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**INTERNATIONAL PRODUCTIVE FRAGMENTATION AND
THE VULNERABILITY OF LESS-SKILLED WORKERS IN
BRAZIL AND OTHER DEVELOPING COUNTRIES**

Rio de Janeiro

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Bárbara Cardoso Dias

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Tese apresentada ao Programa de Pós Graduação em Economia da UFRJ, como requisito parcial obrigatório para obtenção de título de Doutorado em Economia.

Supervisor: Fabio Freitas

Co-supervisor: Marta Castilho

Rio de Janeiro

2021

**AUTORIZO A REPRODUÇÃO E DIVULGAÇÃO TOTAL OU PARCIAL DESTE
TRABALHO, POR QUALQUER MEIO CONVENCIONAL OU ELETRÔNICO, PARA
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To my mother, who gave me wings and set me free to fly.

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I believe that virtually all the problems in the world
come from inequality of one kind or another.

Amartya Sen

RESUMO

No contexto de crescimento da fragmentação produtiva, a literatura empírica revela que os trabalhadores menos qualificados nos países em desenvolvimento têm mais dificuldade em capturar os benefícios da integração das Cadeias de Valor Globais (CGV) e sua participação no valor agregado à CGVs manufatureiras diminuiu desde meados de 1990. Portanto, compreender as circunstâncias e os canais pelos quais a fragmentação produtiva afeta os mais pobres é um passo importante para que os países em desenvolvimento possam conduzir sua integração econômica internacional a favor de um crescimento econômico inclusivo. O objetivo principal desta pesquisa é investigar os determinantes da evolução da participação dos trabalhadores menos qualificados no valor agregado brasileiro às CGVs manufatureiras. O primeiro ensaio investiga os canais teóricos pelos quais a fragmentação produtiva afeta a parcela do trabalho menos qualificado no valor agregado nos países em desenvolvimento e as evidências empíricas. O segundo ensaio apresenta uma análise da evolução da inserção brasileira nas CGVs, das rendas e empregos relativos dos trabalhadores menos qualificados e sua estrutura produtiva que atende essas cadeias de valor entre 1995 e 2009, em uma perspectiva comparada com outros países em desenvolvimento (China, Índia, Indonésia, México e Rússia). O terceiro ensaio quantifica o impacto dos principais determinantes da evolução da participação da mão-de-obra menos qualificada no valor adicionado brasileiro às CGVs manufatureiras de 1995 a 2009, também na perspectiva comparada. Para esta quantificação, decomparamos a evolução da participação da mão de obra menos qualificada em efeitos intra-setoriais e efeitos de especialização vertical. O segundo e o terceiro ensaios utilizam matrizes insumo-produto mundiais para rastrear a distribuição do valor agregado, receitas e empregos nas CGVs. Os resultados mostram que a participação ‘para trás’ do Brasil nas Cadeias Globais de Valor, medida pela parcela externa no valor adicionado de bens finais produzidos no Brasil, é relativamente baixa. Diferentemente dos outros países, no Brasil, a participação da mão de obra menos qualificada no valor adicionado aumentou nas CVGs concluídas domesticamente. O principal fator por trás dessa diferença foi a melhor evolução da distribuição intra-setorial das rendas entre trabalho e capital no Brasil. Observamos também que a participação da mão de obra menos qualificada nas rendas do trabalho na CGVs manufatureiras teve uma tendência decrescente nos países em desenvolvimento analisados devido à participação decrescente da mão de obra menos qualificada no emprego total. Os resultados suportam as hipóteses de que a fragmentação produtiva impacta negativamente no poder de barganha dos trabalhadores e reduz o emprego permanente para os menos qualificados nos países em desenvolvimento.

PALAVRAS-CHAVE: cadeias globais de valor; especialização vertical; desigualdade de renda, poder de barganha dos trabalhadores

ABSTRACT

In the context of increasing productive fragmentation, the empirical literature reveals that the less-skilled workers in developing countries have more difficulty in capturing the benefits from Global Value Chains (GVCs) integration, and their share in the value-added to manufacturing GVCs have decreased since the mid 1990's. Thus, to understand the circumstances and channels through which productive fragmentation affect the poorer is one important step so that developing countries can conduct their international economic integration in favor of an inclusive economic growth. The main objective of this research is to investigate the determinants of the evolution of less-skilled workers share of Brazilian value-added to manufacturing GVCs. The first essay investigates the theoretical channels through which productive fragmentation affects the less-skilled labor share of value-added in developing countries and the available empirical evidence. The second essay presents an analysis of the evolution of the Brazilian GVC insertion, the less-skilled worker's relative incomes and jobs in manufacturing GVCs and its productive structure that serves these value chains from 1995 to 2009, in a comparative perspective with other developing countries (China, India, Indonesia, Mexico and Russia). The third essay quantifies the impact of the main determinants of the evolution of the less-skilled labor share of the Brazilian value-added in manufacturing GVCs from 1995 to 2009, also in a comparative perspective. For this quantification we decompose the evolution of the less-skilled labor share in intra-sectoral effects and vertical specialization effects. The second and third essays rely on World Input-Output databases to track value-added, incomes and jobs distribution along GVCs. Our results show that the Brazilian backwards participation in Global Value Chains measured by the share of foreign value-added in domestically completed final manufacturing outputs was relatively low. Differently from the other countries, the less-skilled labor share of value-added increased in Brazilian domestically completed GVCs and the main factor behind this difference was the better evolution of the intra-sectoral distribution of incomes between labor and capital in Brazil. We also observed that the less-skilled labor share of total labor income in manufacturing GVC had a decreasing trend in the developing countries analyzed because of a decreasing participation of the less-skilled labor in total employment. The results support the hypothesis that productive fragmentation has a negative impact on labor bargain power and reduces permanent job for the less-skilled in developing countries.

KEYWORDS: global value chains; vertical specialization; income inequality; workers bargaining power

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Introduction

Inequality, together with poverty and unemployment, are still primary concerns of the developing world. Income inequality among countries, measured by the Gini Index, showed a convergence trend in the decades of 1990s and 2000s (Chambers and Dhongde, 2016). While the countries became more similar, they also became, on average, more unequal (Alvaredo and Gasparini, 2015). Chambers and Dhongde attribute the observed Gini Index convergence to the concomitant convergence in the economic policy adopted in these countries during the 1990s. During the period, there was an intense commercial and financial liberalization, privatization and technology transfer to developing countries, which also characterized a period of increasing globalization.

International trade theory, largely based on Heckscher-Ohlin (HO) model, predicted that the commercial openness would favor the less-skilled workers in developing countries, reducing unemployment, inequality, and poverty. However, increasing inequality in the 1990s, both in advanced and developing economies, challenged the HO conclusions – as shown in the review of the empirical literature covered by Harrison et. al. (2011). Even in China, a benchmark for economically benefiting from international trade, global economic integration has been positively associated to income inequality. Mah (2013) finds evidence that, between 1985 and 2007 in China, commercial liberalization had a strong and positive effect on inequality measured both as the ratio of the income share of the first to the tenth decil and as the average income of the first decil divided by the average income of the four lowest deciles. Kanbur and Zhang (2005) find similar evidence based on estimations for the 1979–2000 period. Similar results are also found for other developing countries. Kratou and Goaid (2016), using panel data for 66 developing countries from 1984 to 2005, find evidence that international trade increased income inequality within these countries. According to their estimations, commercial openness reduced the income shares of the lowest deciles and raised the income shares of the two richer deciles. The effect over the lowest deciles was differentiated according to the country's per capita income: the poorer individuals in higher per capita income countries benefited from commercial openness, although less than their richer fellow countrymen.

Since the predictions of the standard HO model were questioned by empirical studies, a variety of hypothesis has been explored to investigate the relation between global economic

integration and inequality in developing countries – e.g., the incorporation of search friction and unemployment to trade models and the relationship between trade and innovation (Harrison et al., 2011). Among these hypotheses are the effects of the growing relevance of international trade in intermediate goods associated to the concepts of international outsourcing, (across border) productive fragmentation and the diffusion of Global Value Chains (GVCs).

Technological progress promoted the reduction in transportation and communication costs which allowed the geographical fragmentation of vertically integrated productive processes beyond national borders in global and regional levels (Baldwin, 2011). According to UNCTAD's (2013) report, in 2013, 60% of international trade accounted for intermediary goods and services. One of the consequences of productive fragmentation is the fragmentation of the value-added embodied in a final good among different countries. In a broad study, including 555 productive chains, Los et. al. (2014) find that the proportion of foreign value-added encompassed in final goods of manufacturing productive chains increased 20 percent between 1995 and 2008, on average. This trend is observed in all manufacturing productive chains, regardless of the country where the last stage of production is completed.

The Global Value Chains studies originated in sociology and their main objective is to explore cross-border production-consumption relationships and its value distribution mechanisms (Inomata, 2017). Kaplinsky (2000) enumerates three components of Global Value Chains that characterizes it as an analytical tool: GVCs are repository of rents, their effective functioning requires some degree of governance and their effective competitiveness arises from systemic rather than point efficiencies. Economic rents arise from productivity differentials and barriers to entry generating higher than normal profits, but they are in most cases dynamically eroded by the forces of competition. Entrepreneurs are constantly searching for “new combinations” to escape normal profits. The expansion of transnational corporations through the creation of subsidiaries in search for rents is an important driver of the process of productive fragmentation and the globalization of value chains. However, GVC's governance can assume different forms, from vertically integrated firms (headquarter-subsidiary coordination) to market based relationships among firms, depending on the complexity of the transactions, the extent to which information and knowledge can be efficiently transmitted and the capability of suppliers (Gereffi, Humphrey and Sturgeon, 2005). In these increasingly complex market arrangements, gaining competitiveness is requiring increasing

systemic integration involving cooperation between the links along value chains (Kaplinsky, 2000).

The integration of developing countries into these GVCs is considered an opportunity for economic development and catching up. Instead of building an entire manufacturing chain, developing countries can capture stages of production generating income and jobs (Baldwin, 2011). However, the GVC approach to international trade holds that the stages of production hosted by a country matter for its long-term economic performance (Kaplinsky, 2000; Milberg and Wrinkler, 2013). According to neoclassical theory, technology and capital accumulation are the main determinants of labor demand and, together with labor supply, of wages. This literature frequently assumes that moving to higher value-added stages of production in GVCs translates into better jobs and wages. Yet even when participation in GVCs boosts economic performance, theoretical and empirical studies have pointed to asymmetric and adverse effects of productive fragmentation on labor markets (Barrientos et. al., 2011; Gutelius, 2015). The less-skilled workers are often pointed as the least benefitted from this process. A comprehensive study held by Timmer et. al. (2014), covering 560 production chains, found that between 1995 and 2009, there was a shift in the functional distribution of the value-added of GVCs in favor of high skilled labor and capital, in both developed and developing countries. Thus, to understand the circumstances and channels through which productive fragmentation affect the poorer is one important step so that developing countries can conduct their international economic integration in favor of an inclusive economic growth.

The main objective of this research is to investigate the determinants of the evolution of less-skilled workers share of Brazilian value-added to manufacturing GVCs. We analyze the changes in less-skilled labor relative employment and wages within the manufacturing GVCs in Brazil and how it was affected by the country's productive structure transformations within these fragmented production systems, compared to other developing countries. Brazil is considered a country with limited integration to GVCs. International trade policy in Brazil is seen as detached from worldwide context of increasing fragmentation of production, relying on incentives for the domestically development of vertically integrated chains (Sturgeon et. al., 2013; Oliveira, 2015; Veiga and Rios, 2015). Examples of these incentives are restrictive local content requisites (Sturgeon et. al., 2013) and high import tariffs on intermediate inputs when compared to other developing countries as China, Indonesia and Mexico (Baumann and Kume, 2013). Studies that

analyze the value-added content of Brazilian exports conclude that although the Brazilian participation in GVCs grew in the late 1990's and during the 2000's, it was a late integration and it still lags behind European and BRIC economies (Guilhoto and Imori, 2014; Hermida, 2016, Marcatto, 2018). However, the Brazilian insertion in GVCs via the generation of value-added in early stages of the production chain, sourcing natural resources and commodities as input to foreign manufacturing activities, is not negligible (Hermida, 2016; Guilhoto and Imori, 2014, Marcatto, 2018).

