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ARTICLE

Geographical and sectoral specialization of Brazilian value-added exports

*Leonardo Thuler Costa** , *Marta dos Reis Castilho*** ,
*Kaio Vital da Costa****

* Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro (RJ), Brasil. E-mail: leotc.07@gmail.com

** Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro (RJ), Brasil. E-mail: castilho@ie.ufrj.br

*** Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro (RJ), Brasil. E-mail: kaio.costa@ie.ufrj.br

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ABSTRACT

This paper deepens the existing analysis of the Brazil's integration into Global Value Chains by applying the decomposition methodology of gross exports proposed by Wang, Wei and Zhu (2018). This decomposition method breaks down gross exports into several components corresponding to the domestic and foreign value added embedded in bilateral and sectoral exports, which allow an accurate characterization of the countries' participation into GVCs. Using data from the WIOD database for the period 2000-2014, we examine the Brazilian specialization for exports in value added for three of its main trading partners (China, the United States, and the European Union). The geographical and sectoral export profile analysis is of interest to Brazil since the country's commercial specialization differs significantly according to its partners.

KEYWORDS: Global Value Chains; International fragmentation of production; Trade in Value Added; Brazil; Trading Partners

1. Introduction

The possibility of fragmenting production and distributing it across geographically dispersed countries has led to changes in the composition of global trade flows in two significant aspects: the expansion of intermediate goods trade compared to final goods trade, and the shift in the production and trade geographies (BALDWIN, 2016). While manufacturing activities have moved relatively towards the Asian region, the networks that organize fragmented production activities have shown a tendency towards regionalization. Since the 1980s, networks with relevant regional characteristics (although internationally connected) have emerged, especially in North America, Europe, and Asia, regions that have been called the “three global factories”[1].

The increasing fragmentation of international productive processes has raised discussions on the measurement of trade and production, aiming to distinguish the share of products and services’ value generated abroad from that produced domestically and to identify the direct and indirect relationships between the productive structures of various economies.

The fragmentation of production processes, which distributes production stages to different regions and countries, has increased the imported content of goods and services and widened the gap between the goods’ gross value and the domestic value added (DVA). This is particularly relevant to comprehend the economic internationalization degree, which involves understanding not only how foreign trade contributes to each economy in terms of income, employment, and economic dynamism but also how various types of shocks are propagated in an interconnected economy.

The tools used to measure trade flows have kept pace with the evolution of production organization, which is characterized by the international fragmentation of production processes, seeking to

1 This nomenclature can be attributed to BALDWIN (2016), however, this finding is present in multiple studies (LI; MENG; WANG, 2019; WORLD TRADE ORGANIZATION, 2021; MARCATO, 2022; XIAO et al., 2020; LOS et al., 2013).

represent as accurately as possible the links of supply and demand between different economies. These tools must take into account the difference between gross trade values and the net amounts of imported components and double counting, which are perceptible for total trade but can be still more important in the case of bilateral or regional flows. This is because the direct importing country often differs from the final destination where the good is consumed by the final demand. Indeed, the more complex the value chain and the more dispersed the production in different countries, the greater the difficulty for traditional statistics to adequately reflect the contribution of each country in terms of value added incorporated into goods and services.

Measuring the trade value added has been a methodological challenge since Hummels, Ishii and Yi (2001) proposed characterizing the vertical integration of countries. In addition to the studies by Daudin, Rifflart and Schweisguth (2011), Johnson and Noguera (2012), among others, who contributed to the concept of value added trade consolidation, several papers by Koopman and his co-authors (in particular, KOOPMAN et al., 2010, and KOOPMAN; WANG; WEI, 2014) have rigorously detailed the complex network of value added originating from different partners and contained in countries' imports and exports.

Koopman, Wang and Wei (2014) (hereafter referred to as KWW) proposed a detailed decomposition of gross exports, with particular emphasis on the rigorous treatment of double-counting terms that are present in gross trade flows. Building on the research of Johnson and Noguera (2012), KWW classified the value added in exports while also considering the final absorption destination. The decomposition proposed by KWW was further refined by Wang, Wei and Zhu (2018, hereafter WWZ), whose methodology allows for sectoral and geographical disaggregation of trade flows. In the present study, this methodological refinement makes it possible to identify the various components of exports, distinguishing between the value added by Brazil and its trading partners, as well as double-counting shares, and to assess whether Brazil is integrated into chains involving its partners.

Beyond methodological issues, a good understanding of the intensity and form of a country's integration into global value chains (GVC) can shed light on the associated economic challenges. Several studies have explored the various patterns of countries' insertions in GVCs, highlighting the difficulties developing economies face in advancing their development processes[2]. In the case of Brazil, several researches (HERMIDA; XAVIER, 2018, MARCATO et al., 2019, FERRAZ et al., 2015) indicate that the country has low integration in GVCs, usually at the simplest stages. This article aims to contribute to the discussion on Brazil's GVC insertion by analyzing a dimension that has already been addressed in terms of gross value of trade (CASTILHO; COSTA; TORRACCA, 2019; KUPFER et al., 2013), but little explored from the perspective of trade in value added - namely, the different specializations of Brazilian exports according to their partners.

Different trade specializations concerning varied partners express the diversity and heterogeneity of the country's productive bases, which may prove to be more competitive for certain industries in the relationship to one country, and less in the relationship to other. The notion of "hierarchy of comparative advantages" formulated by Lassudrie-Duchene and Mucchielli (1979)[3] is very useful to illustrate this issue. According to this concept, a country's commercial insertion should consider its relationship with all partners, and the relative costs of the commercialized products build a kind of chain in which the country is positioned.

Brazil's trade profile can illustrate this proposition by presenting different patterns across its various partners. As an economy in an intermediate level of development, with a large production structure heterogeneity, the country is involved in production tasks of a wide

[2] See, for example, Milberg and Winkler (2013), Medeiros (2019), Dünhaupt and Herr (2021), Biurrun et al. (2021) and Smichowski, Durand and Knauss (2021).

[3] These authors propose the notion of the "hierarchy of comparative advantages" in an attempt to explain intra-industry trade by means of Ricardian comparative advantages, but they argue that the concept of hierarchy is also compatible with formulations à la Linder (representative demand) and technological explanations (such as Posner or Vernon's product cycle).

range of products, whose competitiveness may differ depending on the destination markets. With certain partners, such as Europe and Japan, Brazil's trade seems to follow a typical North-South specialization, in which Northern countries export more complex goods with higher technological content and Southern countries export primary or manufactured products with lower technological content[4].

In terms of trade with Latin America and Africa, Brazil's export agenda is more sophisticated, with a higher share of manufactured products, as opposed to its trade with North America and Europe. Trade theories - whether those based on factor endowments' discrepancies or those based on technological differences - justify the existence of North-South trade by the disparity between the countries' development levels, even though other elements such as geographical distance may also play a role[5]. Even among developed countries, the export pattern to the United States (US) differs from that to the European Union (EU) and Japan. Meanwhile, Brazil's bilateral trade with China could be characterized as North-South, with Brazil exporting agricultural and mineral commodities and importing manufactured goods. One should also pay attention to the changes in Brazilian exports' composition, which have been characterized by an increasingly regressive specialization (NASSIF; CASTILHO, 2020).

