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BRAZILIAN TIVA UNDER US-CHINA STRATEGIC COMPETITION AND IMPACT ON EXPORT-RELATED JOBS (2000-2015)

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Abstract

Domestic discussion in Brazil about its most suitable commercial partners to promote economic development, through deeper and broader integration onto the Global Value Chain (GVC), is a subject with divergent political narratives. Therefore, empirical evidence is crucial to complement those political considerations with a comprehensive scientific approach on the available sets of optimal choices for Brazil under great power strategic competition between China and US. Even though increasing volumes of Trade-in-Value-Added (TiVA) can boost both exports and GDP growth rates, long-term effects on labor market conditions in Brazil are linked to variables such as industrial value-added, domestic production, vertical integration, technological transfers and capital-labor ratios (K/L). Within the period 2000-2015, Brazilian TiVA exchanges with China did grow at a much faster rate than those of US, thus becoming the world second largest partner for Brazil. Through this chapter, therefore, we will measure overall effects of TiVA exchanges with both China and US on Brazilian labor market. And will also determine which countries/industries might become the most optimal choice for Brazil in terms of TiVA.

Keywords

Trade in Value Added, GVC, Brazil, Great Power Politics, China, US.

Resumo

A discussão interna no Brasil sobre os seus parceiros comerciais mais adequados para promover o desenvolvimento económico, através de uma integração mais profunda e ampla na Cadeia Global de Valor (CGV), é um assunto com narrativas políticas divergentes. Por conseguinte, a evidência empírica é crucial para complementar estas considerações políticas com uma abordagem científica abrangente sobre os conjuntos disponíveis de escolhas óptimas para o Brasil sob competição estratégica de grandes potências entre a China e os EUA. Embora o volume crescente de comércio de valor acrescentado (TiVA) possa impulsionar as exportações e as taxas de crescimento do PIB, os efeitos a longo prazo nas condições do mercado de trabalho no Brasil estão ligados a variáveis como o valor acrescentado industrial, a produção interna, integração vertical, transferências tecnológicas e relações capital-trabalho (K/L). No período 2000-2015, as trocas brasileiras de TiVA com a China cresceram a um ritmo muito mais rápido do que as dos EUA, tornando-se assim o segundo maior parceiro mundial do Brasil. Neste capítulo, iremos, portanto, medir os efeitos globais das trocas de TiVA com a China e os EUA no mercado de trabalho brasileiro. Para além disso, este artigo também determinará quais os países/indústrias que se podem tornar a escolha ideal para o Brasil em termos de TiVA.

Palavras-chave

Comércio de valor acrescentado, Cadeia Global de Valor, Brasil, Política de Grandes Potências, China, EUA.

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1. Introduction

This paper will estimate Brazilian TiVA exchanges with both US and China, within the GVC, to measure their overall impact on Brazilian export-related jobs. We aim at theorizing whether Brazil should further deepen its commercial ties with either China, US or both; under conditions of great power politics (Mearsheimer, 2001). Bilateral TiVA exchanges and their impact on export-related jobs, therefore, will be determinant to assess potential optimal choices for commercial policies in Brazil when considering the period 2000-2015.

Section 2 in this chapter will introduce a theoretical framework about optimal choices for Brazilian commercial policies under conditions of aforementioned great power politics or strategic competition between China and US. Several US scholars and politicians have noted that Chinese economic engagement with the Western Hemisphere has significant national security implications for their country (Ellis, 2005). It can be inferred, therefore, that US has strong incentives to undermine Chinese commercial ties in Latin America (including Brazil). However, an effective vertical integration with China has strengthened the fundamentals for industrial development and long-term economic growth in countries like Brazil, despite such "Chinese threat" to geostrategic interests of US. This creates a dilemma in peripheral countries that must choose between maximizing their own economic interests or those of US (Farrell & Newman, 2019; Vogelmann, 2020).

Section 3 will just introduce the data and related empirical evidence. Relevant variables, from export-related jobs to TiVA magnitudes (such as Foreign Value Added -FVA- and Indirect Value Added or DVX), will be estimated using standard input-output computation. Interpretation of those numbers, i.e. how export-related jobs are correlated to TiVA exchanges, will be shared in section 4. And a brief conclusion has also been drafted in section 5.

2. Theoretical framework of constraints for optimal choice in trade and commercial policies under great power politics between China and US

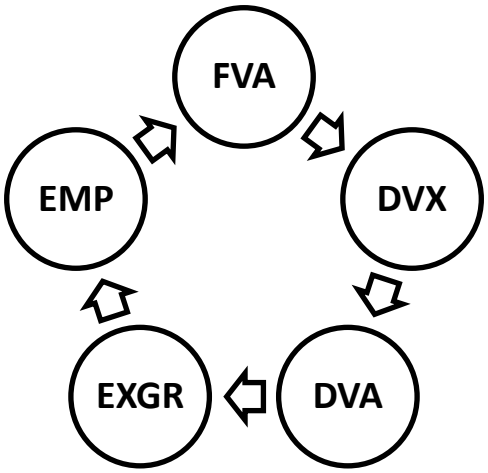
The political economy of optimal choices in foreign trade policies can be analyzed from two complementary perspectives. Academic discussion on how states interact within a given international order, from either realist or liberal theoretical approaches, can provide some basic understanding of policy making and strategic choices. This paper will assume that specific economic considerations based on rational choices might pose conflicts with hegemonic interests under conditions of great power politics between China and US.

Both realists and liberals do attach importance to the influence of great powers over a given international order (Keohane & Nye, 1977). Even though realists have refused to rule out international cooperation as a feasible option, it would never take place if actual distribution of power is challenged (Grieco, 1990; Jervis, 1999; Mearsheimer, 2001; Snidal, 1991; Taliaferro, 2011). This is a reasonable assumption irrespective of recurrent discussions about underlying reasons and different dimensions related to strategic decision-making within countries (Buzan, 1995; Singer, 1961). Autonomy of a given country within the international system will depend on geographical position, relative power, resources endowment, foreign investments and technology transfers dependence, among other variables (Lee & Thompson, 2022; Krasner, 1978). Therefore, it can be deducted that not every country is free to pursue the materialization of its own optimal choices, given external pressure and influence exerted from a superpower such as US. In a nutshell, great powers can exert influence over other countries' choices, subordinating core interests of the latter to theirs (Beckley, 2018; Karen & William, 1994; Taliaferro, 2004).

From an economic perspective, however, agents are expected to make optimal choices based on rational considerations such as profit maximization. States are not an exception and, among other spheres of action, will seek to remain competitive within the GVC. The boom in international trade resulting from globalization has generated a gradual geographic fragmentation of production processes. The GVC is based on "trade in tasks" (Inomata, 2017; Xing & Detert, 2011; Xing, 2021). Since fragmentation of production favors a drastic reduction in overall costs, increasing competitiveness has contributed to greater trade volumes and economic growth rates (Baldwin & Lopez-Gonzalez, 2015, Feenstra, 1998; Kwok, 2018). Several authors have also established a direct relationship between domestic participation in the GVC and industrial development (Baldwin & Lopez-Gonzalez, 2015; Gereffi & Fernandez-Stark, 2011; Vrh, 2017). Main logic behind this assertion is that further integration onto the GVC, either through forward (DVX) or backward linkages (FVA), contributes to increase overall productivity (Dauth et al., 2014; Donoso et al, 2015; Iodice & Tomasi, 2016; Lurweg & Westermeier.A., 2010; Kreutzer & Berger, 2018). Choi et al. (2019), for instance, have provided empirical evidence that innovation enables certain countries to improve their position within the GVC. So industrial upgrading, which stems from sustained increases in productivity, can boost both domestic value added and export-related jobs (Montalbano et al., 2018; Shimbov et al., 2019).