Hence, the Brazilian case of a lower degree of GVC integration works as a counterexample to the labor markets dynamics in developing countries that went through a deeper process of productive fragmentation during the 1990's and 2000's. Our main hypothesis is that increasing integration to international trade, in the context of Global Value Chains, do not lead necessarily to higher employment of the abundant factor or to the tendency of factor price equalization as predicted by the Hecksher-Ohlin model. On the contrary, the integration of middle-income countries to these fragmented production networks in lower value-added stages of production exerts degrading pressures on labor markets that need to be counterbalanced by an economic development strategy and social policies to strengthen workers bargain power.

The thesis will be organized in three essays. The first one will address the theoretical channels through which productive fragmentation affects the less-skilled labor share of value-added in developing countries and the available empirical evidence. This essay will be important to organize the main theoretical results and empirical evidence that will serve both as a base for hypothesis formulation in the subsequent essays and as a comparison basis for our empirical analysis. The literature review is organized according to the impact of productive fragmentation on each of the components of the less-skilled labor of value added that will be measured and analyzed in the second and third essays. The second essay will present an analysis of the Brazilian less-skilled worker's share of value-added in manufacturing GVCs between 1995 and 2009 and its mains components which are the relative incomes and jobs of the less-skilled workers and the total labor share of value-added. We also analyze the productive structure that serves these value chains and the labor markets institutional environment that could partially explain the across-countries differences and evolution of less-skilled labor share of value-added in manufacturing GVCs. The third essay will appraise the question of what were the main determinants of the evolution of the less-skilled labor share of the Brazilian value-added in manufacturing GVCs? This chapter aims

to quantify the contribution of the different components of the less-skilled labor income share to its trajectory in Brazil from 1995 to 2009. In the second and third essays, the Brazilian case is examined in a comparative perspective with other developing countries (China, India, Indonesia, Mexico, and Russia) and we separate the GVCs between those in which the last stage of production is held within the country and those that are completed abroad. Most quantitative studies on GVC integration analyze only the trade flows of final and intermediate goods, not accounting for the value chains where the last stage is completed within a country to supply its domestic final demand. These studies are missing one large part of the characterization of countries' insertion in GVCs as importers of inputs to deliver final goods (Castilho, 2019). Thus, we consider the GVCs completed within the country, irrespective of the final good destination. Furthermore, the separation of GVCs between those completed domestically and abroad considers that vertical specialization within a domestically completed chain is driven by different forces than those within a foreign completed GVC. Within domestic GVCs, that is a stronger influence of the country's historical path of industrial development, domestic demand, and tariff protection patterns. While in foreign GVCs, foreign demand and patterns of trade protection, and geopolitical forces are more relevant. These different forces may lead to different vertical specialization patterns that can lead to different labor market outcomes.

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Essay 1. International Productive Fragmentation and Less-skilled Labor Share of Income in Developing Countries: channels of influence and empirical evidence

1.1. Introduction

This essay analyzes the theoretical and empirical literature about the effects of productive fragmentation on less-skilled workers' share of income in developing countries. We explore what are the channels of influence of productive fragmentation on the less-skilled labor share in a theoretical level and the empirical evidence for these channels. We consider that productive fragmentation can affect less-skilled labor share of income both on the firm or industry level and via structural change. As the sectoral activities diverge in terms of average absolute and relative wages and of the structure of employment of different skill categories of labor, the pattern of vertical specialization is determinant of the economywide structure of employment and labor income. This argument is especially relevant for developing countries. The structural heterogeneity of developing countries was broadly described by the Latin-American structuralist approach to economic development. Technological gap between the industrialized center and a backward periphery configured an unequal spread of new technologies in the periphery (Rodriguez, 2009). The periphery developed a heterogeneous and specialized structure. As a result of its initial specialization, industrialization in the periphery starts with low-technological consumer goods slowly advancing to sectors with greater technological complexity. The heterogeneous character of its productive structure also limits the possibility of incorporation of technical progress in activities of lower productivity. The uneven incorporation of technical progress in the periphery acts directly in the differentiation of real income across the economic activities.

Departing from the premise of the heterogeneity of employment structure and wages across sectors, the theories of international trade will be explored in order to identify the expected pattern of specialization within the GVCs and its implication to the aggregate employment and wage structure. We will discuss the pattern of specialization given by comparative advantage and absolute advantage theories, new trade theory, the theory of technological gaps, product cycle theory, and by the GVC approach which emphasizes the institutional aspects of the value chains.

Furthermore, the intra-industry level can be split into the relative average wages of the less skilled, the relative employment and the total labor share of value-added. Productive fragmentation can affect each of these terms through different channels. The intra-sectoral less-skilled labor share of value-added can either increase or diminish as a direct consequence of the changes in the sectoral employment structure, supposing constant labor shares and relative wages between skill categories of workers. Some of the channels of influence of productive fragmentation on the intra-sectoral employment structure that we will appraise are: (i) changes in the composition of firms as fragmentation increases competitiveness, (ii) technical change allowed by technological diffusion via trade in intermediates and (iii) diffusion of leaner production strategies across GVCs.

Regarding sectoral relative wages of less-skilled and high-skilled workers and the total labor share of value-added, the neoclassical theory makes a direct link between the changes in the relative demand of the factors of production and changes in the relative wages or in the labor share. From the classical and institutionalists theories we will explore other channels of influence of productive fragmentation on less skilled labor share of income. We discuss the hypothesis that specialization in lower value-added stages of production which are more price competitive exert a downward pressure on less-skilled workers' compensation reducing its relative wages. Furthermore, we consider the effects of productive fragmentation on labor bargaining power that will impact total labor share of value-added.

Equation 1 illustrates the composition of less-skilled labor share of income ($\frac{W^{ls}}{V}$):

$$(1) \quad \frac{W^{ls}}{V} = \sum_{i=1}^n \frac{w_i^{ls}}{v_i} \times \frac{v_i}{V} = \sum_{i=1}^n \frac{w_i^t}{v_i} \times \frac{w_i^{ls}/l_i^{ls}}{w_i^t/l_i^t} \times \frac{l_i^{ls}}{l_i^t} \times \frac{v_i}{V}$$

where W_{ls} is aggregated less-skilled labor income, V is aggregated value-added. After the first equals sign, the less-skilled labor share of value-added is given by the industry level less-skilled labor share of value-added ($\frac{w_i^{ls}}{v_i}$) and the value-added composition ($\frac{v_i}{V}$), where w_i^{ls} is the less-skilled labor income in industry i , and v_i is the value added in industry i . After the second equal sign, the intra-industry less-skilled labor share of value added is decomposed between relative average industry wages of the less-skilled ($\frac{w_i^{ls}/l_i^{ls}}{w_i^t/l_i^t}$), the relative employment ($\frac{l_i^{ls}}{l_i^t}$) and the

total labor share of value-added ($\frac{w_i^t}{v_i}$), where w_i^t is the total labor compensation of sector i , l_i^{ls} is total less-skilled labor employed in sector i , and l_i^t is the total labor employed in sector i .

This literature review is structured according to impact of productive fragmentation on each of the terms in Equation 1 from the right to the left: vertical specialization and the within sector changes in employment structure, wage inequality and the labor share of value added.

1.2. International productive fragmentation and vertical specialization

The traditional approach to international trade follows the Heckscher-Ohlin (HO) model. The HO is a derivation of Ricardo's comparative advantage theory which states that, in a free trade context between two countries, each country specializes in goods and services for which they have comparative advantage. Considering a case where one country has absolute advantage in all trade goods, in a model including exchange rates/monetary flows, the "price-specie-flow mechanism" ensures that price levels in the less productive country will drop sufficiently to offset its absolute productivity disadvantage (Vernengo, 2000). Initially, free trade causes the less competitive country to incur in trade deficits. Trade imbalances are then compensated by currency devaluation, causing a price deflation of the less-competitive country goods in the international market.

The comparative advantage, in Ricardo, is a cost advantage measured in differences of labor requirements to produce a given amount of output. The HO model considers that differences in factor endowments (capital and labor) are the principal determinant of cost differences. Departing from the assumptions of homogeneous and constant returns to scale technology, homogenous preferences and perfect competition, the model predicates that commercial openness increases the relative price of the goods intensive in the factors relatively abundant in each country. Hence, there is a reallocation of production to these goods raising the relative demand for the factors used more intensively in their production. Wood (1995) respecifies the HO model to explain the North-South trade. The HOW (Heckscher-Ohlin-Wood) model dismissing capital and considering only skilled and unskilled labor as the factor endowments. As developing countries are more abundant in less-skilled labor, relatively to developed countries, the model predicts that free international trade contributes to a rise in the demand for less-skilled labor-intensive goods in the former countries (Wood, 1995).

The empirical studies covering the post liberalization period in developing countries show mixed evidence for the HO prediction of employment reallocation to industries more intensive in less-skilled labor. For example, Verhoogan (2004) observes a shift in relative output in Mexico during the 90s in favor of unskilled labor and low capital-intensive sectors. Gonzaga et. al. (2006) notice that the employment shifted from skilled to unskilled sectors after liberalization in Brazil from 1988 to 1995. However, Meschi et. al. (2011) find that, during and after trade liberalization in Turkey from 1987 to 2001, labor reallocation had a minor effect on relative demand for unskilled labor in manufacturing industries and its direction was towards more skilled-labor intensive sectors. Revenga (1997) and Feliciano (2001) fail to find evidence for significant effects of trade liberalization on employment reallocation in Mexico, while Currie and Harrison (1997) find only a small impact of trade reform on output and employment in Morocco. Wacziarg and Wallack (2004) investigate the effect of 25 trade liberalization episodes on intersectoral employment reallocation in developing countries and their results suggest far smaller effects than predicted by standard trade theory.

In the post liberalization period in developing countries, a rise in the relative price of capital and skilled intensive industries and the shifts of output to these sectors is attributed by some authors to the pattern of previous trade protection and of tariffs' drops (Hanson and Harrison, 1999; Currie and Harrison, 1997; Meschi et. al., 2011). Hanson and Harrison (1999) present evidence that trade protection in Mexico favored the sectors with a more intensive use of unskilled labor in 1984, prior to the 1985 trade reform. Currie and Harrison (1997) find the same pattern of protection in Morocco. This pattern of protection is also inconsistent with the conception of developing countries having a global comparative advantage in sectors intensive in unskilled labor. If this is the rule, these sectors would not require higher tariff protections.

Another explanation for the shift in labor and output to more skill intensive sectors in developing countries is found in Davis and Mishra (2007) who argue that in the real-world comparative advantage vary across trade partners. A country that is less-skilled labor abundant in global terms may also import unskilled intensive products. Factor abundance must be compared to that of countries producing the same sets of goods. Following this line of argument, commercial liberalization between countries that produce different sets of goods will cause only minor impacts on labor allocation. The increased competition among developing countries, which are unskilled

labor abundant in global terms and produce similar goods, lead to a decrease in the unskilled labor relative demand in the least unskilled labor abundant country.

These long-term consequences of trade based on the theory comparative advantage depends on two crucial assumptions: (i) trade imbalances dominate the Balance of Payments outcome; and (ii) the level of employment is fixed (Vernengo, 2000). If we assume that capital account is more important than current account to Balance of Payments results and that it is demand that determines output, the effect of the introduction of free trade would be the reduction of the level of employment in the less competitive country and not price deflation. Trade imbalances might be persistent if capital flows determine the Balance of Payments result. If capital has free mobility, trade deficits can be maintained for long periods if a country sustain sufficiently high rates of interest to attract capital flows. Hence, producers will move to the most profitable countries and absolute, instead of comparative advantage, will be the principle determining productive specialization and trade performance (Brewer, 1985). Increased competition between developing countries which have absolute advantage in unskilled labor-intensive sectors in global terms (usually because they have lower unit labor costs) may produce unemployment for the unskilled workers in the least profitable country.