The Brazilian diversified trade profile has already been analyzed, however, in terms of gross trade values. This paper seeks to investigate to what extent these patterns persist when considering trade flows in value added. The results seem to reinforce the findings on Brazil's position in the international division of labor observed from gross trade data, albeit with some small nuances mainly for the regions where Manufacturing plays a greater role. In this sense, this study

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4 This characterization can be found in several North-South trade modeling approaches, such as Krugman's technology gap model (Krugman, 1984) or the growth and specialization models of Cimoli and Porcile (2010).

5 Geographical distance appears as a relevant factor for trade for several reasons - transport cost, border trade, or cultural proximity - as discussed in Michaely and Wajnryt (2016).

intends to contribute to the literature on Brazil's commercial insertion by applying the methodology of Wang, Wei and Zhu (2018).

The paper is organized into two sections, besides the introduction and the concluding remarks. Section II presents a critical review of the main advances in methodological and analytical terms within the GVC approach. Section III is dedicated to the analysis of the results found from the application of the structural decomposition method of Brazilian gross exports.

2. Measuring trade in value added in global value chains: methodology and database

The term "global value chains" refers to the way production and trade have been organized since the fragmentation of production processes. Although it is associated with the analytical tool proposed by Gereffi (see GEREFFI; PONTE; RAJ-REICHERT, 2019), the term is widely used regardless the theoretical framework, being often employed as a synonym for expressions seeking to describe the same phenomenon or part of it[6].

GVCs can be identified and analyzed by tracking the value added along these production chains (CATTANEO et al., 2013; ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT; WORLD TRADE ORGANIZATION; UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT, 2013). Such tracking is useful both for analyzing the value chains themselves and for assessing the participation and positioning of countries in the global system of production and trade.

Since the 1990s, numerous initiatives and efforts have been made to address these issues. New datasets have been compiled combining input-output tables with detailed bilateral trade statistics. These cross-country input-output tables provide an extensive map of international

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6 Such as "global production and trade networks", "vertical specialization", "disintegration of production", "production sharing", "fragmentation of international production".

transactions of goods and services in a vast dataset that combines the national input-output tables of several countries at a given point in time.

Since the tables contain information on supply-use relationships across industries and countries, we can identify the vertical structure of the international fragmentation of production and measure cross-border value flows to a country or region (INOMATA, 2017). Therefore, these tables can be used in combination with long-established accounting relationships (LEONTIEF, 1936) to define the links between the sector and country where the value of production originates and the market where it is absorbed by the final demand (BORIN; MANCINI, 2023). Theoretically, it would be possible to track the process of value added generation for each product in each country at each stage of production. Intercountry input-output matrix tables also allow us to investigate trade and production linkages by identifying the share of a country's gross domestic product (GDP) that is embedded in its own total exports (value added created by domestic production factors) and the share of the foreign country's GDP embedded in the same total exports (value added created by foreign production factors).

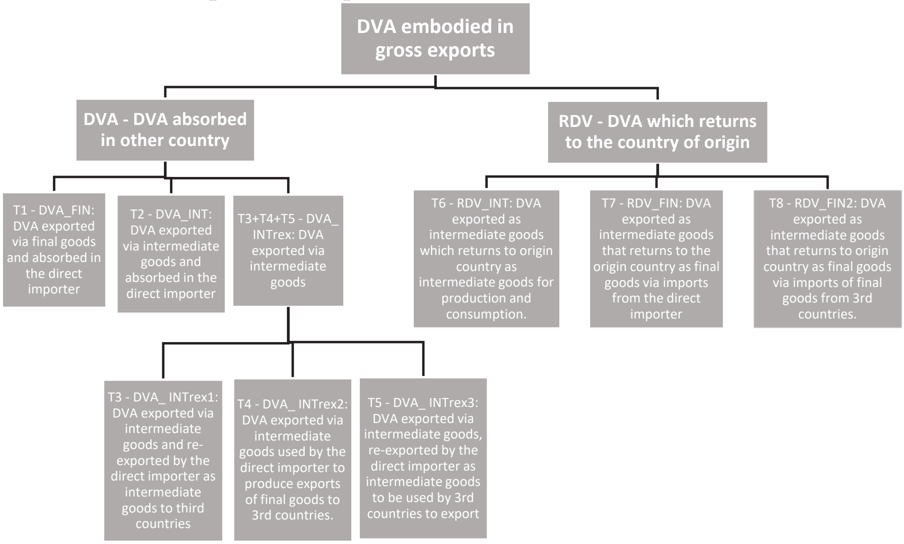
Methodologies that decompose gross trade flows into different value added components have been developed to exploit this data, supported by a range of indicators (see, among others, HUMMELS et al., 2001; DAUDIN; RIFFLART; SCHWEISGUTH, 2011; JOHNSON; NOGUERA, 2012; KOOPMAN; WANG; WEI, 2014; FALLY, 2012; ANTRÀS et al., 2012; ANTRÀS; CHOR, 2018; WANG et al., 2017). By using them, it is possible to identify the length of value chains (more or fewer stages of production between primary inputs and final goods) and the degree of participation in GVCs at the country and sector levels, as well as to measure how complex is the participation of these economies.

One of the most widely used decomposition methodologies is the one proposed by Koopman, Wang, and Wei (KWW, 2014), who provided a thorough exposition of the main concepts required to calculate trade in value added. They decompose gross exports into various sources of value added and associate official gross statistics with value added measures. More specifically, gross exports are divided into nine different components of domestic and foreign value added (FVA), as well as double-counting items that arise when intermediate goods cross borders multiple times. As a result, a complete picture of the value added generation process is obtained, in which several previous formulas for measuring value added trade are systematically integrated into a single accounting framework. This method encompasses most of the methodologies previously proposed in the literature (e.g., HUMMELS et al., 2001; DAUDIN; RIFFLART; SCHWEISGUTH, 2011; JOHNSON; NOGUERA, 2012). KWW (2014) show that gross exports generally consist not only of value added that can be traced back to GDP generated at home or abroad, but also of some trade flows that are purely double counted, as when intermediate inputs cross a country's borders multiple times at different stages of production.

Building on the decomposition performed by KWW (2014), Wang, Wei and Zhu (2018) extended the method to include more components from the domestic value added perspective, foreign value added perspective, and double counting elements. In this way, the authors were able to decompose the value added contained in exports into bilateral, sectoral, and bilateral-sectoral levels. This decomposition allowed the allocation of bilateral trade of intermediate goods according to their place of final absorption, permitting further subdivision of the components in KWW (2014). Figures 1 and 2 below illustrate the decomposition in WWZ (2018) by the optics of domestic value added, foreign value added, and double-counting elements (See Appendix 1 for more details methodology and on definition of decomposition terms – Table A1).