Main assumption of this paper, consistent with aforementioned literature and empirical evidence, is that greater vertical integration onto the GVC can contribute to economic development and create additional jobs in non-industrialized countries such as Brazil. A virtuous circle of industrial development would require from backward linkages (FVA) to promote a forward integration (DVX) onto the GVC. Then both variables would also result in a positive impact on Brazilian domestic value added (DVA), overall gross exports (EXGR) and export-related jobs (EMP).

Graph 1: Vertical integration, through backward and forward linkages, has a positive impact on export-related jobs.



Source: Authors

Then should countries such as Brazil abandon their optimal choices in commercial policies, interrupt its value chain integration with China and subordinate to the core interests of hegemonic powers like US? Realists would answer in the affirmative. For them, US-China strategic competition can be described as a battlefield which is not on the sphere of direct confrontation but in other actors' soil (Gill-Tiney, 2023; Treistman, 2017). Realist theorists, like John Mearsheimer (1994), warned almost three decades ago that a wealthier China could increase its military capabilities and challenge the US-led international order. According to realist theories like "Power Transition" or "Hegemonic Stability", a declining hegemon becomes more assertive as ascending powers reduces their power gap (Feng, 2013; Gilpin, 1988). This will happen whenever emerging powers, like China, were perceived as a threat against an international order primarily conceived to benefit the hegemonic power (Mearsheimer, 2019; Nye, 2011). Hence, US-China strategic competition can be depicted as a sole hegemonic power (US) that has become more assertive against its main emerging rival (China), to prevent other peripheral countries (Brazil) from being neutral or even deepening ties with the latter. Such political restrictions, however, would come at the expense of efficient optimal choices for commercial and trade policies in peripheral countries like Brazil.

The present paper, nonetheless, aims at offering some empirical evidence on potential costs of subordinating national interests to foreign ones when pursuing non-optimal choices in trade and commercial policies. A clear correlation between TiVA flows with export-related jobs can help to determine some optimal choices for commercial policies in Brazil which should not be dependent of hegemonic interests imposed from US.

3. Data and methodology

Correlations between Brazilian export-related jobs and TiVA flows have been derived from standard Input-Output Tables (IOT). IOT are configured using Transactions (T), Value-Added (VA) and Final Demand (FD) sets of matrixes from Eora26 MRIOT (Lenzen et al., 2013)[1]. Here gross output (X) will be equal to the sum of intermediate consumption (T) plus final demand (FD). Using matrix algebra notation this can be expressed as:

$$X = T + FD \tag{1}$$

Rearranging:

$$X = AX + FD$$
$$X = (I-A)^{-1} FD$$
$$X = L FD \tag{2}$$

Whereas X is the gross output matrix. FD is the matrix of goods that are used for final demand (also noted as Y). A is the matrix of input-output coefficients obtained after dividing T between X (T = AX). Thus $(I-A)^{-1}$ will result in an inverse Leontief matrix expressing the total output required both directly and indirectly to produce a unit of goods for final demand (L).

[1] The Eora26 MRIO database is available under license at www.worldmrio.com.

Table 1: Basic scheme of a standard Multi-Regional Input Output Table (MRIOT)

Source: Authors

T MATRIX		RoW	BRAZIL	CHINA	USA	FD MATRIX		RoW	BRAZIL	CHINA	USA	OUTPUT	EXPORTS
		INDUSTRIES	INDUSTRIES	INDUSTRIES	INDUSTRIES			FD AGG	FD AGG	FD AGG	FD AGG	X	EXP
RoW	INDUSTRIES	AX(20x20)	Intermediate use by Brazil of exports from RoW	AX(20x20)	AX(20x20)	RoW	INDUSTRIES	FD (20x6)	Final use by Brazil of exports from RoW	FD (20x6)	FD (20x6)	X = AX + Y	Exports are calculated by substracting intermediate and final use of domestic output to X
BRAZIL	INDUSTRIES	Intermediate use by RoW of exports from Brazil	Intermediate use of domestic output X	Intermediate use by China of exports from Brazil	Intermediate use by USA of exports from Brazil	BRAZIL	INDUSTRIES	Final use by RoW of exports from Brazil	Final use of domestic output X	Final use by China of exports from Brazil	Final use by USA of exports from Brazil		
CHINA	INDUSTRIES	AX(20x20)	Intermediate use by Brazil of exports from China	AX(20x20)	AX(20x20)	CHINA	INDUSTRIES	FD (20x6)	Final use by Brazil of exports from China	FD (20x6)	FD (20x6)		
USA	INDUSTRIES	AX(20x20)	Intermediate use by Brazil of exports from USA	AX(20x20)	AX(20x20)	USA	INDUSTRIES	FD (20x6)	Final use by Brazil of exports from USA	FD (20x6)	FD (20x6)		
VA MATRIX		RoW	BRAZIL	CHINA	USA								
PRIMARY INPUTS		VA RoW	VA BRA	VA CHN	VA USA								
OUTPUT		X = AX + VA											

For a correct classification of industries, Brazilian IOT and EORA-26 have been harmonized as shown in Table 2.

Table 2: Classification of industries in Brazilian IOT and EORA26.

BRA IOT (Source: IBGE)	EORA26 (Source: EORA)
Agriculture and Forestry	Agriculture
Grazing and Fishing	Fishing
Crude Oil and Natural Gas Iron Ore Other Minerals and Ores	Mining and Quarrying
Food and Beverages Tobacco Products	Food & Beverages
Textiles Clothing Leather and Footwear	Textiles and Wearing Apparel
Wood Products Except Furniture Cellulose and Paper Products Newspapers, Magazines and Electronic Publishing	Wood and Paper
Petroleum Refining and Coke Products Alcohol Chemical Products Resins and Elastomers Pharmaceutical Products Pesticides	Petroleum, Chemical and Non-Metallic Mineral Products

Soaps and Detergents Inks, Varnishes, Enamels, Lacquers Other Chemical Products Rubber and Plastic Products Cement and Other Non-Metallic Mineral Products	
Manufacturing of Steel and Steel Alloys Non-Ferrous Metals Fabricated Metal Products Except Machines and Equipment	Metal Products
Machines and Equipment (including maintenance)	Electrical and Machinery
Household Appliances	
Office Equipment Electric Machines and Materials Electronic and Communication Equipment Medical and Optical Equipment	
Passenger and Light Utility Vehicles, Trucks and Busses Vehicle Parts Other Transport Equipment	Transport Equipment
Furniture and Other Manufacturing	Other Manufacturing and Recycling
Electricity, Gas, Water, Sewerage and Drainage Services	Electricity, Gas and Water
Construction	Construction
Wholesale and Retail Trade	Wholesale and Retail Trade
Transport and Postal Services Information Services	Transport, Post and Telecommunications
Finance and Insurance Property Services and Hiring Business Services	Financial Intermediation and Business Activities
Maintenance and Repair	Maintenance and Repair
Hotels and Restaurants	Hotels and Restaurants
Private Education Private Health Services Other Services	Education, Health and Other Services
Public Education Public Health Services Public Administration and Social Security	Public Administration

EORA26 items have also been reduced from 26 to 20 following the standard classification of IBGE for overall jobs in Brazil[2].

[2] As "Other Manufacturing", "Recycling", "Wholesale Trade", "Retail Trade", "Post and Telecommunications", "Transport", "Education, Health and Other Services", "Private Households" and "Others" have been

3.1 Brazilian export-related jobs by industry/country

First, as in Duran & Banacloche (2022), we have estimated overall employment associated with Brazilian exports by industry/country of destination. Vector N* of Brazilian workers by industry has been sourced from standard Supply-Use tables (SUT) which are available at Instituto Brasileiro de Geografia e Estatistica (IBGE)[3].