The HO model focuses on the explanation of static consequences of trade liberalization. The theories of technological gap incorporate an analysis of dynamic consequences of trade, abandoning the assumption of homogeneous technology and showing its implication to transnational market power. In this formulation, a country specialized in a new product will be a monopolist receiving rents until the product is imitated by the other countries (Posner, 1961). It follows that innovation capacity or innovation leadership can determine commercial specialization as the gap between leaders and followers may persist self-fed by technological externalities and to further investment in R&D supported by accumulated rents (Grossman and Helpman, 1991). The product cycle theory of Vernon (1966) also emphasizes the role of innovation capacity to the pattern of international trade. Vernon split the product cycle in three stages: the first is the introduction of the new product, when the uncertainty regarding the product profitability is compensated by potential monopoly rents; the second stage is when the product is accepted in the market and scale economies become more important to supply the new demand; the last stage is when the production process is standardized and becomes less skill intensive. In this last stage, the production is transferred to developing countries with lower labor costs and the workforce in

developed countries are allocated to the development of new products. The technological gap related theories predicate that developing countries will specialize in products and sectors with less technological content which tend to be relatively intensive in less-skilled labor. But it occurs not because of the relative abundance of unskilled to skilled labor but because of the initial (and cumulative) differentiated capacity of innovation and production, aggravated by trade and other barriers that reduce the market access to dynamic consumer markets.

New trade theory models with increasing returns to scale that introduce transportation costs and other barriers to trade encompass the role of the dimension and structure of domestic and regional demand to the pattern of trade specialization. According to these theories, scale economies and product differentiation play a major role in trade between countries with similar technology and factor endowment. Countries specialize and trade occurs not because of initial costs advantage, but because the access to bigger consumer markets reduces the product unit cost which may increase profit margins. In these models, increasing returns industries will tend to concentrate in regions with larger markets (Helpman and Krugman, 1985). Developing countries have a larger proportion of low incomes families and consequently their demand structure is more concentrated in less-skilled labor-intensive consumer goods and services. Thus, regional economic integration among developing countries enables further scale economy gains in less-skilled labor-intensive sectors.

The previous models and hypothesis are focused on final goods trade, but trade in parts grew much faster in the 1990s and 2000s (Hummels et. al., 1998, UNCTAD, 2013). Trade in intermediate goods have a potentialized effect on output shifts, as it affects labor demand both in import competing firms and the firms that use the foreign input. It can shrink the production of domestic manufacturers of intermediate products. Also, as some firms opt to internationally outsource some previously internalized stages of production, its value-added per unit of output may be reduced. On the other hand, international outsourcing can reduce production costs for domestic firms and increase their international competitiveness, leading to an increase in output and employment. Depending on the stage of production that is being externalized, value-added composition and employment structure can take a different direction. For example, Amiti and Cameron (2011) find evidence that in Indonesia from 1990 to 2001, intermediate goods were produced with more skilled labor-intensive technologies and that tariff reduction over inputs reduced the relative demand for skilled labor.

Although there were some early models that incorporated trade in intermediate inputs (Krugman 1995), it gained relevance within the comparative advantage framework in the late 1990s. One line of these models treats production fragmentation as technological progress that lowers production costs and increases productivity in the sector where fragmentation occurs, expanding the production frontier and enhancing the gains from trade (Arndt, 2001; Deadorff, 2001a, b). The outcome of skill specialization in trade depends on the factor endowments and on factor intensities of the fragmented sector and of the stage of production that is being offshored. Hence, it is not easy to derive general principles from these models (Grossman and Rossi-Hansberg, 2006). Following a different path within the comparative advantage framework, Grossman and Rossi-Hansberg (2008) model offshoring as trade of a continuum of intermediate tasks produced by low skilled and higher skilled labor that can happen in different locations and with variate offshoring costs. In this model, firms in the home country offshore tasks in order to take advantage of the lower foreign wages. They initially assume high-skilled intensive tasks are prohibitively costly to offshore. So developed countries would offshore low-skilled intensive tasks to the south. If the costs of offshoring are the same for low-skilled and high skilled tasks, the fraction of low and high skilled intensive tasks offshored will depend on relative factor prices in the foreign country.

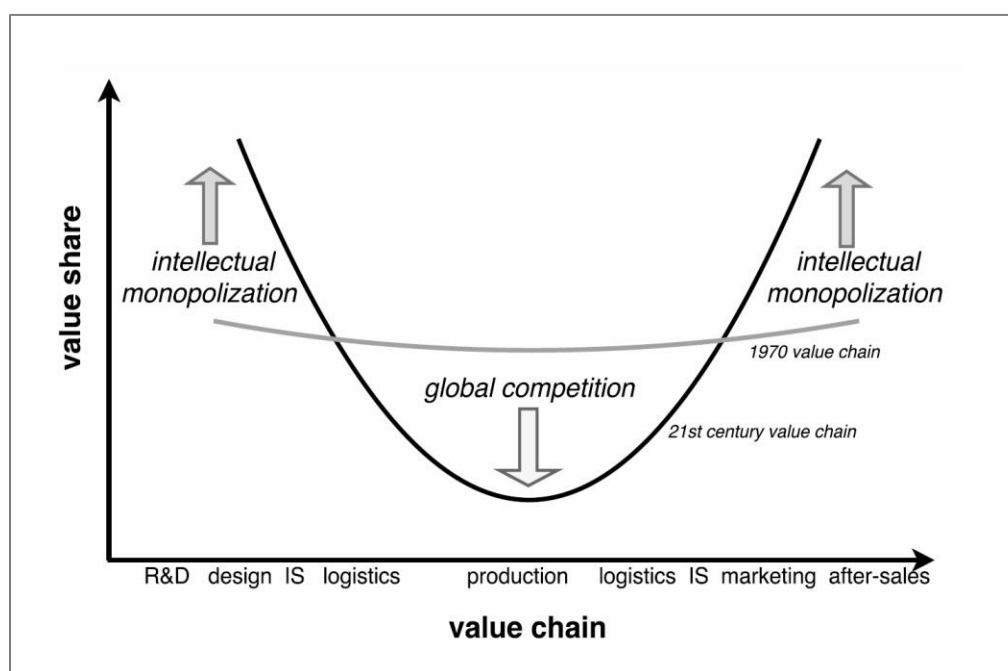
The comparative advantage models that incorporate trade in intermediates still assume full employment, so balance of payments disequilibrium is adjusted by currency valuation/devaluation. Like most trade models adopted since the mid-1990s, they also ignore capital incomes, and this implies the effective disappearance of profits from the discussion of offshoring (Wrinkler and Milberg, 2011). Hence, they provide little reference for discussion of the distribution of income between labor and capital. Furthermore, they ignore the roots of offshoring decisions that was the search for reduced production costs and increasing rents.

The literature on GVC¹, provides an alternative, and institutionally grounded, analytical tool to examine international trade focused on trade in intermediate inputs. The common starting point in this literature is that the GVCs came to existence because they enabled higher profit gains for companies internationally outsourcing some stages of production (Ravenhill, 2014). “*Whether*

¹ The literature about GVCs has an interdisciplinary characteristic and encompasses different theoretical frameworks. “*The ideas [about GVCs] only recently started to cross over academic borders, and they continue to evolve along dynamic interactions of theories and empirics*” (Inomata, 2017, p. 17).

the driver is a producer or a buyer, the motivation for global production sharing is normally the search for reduced costs or increased flexibility” (Milberg and Winkler; 2013, p. 5). The division of labor within the GVCs is functional to the increase in incomes appropriated by transnational companies that are the leaders and coordinators of the process of productive fragmentation (Medeiros and Trebat, 2017). The host countries of these companies are, in large majority, the developed ones. They specialize in skill-intensive and higher value-added functions as R&D, marketing and management (Timmer et. al., 2018, Stollinger, 2019), which receive monopoly rents, guaranteed by intellectual property rights, marketing, logistic channels and financial innovations (Medeiros and Trebat, 2017; Durang and Milberg, 2018). The suppliers of the host companies located in developing countries engage in lower value-added stages of production in which price competition prevails and have increased with the growing inclusion of developing countries into these production systems. These lower value-added stages are generally more less-skilled labor intensive.

Figure 1: Intellectual monopoly versus global competition in the smile curve



Source: Durang and Milberg (2018)

The increasing inequality in the bargain power of firms along the GVCs was responsible for making the curve of value-added distribution steeper in the twenty first century, as illustrated

in Figure 1 (Durang and Milberg, 2018). Production stages have decreased their share of value-added while activities as research and development, design, marketing, and after-sales were increased their value share. Hence, differently from the standard theories of international trade, in the GVC approaches, trade specialization matters because it, to a large extent, determines who will capture the gains from trade. In this context, economic development is practically synonymous for the firms within the country to move to higher value-added stages of production, referred to as economic or industrial upgrading. *“The notion of industrial upgrading is premised on a rejection of optimality of the given international division of labor based on comparative advantage”* (Milberg and Wrinkler, 2013, p. 97). Then, structural change within GVCs depends on the capacity of countries to upgrade which has been linked to national innovation systems (Lee et. al. 2017, Corrêa et. al, 2017), industrial or productive sector policy (Kaplinsky and Morris, 2016), national strategies translated in trade and technological transfer agreements (Laget et. al, 2020) and the form of governance of the value chain by the lead firms (Gereffi and Lee, 2014).

The integration of firms to GVCs *per se* is also related to increasing possibilities for upgrading through greater access to foreign knowledge and technology, scope for scale economies and increasing productivity by facilitated access to cheaper and better-quality intermediate goods (OECD, 2013). These channels affect not only the firms directly engaged with companies abroad but also have spillovers along other domestic stage of production via industries backward and forward linkages, and by providing minimum scale for infrastructure investments with positive externalities through the overall economy (Taglioni and Winkler, 2016). A study of Piermartini and Rubínová (2014) finds evidence that transfers of technology and knowledge tend to be higher in countries with higher degree of GVC insertion. However, upgrading in the firm level does not mean necessarily higher value-adding for the country (Marcato and Szapiro, 2020). *“The effort is not only about becoming more competitive in higher value-added activities but also about engaging more local actors, both firms and workers, in the GVCs”*. And GVC insertion may on the opposite side, loosen domestic backwards and forwards linkages, in a manner that upgrading for some firms or industries may result in downgrading for others. Even when suppliers in GVCs are able to gain efficiency and enhance capabilities, the lead companies maintain the higher share of value by controlling the key dimensions of the value chain as brand, design and logistics channels (Ravenhill, 2014). This may explain the results of Pahl and Timmer (2019) on the long-run effects of GVC participation where they find positive effects on productivity growth in the

formal manufacturing sector and no evidence of positive effects on employment generation. When efficiency gains are captured by lead firms, it is not translated in incomes, investment, or output growth within the country. Baglioni et. al (2019) further argues that there is no reason lead firms should disperse knowledge and develop economies when knowledge concentration in one important mechanism of their capacity to capture value and expand profits. Corrêa et. al (2020) show that countries that increased their participation in GVC also became more technological dependent, observed in the increasing income outflows for payments of intellectual property rights. Thus *“the innovative potential of regions at the bottom of the GVC is stifled because what they learn is proscribed by the value chain itself – that is, they are limited to whatever ‘upgrading’ they are permitted”* (Baglioni et. al, 2019, p. 12).

The different theories and hypothesis regarding vertical specialization in international trade converge to the conclusion that developing countries, compared to the developed ones, specialize in products and tasks that are less-skilled labor intensive. But they diverge about the explanation of the mechanisms behind this pattern and consequently diverge in the dynamic consequences of increasing trade integration in the context of productive fragmentation. In a world where trade occurs not only between north and south countries and where capital incomes dominate balance of payments, absolute advantage seems more relevant to explain the empirically observed changes in the productive structure of developing countries in the context of productive fragmentation.