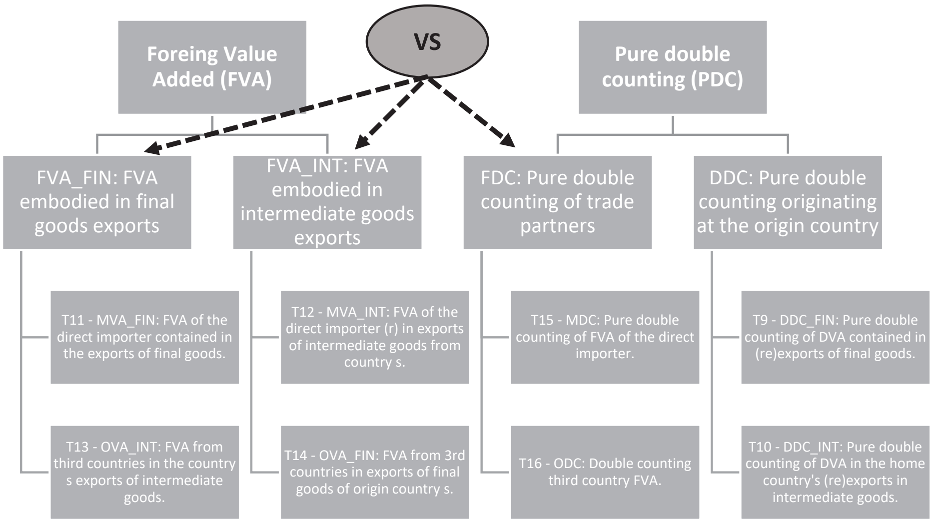
As we can see in Figure 1, the domestic value in exports of both final and intermediate goods is divided into two parts: one absorbed in another country and one that returns to the country of origin. In addition, the third term is referred to as re-exports to third countries and can be further decomposed into three other terms of intermediate and final goods' exports to other countries. Thus, the domestic content is obtained by summing from T1 to T8.

FIGURE 1
Decomposition of exports to domestic content in WWZ (2018).



Source: Wang, Wei and Zhu (2018). Own elaboration.

FIGURE 2
Decomposition of exports to foreign content and double-counting in WWZ (2018).



Source: Wang, Wei and Zhu (2018). Own elaboration.

Figure 2 shows how the foreign value added can be decomposed into shares for both intermediate and final goods' exports to be absorbed in the importing country and exported to third countries.

This last concept is important for the GVC analysis, in view of the cross-border flow of value added incorporated in goods and services from other countries.

The double counting terms (T9, T10, T15 and T16) can also be decomposed into a part related to trading partners and another one associated with domestic production. The latter is further decomposed into final goods and intermediate goods. As illustrated in Figure 2, these terms do not belong to the domestic or foreign value added categories.

According to Black (2021), the decomposition performed by WWZ (2018) allows us to distinguish four important concepts of GVC:

i. Exports in value added: relative to the value added originating in country "s" and consumed in country "r". That is, the place of creation differs from the place of absorption (T1 to T5);
ii. Domestic value added embedded in exports: this is a concept that takes into account the local content of value added (its origin), but disregards the place of destination of the final consumption;
iii. Domestic content: relative to the value added embedded in exports plus the pure double counting term, which arises when the domestic intermediate input crosses multiple borders until its final absorption (T1 to T8, added to T9 and T10);
iv. Foreign value added embedded in exports: correspondent to the sum of T11 to T14, which may include the pure double counting terms (T15 and T16) and is equal to VS[7].

Borin and Mancini (2023) provide exhausting decompositions of value added exports at the aggregate, bilateral, and sectoral levels, which are consistent with the KWW framework and addresses the shortcoming of their method, as well as difficulties faced by previous

[7] VS1 is equal to the sum of the terms T3 to T10. In turn, VS1*, a subset of VS1, is considered the sum of T6 to T8 (DAUDIN; RIFFLART; SCHWEISGUTH, 2011), while VS1* proposed by KWW (2014) is the sum of T8 to T10. For vertical trade, KWW (2014) use the sum of VS1 and VS, differing from Daudin, Rifflart and Schweisguth's (2011) definition of vertical trade, which would include only VS1* and VS.

attempts to obtain a bilateral counterpart. Based on the reasoning proposed by Nagengast and Stehrer (2016), Borin and Mancini (2023) developed two different approaches for accounting for value added in bilateral trade: the "source-based approach" (source), that assumes the perspective of the country where the value originates, and the "absorption-based approach" (sink), that adopts the perspective of the country of final demand. In both cases, the original KWW components can be accurately retrieved by aggregating the bilateral export flows in all destinations.

More recently, Borin and Macini (2023) have made advancements in improving the definitions for some components that were incorrectly specified in KWW (2014), namely: i) domestic value added that is directly (and indirectly) absorbed by the final demand of the importing country; ii) foreign value added in exports; iii) the double counting of items produced abroad. Their contribution, through the refinement of value added decompositions by KWW, enables the determination of the aggregate value of bilateral exports, with results similar to those obtained by WWZ.

In this study, we have used the World Input-Output Database (WIOD), which spans the period between 2000 and 2014 and includes 43 countries, along with an estimation for the rest of the world[8]. To facilitate multi-country analysis, the original 56 WIOD sectors based on the International Standard Industrial Classification (ISIC/REV 4) have been regrouped into five major sectors, namely Agriculture, Mining, Manufacturing, Services, and Other Services[9].

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[8] At the time of preparing the estimates which are used here, TiVA-OECD had not yet published its most recent version, and among those available, the two input-output matrices whose estimates for non-OECD countries show less variation relative to national input-output matrices are WIOD and TiVA. For a comparative analysis between the different multiregional input-output matrices see Tukker and Dietzenbacher (2013) and Owen et al. (2016).

[9] Services have been aggregated into two groups in order to isolate the two most knowledge-intensive sectors (Consulting, programming and information services, and legal, accounting, and clerical activities).

Data availability led us to focus on a select group of Brazilian trade partners, which include China, the US and the EU. This group accounted for 42.5% of Brazil's gross exports in 2014. Regrettably, the WIOD database does not contain data for Latin American countries, which are of significant interest due to their relevance for Brazilian exports, in particularly in terms of manufactured goods and higher degree of elaboration.

3. Geographical patterns of Brazilian exports

The analysis of the components proposed by the WWZ (2018) decomposition allows us to identify not only the domestic and foreign value added contained in exports but also makes it possible to evaluate the degree of productive integration, as it maps the trade interactions of productive structures among various countries. In the following sections, we will use the results of the decomposition to analyze the sectoral and geographical differences in Brazil's participation in Global Value Chains (GVCs), with the aim of identifying three important aspects: i) the domestic content of value added embedded in exports by partner and major sector, ii) the share of trading partners' value added contained, directly and indirectly, in Brazilian exports, and iii) the interdependence between the national productive structure and other countries. The first section compares the geographical composition in gross value and domestic value added of Brazilian exports, as well as the composition of exports by partner according to the various components of gross exports decomposition. In the following section, we evaluate the different components of gross exports, disaggregated into the five major sectors, for both exports to the group of partners and the three partners analyzed in this paper.