The employment coefficient vector matrix is calculated as follows:

$$EC = N^{*}x^{-1} = \left[\frac{N_1^*}{x_1} \quad \frac{N_2^*}{x_2} \quad \frac{N_3^*}{x_3} \quad \dots \quad \frac{N_n^*}{x_n}\right] \tag{3}$$

Where N* is the labor factor of sector N. And X_n is the gross value of production of sector N. Equation 4 plots the multiplier of EC:

$$MEC = \widehat{EC}\,(I - A)^{-1} = \begin{bmatrix} EC_1l_{11} & EC_1l_{12} & EC_1l_{13} & \cdots & EC_1l_{1n} \\ EC_2l_{21} & EC_2l_{22} & EC_2l_{23} & \cdots & EC_2l_{2n} \\ EC_3l_{31} & EC_3l_{32} & EC_3l_{33} & \cdots & EC_3l_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ EC_nl_{n1} & EC_nl_{n2} & EC_nl_{n3} & \cdots & EC_nl_{nn} \end{bmatrix} \tag{4}$$

Whereas l_{ij} comes from the Leontief inverse matrix or $(I - A)^{-1}$. The matrix of technical coefficients, which results from dividing transactions of intermediate inputs (T_{ij}) between the diagonalized and inverted gross value of production (x_n), is labelled as the NxN matrix of domestic technical coefficients A:

$$A = T\hat{x}^{-1}$$

$$A = \begin{bmatrix} T_{11} & T_{12} & T_{13} & \cdots & T_{1n} \\ T_{21} & T_{22} & T_{23} & \cdots & T_{2n} \\ T_{31} & T_{32} & T_{33} & \cdots & T_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ T_{n1} & T_{n2} & T_{n3} & \cdots & T_{nn} \end{bmatrix} \begin{bmatrix} 1/x_1 & 0 & 0 & \cdots & 0 \\ 0 & 1/x_2 & 0 & \cdots & 0 \\ 0 & 0 & 1/x_3 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & 1/x_n \end{bmatrix}$$

$$A = \begin{bmatrix} T_{11}/x_1 & T_{12}/x_2 & T_{13}/x_3 & \cdots & T_{1n}/x_n \\ T_{21}/x_1 & T_{22}/x_2 & T_{23}/x_3 & \cdots & T_{2n}/x_n \\ T_{31}/x_1 & T_{32}/x_2 & T_{33}/x_3 & \cdots & T_{3n}/x_n \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ T_{n1}/x_1 & T_{n2}/x_2 & T_{n3}/x_3 & \cdots & T_{nn}/x_n \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} & \cdots & a_{1n} \\ a_{21} & a_{22} & a_{23} & \cdots & a_{2n} \\ a_{31} & a_{32} & a_{33} & \cdots & a_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & a_{n3} & \cdots & a_{nn} \end{bmatrix} \tag{5}$$

simplified to "Other Manufacturing and Recycling", "Wholesale and Retail Trade" and "Education, Health and Other Services"; while "Re-exports" are not considered for labor market comparisons, original EORA26 IOT items were reduced to 20.

[3] Available at https://www.ibge.gov.br/

The inverse Leontief matrix, therefore, has been derived from (5):

$$L = (I - A)^{-1}$$

$$L = \begin{bmatrix} l_{11} & l_{12} & l_{13} & \cdots & l_{1n} \\ l_{21} & l_{22} & l_{23} & \cdots & l_{2n} \\ l_{31} & l_{32} & l_{33} & \cdots & l_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ l_{n1} & l_{n2} & l_{n3} & \cdots & l_{nn} \end{bmatrix} \quad (6)$$

Where I is the NxN identity matrix. Export-related jobs, then, will result from multiplying corresponding Brazilian diagonalized exports by the MEC:

$$EMP_{exp} = MEC\ \hat{e}$$

$$EMP_{exp} = \begin{bmatrix} EC_1 l_{11} e_1 & EC_1 l_{12} e_2 & EC_1 l_{13} e_3 & \cdots & EC_1 l_{1n} e_n \\ EC_2 l_{21} e_1 & EC_2 l_{22} e_2 & EC_2 l_{23} e_3 & \cdots & EC_2 l_{2n} e_n \\ EC_3 l_{31} e_1 & EC_3 l_{32} e_2 & EC_3 l_{33} e_3 & \cdots & EC_3 l_{3n} e_n \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ EC_n l_{n1} e_1 & EC_n l_{n2} e_2 & EC_n l_{n3} e_3 & \cdots & EC_n l_{nn} e_n \end{bmatrix} \quad (7)$$

A row sum results in the number of workers required from industry i to satisfy final demand for exports by country (region).

Table 3: Export-related jobs by industries/countries (regions)

Unit: ' 000	2000					2015				
	CHN	HKG	MAC	USA	RoW	CHN	HKG	MAC	USA	RoW
Agriculture	14.905	8.301	0.174	110.263	428.772	38.544	15.058	0.327	115.071	656.553
Fishing	0.836	20.544	0.058	425.326	170.078	3.094	15.436	0.053	259.168	147.476
Mining and Quarrying	7.137	0.394	0.001	8.684	23.698	42.012	0.744	0.004	14.237	60.124
Food & Beverages	1.054	2.869	0.065	20.273	81.911	8.881	7.472	0.168	29.541	190.647
Textiles and Wearing Apparel	2.506	2.524	0.023	227.049	188.034	13.302	4.663	0.045	200.327	290.803
Wood and Paper	2.396	1.302	0.007	77.287	108.096	11.514	1.902	0.012	79.222	153.370
Petroleum, Chemical and Non-Metallic Mineral Products	2.978	0.737	0.008	58.406	97.763	22.714	1.743	0.022	67.970	229.411
Metal Products	2.582	0.617	0.004	42.131	111.326	19.183	1.122	0.009	57.286	235.411
Electrical and Machinery	2.354	0.783	0.007	42.337	89.573	20.101	1.405	0.013	60.494	233.340
Transport Equipment	1.344	0.076	0.001	28.190	73.598	8.117	0.144	0.002	34.261	156.103
Other Manufacturing and recycling	0.424	0.056	0.001	36.682	41.683	2.195	0.082	0.002	32.588	64.181
Electricity, Gas and Water	0.919	0.183	0.002	8.624	19.757	6.997	0.387	0.005	11.702	44.410
Construction	2.131	1.010	0.002	8.202	31.989	15.519	1.982	0.005	8.139	63.674
Maintenance and Repair	0.994	0.952	0.008	28.076	51.530	6.303	1.950	0.018	29.492	101.804
Wholesale and Retail Trade	32.562	31.186	0.262	919.453	1687.537	178.112	55.092	0.508	833.398	2876.794
Hotels and Restraurants	1.690	0.320	0.012	7.499	111.052	15.134	0.763	0.041	12.222	266.710
Transport, Post and Telecommunications	12.332	2.119	0.031	97.881	271.836	101.779	4.911	0.087	144.664	719.580
Finacial Intermediation and Business Activities	7.915	1.394	0.018	60.736	183.837	76.312	3.644	0.058	99.966	521.602
Public Administration	0.016	0.114	0.001	0.020	4.662	0.132	0.169	0.001	0.019	8.535
Education, Health, Private Households and Other Services	5.212	1.025	0.016	31.283	130.882	32.910	1.868	0.039	34.106	277.334
Total	102.290	76.509	0.700	2238.402	3907.614	622.856	120.537	1.420	2123.875	7297.860

Source: Authors's calculation from EORA-26 MRIOT

Table 3 shows that Brazilian total export-related jobs by industry/country (region) have almost doubled between 2000 and 2015.