Absolute advantage depends on technology, trade protection, government incentives, labor and other national specific costs and as well as the possibilities for exploring scale economies. Developing countries usually have lower labor costs and this is what drove the multinational companies to offshore part of their production to these countries in the first place. Developing countries were able to perform less-skilled intensive tasks with lower costs, increasing profit margins. Hence, integrating to GVCs may initially be accompanied to an increase in the relative size of less skilled labor-intensive sectors. But as productive fragmentation spreads to include more developing countries, with even lower-labor costs, to the global factory, the outcome will depend on the interplay of factors that define competitiveness, absolute advantage and the distribution of power. Middle income countries, on one hand, are usually halfway in the scale of labor costs relative to higher and lower income countries and so their less-skilled labor-intensive production is threatened. On the other hand, innovation capacity, consumer market access, and the structure

of market power in GVCs challenge their way to higher value-added and more skilled-intensive specialization.

1.3. International productive fragmentation and intra-industry less-skilled labor share of value-added

In this section we explore the mechanisms through which productive fragmentation may affect the intra-sectoral less-skilled labor share of value-added. The first channel is related to the change in the intra-sectoral employment structure (1.3.1). Supposing constant absolute and relative wages, the intra-industry labor shares varies with the change in the employment structure. Next, we explore the channels through which increasing trade integration may affect relative wages (1.3.2) and the total labor share of value-added (1.3.3).

1.3.1. International productive fragmentation and the intra-industry employment structure

Productive fragmentation affects the intra-industry employment structure by changing the composition of firms within an industry. The increased competition may lay off less competitive plants, leading to increased participation of more competitive plants that tend to have higher labor productivity and higher capital and skilled labor intensity (Harrigan and Reshef, 2015; Melitz, 2003).

In developing countries, outsourcing from developed countries may act as a channel for technological diffusion, as the imported inputs carry technologies which are domestically non-existing (Grossman and Helpman, 1991). The new technologies are normally associated with a higher demand to skilled labor, which tend to change the within firm employment structure in developing countries. Several studies offer empirical support for this hypothesis. Giovanetti e Menezes-Filho (2007) find a positive relation between the reduction of tariffs in intermediary goods and the employment share of college workers in the Brazilian firms situated in the state of São Paulo from 1990 to 1996. The effect was stronger for firms that used inputs that were also skilled labor intensive. Fanjzylber e Fernandes (2009) find that in 2003 the Brazilian firms that used imported inputs and received foreign direct investment (FDI) were associated with a higher

share of skilled labor in total employment. Paul e Yasar (2009) find evidence that imports of intermediate goods reduced the relative employment of the less-skilled workers, compared to technical and administrative workers, in the firms of Turkey from 1990 to 1996. Meschi et. al. (2011) find similar results using firm-level data from 1980 to 2001. The increase in international openness led to increased relative demand for skilled labor in Turkey. In addition, the industries belonging to sectors with the highest growth in the share of imported inputs from developed countries had a greater increase in the demand for skilled labor. Crinò (2012) uses firm-level data for 27 transition economies in Europe and Asia in the years 2002 and 2005. The author finds a positive relation between the imports of inputs and the relative demand for skilled labor. However, unlike previous studies, Pavcnik (2003) finds evidence that the use of imported inputs is not related to the demand for skilled labor in Chilean firms from 1979 to 1986 and Fanjzylber and Fernandes (2009) find a negative relationship between skilled labor demand and input imports in China using cross-section firm level data in 2001. Since the last authors have data from only single point in time, it is only possible to conclude that the firms who used more imported input in China 2001 did not have a higher relative demand for skilled labor. However, it is not possible to infer on how an increasing international outsourcing would impact the intra-firm demand for skilled work.

Another argument is that FDI involving outsourcing of firms from developed countries may transfer production stages that are relatively skilled intensive in developing countries although they are relatively less-skilled labor intensive in the former countries. Feenstra e Hanson (1996) develop a model which in the first stage, tasks that are less skill intensive within a firm are transferred to countries of lower labor costs. However, as new technologies become available and regulatory and institutional changes facilitate commercial integration, more complex tasks, that use skilled labor more intensively, also become more competitive in these countries. Hence, in a second stage, relative demand for skilled labor would also increase within industries in countries where unskilled labor is more abundant. Feenstra e Hanson (1997) find evidence for this hypothesis with a positive relation between FDI and the share of skilled labor in total employment in Mexico between 1975 and 1988 using panel data for industries and states. The authors stress the fact that the majority of the increase in skilled labor demand occurred within the industry rather than by the reallocation of employment between industries. Harrison and Hanson (1999) find similar results between 1984 and 1990.

Finally, Raworth and Kidder (2008) point to another aspect of GVCs that refers to their association to "lean" production strategies. The goal of lean production would be to eliminate waste, or eliminate any activity that creates a cost, but does not create any value. The lean strategy is not a new concept. It was developed by Toyota in the 1950s. However, the problem with this strategy in GVCs, for Raworth and Kidder (2008), is that those who define what constitutes value are the leading companies whose value conception generates chains of suppliers that transfer costs and risks to their next suppliers in the chains, who in turn transfer them for workers. This aspect of GVCs generates decreasing job security and erosion of working conditions. Gutelius (2015) argues that the growth of the temporary labor supply industry plays a significant role in the restructuring of the labor market in GVCs and in the increase of precarious employment. Temporary hiring agencies push the possibility of transferring costs and risks to some segments of workers to the limit. Gutelius (2015) find evidence of reduced permanent jobs for low-skilled workers in his case study of the logistic global supply chain firms in the U.S.

1.3.2. Productive fragmentation and relative wages: relative labor demand and the Stolper-Samuelson Theorem or Decreasing Rents?

The within industry less-skilled labor share of value-added may change because of modifications in the employment structure caused by fragmentation. One mechanism is the direct one, considering the labor share of value-added and relative wages constant, changes in the ratio of skilled to unskilled labor employed will imply a change in each skill labor category share of the industry value-added. However, productive fragmentation can also affect relative wages, given by the average wage of the less skilled compared to high skilled workers, and the total labor share of value-added, given by the distribution of value-added between workers and capital owners. One implication of the HO model in competitive markets, known as the Stolper-Samuelson theorem, is that trade integration would increase relative price of less-skilled intensive goods leading to a shift in output towards these sectors, increasing relative demand for less-skilled labor in developing countries. This would produce a tendency of increase in less-skilled relative returns compared to capital and skilled labor (Stolper and Samuelson, 1941).

However, according to Behrman et. al. (2000) findings, trade liberalization contributed to an increase in inequality between the less skilled and more skilled workers in developing countries.

Their study show that trade liberalization contributed to the increase in the average real wage using panel data for 18 Latin American economies between 1980 and 1998. The strongest positive effect was on the average wage of college degree workers. The effect on workers with full secondary education was also positive, but lower, while the effect on the average salary of workers with less years of study was negative and significant.

As consequence of the different institutional arrangements, the evidence for country-specific cases is mixed. Robbins (1997) and Attanasio et. al. (2004) find a positive relationship between trade liberalization and the dispersion of wages in Colombia from 1976 to 1994 and 1990 to 1996. Similar results are found for Chile by Beyer, Rojas and Vergara (1999). Galiani e Sanguinetti (2003) also find a positive association between the rise in import penetration and the rise in the college wage premium in the industry-level in Argentina. Harrison and Hanson (1999) find similar results for the Mexican case, while the result of Robertson (2005) for Mexico is mixed. Pavcnik. et al. (2004) find no evidence that trade reforms have affected neither the skill premium nor the industry-wage premium for workers with the same characteristics in Brazil for the period 1987-1998. On the other hand, Gonzaga et. al. (2006) and Ferreira et. al. (2010) find evidence of a negative relationship between trade liberalization and the skill premium between 1988 and 1995 in Brazil. Mishra and Kumar (2005) find a negative relation between variations in wage premiums and tariffs on imports in Indian industries between 1983 and 2000. Amiti and Cameron (2011) find a strong relationship between tariff reductions and the fall in the Indonesian skill premium between 1991 and 2000.

There is evidence that the evolution of the relative prices after trade reform had a significant effect on the relative wages in country-specific cases. Robertson (2005) examines the effects of Mexico's entry into the GATT (General Agreement on Tariffs and Trade) in 1986 and into NAFTA (North American Free Trade Agreement). The author shows that, in the first case, as the tariffs were reduced mainly for low-skilled sectors, the price of these products fell, which led to the reduction in the relative salary of these workers. In the second case, free trade between Mexico and two skilled labor-intensive nations reduced the prices of skilled labor-intensive goods and, consequently, the skill premium – defined as the ratio of the wages of skilled to unskilled workers. Robertson (2005) also estimates that the relationship between prices and relative wages appears in a space of 3 to 5 years. The Chilean case, studied by Beyer, Rojas and Vergara (1999), shows that the decrease in the relative prices of labor-intensive goods explains the reduction in the relative

wage of the less-skilled workers. Thus, economic openness was associated with the increase in the skill premium during the period 1960-1996. Gonzaga et. al. (2006) note that although tariff reduction was not correlated with sectoral skill intensity in Brazil, in the more skilled labor-intensive sectors, the reduction of tariffs resulted in a greater drop in prices, that explained the reduction in the skill premium.

The empirical evidence is stronger for a trade-induced fall in industry-specific wage premium (referring to the degree in which wages of workers employed in specific industries exceeds that of workers as whole) than for an economy-wide skill premium reduction, predicted by the Stolper-Samuelson effect. An alternative explanation for these results is that increasing competition reduces the domestic mark-ups and the rents shared with workers. When the industries that use low-skilled labor more intensively are the most affected, with larger tariff cuts or greater competing import penetration, the aggregate ratio of skilled to unskilled labor wages tend to increase and vice-versa.

The results of Harrison and Hanson (1999) for the positive relationship between trade openness and income inequality in Mexico shows there were little output or employment shifts and the adjustment occurred via reduction in wages and mark-ups in the previously protected and highly unionized sectors. The reduction of tariffs occurred mainly in the more unskilled labor-intensive sectors. The evidence found by Attanasio et. al. (2004) in Colombia from 1990 to 1996 was that the industry-specific wage premium was further reduced in those sectors where there was a greater cut in tariffs and, as these sectors already paid a lower premium, there was an increase in wage inequality. Arbache, Dickerson and Green (2004), controlling for education and experience, find evidence that wages in the tradable goods sector have substantially reduced by the increase in the degree of trade openness. There was also a less intensive reduction in non-tradable goods. These results are consistent with the view that trade liberalization has increased the degree of competition reducing rents and wage incomes in the tradable sector.

Where the less-skilled share of rents is already low, firms may adjust to increased international competition by lowering the skill-premium, leading to industry-specific decrease in skill-premium. Amiti and Cameron (2011) find that in Indonesia, between 1991 and 2000, the drop in the skill premium was more robust within firms: a drop of 10 percentage points in tariffs was associated with a 10 percent reduction in the skill premium for an average importing firm. In other cases, firms may adjust reducing mark-ups. Ahsan and Mitra (2014) show that in Indian firms

between 1988 and 2003, international trade increased the labor share of value-added in the smaller and more labor-intensive firms and reduced the labor share in larger ones. The mark-ups in the former companies were negatively affected by international competition. Therefore, the increase in the labor share in these companies does not come from the improvement in wages, but from the fall in profits.

In the context of GVCs, increasing competition in the less skilled labor-intensive stages of production held in developing countries is more pronounced. There are a growing number of producers in developing countries engaged in supply contracts for a decreasing number of global buyers (Antonelli, 2011). The effect of China and low-cost manufactures, coupled with increased capital mobility through financial deregulation, intensifies competition in the lower value-added stages of production, which are mainly located in developing countries (Kaplinsky, 2000; Medeiros and Trebat, 2017). At the same time, lead firms in developed countries strengthened their competitive advantage relying on intangible assets, as branding and property rights over technologies, mergers and acquisitions and purchasing practices that squeeze suppliers prices and impose shorter lead times and higher order volatility on intermediate goods (Kaplinsky, 2000; Hiratuka and Sarti, 2017; Durang and Milberg, 2018; Anner, 2019). With these factors combined, productive fragmentation decreased the value captured by less-skilled labor intensive functions within GVCs eroding incomes and exerting pressure to costs reduction, which led to lower wages, less stable jobs and poor work conditions in developing countries (UNCTAD, 2013; Selwyn, 2019; Baglioni et. al, 2019). These factors also allowed a greater concentration of the GVCs value-added in the lead companies. Usually, in a vertically integrated enterprise, the various segments of workers tend to appropriate, to some extent, of part of the firm's incomes, depending on the power of collective bargaining institutions (Nathan and Sarkar, 2016). However, the sub-contracted stages of the production capture a small fraction of a final good value-added leaving little value to be shared with the workers.