3.1. The importance of trading partners in Brazilian geographic specialization

The profile of Brazilian exports has undergone profound changes since the beginning of the 21st century, both in geographical and sectoral terms. These two dimensions are related, given the aforementioned differences in trade specialization according to trading partners. In this research, we will analyze the decomposition of Brazilian gross exports to three of its main trading partners – China, the US, and the EU. Unfortunately, the countries of Latin America and the Caribbean, which absorbed about 20% of Brazilian exports, are underrepresented in the WIOD database[10]. Considering these countries would be desirable not only due to their weight in exports but also due to the composition of these exports. Manufactured exports are particularly important for Latin American neighbors, showing greater sophistication than exports to other partners and still reflecting some degree of productive articulation, a relevant point from the perspective of GVC analysis and productive development (KUPFER et al., 2013; CASTILHO; COSTA; TORRACCA, 2019).

Figure 3 shows the evolution of the weight of partners in total Brazilian gross exports and highlights an important change in the geographical distribution of Brazilian exports. Traditional partners such as the US and the EU have lost importance, while China became the main destination for Brazilian exports during the 2000s (MEDEIROS, 2010; HIRATUKA; SARTI, 2016; CASTILHO; COSTA; TORRACCA, 2019)[11].

Figure 4 presents the share of Brazilian value added in exports that do not return to the country, after removing double counting. This indicator includes Brazilian exports that are consumed in the

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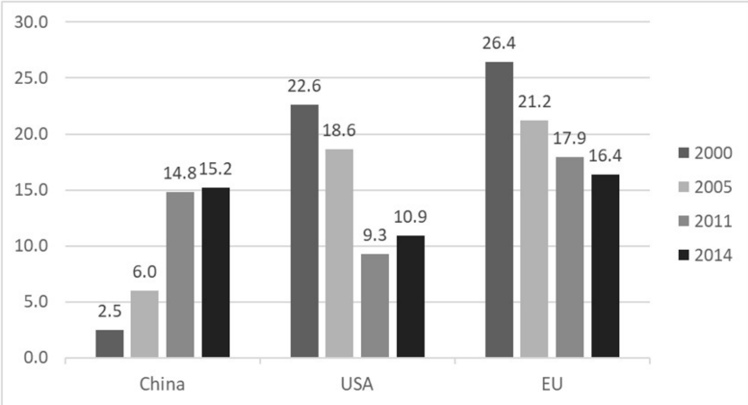
[10] According to Cadestin, Gourdon and Kowalski (2016), the regional dimension of value chain activity becomes apparent when examining the backward and forward participation of GVC by the origin and destination of traded value added. In Latin America, only 9% of foreign value added used for exports, on average, was obtained within the region or exported as intermediates for further processing within the region. In the European Union and Southeast Asia - the two regions with some of the highest global rates of participation in GVC - regional linkages were much stronger. For instance, in the European Union, an average of 49% of foreign value added used for exports came from other EU countries, and in Southeast Asia, this index was 40% in 2011. See also Zaclicever (2017).

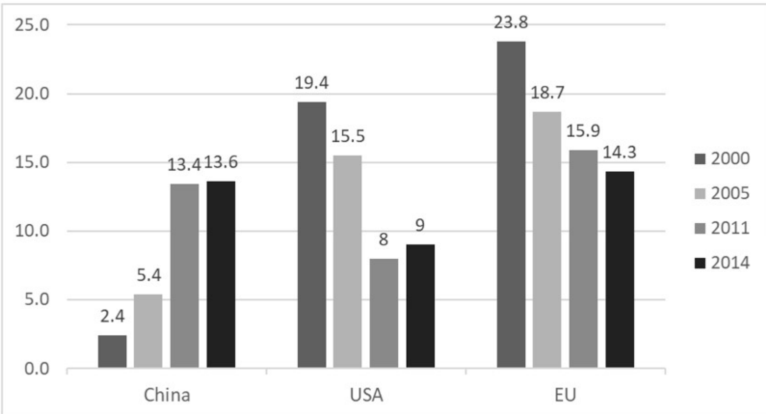
[11] The increasing importance of Chinese industrial exports in Latin America represents a threat to the formation of a market or a “factory” in the region. See the discussion in Marcato (2022) or in Castilho, Costa and Torracca (2019).

FIGURE 3
Participation of China, US, and the EU in Brazilian gross exports - 2000, 2005, 2011, and 2014 - (as % of the total gross exports).



Source: Own elaboration based on the WIOD database using the *decompr* algorithm package in R software.

FIGURE 4
Participation of China, US, and the EU in the domestic value added embodied in Brazilian exports - 2000, 2005, 2011, and 2014 - (% of exports in total value added).



Source: Own elaboration from the WIOD database applied to the *decompr* algorithm package in R Software.

importing country, as well as those that are re-exported to third countries. This is an indicator that can point to a greater complexity of participation in value chains, as will be seen from the results of the decomposition (WANG et al., 2017). As expected, the participation of the EU, China, and the US in DVA contained in Brazilian exports maintains the ordering presented in Figure 3: the EU accounts for 14.3%, China for 13.6%, and the US for 9.0%.

The high share of domestic value added in gross exports to each partner reflect the export specialization, being highest in the case of China (89%), close to the Brazilian total in the case of the EU (87%), and finally lower in the case of the US (82%). Throughout the 2000s, there was a strong growth in both gross and domestic value added exports to China, although the growth rate of gross exports exceeded the variation of domestic value added contained in Brazilian exports to the Chinese market. For the US and the EU, there was a decline in both gross and DVA exports. As will be seen later, the sectoral composition of exports is largely responsible for the different ratios between gross and aggregated value by partners, given that the higher the degree of elaboration of the products, the higher the imported content of exports.

Despite the different weights of the three partners in Brazilian exports, the domestic value added incorporated in exports consumed directly by the importer accounts for most of the gross exports to the three countries (the sum of the DVA_FIN and DVA_INT elements in the three cases corresponds to about 72% of bilateral gross exports - see Table 1). These results suggest that, despite the different specializations according to the partners, the DVA of Brazil "changes" little along the American (US), Asian (China) and EU hubs. (BALDWIN, 2008).

One relevant characteristic concerns the greater weight of China in exports as the final destination of DVA_INT, compared to the other components and partners. The percentage in 2014 reflects a strong growth of this component (8.2%), a variation that was negative in the case of the EU and the US (-3.9%).