3.2 Vertical integration "in" and "from" Brazil

Vertical integration has emerged as standard indicator for trade in value added (Duran & Banacloche, 2022; Koopman et al., 2014; Wang et al., 2013). Vertical integration can be estimated from TiVA data that has been derived in aforementioned EORA26 MRIO tables (Aslam & Rodrigues-Bastos, 2017; Casella et al., 2019). Vertical integration "in" Brazil will be defined as the Foreign Value Added (FVA) content of its exports generated by other countries. Conversely, vertical integration "from" Brazil refers to Brazilian indirect value added embodied in exports of other countries or DVX. Both variables shall be considered to further measure Brazilian integration onto the Global Value Chain (using an index labelled as GVC).

To estimate both FVA and DVX figures, alongside Brazilian DVA embodied in its own exports, we calculate a matrix of value-added flows (F):

$$F = \begin{bmatrix} F_{11} & F_{12} & F_{13} & \cdots & F_{1n} \\ F_{21} & F_{22} & F_{23} & \cdots & F_{2n} \\ F_{31} & F_{32} & F_{33} & \cdots & F_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ F_{n1} & F_{n2} & F_{n3} & \cdots & F_{nn} \end{bmatrix}$$

$$F = \hat{V}\, L\, \hat{e}$$

$$F = \left(\begin{bmatrix} v_1 & 0 & 0 & \cdots & 0 \\ 0 & v_2 & 0 & \cdots & 0 \\ 0 & 0 & v_3 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & v_n \end{bmatrix} \begin{bmatrix} l_{11} & l_{12} & l_{13} & \cdots & l_{1n} \\ l_{21} & l_{22} & l_{23} & \cdots & l_{2n} \\ l_{31} & l_{32} & l_{33} & \cdots & l_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ l_{n1} & l_{n2} & l_{n3} & \cdots & l_{nn} \end{bmatrix} \begin{bmatrix} e_1 & 0 & 0 & \cdots & 0 \\ 0 & e_2 & 0 & \cdots & 0 \\ 0 & 0 & e_3 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & e_n \end{bmatrix} \right) \quad (8)$$

Whereas $\hat{V}$ is the value-added coefficients matrix. $\hat{V}$ can be obtained by summing each column of the full technical coefficient's matrix A, putting these elements on the diagonal of a square matrix and subtracting it from an identity matrix of the same size. L is the full inverse Leontief matrix. And $\hat{e}$ is the diagonalized export vector. Their product results in the value-added flows matrix F. This, henceforth, describes how value added contained in the exports of each industry/country (region) is generated and distributed across countries (see Table 4).

Table 4 : Brazilian GVC matrix (F)

F MATRIX		RoW				BRAZIL				CHINA				USA			
		SEC 1	SEC 2	...	SEC 20	SEC 1	SEC 2	...	SEC 20	SEC 1	SEC 2	...	SEC 20	SEC 1	SEC 2	...	SEC 20
RoW	SEC 1					FVA FROM RoW EMBODIED IN BRAZILIAN EXPORTS											
	SEC 2																
	...																
	SEC 20																
BRAZIL	SEC 1	DVX OF BRAZIL EMBODIED IN RoW EXPORTS				DVA EMBODIED IN BRAZILIAN EXPORTS				DVX OF BRAZIL EMBODIED IN CHINA EXPORTS				DVX OF BRAZIL EMBODIED IN USA EXPORTS			
	SEC 2																
	...																
	SEC 20																
CHINA	SEC 1					FVA FROM CHINA EMBODIED IN BRAZILIAN EXPORTS											
	SEC 2																
	...																
	SEC 20																
USA	SEC 1					FVA FROM RoW EMBODIED IN BRAZILIAN EXPORTS											
	SEC 2																
	...																
	SEC 20																

Source: Authors

The results for Brazil are shown in Table 5.

Table 5: FVA and DVX values for Brazil by industry / country (region) in 2000-2015

BRAZILIAN FVA IN EXPTOT TO THE WORLD PER ORIGIN (UNIT = '000)	2000					2015				
	ROW	CHN	HKG	MAC	USA	ROW	CHN	HKG	MAC	USA
Agriculture	58257.0	1680.7	166.6	1.2	18774.3	320319.3	25024.6	744.1	12.3	71482.4
Fishing	2127.3	52.9	6.1	0.0	542.1	7531.1	493.7	16.1	0.3	1359.2
Mining and Quarrying	192396.6	6814.0	1405.4	5.3	59860.4	1512714.5	144918.9	9231.3	69.9	318835.7
Food & Beverages	234797.9	5300.8	690.2	4.3	51590.6	1236092.9	72397.8	2642.3	41.3	192144.9
Textiles and Wearing Apparel	227047.5	12811.7	2958.9	15.1	66862.0	822652.8	123793.9	6391.1	116.5	167415.5
Wood and Paper	231722.9	7318.8	1010.7	6.4	88166.8	960513.6	75806.2	3122.9	49.7	238236.3
Petroleum, Chemical and Non-Metallic Mineral Products	834631.2	29856.8	2646.5	17.3	320513.3	3038020.4	293488.7	8411.7	119.0	740527.4
Metal Products	329093.4	16986.6	1431.9	7.0	124013.1	1352669.4	166903.5	4751.0	56.9	366579.6
Electrical and Machinery	823228.7	59216.1	17305.8	29.5	342274.5	3762461.6	779757.3	69518.2	276.9	845691.6
Transport Equipment	1091335.6	39645.6	5738.1	26.0	363477.9	4902829.9	471094.5	19000.4	224.8	1073490.5
Other Manufacturing and recycling	66750.7	3622.3	712.5	4.7	24860.5	280965.8	40252.0	2294.7	34.8	70627.1
Electricity, Gas and Water	3620.0	145.8	28.3	0.1	1519.4	1937.6	210.4	11.1	0.1	600.2
Construction	6718.7	291.0	46.8	0.2	2370.4	45886.9	5229.6	250.2	2.2	10302.3
Maintenance and Repair	439.5	15.3	2.6	0.0	155.4	2446.9	209.5	10.0	0.1	667.2
Wholesale and Retail Trade	18264.4	634.7	108.9	0.5	6456.7	101682.6	8706.5	414.5	5.4	27727.0
Hotels and Restraurants	17911.5	469.7	66.9	0.4	4327.3	111096.1	7274.8	296.9	4.7	18953.0
Transport, Post and Telecommunications	153868.1	5254.3	1041.4	4.4	48963.3	942650.2	81057.8	4564.9	51.1	202728.9
Finacial Intermediation and Business Activities	71911.2	3022.6	639.9	2.7	28117.6	369253.5	38861.1	2353.7	26.9	94008.8
Public Administration	1153.4	42.2	7.8	0.0	409.2	5618.5	514.2	27.6	0.3	1426.4
Education, Health, Private Households and Other Services	18714.8	713.5	111.4	0.6	6339.7	103937.0	10145.9	443.6	6.0	23233.0
FVATOT	4383990.6	193895.3	36126.9	125.9	1559594.5	19881280.6	2346141.1	134496.2	1099.2	4466037.1
BRAZILIAN DVX TO THE WORLD PER DESTINATION (UNIT = '000)	2000					2015				
	ROW	CHN	HKG	MAC	USA	ROW	CHN	HKG	MAC	USA
Agriculture	103189.4	17997.0	4568.4	144.0	32768.7	446219.9	85167.2	30441.1	888.2	121717.4
Fishing	392.2	22.3	89.1	0.9	1239.2	1198.4	186.4	341.5	3.1	3668.6
Mining and Quarrying	306091.4	228153.1	19077.1	117.2	119039.6	1344465.7	1867944.6	125916.8	826.0	377887.7
Food & Beverages	39465.5	2862.5	3095.3	134.9	12346.1	170347.8	30266.9	21972.7	755.2	43697.3
Textiles and Wearing Apparel	71641.0	5418.0	2474.0	25.5	24519.2	256626.4	51755.8	11179.4	136.9	71865.3
Wood and Paper	148348.7	12768.0	6830.9	45.6	115323.9	632067.8	136746.6	40408.0	287.3	407628.8
Petroleum, Chemical and Non-Metallic Mineral Products	342378.6	35653.0	10521.2	94.4	164539.9	1445063.8	388654.3	60914.5	565.2	508945.5
Metal Products	334981.4	24762.2	9641.6	53.8	165352.4	1442675.1	280230.6	50387.1	316.6	485576.6
Electrical and Machinery	202593.4	21656.1	8361.8	49.3	113507.4	858786.2	234146.2	42471.9	285.5	337498.2
Transport Equipment	171513.9	5982.8	1403.7	11.5	44909.2	590014.7	58135.4	8111.1	73.9	161664.7
Other Manufacturing and recycling	11463.8	898.4	235.2	2.3	5997.5	45983.3	10717.3	1396.3	14.5	22861.2
Electricity, Gas and Water	88352.3	14417.3	3094.3	26.5	39223.3	379274.6	164452.5	19461.0	164.4	126393.2
Construction	12630.4	3153.9	944.1	4.7	4206.4	40732.7	25641.6	6074.4	24.7	9925.6
Maintenance and Repair	4636.5	385.6	235.1	1.9	2010.9	16841.0	3454.6	1290.1	10.1	5271.7
Wholesale and Retail Trade	192671.4	16023.6	9771.4	80.1	83563.1	699836.7	143556.4	53611.0	419.3	219070.3
Hotels and Restraurants	16505.8	2281.4	507.2	4.7	3128.2	79042.4	30012.2	3711.0	33.4	12228.2
Transport, Post and Telecommunications	261498.9	50844.5	9290.2	96.6	91513.1	1267042.5	611030.5	66757.9	680.8	326362.2
Finacial Intermediation and Business Activities	445205.3	73989.6	14658.0	153.8	148260.5	2160012.9	948673.1	107649.2	1123.5	546887.2
Public Administration	430.7	13.2	8.1	0.6	33.4	1781.0	131.4	37.0	3.0	102.3
Education, Health, Private Households and Other Services	58785.6	9589.4	1933.1	25.7	16708.7	288990.9	117497.2	13944.4	196.8	59577.2
DVXTOT	2812776.2	526871.7	106739.7	1074.0	1188190.7	12167003.6	5188401.0	666076.4	6808.6	3848829.1