A great number of studies within the GCV approach engage in understanding the process of economic upgrading defined as the country progress to higher value-added productive stages (Gibbon and Ponte, 2005). According to neoclassical theory, technology and capital accumulation are the main determinants of labor demand and, together with labor supply, of wages. Hence, this literature frequently assumes that economic upgrading in GVC translates into social upgrading through better jobs and wages. Following this perspective, the influence of international trade, via

GVCs, on labor markets depends, in the medium run, on the capacity of countries to advance to higher value-added productive stages.

Less attention has been directed towards social upgrading which is defined as the improvement in work conditions, job quality, social security and social rights (Milberg and Wrinkler, 2013). Social upgrading encompasses the access to better jobs that may occur together with economic upgrading when workers acquire higher levels of qualification on the job, allowing them to obtain better occupations within the GVC (Barrientos et. al., 2011). Bernhardt and Milberg (2011) analyze four GVCs - clothing, horticulture, cell phones and tourism - involving 10 to 20 countries each. Economic upgrading is defined as the increase in the market share of exports and the unit value of exports, while social upgrading is defined as employment and real wages growth. They find that social downgrading was more frequent than the economic downgrading or social upgrading. The authors note that in only half of the cases economic upgrading was associated with social upgrading. But in every case where social upgrading occurred, economic upgrading was present, evidencing that this is a necessary condition, but not sufficient. Bernhardt and Pollak (2015) conduct a similar work, but analyze the clothing, automotive, mobile and cellular GVCs. Like Bernhardt and Milberg (2011), the authors find evidence that social upgrading is more likely to occur in cases where there is economic upgrading. The studies of Milberg and Wrinkler (2011) and Bernhardt and Pollak (2015) support that the capacity of the nations to advance to higher value-added stages of production within the chains is nearly a necessary condition for the GVC participation to translate into both higher employment and wage levels. However, they also find that it is not a sufficient condition.

Case studies on the effects of developing countries GVC participation on the labor markets support that competition in lower value-added stages of production is pervasive for segments of low-skilled workers, even when economic upgrading is present. Anner (2019) analysis of Bangladesh garment industry finds that profit margins decreased by 13.3% between 2011 and 2016 and that the price squeeze contributed to sub-poverty wages, increased work intensity and a rise in labor rights violation. Rainbird and Ramirez's (2012) analysis social upgrading of Chile's salmon industry insertion in GVCs showed that labor market improvements from GVC integration were insignificant. Producers compete in the international market through price and cost reduction, pressing wages and working conditions. Although some jobs were created requiring a higher level of qualification, the impact on qualification or career advancement plans were very small. Along

the same lines, Rossi (2013) analyzes the case study of the clothing industry in Morocco. The author notes that the main social improvements, in terms of labor rights and standards, generated by the GVCs were limited to workers with stable and usually permanent jobs. In addition, the study indicates that the limitations on the extent of benefits to irregular workers, such as casual workers, migrants and subcontractors, are structurally inherent. Economic upgrading was associated with greater pressure for flexibility and speed of delivery. To meet the demands, supplier firms use a mix of job categories, employing regular workers to ensure quality and consistency of production, and irregular workers to deal with order fluctuations and costs pressures. While for regular workers, economic upgrading was associated with increased training and higher labor rights, for irregular workers, it meant a social downgrading, with casual or non-existent employment contracts, low wages and long working hours. Analyzing the case of Vietnam garment industry insertion in GVCs, Nadvi et. al. (2004) also concludes that workers gains were unevenly distributed. Workers employed in state-owned enterprises or large multinationals have benefited from increased employment and better wages. However, small private firms had difficulties accessing higher value chains and mainly supplied for regional buyers. These firms employed relatively more marginalized workers, offered worse working conditions and lower wages. Selwyn (2019) shows that low-skilled workers in garments chains in Cambodia and electronics in China receive base wages, insufficient to meet individual reproduction requirements, despite being highly productive. Besides, wage gains acquired with strikes and protests have been offset by intensification of work and cuts in non-wage benefits.

We observed in this section that country-specific empirical evidence about the impact of trade liberalization on wage inequality was mixed. There were cases where it went in the direction predicted by the HO theory: trade opening reduced wage inequality. However, the empirical evidence does not support that this happened through the Stoper-Samuelson mechanism with a shift in output to less-skilled labor-intensive sector (see also Goldberg and Pavinik, 2007). It was often the reduction in rents that led to the reduction in the wages of more skilled labor when high skilled intensive were most affected by international competition. Hence, trade liberalization squeezed rents in the sectors and the way it interfered in the distribution between profits, less-skilled and high-skilled workers depended on the industries which were most affected by tariffs reduction and on the different institutional arrangements that shape relative power. In the context of fragmented production systems, rent squeeze in developing countries is aggravated by the

capture from lead firms in developed countries of an increasing share of the value-added generated along the chains. The less-skilled labor-intensive stages held in developing are subject to stronger price competition and associated to lower value-added which contributes to increasing inequality between less-skilled and high skilled workers. Upgrading to higher value-added stages of production is pointed as a necessary condition for countries to avoid the rent squeeze. However, there is doubt whether increasing GVC insertion can help middle-income countries in their upgrading process.

1.3.3. Productive fragmentation and the labor share of income: the decrease in labor bargaining power relative to capital

The trade liberalization and globalization are negatively associated with the labor share of value-added in empirical studies. Oyvatt (2011) examine the effect of globalization on the labor share of income in Turkey between 1981 and 2001 using industry-level panel data. The study analyzes the effect of trade flows on the labor share in low-skilled, medium-skilled, and highly skilled labor-intensive sectors. The results point to a negative impact of the intensity of exports on the labor share in all three sectors. Jayadev (2007) using panel data for a sample of over 100 countries between 1972 and 1995 finds evidence of a strong negative correlation between financial openness and labor share across all samples and sub-samples, except for low-income countries. Controlling for the level of trade openness, the impact of financial openness is reduced; with both variables showing a negative and significant relationship with the labor share of income. These results support the hypothesis that trade integration reduces labor bargaining power. However, the specific mechanism behind this association is not identified.

The argument of reduction in the bargaining power, unlike Stolper-Samuelson's theorem does not assume perfect markets with zero profits. There must be some profits for workers and capital owners to bargain over. The classical theory of wages considers the wage rate of a common laborer as connected to the subsistence level of consumption which is given by the norms and convention in the country in a historical period (Stirati, 1994). This wage level is not fixed, it may rise persistently with changes in social, economic and institutional factors that enhance the relative power of workers to employers in the process of wage bargaining (Stirati, 1994). In institutionalist

theory, the relative power of workers in the bargaining process is influenced by labor market institutions as labor unions, labor regulation and social protection (Kristal, 2010).

Nathan and Sarkar (2011) argue that a vertically integrated firm does not explore the labor market segmentation to its fullest as all workers will bargain for their share in overall profits. As production is split in stages of production held in different firms while profits remain concentrated in the lead firm, workers are dissociated from the final product which they contribute and their rents. The dispersion of workers and rents disarticulate labor unions.

Productive fragmentation is also associated with increasing capital mobility facilitating the reallocation of production to other geographic locations. The threat to capital reallocation diminishes even further workers bargaining power (Rodrik, 2007). And while trade opening has been associated to increasing labor fragilities and higher demand for social protection, Rodrik (2007) shows that the increasing capital mobility also reduces the government capacity to tax capital incomes and to afford social protection programs.

Another mechanism from which economic integration and productive fragmentation may decrease workers bargaining power is by closing formal job positions and increasing the unemployment level. The classical theory of wages does not establish a straight inverse relationship between wages and the level of unemployment, but the economic condition of the country and the associated shortage of labor or unemployment influence wages as the existence of unemployment is what pressures the wage rate to its subsistence level (Stirati, 1994).

Reventa (1997) analyzes the effect of trade liberalization on employment and wages in Mexican manufacturing plants between 1984 and 1990. According to his empirical results, trade liberalization affected the level of employment negatively by reducing industrial output. Attanasio et. al. (2004) also show the increase in the size of the informal sector is associated with the increase of external competition in Colombia. Tariffs and exposure to international trade were positively related to the increase in sectoral informality between 1990 and 1996. Menezes-Filho and Muendler (2011) find evidence that the reduction of tariffs in Brazil in the 1990s led to the reduction of employment in previously protected industries. These workers were not completely absorbed by competitive firms in the international market. On the other hand, the authors find evidence that the reduction of tariffs on inputs increases the retention of workers. They also point out that commercial liberalization led to the transition of workers to the services sector, unemployment, and abandonment of the labor force, but it was not related to informality. Gaddis

and Pieters (2014) using data from Brazilian microregions between 1991 and 2000 also found evidence that trade liberalization reduced the rate of labor force participation and the employment rate, especially among low-skilled workers. Karmbhampati et al. (1997) investigate the commercial reform in India in 1991 on the level of employment. The authors use panel-level panel data for five industries between 1987 and 1993. Their results point to an insignificant effect of reducing tariffs on the level of employment in general or within each industry.

There is evidence that increasing labor market flexibility reduces the negative effect of international trade on formality and employment rate. Goldbergh and Pacvinik (2003) study the relationship between trade liberalization and informality in Colombia between 1986 and 1998 and Brazil between 1987 and 1998. The authors do not find a significant correlation between variables in Brazil. In Colombia, however, there is evidence that trade liberalization led to increased informality in the period preceding reforms that increased labor market flexibility. Hasan et al. (2012) analyze how trade liberalization affects the probability that the worker in a particular industry and in a given state will become unemployed in India. Job destruction data by industry and state covered eight years from the period beginning in 1987 to 2005. The authors found evidence that liberalization was associated with a reduction in the probability of unemployment. The effect of liberalization was also stronger for workers in states where labor market was more flexible and for workers in net export industries. However, reforms that are related to the greater flexibility of the labor market reduce the benefits of formal employment, especially its greater stability in relation to informal employment. The higher employment instability weakens labor bargaining position.

Empirical studies on the impact of productive fragmentation on employment using the GVC framework at the country level are scarce. At the firm level, Banga (2016) finds that GVC insertion was associated to a negative impact on employment growth in India firms from 1995 to 2011. At the industry level, Pahl and Timmer (2019) finds that GVC participation did not affect formal employment growth in manufacturing industries in 58 countries including 38 developing from 1970 to 2008.

Trade in intermediate goods can also change the stability of employment. According to Hoegrefe e Yao (2015), the intensification of international trade in intermediates can augment the elasticity of labor demand. International *outsourcing* can be used as a strategy to export the risk related to market volatility. Firms would tend to maintain in their countries of origin the less

volatile activities, internationally outsourcing the more volatile, reducing their adjustment cost. As developing countries are the usual recipients of the outsourced activities, they may experience a corresponding increase in employment volatility. Hogrefe and Yao (2015) analyze how the increase in the import of inputs affects the risk on labor rents with panel data for German industries. Risk is defined as the variability of shocks on incomes that do not dissipate over time. The results show that the permanent risk on workers' incomes is reduced by international outsourcing.

Conclusions

This essay analyzed what are the channels of influence of productive fragmentation on the less-skilled labor share in a theoretical level and the empirical evidence for these channels. We covered how productive fragmentation may affect the less-skilled labor share by influencing vertical specialization and by changing the intra-sector less-skilled labor share of value-added. The intra-sector impact was split in the impact over the employment structure, relative wages and the total less-skilled labor share of value-added.