According to Wang et al. (2017) and Li et al. (2019), DVA exports that denote greater complexity of integration into GVCs are represented by columns 3 to 9 (DVA_INTrex1 to FDC). These indicators encompass both DVA re-exported by trading partners and foreign value added (FVA) exported by Brazil to these same partners. The results again

TABLE 1
Components of bilateral decomposition for China, US and EU (% of total gross exports) - 2000 and 2014

Country	Year	DVA_FIN	DVA_INT	DVA_INTrex1	DVA_INTrex2	DVA_INTrex3	RDV[1]	DDC[2]	FVA[3]	FDC[4]	VS1[5]	VS[6]
China	2000	0.6	1.4	0.1	0.2	0.0	0.0	0.0	0.1	0.0	0.3	0.2
	2014	1.3	9.7	1.0	1.4	0.2	0.1	0.0	1.2	0.3	2.6	1.6
	Variation 2000-14 (p.p.)	0.7	8.2	0.8	1.2	0.2	0.1	0.0	1.1	0.3	2.3	1.4
USA	2000	8.3	9.5	0.7	0.7	0.3	0.0	0.0	2.9	0.3	1.6	3.1
	2014	2.2	5.6	0.6	0.4	0.2	0.0	0.0	1.6	0.3	1.3	1.9
	Variation 2000-14 (p.p.)	-6.1	-3.9	-0.1	-0.2	-0.1	0.0	0.0	-1.3	0.0	-0.4	-1.3
European Union	2000	8.3	9.5	0.7	0.7	0.3	0.0	0.0	1.8	0.7	1.7	2.5
	2014	3.4	5.6	0.6	0.4	0.2	0.1	0.0	1.2	0.9	1.3	2.0
	Variation 2000-14 (p.p.)	-4.7	-3.9	-0.1	-0.2	-0.1	0.0	0.0	-0.6	0.1	-0.4	-0.5

Source: Own elaboration from WIOT data applied to the algorithms in the decompr package (Quast and Kummritz, 2015) in R software.
Notes: [1]RDV = RDV_INT + RDV_FIN + RDV_FIN2; [2]DDC = DDC_INT + DDC_FIN; [3]FVA_FIN = OVA_FIN + MVA_FIN; [4]FDC = ODC + MDC; [5]VS1, for WWZ (2018) is the sum of DVA_INTrex (1, 2 and 3) and RDV; [6]VS is the sum of DDC, FVA and FDC.

indicate a very low participation of Brazil in the value chains of the three main trading partners (the sum of these components corresponds to 4.2% in the case of China, 3.1% for the US, and 3.4% for the EU).

The analysis of forward (VS1) and backward (VS) participation indicators reveals a differentiated pattern of Brazilian exports to the three trading partners. On the one hand, with China, a forward participation pattern is presented, given that VS1 shows a value (2.6%) higher than VS (1.6%) (KOOPMAN et al., 2014). This participation is driven by the domestic value added (DVA) re-exported by China as products for consumption in other countries (DVA_INTrex2).

In relation to the US and the EU, backward participation (VS) exceeds forward participation (VS1). Both indicators have similar values in 2014 for the two partners, but they result from different evolutions and have a distinct composition. The sharp decline of VS in the US case indicates a reduction in participation as a supplier of inputs for the US to produce its exports to other countries.

For Europe, the reduction in both types of participation was similar. Regarding the composition of VS1, the primary reduction came from the component related to the exports of foreign value added (FVA) from third countries, reaching 1.2% in 2014. In the case of the EU, in addition to this component, the component related to double-counting of DVA contained in the re-exports of goods by European countries stands out relative to the two other partners (0.9% of total Brazilian gross exports).

In summary, results suggest that Brazil has a low participation in its trading partners' value chains. The three trading partners are primarily the final destination of Brazil's DVA in exports, with only a small share being re-exported or returning to the country. The rise of China as the main destination of DVA, which is characterized by agricultural and industrial commodities, has resulted in a type of participation in which China re-exports some of these products, with some degree of industrial processing, to a third country, especially for final consumption. In contrast, for the US and the EU, Brazil appears to depend more on foreign intermediate goods and services for its domestic production and exports (VS or backward). The data suggest that Brazil has increasingly come to rely both forward (final consumer or not) and backward (input supplier) on the Chinese economy for its domestic production.

Koopman et al. (2014) and Johnson and Noguera (2017) argue that increased participation in GVC is associated with the growth of VS1 over time. This can be attributed to the fact that a country's intermediate inputs may be integrated into the value chains of countries other than the direct importer, such as China, for example. However, it is important to note that the growth of VS1 can also result from inputs with low industrial transformation capacity and low technological content, such as iron ore in the case of Brazil. As Dosi, Riccio and Virgillito (2021) emphasize, "microchips" are not "potato chips" regarding their impact on a country's long-term economic development.

3.2. Brazilian trade specialization in value added per partner and major sectors

This section presents a decomposition of gross exports into five major sectors. For comparison purposes, Table 2 provides an analysis of Brazilian exports to its partners, while Table 3 highlights the differences among the three partners chosen in this research.

TABLE 2
Decomposition of Brazil's gross exports for major sectors - 2000 and 2014
(as % of gross exports)

Sector	Year	DVA_FIN	DVA_INT	DVA_INTrex1	DVA_INTrex2	DVA_INTrex3	RDV[1]	DDC[2]	FVA_FIN[3]	FVA_INT[4]	FDC[5]	VS1	VS
Agriculture	2000	0.9	4.6	0.4	1.1	0.1	0.0	0.0	0.1	0.4	0.1	1.6	0.5
	2014	0.6	9.3	0.9	1.8	0.2	0.1	0.0	0.1	1.1	0.4	2.9	1.5
Mining	2000	0.2	3.0	1.1	0.4	0.2	0.1	0.0	0.0	0.2	0.1	1.8	0.4
	2014	0.1	9.8	3.7	1.2	0.7	0.2	0.0	0.0	0.9	0.6	5.9	1.5
Manufacturing	2000	**26.8**	**23.9**	4.8	5.0	1.4	0.2	0.0	4.2	3.5	1.8	11.3	9.5
	2014	**17.9**	**18.3**	4.4	3.4	1.2	0.2	0.0	3.3	3.7	2.0	9.1	9.0
Services	2000	2.3	4.6	0.9	0.7	0.2	0.0	0.0	0.1	0.2	0.1	1.8	0.4
	2014	1.7	4.2	0.9	0.5	0.2	0.0	0.0	0.1	0.2	0.1	1.7	0.4
Outros Serviços	2000	2.3	2.7	0.4	0.3	0.1	0.0	0.0	0.2	0.2	0.1	0.9	0.4
	2014	1.9	2.9	0.5	0.3	0.1	0.0	0.0	0.1	0.2	0.1	0.9	0.4

Source: Own elaboration from WIOT data applied to the algorithms in the *decompr* package (Quast and Kummritz, 2015) in R software.
Notes: [1]RDV = RDV_INT + RDV_FIN + RDV_FIN2; [2]DDC = DDC_INT + DDC_FIN; [3]FVA_FIN = OVA_FIN + MVA_FIN; [4]FVA_INT = OVA_INT + MVA_INT; [5]FDC = ODC + MDC. The sum of the parcels of all the components for all the sectors corresponds to 100% for each year.

For total exports, the manufacturing sector is the leading contributor to Brazilian value added exports, despite experiencing a decline from 2000 to 2014[12]. The sum of the first two columns in the dataset can

[12] The main manufacturing sectors in 2014 are: Food Products, Beverages and Tobacco Products (16.6% share in Brazilian gross exports); Basic Metals (7.2%); Motor Vehicles, Trailers and Semi-Trailers (4.7%); Chemicals and Chemical Products (4.4%); Machinery and Equipment (3.1%); Coke and Refined Petroleum Products (3%) and Paper and Paper Products (2.7%).