Source: Authors' calculation from EORA-26 MRIOT

Finally, in order to measure Brazilian backward linkages within the GVC by partner/industry, the $\frac{FVA_{ij}^{S-BRA}}{EXPTOT_{BRA}}$ ratio is calculated (whereas forward linkages will be noted as $\frac{DVX_{ij}^{BRA-S}}{EXPTOT_{BRA}}$). Adding both $\frac{FVA_{ij}^{S-BRA}}{EXPTOT_{BRA}}$ and $\frac{DVX_{ij}^{BRA-S}}{EXPTOT_{BRA}}$ we will also estimate the Global Value Chain index for Brazil (GVC_{BRA-S}).

4. Correlation between export-related jobs and TiVA in Brazil

Brazil reveals a relatively low integration onto the GVC. Its overall GVC index ranks 32th in the world marking a value of just 0.462%[4]. China, however, is the world second largest nation when considering both FVA and DVX flows within GVC, also ahead of US. China and US then should be considered as "core" countries which could help other "peripheral" commercial partners like Brazil to further integrate onto the GVC.

Table 6: Brazil position in the GVC (2015)

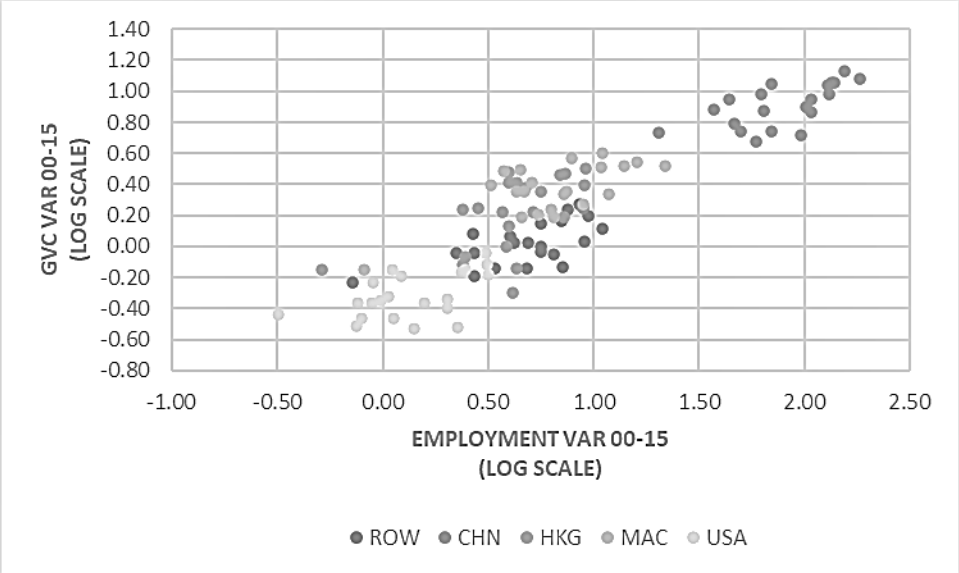
RANK	COUNTRY	GVC INDEX
1	Germany	6.211%
2	China	4.402%
3	USA	4.030%
4	Netherlands	2.943%
5	France	2.812%
6	UK	2.484%
7	Japan	2.417%
8	Belgium	2.404%
9	Italy	2.297%
10	South Korea	1.794%
11	Canada	1.474%
12	Singapore	1.389%
13	Spain	1.321%
14	Russia	1.079%
15	Switzerland	1.076%
…	…	…
32	Brazil	0.462%

Source: Author's calculations from UNCTAD-EORA GVC Database

[4] $GVC_{BRA-WLD} = (DVX_{BRA-WLD} + FVA_{WLD-BRA}) / EXGR_{WLD}$.

When calculating Brazilian GVC indexes by country, as $GVC_{BRA\text{-}S} = \frac{DVX_{ij}^{BRA-S} + FVA_{ij}^{S-BRA}}{EXPTOT_{BRA}}$, empirical evidence shows a decoupling between Brazil and US alongside overall job losses within the period 2000-2015. Yet, on the other hand, a sustained growth of Brazil-China TiVA flows, or $GVC_{BRA\text{-}CHN}$, has nonetheless contributed to substantial increases in Brazilian exports-related jobs (508.9%)[5].