Regarding the vertical specialization effect of productive fragmentation, we discussed the comparative and absolute advantage theories, technology gap theories, new trade theory and the GVC approach. We argue that absolute advantage seems more relevant to explain the changes in the productive structure of developing countries in the context of productive fragmentation. The outcome of increasing productive fragmentation will depend on the interplay of factors that define competitiveness. The empirical evidence discussed, in general, falsifies what is predicted by the HO model and the Stolper-Samuelson theorem that greater international integration would lead to increased relative demand for less skilled labor and its relative wage in developing countries.

In most cases, there was a decrease in the relative demand for the less-skilled labor associated to the intensification of international trade in the 1980s and 1990s that occurred mainly intra-firm and intra-sector, via skill upgrading through technological spill overs. However, in the post-trade liberalizing period, the evolution of the relative demand for labor in terms of skill category varied according to the sectors most exposed and vulnerable to international competition.

There was evidence that the change in relative prices, induced by trade liberalization, influenced the relative wages of more and less skilled workers. The main channel is the

transmission of the reduction in mark-ups, due to an increase in competition, for wages. In the post-liberalizing period, there is no evidence of a generalized increase in the relative prices of low-skilled labor-intensive goods in developing countries, as predicted by standard trade theory. In the most recent period, empirical investigations that goes beyond trade liberalization and uses the GVC approach reinforces the thesis that, in a commercially more integrated world, the competitive pressure exerted on stages of production held in developing countries, have perverse effects on mark-ups, wages, and employment conditions of the less-skilled workers.

Economic upgrading related to structural change towards the production of goods and services with higher value-added seems to be a necessary but not sufficient condition for global integration to have positive effects in the labor market. Hence, the institutions matter in determining the capacity of workers to absorb the gains from GVC integration by reinforcing or destroying labor bargaining power. At the same time, GVC integration also impact the institutions and economic environment where labor bargaining power is built. The empirical results tend to corroborate the hypothesis that the increase of the international integration contributes to the reduction in the bargaining power of workers, especially the less skilled, with an upward impact on the income inequality and negative impact on the labor share of national incomes. The increase in inequality has also been associated with the reduction in the level of wages of the less-skilled workers and of the individuals in the poorest income deciles.

Hence, the observed deterioration of the less-skilled labor incomes and jobs within GVCs are not exceptional cases. It appears most likely that the less-skilled workers in emerging countries will be worse off with increasing productive fragmentation, at least in relative terms. The opposite case are the exceptions we need better understanding to pursue an inclusive integration. The fact that there is a potential compensation for the main disadvantaged in the path of economic integration does not mean they will be compensated in practice (Antras et al., 2017). *“Compensation is likely to remain inadequate, is hard to render credible, and fails to address deeper conflicts trade agreements pose. Much better solution: make the rules fairer ex ante, instead of compensating ex post”* (Rodrik, 2018).

Finally, we observed that much of the empirical literature on international trade and labor markets focus on commercial liberalization and its more immediate effects. There are few studies analyzing the decade of 2000s in which there was an acceleration of international trade and of the fragmentation of production and trade in intermediate goods. The GVC approach to trade and

industrial policy is still poorly targeted for its consequences and what is needed to promote socio-economic development in the least developed countries (Fento and Ponte, 2016). There is room in the literature for empirical works that seek a more comprehensive understanding of the impact of GVCs on the labor markets in developing countries. The case studies are of great importance for understanding the relationships that occur along the chains, with their specificities, and how these relations translate into opportunities for economic growth and social development. However, the evidence from this methodology is limited in terms of the general effects of CVGs diffusion on the labor markets.

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Essay 2. International Productive Fragmentation and Labor Markets in Brazil in a Comparative Perspective

2.1. Introduction

The international fragmentation of production created an opportunity for developing countries to increase their participation in the global and regional production systems (Baldwin, 2011). Instead of building entire vertically integrated industries to deliver final goods to the international trade markets, they can focus on specific stages of production. They can either specialize in early stages of production chains by supplying intermediates that add up value to products finished abroad or they can import the intermediary goods and services necessary for the domestic assembly of final goods.

Although there is a consensus that international trade openness and the integration to Global Value Chains is not a sufficient condition for achieving economic development, international organizations point the Brazilian relatively low GVC integration as an obstacle to productivity growth, constraining economic growth, job generation and improvements in living standards (OECD, 2013a, 2013b; World Bank, 2018). In fact, the studies that analyze the Brazilian international trade in value-added converge to the same evidence: the Brazilian participation in Global Value Chains is limited when compared to both developed and developing countries (Hermida, 2016; Marcato, 2018; Dietzenbacher et. al 2013; Araujo Junior 2018, Veiga e Rios 2015, Reis e Almeida 2014; Guilhoto and Imori, 2014).

According to standard models of international trade (Heckscher-Ohlin, Heckscher-Ohlin-Wood and derivations) that follows the comparative advantage from Ricardo, no products or stages of production on which a country specializes is superior in terms of delivering higher economic growth rates. That is, a particular vertical specialization in international trade does not influence economic performance. Since one assumes perfect competition and full employment, any trade imbalances are compensated by changes in factor and product prices in national currencies or changes in the exchange rate. In this framework, trade opening unequivocally causes a better allocation of resources and increases welfare. This conclusion is achieved by a static comparative analysis of overall wealth before and after trade openness. However, the Heckscher-Ohlin trade

model of comparative advantage with two countries and two goods predicts that, although trade opening improves the overall country income, there may be winners and losers, with an increase in the relative demand and income of the production factor in which a country is relatively more abundant. For developing countries, it would be labor (in models that consider labor and capital as production factors) or unskilled labor (in models that distinguish labor according to its skill level).

If reality does not bind with full employment and perfect competition and capital flows dominate the outcome of the Balance of Payments, absolute advantage may be a stronger force driving vertical specialization in international trade and the dynamic consequences of trade specialization may be more relevant (Vernengo, 2000). If capital flows are more important the current account outcomes to determine the Balance of Payments results, then trade imbalances might be persistent implying no exchange rate adjustments. Hence, producers will move to the most profitable countries and free trade would reduce the level of employment in the least competitive country (Brewer, 1985). For international trade to contribute to a virtuous cycle of economic growth, profit margins, innovation capacity and demand elasticities of a country exports are important matters. The structuralist and kaldorian-keynesian literature have long emphasized the importance of vertical specialization in higher value-added products, that allow faster innovation incorporation, have stronger backward and forward linkages and have higher income elasticities of demand (Prebisch, 1949; Furtado, 2010; Rodriguez, 2009; McCombie and Thirlwall, 1994; Thirlwall and Hussain, 1982; Verdoorn, 1949).

Similarly, in the GVC approach, trade specialization matters because it greatly determines who will capture the gains from trade. In fragmented production systems, these gains are not differentiated only across finished good. Stages and tasks held in distinct locations also vary on their capacity of capturing the value of a final product. In this context, economic development is practically synonymous for the firms within the country to move to higher value-added stages of production referred to as economic upgrading (Gereffi, 2005). As in the structuralist and kaldorian-keynesian approach, the concept of economic upgrading rejects that the international division of labor based on comparative advantage is an optimal solution (Milberg, Wrinkler, 2013). However, economic upgrading does not seem to be a natural path that follows from GVC integration. It depends on economic and institutional factors as the previous production structure of the country (Corrêa, 2016; Costa, Castilho and Anyul, 2017), industrial development policies (Lee, Szapiro and Mao, 2018; Ravenhill, 2014), geopolitics and trade agreements (Pereira, 2014) and the form

of governance of the value chain by the lead firms (Humphrey and Schmitz, 2002; Gereffi and Lee, 2014).

The GVC insertion of developing countries in low value-added stages of production have perverse effect on the labor markets. Case studies have found that increasing price competition in lower value-added stages typically held in developing countries diminishes rents exerting pressure on wages and employment stability of the less-skilled (Nadvi et. al., 2004; Ramirez's, 2012; Rossi, 2013, Anner, 2019). On the other side, when less-skilled wages are already low, the adjustment to decreasing rents resulted from trade integration may fall upon the skill-premium paid to college workers, reducing wage inequality (Gonzaga et. al., 2006; Ferreira et. al., 2010; Amiti and Cameron, 2011). In the last case, wage inequality is reduced by leveling down the labor incomes.

Moreover, economic upgrading related to structural change towards the production of goods and services with higher value-added does not guarantee that the benefits of global integration are equally diffused to the labor markets (Bernhardt and Milber, 2011; Bernhardt and Pollak, 2015). A study of Timmer et. al. (2014) showed that the less-skilled labor (workers that completed up to the secondary educational level) has captured a decreasing share of value-added both in developed and developing countries.

The intra-industry less-skilled labor share of value-added is affected by changes in the employment structure. GVC integration may cause less-skilled labor demand to decrease if job losses in less-competitive firms exposed to international competition are not absorbed by those benefiting from the integration process (Harrigan and Reshef, 2015; Melitz, 2003). It can also decrease because of technical change that favor more skilled labor allowed by technological diffusion occurred via trade in intermediates (Grossman and Helpman, 1991; Giovanetti and Menezes-Filho, 2007; Fanjzylber and Fernandes, 2009; Paul and Yasar; 2009; Meschi et. al.; 2011; Crinò, 2012) and the diffusion of leaner production strategies across GVCs that reduces less-skilled labor permanent jobs (Kidder, 2008; Gutelius, 2015).

Furthermore, productive fragmentation may negatively impact wages reducing workers bargain power, empirically observed through the fall in the labor share of income (Feliciano, 2001; Oyvat, 2011; Jayadev, 2007). It has a disarticulating effect on labor unions as production split in stages and workers are dissociated from the final product which they contribute for. It also increases capital mobility imposing a threat of reallocation of production stages to other geographic locations. As a result of increasing capital mobility, it also reduces the government

capacity to tax capital incomes and to provide social protection, weakening the labor position in the wage bargaining (Rodrik, 2007). Finally, it can reduce employment stability (Hoegrefe and Yao, 2015) and cause the close of formal job positions increasing the unemployment level (Revenga, 1997; Attanasio et. al., 2004; Menezes-Filho and Muendler, 2011; Gaddis and Pieters, 2014). Hence, the empirical evidence reveals that low-skilled and informal workers in developing countries have more difficulty in capturing the benefits from GVC integration.

Few studies have concentrated on the labor market developments associated to the international production fragmentation in Brazil. Most of the available literature on the labor markets' dynamics within GVCs builds on case studies which fails to unfold a more generalized picture of the labor market changes within the international fragmentation framework. Our objective in this essay is to identify the distinctive features of the Brazilian insertion in manufacturing GVCs and its possible associations with the less-skilled labor share of value-added between 1995 and 2009. The less-skilled workers are defined as those who completed up to the secondary educational level. We compare the Brazilian case to other developing countries (China, India, Indonesia, Mexico and Russia) in order to shed light on how the different degrees of GVC participation, the productive specialization and the institutional features are linked to the observed labor market outcomes. These countries were selected because they were emerging economies with available comparable data.

We will analyze the evolution of the functional income distribution, relative wages, employment structure and sectoral composition of the Brazilian value-added in manufacturing GVCs completed both inside the country territory and abroad. We will also analyze alternative measures of productive fragmentation, countries' GVC participation and the evolution of labor markets indicators as unemployment, minimum wages and unionization rates. Our main hypothesis is that the evolution of a country's employment and wage structure within the GVCs depends on the manner and to what extent these countries are integrated into these global systems and on their labor markets institutions.