TABLE 3
Components of the decomposition of Brazil's exports to China, the US and the EU by major sectors - 2014 (% of total gross exports)

Country	Year	DVA_FIN	DVA_INT	DVA_INTrex1	DVA_INTrex2	DVA_INTrex3	RDV[1]	DDC[2]	FVA[3]	FDC[4]	VS1[5]	VS[6]
China	Agriculture	0.0	4.6	0.3	0.6	0.1	0.0	0.0	0.6	0.1	1.0	0.7
	Mining	0.0	2.8	0.4	0.4	0.1	0.0	0.0	0.3	0.1	0.9	0.4
	Manufacturing	0.5	1.5	0.2	0.3	0.0	0.0	0.0	0.3	0.1	0.5	0.4
	Other services	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
	Services	0.4	0.6	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.0
USA	Agriculture	0.1	0.5	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1
	Mining	0.0	0.7	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.1
	Manufacturing	1.9	4.0	0.4	0.3	0.1	0.0	0.0	1.4	0.2	1.0	1.6
	Other services	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	Services	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
European Union	Agriculture	0.2	1.4	0.3	0.7	0.1	0.0	0.0	0.2	0.1	1.1	0.3
	Mining	0.0	0.5	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.5	0.1
	Manufacturing	2.5	2.4	1.3	1.2	0.4	0.0	0.0	0.8	0.6	2.9	1.4
	Other services	0.4	0.5	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.2	0.1
	Services	0.3	0.9	0.3	0.2	0.1	0.0	0.0	0.1	0.0	0.7	0.1

Source: Own elaboration from WIOT data applied to the algorithms in the decompr package (Quast and Kummritz, 2015) in R software.
Notes: [1]RDV = RDV_INT + RDV_FIN + RDV_FIN2; [2]DDC = DDC_INT + DDC_FIN; [3]FVA_FIN = OVA_FIN + MVA_FIN; [4]FDC = ODC + MDC; [5]VS1, for WWZ (2018) is the sum of DVA_INTrex (1, 2 and 3) and RDV; [6]VS is the sum of DDC, FVA and FDC.

indicate whether the domestic value added (DVA) is participating in more or less complex chains (WANG et al., 2017; XIAO et al., 2020). As we can see, in 2000 this share was approximately 50% while in 2014 it had fallen to 36%. On the one hand, these results indicate that domestic production has tended to add a smaller share of domestic value to exported industrial products. On the other hand, another characteristic of domestic industry's DVA exports is that the largest share goes to the final demand of the direct importer, indicating that DVA crosses few borders, i.e., it participates in less complex chains.

The mining sector showed the highest growth in terms of integration into GVCs. For Agriculture, participation in GVCs also grew between 2000 and 2014, mainly in terms of VS1 (1.3 percentage points of growth). However, unlike mining industry, the forward participation growth occurred due to an increase in the share of domestic value added re-exported to third countries as final goods in Brazilian gross exports. This means that most of the re-exported VA from Agriculture crosses only one border as an intermediate good[13].

In the case of Services, their share in Brazilian exports has decreased, although the exports integrated into the GVC have maintained their share in gross exports. The same pattern applies to Other Services. Among all sectors, Services and Other Services have the lowest (and decreasing) share in Brazil's exports, both in gross terms and in terms of DVA.

Table 2 presents important overall results, which highlight several structural changes that occurred in the Brazilian economy during the analyzed period. As expected, the domestic manufacturing sector displays a higher level of integration in GVC than the national average and other sectors, although this has been declining. Furthermore, there has been a significant increase in the participation of the agriculture and mining sectors, which are characterized by a low industrial processing capacity and therefore by a low participation in more complex chains. These findings help to shed light on two phenomena: deindustrialization (PASSONI, 2019) and regressive specialization (NASSIF; CASTILHO, 2020). The domestic industry tended to add less DVA to the value chains of other countries, while simultaneously becoming increasingly dependent on inputs imported from other countries.

Table 3 compares the components of the decomposition for the top five export sectors to the three main trading partners in 2014. In general, and consistent with the findings of the previous sections, different trading partners imply varying capacities of sectors to add value in the production chains of other countries. While Kupfer et al.

[13] The leading sector in this industry was Animal Production and Cutting (14.1% of Brazilian exports and growth of seven percentage points) and, as expected, its participation in the GVC is forward in both periods. In 2014, the share of exports from this sector in GVC was 4.4%, of which 2.5% represented forward participation.

(2013) have highlighted the importance of different countries in terms of employment generation, the results of this study suggest that the geographical orientation also plays a crucial role in determining the participation of a country's sectors in GVCs.

According to the findings, China emerged as the primary destination for domestic value added (DVA) generated by agriculture and mining sectors, mainly for re-export to other countries (DVA_Int). The DVA incorporated by agricultural exports to China constituted 4.6% of total Brazilian gross exports in 2014, surpassing both the contribution in total Brazilian exports to the Asian country and the DVA embedded in agricultural exports to the other two analyzed trading partners. Mining ranked second in the same terms, i.e., DVA incorporated in exports to China, also exceeding DVA in manufacturing and service exports to the Asian country and DVA in mineral exports to the US and EU.

Most of the domestic value added of these two sectors is exported as intermediate goods for final consumption in China itself (DVA_INT exceeds DVA_FIN in all sectors). Nonetheless, China also re-exports some of these intermediate goods, which partially suggests the forward participation. The value of VS1 exceeds the backward share (VS), explaining why these sectors are the most integrated into global value chains in the Chinese case.

The pattern observed in the US and the EU exhibits a specialization that is different from that of China. The manufacturing sector, which has a considerably higher weight in gross and value added perspectives, is the industry of greatest importance in terms of DVA content, particularly in exports targeted at the North American and European final markets. This sector displays participation in supply chains that are much higher than those of other sectors, being the backward participation (VS) higher than the forward participation (VS1) for both partners. The exports of manufactured goods are not only higher than those directed at China but also much more diversified, thereby largely explaining the higher foreign content of exports (VS)[14]. An interesting feature of the European pattern is the participation of Services, which is superior to that observed for the other two partners. Another relevant aspect of manufactured goods' exports to the EU is that the DVA participation in exports linked to the Global Value Chains (GVCs) (VS1) surpasses that observed for all sectors of other countries. This attests to a greater integration of Brazilian exports into the GVCs in which the EU participates, despite the marked specialization in natural resource-intensive products[15].

The findings indicate that various trade partners require different strategies for bilateral-sectoral involvement in Global Value Chains (GVCs). Curiously, trade between Brazil and China displays characteristics of a purely Ricardian form of trade (LINDENBERG; ESCAITH; MIROUDOT, 2010): Brazil exports DVA in agricultural and industrial commodities and imports FVA from Chinese manufacturing industry[16]. Conversely, the patterns observed between Brazil and the US and the EU reveal a greater share of intra-industry trade, given the higher weight of Manufacturing DVA exported for final consumption in these countries.

That is, the present study's findings indicate that the bilateral trade patterns between Brazil and China deviate from what is predicted by several trade models, resembling more the North-South trade stereotype than trade flows between Brazil and the EU and US. Such a result appears to

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[14] Metals, Chemicals, Paper and Coke, and Petroleum Products are the main sectors in terms of importance of domestic value added. These sectors are those with the largest participation in GVC.