Graph 2: There is a positive correlation between variation rates of export-related jobs and the GVC

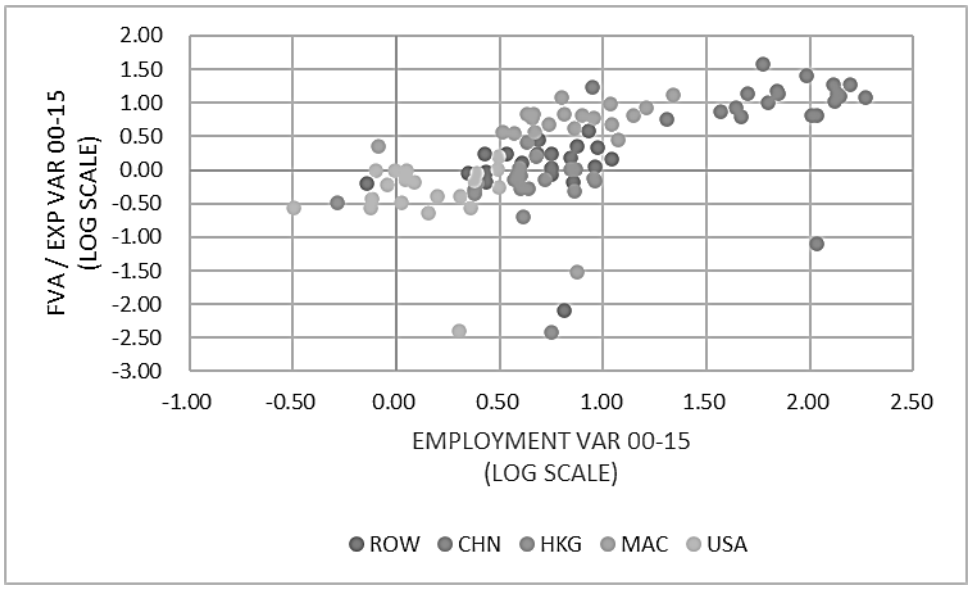


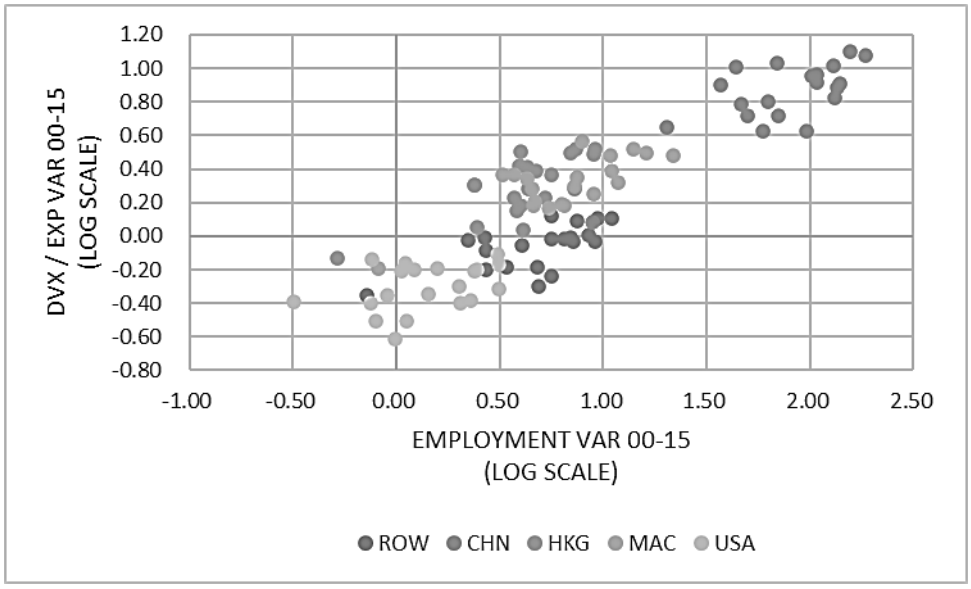
Source: Authors' calculation from EORA-26 MRIOT

Empirical evidence also suggests a direct and stronger impact of DVX over employment growth rates when compared to FVA. Then it could be theorized that backward linkages incentivize variables such as DVX, thus boosting both exports and overall jobs, which facilitate a continuous integration of Brazil onto the GVC.

[5] Excluding both Macau SAR and Hong Kong SAR.

Graph 3: DVX is more strongly correlated to export-related jobs than FVA





Source: Author's calculations from UNCTAD-EORA GVC Database

Then, corresponding increases/decreases in GVC indexes are consistent with the main assumption outlined throughout this chapter which is that TiVA exchanges have a direct correlation to growth rates of export-related jobs. For instance, while $GVC_{BRA\text{-}USA}$ in "Wholesale and Retail Trade" did register a sharp decrease, Brazilian export-related jobs to US were also cut by -9.4%. Yet high growing rates in $GVC_{BRA\text{-}CHN}$ have contributed to increase Brazilian export-related jobs in "Wholesale and Retail Trade" more than five times (447%). This is significant since "Wholesale and Retail Trade" was also the largest single source for Brazilian export-related jobs in 2015 (38,7%).

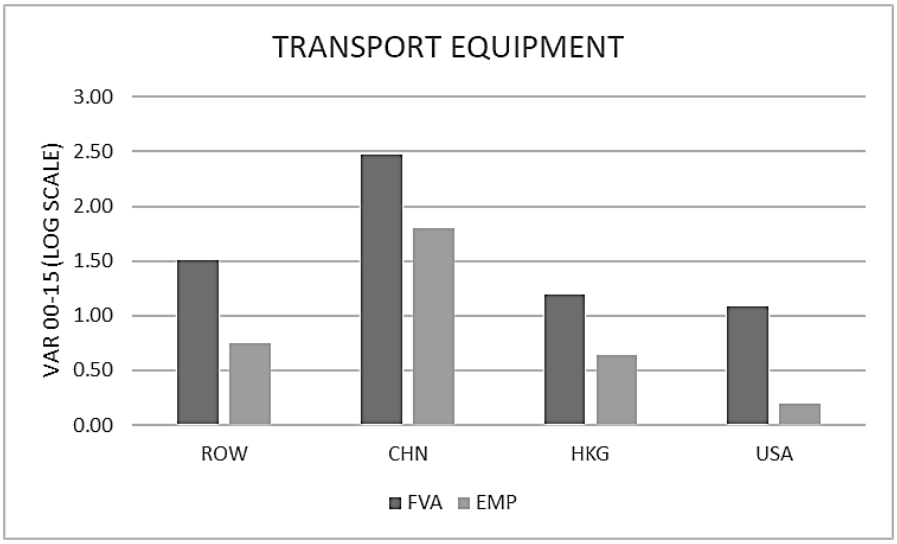
Table 7: Variation rates of GVC indexes and export-related jobs in Brazilian "Wholesale and Retail Trade"

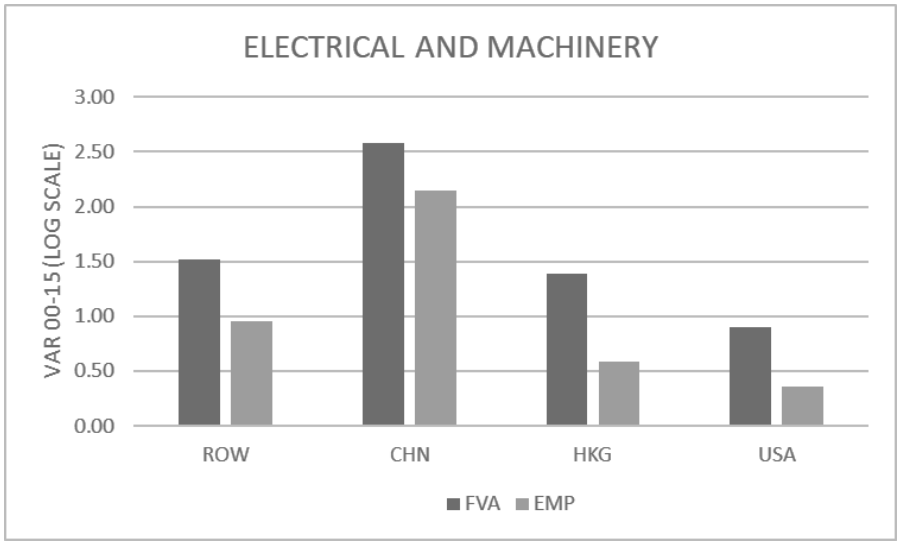
WHOLESALE AND RETAIL TRADE (2000-2015)				
VAR 00-15 (LOG SCALE)	**CHN**	**HKG**	**MAC**	**USA**
GVC	0.74	0.23	0.19	-0.47
EMPLOYMENT	1.70	0.57	0.66	-0.10

Source: Authors' calculation from EORA-26 MRIOT

Both "Electrical and Machinery" and "Transport Equipment" have been the largest receptors of FVA in Brazil. This implies that foreign multinational corporations did invest in Brazil, for export purposes, while importing intermediate inputs from other countries within the GVC. Total share of Chinese FVA embodied in Brazilian "Electrical and Machinery" exports grew from 4.76% to 14.29%, while it decreased when considering US (from 27.5% to 15.5%). And a similar pattern can also be seen in other industries, such as "Transport Equipment", where $FVA_{CHN-BRA}$ over the total grew from 2,6% to 7,2%. Meanwhile, US value added share embodied in Brazilian "Transport Equipment" exports was reduced, from 24,2% to 16,6%. Therefore, even although these two industries account for a small share of export-related jobs, growing $FVA_{CHN-BRA}$ flows have also contributed to increase Brazilian labor through Chinese vertical integration "in" Brazil.