2.2. Methodology and data base

2.2.1. Value-added, employment structure and the measure functional income distribution for GVCs

The analyses will be grounded on the concept of GVCs defined as the vertically integrated sector that supplies the final demand for the output of industry j in country s . Our first step will be to estimate the value-added created in each industry-country along the GVCs, resulting in a vertically integrated sector. For this purpose, we use the following equation:

$$(1) \quad \mathbf{V} = \hat{\mu}(\mathbf{I} - \mathbf{A})^{-1}\hat{\mathbf{f}}$$

In Equation (1), \mathbf{V} is a $\text{NC} \times \text{NC}$ matrix of industry-country value-added with each column referring to a given value chain, with N representing number of industries in C countries. The values in each column correspond to the value-added generated by industry (i) in country (r) involved in the productive process of the final goods of industry (j) in country (s). The term $\hat{\mu}$ refers to the diagonal matrix which main diagonal correspond to the amount of value-added per output for each industry-country and the values outside the main diagonal are zero. The term $(\mathbf{I} - \mathbf{A})^{-1}$ refers to the Leontief inverse matrix that captures the direct and indirect requirements along each GVC necessary to satisfy the final demands for output in the system. The term $\hat{\mathbf{f}}$ is a diagonal matrix with main diagonal taking the values of total worldwide final demand for each industry-country output.

The result of Equation (1) is the decomposition of the value-added of the value chains completed in each of the countries. This value-added decomposition considers the value-added generated in all layers of suppliers. For example, in the production of a given output, Country 1 uses inputs from Countries 2 and 3. However, inputs in Country 2 are produced using inputs from country 1 and 3. The adopted measure considers not only the direct suppliers' value-added but also the value-added incorporated by suppliers in earlier stages of production.

Once we decompose the value-added by industry-country, we obtain labor incomes and hours of work pre-multiplying matrix \mathbf{V} by the respective diagonal matrices where the main

diagonal have the values of the less-skilled labor share of value-added ($\hat{\omega}^l$), total labor share of value-added ($\hat{\omega}$), the less-skilled hour employed by unit of value-added ($\hat{\varphi}^l$) and total hours worked per unit of value-added ($\hat{\varphi}$). We define W^l , W^T , L^l and L^T in Equations 2-5 as NCxNC matrices of, respectively, less-skilled labor income, total labor income, hours worked by less-skilled workers and total hours worked in each industry-country engaged in each GVC.

$$(2) \quad W^l = \hat{\omega}^l V$$

$$(3) \quad W^T = \hat{\omega}^T V$$

$$(4) \quad L^l = \hat{\varphi}^l V$$

$$(5) \quad L^T = \hat{\varphi}^T V$$

The sum of the elements of W^l over the rows corresponding to the i industries of a country r generating value-added to the j industries in s countries ($\sum_i \sum_j \sum_s w_{ij}^{rs}$) is the total less-skilled labor income created by manufacturing GVCs in the country. And ($\sum_i \sum_j \sum_s w_{ij}^{rs} / \sum_i \sum_j \sum_s v_{ij}^{rs}$) is the less-skilled labor share of value-added created in country r by manufacturing GVCs. Applying the same logic to W^T we obtain the total labor share of value-added. We obtain the less-skilled labor share of labor income by dividing the less-skilled labor income within the country to the total labor income. The less-skilled labor employment participation is the less-skilled labor hours worked divides by total hour worked. The relative average wages are the less-skilled labor income per less-skilled hours worked divided by the high-skilled labor income per high-skilled hour employed.

2.2.2. Measures of productive fragmentation and GVC integration

In order to measure the country level of integration to fragmented international production networks, we use two different measures of GVC participation. A country participation in early stages of production, supplying intermediate goods and services for the abroad completion of a final output is referred to as forward participation. The domestic value-added (DVAS) to foreign completed GVCs is more suitable to capture the level of forward participation. On the other hand, the participation in GVCs by importing intermediate inputs to produce a final output is a backward

participation and the measure of foreign value-added share (FVAS) of GVCs domestically completed is more suitable to evaluate this type of GVC insertion.

The *FVAS* measures the percentage of the value-added within a GVC generated outside the country where the last stage of production is completed, defined as follows (Los et al., 2015):

$$(6) \quad FVAS(j, s) = FVA(j, s) / FINO(j, s)$$

Equation (6) states that the *FVAS* in the value chain which the last stage is completed in the industry j of country s equals the foreign value-added (*FVA*) in the chain (j, s) over the final output value (*FINO*) of industry (j, s) . The *FVA* accounts for the sum of all value-added created outside the country of completion.

When addressing a country participation in GVCs, the *FVAS* will be higher for countries that participate in GVCs in later stages of production. If a country participates in early stages of production, sourcing intermediate inputs, these measures will tend to be relatively lower. To capture this type of GVC insertion we will also calculate the domestic value-added share in foreign completed GVCs (*DVAS*) (Equation 7).

$$(7) \quad DVAS(j, s) = \sum_{i \neq s} VA(j, i) / \sum_{i \neq s} FINO(j, i)$$

Hence, the *DVAS* of country s in industry j equals the sum of the value-added (*VA*) of country s in value chains completed in sector j of $i \neq s$ countries divided by the sum of the final output value (*FINO*) of industry j of the $i \neq s$ countries.

2.2.3. Data description

The main data source of this study is the ‘*World Input-Output Database*’ (WIOD) Release 2013, covering the periods from 1995 to 2009 (Timmer et al., 2015). The WIOD tracks the value of intermediate goods flows between 35 activities (N) including 14 manufacturing industries of 40 countries (C). There is also available the value of final goods flow from the industry-country of

departure to the country of destination. Although there is a more recent release of WIOD covering the years from 2000 to 2016 we chose to use the previous release because the socio-economic accounts that integrate the WIOD Release 2013 contain industry-level data on the labor share of value-added and hours worked by skill-categories: (i) low skill, for workers with education attainment below high school; (ii) medium skill, for workers that completed high school, including professional qualification but below college graduation; (iii) high skill, for workers that completed tertiary or higher levels of education. Labor income is attributed for each skill level including self-employed and family workers for which an imputation was made in the necessary cases. Capital income is defined as a residual of value-added after the subtraction of labor income. Our group of interest is formed by the less-skilled workers that we define as those who completed up to high school, including categories (i) and (ii).

Labor market and social protection indicators were extracted from the International Labor Organization (ILO) for the available years between 1995 and 2009 or the nearest year available for the six developing countries in our sample (Brazil, China, India, Indonesia, Mexico and Russia). The indicators are listed below:

- Minimum wages
- Trade union density
- Government spending in social protection as a percentage of GDP
- Number of strikes and lockouts
- Unemployment rate
- Informal employment as percentage of total employment
- Unemployment rate by educational attainment

2.3. Results

The results are split in two subsections. The first analyzes the distinctive features of the Brazilian GVC integration and less-skilled labor share of value-added between 1995 and 2009 in aggregate terms, pointing to the more general movements. The second part presents the less-skilled labor share of value-added disaggregated in sectoral activities and analyses how sectoral

specialization in GVCs can help explain the aggregate less-skilled labor share in Brazil compared to the other emerging economies.

2.3.1. Productive fragmentation and the less-skilled labor share of value-added: country level analysis

Table 2.1 presents the indicators of GVC integration for each country and the average for the countries of comparison. In 1995, the Brazilian participation in manufacturing GVCs completed outside the country was around average while its forward participation was relatively low. Both measures grew between 1995 and 2009, but the growth in the backward participation (foreign value-added – domestic last stage) was especially weak. Brazil was still a country characterized by a stronger backward participation rather than a forward participation in 2009. In this last year, the Brazilian backwards participation was bigger than the Indonesian, Indian and Mexican. In opposition, its forward participation (domestic value-added – foreign last stage) indicator was only bigger than the Russian, a country that can also be characterized by a stronger backwards participation.

Table 2.1: Value-added participation

	Domestic VA - foreign last stage (%)			Foreign VA - domestic last stage (%)		
	1995	2009	Δ	1995	2009	Δ
BRA	0.3	0.5	0.2	8.9	11.4	2.5
CHN	0.5	2.0	1.5	14.7	18.0	3.3
IDN	0.2	0.3	0.2	17.0	16.1	-0.9
IND	0.1	0.3	0.2	11.1	16.6	5.5
MEX	0.2	0.3	0.1	21.3	22.8	1.5
RUS	0.5	1.0	0.5	12.1	9.0	-3.1
Average	0.4	1.3	0.2	15.1	17.1	0.8

Source: authors' calculation base on data from WIOD Release 2013.

Meanwhile Brazil presents a below average level of GVC participation, it also showed a better evolution of the less-skilled labor share of value-added (Table 2.2). Less-skilled Brazilian workers involved in the production stages of GVCs within the country increased their share in value-added from 1995 to 2009, contrary to the other countries observed where the less-skilled

labor share of value-added decreased 16,1% on average. China and India, the countries with higher increases in the foreign value-added in domestically completed GVCs experienced the sharpest decreases in less-skilled labor share of value-added in these chains.

The evolution of the less-skilled labor share of value-added in manufacturing GVCs in Brazil went in opposite directions for GVCs completed abroad and inside the country territory. The Brazilian less-skilled workers that produce intermediary goods and services for manufacturing GVCs in which the last stage is completed abroad had a decrease on their share in value-added. The same was observed in the other countries. The average decrease of the less-skilled workers share of value-added to foreign completed GVCs was stronger when compared to the domestically completed. In 2009 domestically completed manufacturing GVCs, compared to foreign completed GVCs, paid a higher share of its value-added to less-skilled labor in all the countries analyzed. Also, in 2009, the less-skilled workers share of value-added became more unequal between the two groups of GVCs.

The reduction of the less-skilled labor share of value-added observed, on average, across the countries could happen because either these countries specialized in stages of production that are less intensive in less-skilled labor or because the less-skilled labor share of value-added decreased within the activities held within the GVCs. Either case contradicts the predictions of the standard Heckscher-Ohlin trade model that increasing trade integration for countries more less-skilled labor abundant would lead to specialization in less-skilled labor-intensive activities followed by a tendency of increasing relative demand and wages for those workers. This result is otherwise compatible with the hypothesis that increasing productive fragmentation and GVC participation of developing countries have harmful effects on less-skilled labor in these countries. Vertical specialization within domestic and foreign completed GVCs will be examined in the next section. In the remainder of this section, we examine how the total labor share of value-added, wage inequality and the employment structures contributed to level and evolution of the less-skilled labor share in Brazil compared to the selected countries, and how these movements may be articulated to the degree of GVC insertion and to the different institutional features.

Table 2.2: Less skilled labor share of value-added to manufacturing GVCs

	Domestic stages/ Foreign completed			Domestic stages/ Domestically completed		
	1995	2009	Δ	1995	2009	Δ
BRA	33.3	30.5	-2.8	33.1	34.7	1.6
CHN	48.0	31.7	-16.3	47.7	37	-10.7
IDN	22.3	19.3	-3	24.3	23	-1.3
IND	24.3	15.8	-8.5	23.9	17.6	-6.3
MEX	20.3	16.2	-4.1	22.4	19.3	-3.1
RUS	38.3	35.6	-2.7	42.5	37.3	-5.2
Average	30.6	23.7	-6.9	32.2	26.8	-5.4

Source: authors' calculation based on data from WIOD Release 2013.

The less-skilled labor share of income varies according to the distribution of value-added between labor and capital and to the less-skilled labor share of labor income which, in turn, depends on their relative average wage and employment. The Brazilian labor share of value-added to manufacturing GVCs was above average since 1995 for domestically and foreign completed GVCs (Table 2.3). In contrast with the countries analyzed, the Brazilian labor share of value-added in domestically completed value chains increased between 1995 and 2009. The amount of value-added appropriated by labor increased relative to the amount of value-added absorbed by capital, reducing inequality between labor and capital incomes generated across domestically completed manufacturing GVCs. Considering the value chains completed outside the country, the evolution of the labor share becomes negative in Brazil. The labor share of value-added evolved in disadvantage compared to the capital share in the intermediary activities that supply for GVC's completed in foreign countries, except in the Russian case. Like the less-skilled labor share of value-added, the total labor share of value-added was on average lower for workers engaged in intermediate stages of foreign completed GVCs and this difference also increased between 1995 and 2009.