[15] Among the manufacturing sectors, Food and Beverages is the most important, but it has the characteristic of exporting goods not only for consumption within the EU, but also for processing and re-exporting by it. Other sectors with significant participation are basic metals and chemicals, whose domestic value added resulting from exports associated with GVCs exceeds that generated in exports for final consumption in the European final market. In the case of Agriculture, forward participation is relatively high, and in the case of services, exports are mainly directed to the EU itself, presenting a very low VS1 indicator.

[16] The pure Ricardian trade to which we refer here is essentially inter-industry, occurring predominantly between countries with different factor endowments or different technological levels. According to the assumptions of the standard trade model or the technology gap-based models, this type of trade would be more likely to occur between developed (North) and developing (South) countries.

arise from two main factors: the Chinese economy's evolution over the last two decades towards a more sophisticated production structure, becoming less representative of a typical "southern" economy, and the diverse nature of Brazil's trade with the US and EU, in contrast to its trade with China.

4. Concluding remarks

The diffusion of global production chains and the deepening of production fragmentation since the 1980s have increased the intensity and complexity of trade interaction between national economies. Understanding this phenomenon requires new tools capable of assessing the direct and indirect trade relations between countries, which are only partially captured by traditional trade statistics. The world input-output tables have been instrumental in filling the gap in traditional statistical sources. These tables allow for a more accurate tracing of the contribution of countries to trade in terms of value added, distinguishing the origin of goods and services embodied in trade flows.

Since the seminal work of Hummels et al. (2001), several methodologies have been developed to map the origin of the value added contained in trade flows, permitting the contribution of final demand and the demand for intermediate goods to production in different economies to be isolated. Koopman et al. (2014) proposed a method to distinguish aggregate export flows according to the origin and destination of their value added content. However, this decomposition neglects the bilateral and sectoral dimension of trade flows, which is relevant from the point of view of countries, especially in the face of chains that have a regionalized character. Wang, Wei and Zhu (2018) have advanced the methodology by proposing a method capable of decomposing value added in a bilaterally and sectorally disaggregated manner.

The aim of this study was to analyze Brazil's international trade pattern with its main trading partners in global value chains (GVCs). The research makes two contributions: firstly, it employs the bilateral and sectoral decomposition methodology proposed by Wang, Wei and Zhu (2018); secondly, it examines Brazil's pattern of participation in GVCs with its three main trading partners. The results of the decomposition indicate that Brazil has a low level of participation in GVCs due to its trade specialization in natural resources, as well as the size of its domestic market. This can be attributed to the Chinese demand for agricultural and industrial commodities during the 2000s, along with the growth in domestic income.

The analysis of the decomposition for Brazil's total exports by major sectors showed that the loss of dynamism in Brazilian exports of manufactured goods, in gross terms, was also observed in terms of domestic value added embedded in exports. The foreign value added contained in manufactured exports also decreased, but to a lesser extent, causing backward and forward participation to be equivalent for Manufacturing in 2014. Manufactured products continue to represent the largest share of domestic value added in exports, as well as in exports associated with GVCs, but the significant increase in the importance of Agriculture and Mining in 2014 relative to 2000 is noteworthy. The two groups of services maintained small and generally decreasing participation in GVCs, indicating their little relevance for Brazil's insertion the production chains.

The rising significance of China as a Brazilian trade partner is evidenced both in gross terms and in domestic value added of exports. While the foreign value added component of exports to China increased between 2000 and 2014, the domestic value added embedded in exports to this country is considerable and exceeds that observed in Brazilian exports to the EU and the US (89% compared to 87% and 83%, respectively). This is primarily due to the prominence of agricultural and mining products in Brazilian exports to China.

The share of exports related to GVCs in bilateral gross exports is relatively similar for China, the US, and the EU, amounting to around 28%. This level is lower than Brazil's overall GVC-related exports, which reach 33% when considering all trade partners. Latin America and Mercosur certainly show higher percentages due to a certain degree of production integration, particularly in the automotive sector. In terms of the type of participation, the EU and the US exhibit a different pattern from that of China: Brazilian participation in exports with the two more traditional partners is mainly a backward one, with higher foreign value added (VS) in exports than in the case of China.

From the sectoral analysis by trade partner, the pattern observed in gross exports is partially reproduced, which is not surprising due to Brazil's low integration into GVCs and its regressive production and trade specialization. In trade with China, the "North-South" type of specialization is evident considering the weight and increasing importance of the agricultural and mineral sectors in traditional exports, but also in those associated with GVCs. In the case of the US, the manufacturing industry, despite being the main large sector in terms of domestic value added in exports and in terms of participation in GVCs, has been decreasing participation in bilateral exports. Finally, the EU presents an intermediate profile, with the manufacturing industry maintaining its position as the main sector (despite its relative decline since 2000).

Here, we find the differences in Brazilian trade specialization with its different partners, as already mapped in the literature from trade in gross values. Furthermore, the GVCs' indicators, considering both backward and forward participation as well as the complexity of the chains in which the country participates, reaffirm, and give another dimension to the regressive nature of Brazilian trade specialization. They point not only to low insertion but also to integration into those production chains that are shorter and less complex, probably associated with less sophisticated goods and services. In other words, Brazil's position in the international division of labor is revealed both in terms of gross trade flows and through indicators of trade in value added with similar characteristics.

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Author's contribution:

A. Literature review and theoretic analysis: Leonardo Thuler Costa and Marta dos Reis Castilho

B. Data collection and statistical analysis: Leonardo Thuler Costa and Kaio Vital da Costa

C. Preparation of figures and tables: Leonardo Thuler Costa, Marta dos Reis Castilho and Kaio Vital da Costa

D. Manuscript development: Leonardo Thuler Costa, Marta dos Reis Castilho and Kaio Vital da Costa

E. Bibliography selection: Leonardo Thuler Costa, Marta dos Reis Castilho and Kaio Vital da Costa

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APPENDIX 1
The 16 terms of Wang, Wei and Zhu's (2018) decomposition

The components of gross export accounting in Figure 1 correspond to each part of Equation 1, so gross exports can be completely decomposed. In this formula, E^{sr} is the export vector denoting the gross exports from country s to country r. E^{*} is the total exports of country r. V^{s} is the coefficient vector of value added of country s, and V^{t} and V^{r} denote the same for countries t and r, respectively. B^{rs} is the inverse Leontief matrix, i.e., the total requirements matrix, providing the amount of gross output in the producing country required to meet the one-unit increase in final demand in country s, and B^{ss}, B^{rr}, B^{rt} and B^{ts} have a similar meaning. A^{sr} is the total input coefficient matrix, providing the intermediate consumption in country r of value added produced in country s. L^{ss} and L^{rr} are the domestic inverse Leontief matrices of countries s and r.