Graph 4: Vertical integration in Brazil and impact on export-related jobs

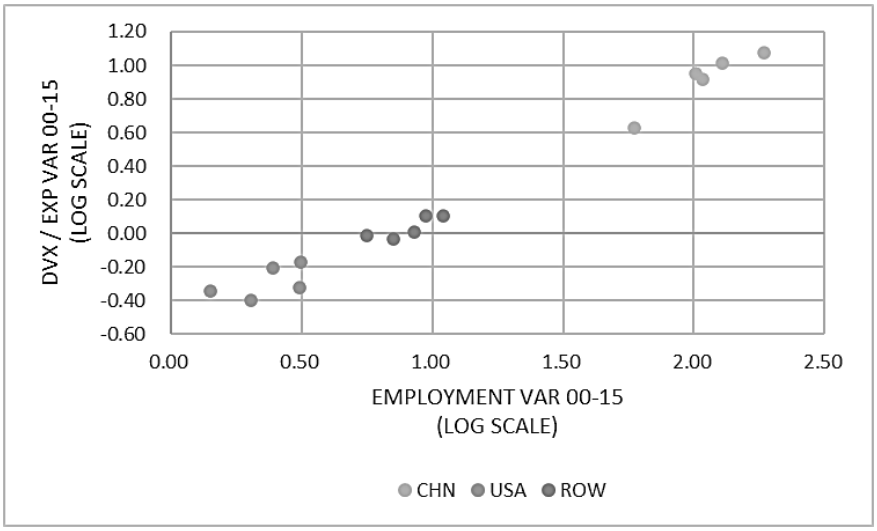




Source: Authors' calculation from EORA-26 MRIOT

Nonetheless, as aforementioned, correlation between vertical integration and export-related jobs is stronger when considering forward linkages or DVX. Brazilian largest DVX shares over the total are concentrated in industries such as "Financial Intermediation and Business Activities" (17.2%), "Mining and Quarrying" (17%), "Petroleum, Chemical and Non-Metallic Mineral Products" (11%), "Transport, Post and Telecommunications" (10.4%) and "Metal Products" (10.3%). Data shows that variation rates of export-related jobs in those industries had a direct correlation to $\frac{\mathrm{DVX}_{ij}^{BRA-S}}{\mathrm{EXPTOT}_{BRA}}$ increases / decreases for the period 2000-2015 (see Graph 5).

Graph 5: Correlation between forward linkages and export-related jobs



Source: Authors' calculation from EORA-26 MRIOT

In addition to this, while "Financial Intermediation and Business Activities", "Mining and Quarrying", "Petroleum, Chemical and Non-Metallic Mineral Products", "Transport, Post and Telecommunications" and "Metal Products" accounted for 65.9% of overall DVX in Brazil, export-related jobs derived from those industries just totaled 23.8%. US industries such as "Financial Intermediation and Business Activities", "Petroleum, Chemical and Non-Metallic Mineral Products", "Metal Products", "Wood and Paper" and "Mining and Quarrying" accounted for 10.64% of overall Brazilian DVX exports to the world but just 3.13% in total export-related jobs. In China, while "Mining and Quarrying", "Financial Intermediation and Business Activities", "Transport, Post and Telecommunications", "Petroleum, Chemical and Non-Metallic Mineral Products" and "Metal Products" accounted for 18.73% of overall Brazilian DVX exports to the world, total export related jobs in those industries were 2.57%. This just indicates that Brazilian vertical integration "onto" China does demand less export-related jobs compared to US.

Table 8: DVX and export-related jobs over the total for selected countries / industries (2015)

USA	DVX	EMP	CHN	DVX	EMP
Financial Intermediation and Business Activities	2.5%	0.98%	Mining and Quarrying	8.54%	0.41%
Petroleum, Chemical and Non-Metallic Mineral Products	2.33%	0.67%	Financial Intermediation and Business Activities	4.34%	0.75%
Metal Products	2.22%	0.56%	Transport, Post and Telecommunications	2.79%	1%
Wood and Paper	1.86%	0.78%	Petroleum, Chemical and Non-Metallic Mineral Products	1.78%	0.22%
Mining and Quarrying	1.73%	0.14%	Metal Products	1.28%	0.19%
Total	**10.6%**	**3.13%**	**Total**	**18.73%**	**2.57%**

Source: Authors' calculation from EORA-26 MRIOT

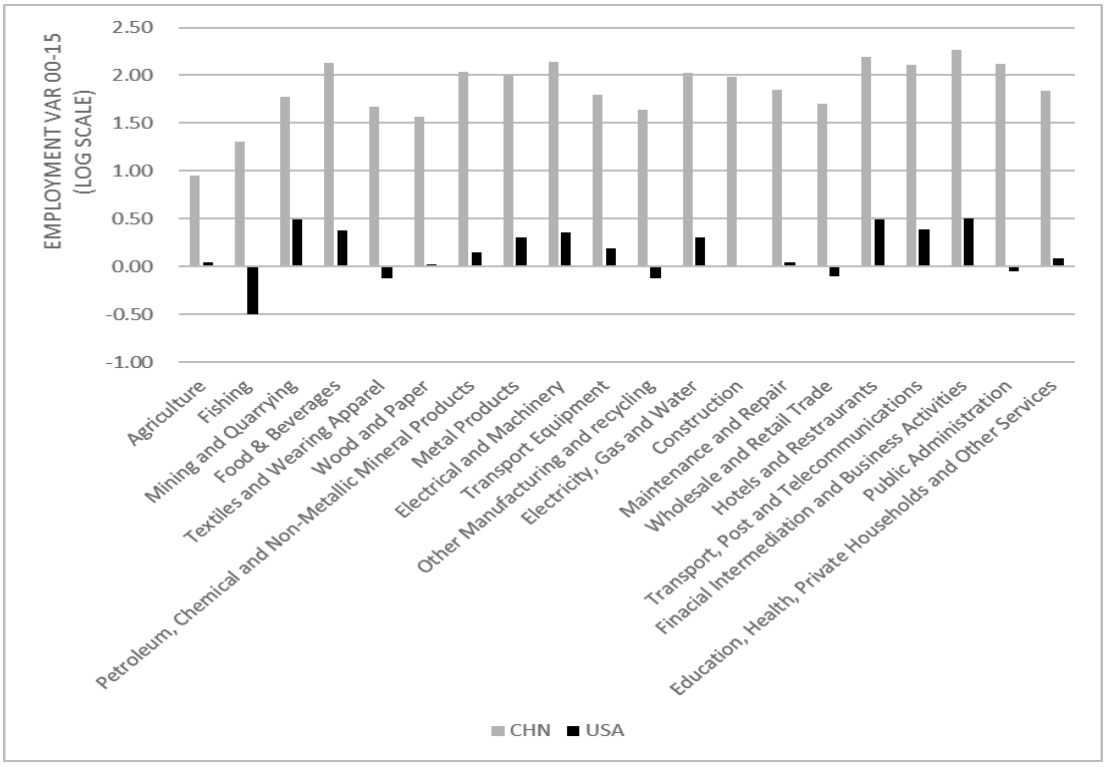
Biggest shares of Brazilian export-related jobs to China, over the world total by industry, were concentrated in "Mining and Quarrying" (35.87%), "Construction" (17.38%), "Electricity, Gas and Water" (11.02%), "Financial Intermediation and Business Activities" (10.88%) and "Transport, Post and Telecommunications" (10.48%). Yet all those industries put together just represented a 2.4% share over total Brazilian export-related jobs. US five largest industries, on the other hand, had an overall share of 13.5% ("Fishing", "Textiles and Wearing Apparel", "Other Manufacturing and Recycling", "Wood and Paper" and "Wholesale and Retail Trade"). Therefore, in absolute terms, US remains dominant when considering Brazilian export-related jobs (accounting for 20.9% of the total).

