846	181	Pakistan	5,4262
41	Sao Tome and Principe	25,8766	88	Mongolia	18,8251	135	Papua New Guinea	13,0833	182	Chad	5,4039
42	Maldives	25,8091	89	Nicaragua	18,7920	136	Niger	13,0272	183	Qatar	5,0449
43	Finland	25,7269	90	Suriname	18,7626	137	Morocco	12,9145	184	Monaco	3,7818
44	Barbados	25,6485	91	Samoa	18,5374	138	Zimbabwe	12,8412	185	Liechtenstein	3,4515
45	Greece	25,6358	92	Canada	18,5238	139	Dominican Republic	12,8355	186	Myanmar	1,7025
46	Turkmenistan	25,5970	93	Kenya	18,3055	140	Trinidad and Tobago	12,7109	187	South Sudan	1,5761
47	Botswana	25,0902	94	Djibouti	18,2729	141	China	12,6289	188	Sudan	0,6425

Source: Authors' calculations.

Table A2. Ranking Sourcing (2015)

Rank	País	(%)	Rank	País	(%)	Rank	País	(%)	Rank	País	(%)
1	China	10,4600	48	Kazakhstan	0,3592	95	Dominican Republic	0,0337	142	Liberia	0,0050
2	USA	9,7987	49	New Zealand	0,3578	96	Ghana	0,0336	143	Albania	0,0049
3	Germany	7,8800	50	Qatar	0,3413	97	Uruguay	0,0335	144	Greenland	0,0045
4	Japan	5,4412	51	Portugal	0,3208	98	Congo	0,0318	145	South Sudan	0,0045
5	UK	4,2781	52	Colombia	0,2743	99	Papua New Guinea	0,0312	146	Uganda	0,0044
6	France	4,1192	53	Viet Nam	0,2605	100	Panama	0,0274	147	Tanzania	0,0042
7	Italy	3,5395	54	Romania	0,2516	101	Zambia	0,0266	148	Fiji	0,0041
8	Canada	3,4719	55	Angola	0,2408	102	Turkmenistan	0,0262	149	Guyana	0,0041
9	Russia	3,0961	56	Slovakia	0,2110	103	Gabon	0,0247	150	Haiti	0,0041
10	South Korea	2,9739	57	Trinidad and Tobago	0,2080	104	Georgia	0,0241	151	Aruba	0,0040
11	Netherlands	2,5265	58	Iraq	0,2007	105	Cameroon	0,0239	152	Bahamas	0,0038
12	Switzerland	1,9602	59	Oman	0,1916	106	Iceland	0,0227	153	Togo	0,0038
13	Spain	1,9542	60	Greece	0,1649	107	Moldova	0,0221	154	Botswana	0,0037
14	Belgium	1,9457	61	Pakistan	0,1547	108	North Korea	0,0220	155	Barbados	0,0033
15	Australia	1,9267	62	Peru	0,1505	109	Cuba	0,0213	156	Mali	0,0033
16	India	1,9159	63	Slovenia	0,1503	110	TFYR Macedonia	0,0194	157	Swaziland	0,0032
17	Indonesia	1,8851	64	Belarus	0,1501	111	DR Congo	0,0192	158	Niger	0,0032
18	Mexico	1,5514	65	Egypt	0,1471	112	Malta	0,0184	159	Liechtenstein	0,0028
19	Malaysia	1,5390	66	Ecuador	0,1406	113	Mongolia	0,0181	160	Burkina Faso	0,0028
20	Brazil	1,3863	67	Ethiopia	0,1375	114	Lebanon	0,0172	161	Bhutan	0,0028
21	Sweden	1,2577	68	Luxembourg	0,1359	115	Sudan	0,0170	162	Maldives	0,0027
22	Venezuela	1,1161	69	Morocco	0,1208	116	Kyrgyzstan	0,0149	163	French Polynesia	0,0025
23	Thailand	1,0793	70	Bulgaria	0,1180	117	Serbia	0,0142	164	Belize	0,0024
24	Austria	1,0723	71	Libya	0,1083	118	Nepal	0,0136	165	Benin	0,0023
25	Norway	1,0576	72	Bolivia	0,0820	119	Bosnia and Herzegovi	0,0133	166	Gaza Strip	0,0020
26	Singapore	0,9716	73	Syria	0,0762	120	Mauritius	0,0132	167	Seychelles	0,0019
27	Saudi Arabia	0,9296	74	Lithuania	0,0750	121	Senegal	0,0127	168	Montenegro	0,0019
28	Iran	0,8638	75	Zimbabwe	0,0643	122	Laos	0,0126	169	Sierra Leone	0,0019
29	Czech Republic	0,7898	76	Estonia	0,0629	123	Honduras	0,0124	170	Eritrea	0,0017
30	South Africa	0,7524	77	Sri Lanka	0,0609	124	Netherlands Antilles	0,0114	171	Andorra	0,0017
31	Taiwan	0,7418	78	Azerbaijan	0,0588	125	New Caledonia	0,0112	172	Cayman Islands	0,0016
32	Finland	0,7383	79	Bangladesh	0,0572	126	El Salvador	0,0110	173	Monaco	0,0016
33	Poland	0,7213	80	Croatia	0,0570	127	Madagascar	0,0106	174	San Marino	0,0016
34	Hong Kong	0,6965	81	Latvia	0,0561	128	Cyprus	0,0099	175	Rwanda	0,0015
35	Denmark	0,6802	82	Brunei	0,0545	129	Cambodia	0,0094	176	British Virgin Islands	0,0014
36	Philippines	0,6732	83	Tunisia	0,0544	130	Mauritania	0,0092	177	Central African Repub	0,0013
37	Ireland	0,6079	84	Costa Rica	0,0524	131	Guinea	0,0087	178	Burundi	0,0013
38	Kuwait	0,5731	85	Uzbekistan	0,0498	132	Namibia	0,0086	179	Vanuatu	0,0013
39	UAE	0,5353	86	Myanmar	0,0479	133	Jamaica	0,0085	180	Bermuda	0,0013
40	Argentina	0,5192	87	Yemen	0,0422	134	Armenia	0,0082	181	Lesotho	0,0012
41	Turkey	0,5113	88	Cote dIvoire	0,0419	135	Tajikistan	0,0074	182	Cape Verde	0,0011
42	Algeria	0,4874	89	Paraguay	0,0418	136	Nicaragua	0,0073	183	Samoa	0,0011
43	Chile	0,4653	90	Bahrain	0,0413	137	Suriname	0,0067	184	Djibouti	0,0010
44	Israel	0,3888	91	Macao SAR	0,0405	138	Chad	0,0060	185	Antigua	0,0010
45	Hungary	0,3746	92	Kenya	0,0375	139	Malawi	0,0059	186	Sao Tome and Princip	0,0009
46	Ukraine	0,3705	93	Guatemala	0,0366	140	Mozambique	0,0054	187	Gambia	0,0007
47	Nigeria	0,3624	94	Jordan	0,0360	141	Afghanistan	0,0053	188	Somalia	0,0004

Source: Authors' calculations.