$$
\begin{aligned}
E^{sr} = {} & \underbrace{\left(V^{s}B^{sr}\right)^{T}\#Y^{sr}}_{(1-DVA_{FIN})} + \underbrace{\left(V^{s}L^{ss}\right)^{T}\#\left(A^{sr}B^{rr}Y^{rr}\right)}_{(2-DVA_{INT})} + \underbrace{\left(V^{s}L^{ss}\right)^{T}\#A^{sr}\sum_{t\neq s,r}^{G}B^{rt}Y^{tt}}_{(3-DVA_{INTrexI1})} + \\
& \underbrace{\left(V^{s}L^{ss}\right)^{T}\#A^{sr}B^{rr}\sum_{t\neq s,r}^{G}Y^{rt}}_{(4-DVA_{\mathrm{INTrexF}})} + \underbrace{\left(V^{s}L^{ss}\right)^{T}\#A^{sr}\sum_{t\neq s,r}^{G}B^{rt}\sum_{u\neq s,t}^{G}Y^{tu}}_{(5-DVA_{\mathrm{INTrexI2}})} + \underbrace{\left(V^{s}L^{ss}\right)^{T}\#A^{sr}B^{rs}Y^{ss}}_{(6-RDV_{INT})} + \\
& \underbrace{\left(V^{s}L^{ss}\right)^{T}\#A^{sr}B^{rr}Y^{rs}}_{(7-RDV_{FIN})} + \underbrace{\left(V^{s}L^{ss}\right)^{T}\#A^{sr}\sum_{t\neq s,r}^{G}B^{rt}Y^{ts}}_{(8-RDV_{FIN2})} + \underbrace{\left(V^{s}L^{ss}\right)^{T}\#(A^{sr}B^{rs}\sum_{t\neq s}^{G}Y^{st})}_{(9-DDC_{FIN})} + \\
& \underbrace{\left(V^{s}L^{ss}\sum_{t\neq s}^{G}A^{st}B^{ts}\right)^{T}\#\left(A^{sr}X^{r}\right)}_{(10-DDC_{INT})} + \underbrace{\left[\sum_{t\neq s,r}^{G}V^{t}B^{ts}\right]^{T}\#Y^{sr}}_{(11-OVA_{FIN})} + \underbrace{\left(V^{r}B^{rs}\right)^{T}\#Y^{sr}}_{(12-MVA_{FIN})} + \\
& \underbrace{\left[\sum_{t\neq s,r}^{G}V^{t}B^{ts}\right]^{T}\#\left(A^{sr}L^{rr}Y^{rr}\right)}_{(13-OVA_{INT})} + \underbrace{\left(V^{r}B^{rs}\right)^{T}\#\left(A^{sr}L^{rr}Y^{rr}\right)}_{(14-MVA_{INT})} + \underbrace{\left[\sum_{t\neq s,r}^{G}V^{t}B^{ts}\right]^{T}\#\left(A^{sr}L^{rr}E^{r^{*}}\right)}_{(15-ODC)} + \\
& \underbrace{\left(V^{r}B^{rs}\right)^{T}\#\left(A^{sr}L^{rr}E^{r^{*}}\right)}_{(16-MDC)}
\end{aligned}
$$

Table A1
The 16 terms of Wang, Wei and Zhu's (2018) decomposition

Equations		Description
$\left(V^s B^{sr}\right)^T \# Y^{sr}$	DVA_ FIN	Domestic VA exported via final goods by the country s and absorbed in the direct importer r
$\left(V^s L^{ss}\right)^T \#\left(A^{sr} B^{rr} Y^{rr}\right)$	DVA_ INT	Domestic VA exported via intermediate goods by the country s and absorbed in the direct importer r
$\left(V^s L^{ss}\right)^T \# A^{sr} \sum_{t \neq s,r}^{G} B^{rt} Y^{tt}$	DVA_ INTrex1	Domestic VA exported via intermediate goods and re-exported by the direct importer, as intermediate goods, to third countries that use them in the production of final goods that they consume.
$\left(V^s L^{ss}\right)^T \# A^{sr} B^{rr} \sum_{t \neq s,r}^{G} Y^{rt}$	DVA_ INTrex2	Domestic VA exported via intermediate goods used by the direct importer to produce exports of final goods to third countries.
$\left(V^s L^{ss}\right)^T \# A^{sr} \sum_{t \neq s,r}^{G} B^{rt} \sum_{u \neq s,\, t}^{G} Y^{tu}$	DVA_ INTrex3	Domestic VA exported via intermediate goods, re-exported by the direct importer as intermediate goods to be used by third countries in the production of their exports (except those that return to the country of origin).
$\left(V^s L^{ss}\right)^T \# A^{sr} B^{rr} Y^{rs}$	RDV_ INT	Domestic VA, exported as intermediate goods from a sector in country s to country r, which returns to country s (of origin) in the form of intermediate goods for the production and consumption of final goods in the country of origin.
$\left(V^s L^{ss}\right)^T \# A^{sr} \sum_{t \neq s,r}^{G} B^{rt} Y^{ts}$	RDV_ FIN	Domestic value added exported as intermediate goods that returns to the country of origin as final goods via imports originating in the direct importer r.
$\left(V^s L^{ss}\right)^T \# A^{sr} B^{rs} Y^{ss}$	RDV_ FIN2	Domestic VA exported as intermediate goods that returns to the country of origin as final goods via imports of final goods originating in third countries.
$\left(V^s L^{ss}\right)^T \#\left(A^{sr} B^{rs} \sum_{t \neq s}^{G} Y^{st}\right)$	DDC_ FIN	Pure double counting of domestic value added contained in (re)exports of final goods.
$\left(V^s L^{ss} \sum_{t \neq s}^{G} A^{st} B^{ts}\right)^T \#\left(A^{sr} X^r\right)$	DDC_ INT	Pure double counting of domestic value added in the home country's (re)exports in intermediate goods.
$\left(V^r B^{rs}\right)^T \# Y^{sr}$	OVA_ FIN	Foreign value added from third countries in exports of final goods of country s.
$\left[\sum_{t \neq s,r}^{G} V^t B^{ts}\right]^T \# Y^{sr}$	MVA_ FIN	Foreign VA of the direct importer (country r) contained in the exports of final goods of a sector from country s to r.
$\left(V^r B^{rs}\right)^T \#\left(A^{sr} L^{rr} Y^{rr}\right)$	OVA_ INT	Foreign value added from third countries in the country s exports of intermediate goods.

Source: Wang, Wei and Zhu (2018). Own elaboration.

Table A1
Continued...

Equations		Description
$\left[\sum_{t \neq s,r}^{G} V^t B^{ts}\right]^T \#\left(A^{sr} L^{rr} Y^{rr}\right)$	MVA_ INT	Foreign value added of the direct importer (r) in exports of intermediate goods from country s.
$\left(V^r B^{rs}\right)^T \#\left(A^{sr} L^{rr} E^{r^*}\right)$	ODC	Third country foreign value added contained in country s exports for those countries to produce their exports - double counting third country foreign value added.
$\left[\sum_{t \neq s,r}^{G} V^t B^{ts}\right]^T \#\left(A^{sr} L^{rr} E^{r^*}\right)$	MDC	Foreign value added of the direct importer (country r) contained in the exports of a sector from country s to r - Pure double counting of foreign value added of the direct importer.

Source: Wang, Wei and Zhu (2018). Own elaboration.