Table 9: Brazilian export-related jobs shares over world total (2015)

BRAZILIAN EXPORT-RELATED EMPLOYMENT (% TOTAL)	2015				
	ROW	CHN	HKG	MAC	USA
Agriculture	79.53%	4.67%	1.82%	0.04%	13.94%
Fishing	34.68%	0.73%	3.63%	0.01%	60.95%
Mining and Quarrying	51.34%	35.87%	0.63%	0.00%	12.16%
Food & Beverages	80.54%	3.75%	3.16%	0.07%	12.48%
Textiles and Wearing Apparel	57.12%	2.61%	0.92%	0.01%	39.35%
Wood and Paper	62.34%	4.68%	0.77%	0.00%	32.20%
Petroleum, Chemical and Non-Metallic Mineral Products	71.28%	7.06%	0.54%	0.01%	21.12%
Metal Products	75.21%	6.13%	0.36%	0.00%	18.30%
Electrical and Machinery	73.99%	6.37%	0.45%	0.00%	19.18%
Transport Equipment	78.59%	4.09%	0.07%	0.00%	17.25%
Other Manufacturing and recycling	64.80%	2.22%	0.08%	0.00%	32.90%
Electricity, Gas and Water	69.94%	11.02%	0.61%	0.01%	18.43%
Construction	71.29%	17.38%	2.22%	0.01%	9.11%
Maintenance and Repair	72.94%	4.52%	1.40%	0.01%	21.13%
Wholesale and Retail Trade	72.94%	4.52%	1.40%	0.01%	21.13%
Hotels and Restraurants	90.45%	5.13%	0.26%	0.01%	4.14%
Transport, Post and Telecommunications	74.11%	10.48%	0.51%	0.01%	14.90%
Finacial Intermediation and Business Activities	74.35%	10.88%	0.52%	0.01%	14.25%
Public Administration	96.36%	1.49%	1.91%	0.01%	0.22%
Education, Health, Private Households and Other Services	80.09%	9.50%	0.54%	0.01%	9.85%
TOTAL EMPexp	**71.8%**	**6.1%**	**1.2%**	**0.0140%**	**20.9%**

Source: Authors' calculation from EORA-26 MRIOT

Graph 6: Variation rates of Brazilian export-related jobs with China and US (2000-2015)



Source: Authors' calculation from EORA-26 MRIOT

Nevertheless, despite US still represents a much larger share of Brazilian export-related jobs in absolute terms, growing TiVA exchanges with China has allowed Brazil to create new export-related job opportunities between 2000 and 2015. Brazilian export-related jobs grew from 2.84% to 7.33% out of the total when considering China, Hong Kong and Macau; but were reduced from 35.4% to 20.9% in the case of US. At the same time, Brazilian DVX to China reached a share of 23.72% in 2015, overtaking US (17.59%).

Table 10: Largest increases / decreases in Brazilian forward linkages and logarithmic variation rates of export-related jobs (2000-2015)

USA	DVX	EMP	CHN	DVX	EMP
Construction	-0.62	-0.01	Hotels and Restaurants	1.10	2.19
Wholesale and Retail Trade	-0.51	-0.10	Financial Intermediation and Business Activities	1.08	2.27
Maintenance and Repair	-0.51	0.05	Education, Health, Private Households and Other Services	1.03	1.84
Textiles and Wearing Apparel	-0.40	-0.13	Transport, Post and Telecommunications	1.01	2.11
Metal Products	-0.40	0.31	Other Manufacturing and recycling	1.01	1.64
Fishing	-0.39	-0.50	Electricity, Gas and Water	0.96	2.03

Source: Authors' calculation from EORA-26 MRIOT

As shown in Table 10, all Brazilian industries without exception have boosted their export-related jobs when increasing $\frac{\mathrm{DVX}_{ij}^{BRA-CHN}}{\mathrm{EXPTOT}_{BRA}}$ with China. Yet, on the other hand, larger declines of $\frac{\mathrm{DVX}_{ij}^{BRA-USA}}{\mathrm{EXPTOT}_{BRA}}$ correspond to either net losses or much smaller increases in export-related jobs when considering US.

5. Conclusion

Increasing TiVA exchanges between China and Brazil constitutes a source of job creation for the latter. But, on the other hand, a sustained decoupling with US has eliminated 114.520 export-related jobs in Brazil between 2000 and 2015. Yet export-related jobs linked to US were one-fifth of the total in 2015. And, in the case of China, such share was just a 6.1%.

Either considering total growth rates or overall shares of export-related jobs, China and US are relevant TiVA partners for Brazil. Therefore, from an economic perspective, optimal choice for Brazilian commercial policies would be maximizing TiVA exchanges with both China and US. Brazilian continuous integration with Chinese GVC would help the former to create more export-related jobs. And, on the other hand, a large number of export-related jobs can be preserved in labor-intensive industries such as "Wholesale and Retail Trade" or "Fishing" through continuous commercial exchanges with US. It might seem obvious, therefore, that great power politics is not in the best economic interest for Brazil.

Brazil should further promote forward-linkages with China in more labor-intensive industries such as "Wholesale and Retail Trade", "Fishing", "Textiles and Wearing Apparel" or "Transport, Post and Telecommunications". Export-related jobs of aforementioned industries, for US, totaled 1,43 million, which is almost five-times when compared to China. Hence, given that a unit of $DVX_{BRA\text{-}CHN}$ requires much less export-related jobs compared to US, Brazil could deepen its TiVA ties in more labor-intensive activities with China.

As aforementioned, some Brazilian largest shares of DVX are still concentrated in extractive basic industries like "Mining and Quarrying", "Petroleum, Chemical and Non-Metallic Mineral Products" or "Metal Products". Yet more labor-intensive industries, such as "Transport Equipment" or "Electrical and Machinery", have been increasing their $\frac{FVA_{ij}^{CHN-BRA}}{EXPTOT_{BRA}}$ inflows from China, thus becoming the largest destinations of overall Chinese FVA embodied in Brazilian exports. Chinese vertical integration, in Brazil, is also coincidental with an increase of Brazilian DVX to China. And, in the case of US, both industries have registered a sharper decline of both $\frac{FVA_{ij}^{USA-BRA}}{EXPTOT_{BRA}}$ and $\frac{DVX_{ij}^{BRA-USA}}{EXPTOT_{BRA}}$. Therefore, export-related jobs have been increasing faster in those industries which shown a deepening vertical integration with China, as opposed to US.

US might consider Brazil as a relevant supplier of raw materials which contributes to strengthen China either through its final demand or processing trade within the GVC. And it could also see China as a competitor in Brazilian labor-intensive industries like "Transport Equipment" or "Electrical and Machinery". However, despite great power politics between declining and emerging powers in Brazil, a strategic balance of TiVA exchanges with both US and China has contributed to increase Brazilian overall export-related jobs about 60.7% during the period 2000-2015.

6. Data resources

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