The evolution of the labor share of value-added is associated to the bargaining power of workers relative to capital which may be negatively impacted by productive fragmentation through its disarticulating effect on labor unions, by increasing capital mobility and unemployment level as well as decreasing employment stability. The labor union disarticulating effect might be stronger in manufacturing intermediary stages of production that supply for foreign completed chains as workers are more strongly dissociated from the value of the final product they contribute for. On the other hand, the different institutions of labor regulation and the economic context are

also constitutive of the labor bargaining power within a country and subsequently to the level of the value-added captured by labor.

Table 2.3: Labor share of value-added to manufacturing GVCs

	Domestic stages/ Foreign completed			Domestic stages/ Domestically completed		
	1995	2009	Δ	1995	2009	Δ
BRA	45.8	43.8	-2	45.4	49.3	3.9
CHN	49.5	35.6	-13.9	49.0	40.3	-8.7
IDN	25.8	23.2	-2.6	27.2	26.9	-0.3
IND	30.3	23.5	-6.8	30.3	24.8	-5.5
MEX	26.2	20.3	-5.9	28.3	23.6	-4.7
RUS	45.0	45.0	0	49.2	45.3	-3.9
Average	35.4	29.5	-5.8	36.8	32.2	-4.6

Source: authors' calculation based on data from WIOD Release 2013.

Differently from the distribution between capital and labor, Brazil shows a more uneven distribution of income between workers of different skill levels in manufacturing GVCs. The less-skilled labor in Brazil captured a smaller fraction total labor income generated in manufacturing GVCs compared to the average of the other emerging economics (Tables 2.4). Furthermore, while the share of labor income in domestically completed GVCs increased relative to the share of capital income in Brazil, this increase was not evenly captured between workers with different skill levels. The share of labor income captured by the less-skilled decreased 2.6 percentage points between 1995 and 2009 in Brazil. The reduction of the less skilled labor income share was observed in all other countries in our sample for both inside and outside completed manufacturing GVCs, except Mexico. The evolution of the less-skilled share of labor income was also worse for chains completed outside the country both for Brazil and the other countries, on average.

Table 2.4: Less skilled labor share of labor income in manufacturing GVCs

	Domestic stages/ Foreign completed			Domestic stages/ Domestically completed		
	1995	2009	Δ	1995	2009	Δ
BRA	72.5	69.6	-2.9	72.9	70.3	-2.6
CHN	97.0	88.9	-8.1	97.4	91.8	-5.6
IDN	86.2	83.2	-3	89.3	85.4	-3.9
IND	80.2	67.3	-12.9	79.0	70.8	-8.2
MEX	77.7	79.9	2.2	79.2	81.6	2.4
RUS	85.3	79.0	-6.3	86.3	82.3	-4
Average	85.3	79.7	-5.6	86.2	82.4	-3.9

Source: authors' calculation based on data from WIOD Release 2013.

The less-skilled labor share of value-added may change because of changes in relative wages or in the share of hours worked by each skill category. Table 2.5 presents the measure of relative less-skilled labor to the high skilled labor average income. By this measure, Brazil had a higher wage inequality in manufacturing GVCs than the average. The higher trade protection in Brazil could be an influence over this indicator by preserving the skill-premium paid to college workers. Another distinctive feature of Brazil is that the level of wage inequality in Brazil was lower for workers engaged in GVCs completed inside the country in 2009.

Table 2.5: Less skilled labor relative average compensation as percentage of high skilled average compensation in manufacturing GVCs

	Domestic stages/ Foreign completed			Domestic stages/ Domestically completed		
	1995	2009	Δ	1995	2009	Δ
BRA	14.6	20.1	5.5	15.8	23.8	8
CHN	86.5	50.7	-35.8	60.8	49.0	-11.8
IDN	15.6	23.2	7.6	13.7	22.2	8.5
IND	17.0	18.1	1.1	16.4	18.3	1.9
MEX	32.7	41	8.3	30.9	38.6	7.7
RUS	43.9	39.5	-4.4	38.4	36.8	-1.6
Average	39.1	34.5	-4.6	32.0	33.0	0.9

Source: authors' calculation based on data from WIOD Release 2013.

We observe that wage inequality between the less-skilled and high-skilled workers also decreased in Indonesia, India and Mexico while it increased in China and Russia. China departs

from a very low level in wage inequality in 1995 with a very strong increase until 2009, especially in foreign completed GVCs. These findings do not support that increasing pressure in lower value-added stages of production less-skilled intensive in manufacturing GVCs usually performed in developing countries are causing a general increase in wage inequality in these chains by exerting pressure on the less-skilled labor wages. The worse evolution of the relative wages of less-skilled workers engaged in the production of intermediate goods for foreign completed GVCs could be explained by a greater competitive pressure on those activities limiting less-skilled wage gains or by productive specialization in activities with bigger wage inequality.

Table 2.6 presents the share in hours worked by the less skilled labor. Brazil had a lower less-skilled labor participation in total hours worked employed in manufacturing GVCs compared to the other countries with a greater decrease in GVCs completed inside the country. This explains why the domestically completed GVCs in Brazil had a stronger decrease in the less-skilled labor share of labor income, as relative wages increase presents a higher increase on these chains.

Table 2.6 Less-skilled labor share in hours worked in manufacturing GVCs

	Domestic stages/ Foreign completed			Domestic stages/ Domestically completed		
	1995	2009	Δ	1995	2009	Δ
BRA	94.8	91.9	-2.9	94.5	90.9	-3.6
CHN	97.4	94.1	-3.3	98.4	95.8	-2.6
IDN	97.6	95.5	-2.1	98.4	96.3	-2.1
IND	96.0	91.9	-4.1	95.8	93.0	-2.8
MEX	91.4	90.6	-0.8	92.5	92.0	-0.5
RUS	93.0	90.6	-2.4	94.3	92.7	-1.6
Average	95.1	92.5	-2.5	95.9	94.0	-1.9

Source: authors' calculation based on data from WIOD Release 2013.

Less-skilled participation in total GVC employment fell in all manufacturing GVCs irrespective of the location of the last stage, although the fall was, on average higher in foreign completed GVCs. Comparing the changes in relative wages (Table 2.5) and in relative demand for less-skilled and high-skilled labor we cannot establish a positive association as predicted by mainstream theory. While the relative labor demand decreased in the manufacturing chains between 1995 and 2009, relative wages were, on average, increasing during the same period. The falling less-skilled labor employment participation may be explained by the hypothesis that GVC

integration decreases less-skilled labor demand because of less-skilled labor-saving technological diffusion occurred via trade in intermediates and the diffusion of leaner production strategies across GVCs that reduces less-skilled labor permanent jobs. This is not necessarily harmful to a country's economic performance once it is associated to labor productivity gains and is accompanied by economic upgrading within GVCs. However, it is not certain that these productive gains will be captured by the country where it occurred. Asymmetric power relations within GVCs allow asymmetric appropriation of increases in productivity along the chains. Hence, these laid off workers may not be relocated to other activities, becoming the uncompensated losers of GVC integration.

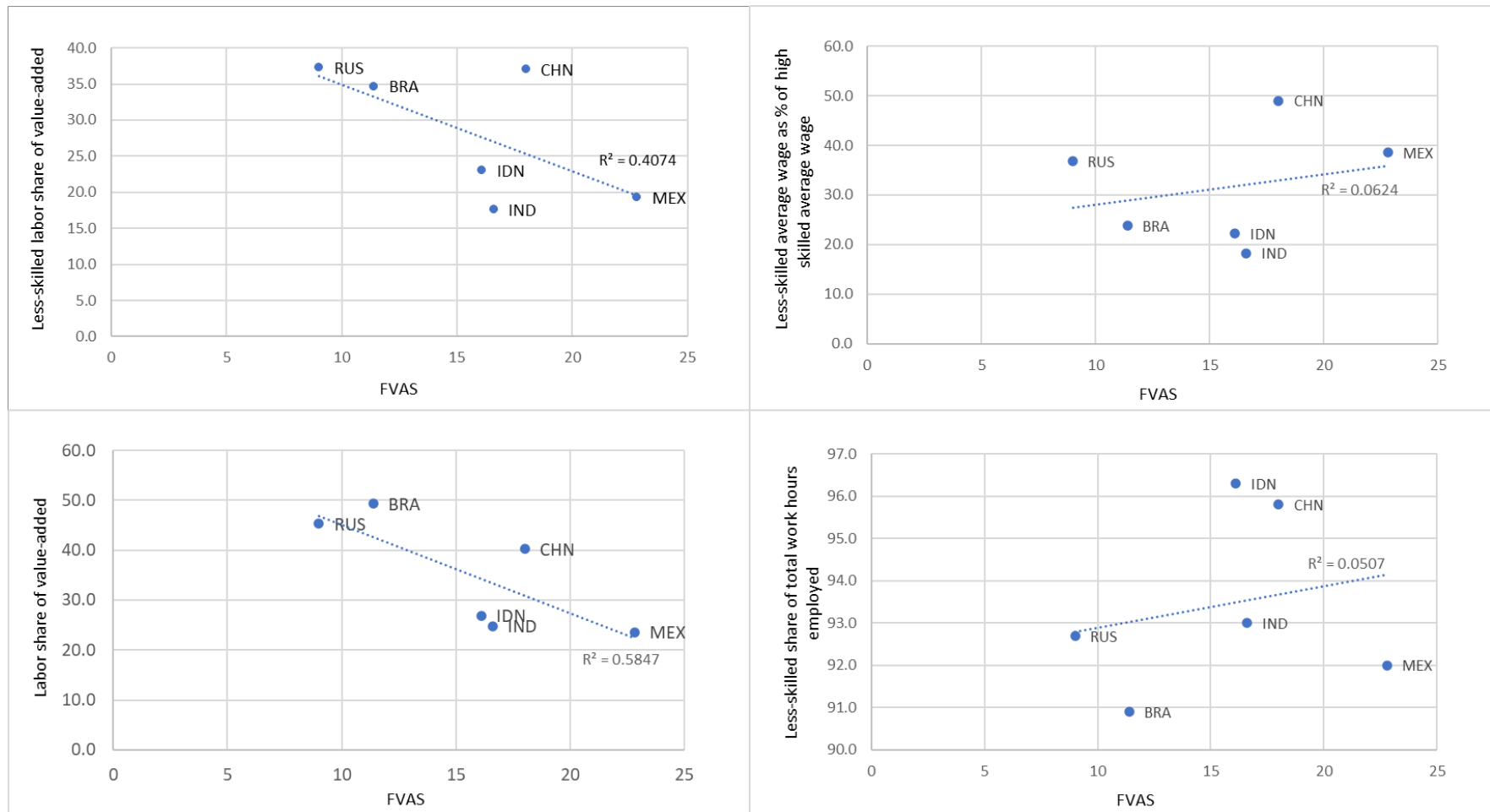
Brazilian GVC insertion mostly differentiates from the other emerging countries by having a lower degree of backwards GVC integration, that is, by incorporating a lower share of foreign value-added to its final manufacturing goods. Concurrently, the evolution of the less-skilled labor share of value-added went in the opposite way as observed in the other selected countries due the distinctive evolution of the total labor share of value-added. Conducting a statistical test of the empirical association between the backwards GVC participation and the less-skilled labor share of value-added in developing countries was not possible since we have only few countries and years of observations. This omission is left for future research. Seeking to explore the possible connections between the less-skilled labor share of value-added in domestically completed GVCs and the level of fragmentation, we plot in Figures 2.1 and 2.2 the position of the countries according to the less-skilled labor share of income and its related measures and the foreign value-added share (FVAS). Figure 1 considers the measures in 2009-level and Figure 2 considers the variation between 1995 and 2009.

We observe in Figure 2.1 a negative association between the level of the less-skilled labor share of value-added and the level of foreign value-added share in 2009. Between the components of the less-skilled labor share of value-added, the total labor share of value-added is the measure that shows a more visible association to the foreign value-added share. The countries with higher levels of foreign value-added to their domestically completed GVCs presented lower levels of the labor share in value-added. The causality can be established both ways. Having a lower labor share of value-added in manufacturing GVCs can be related to lower labor costs and reduced costs increases international competitiveness that facilitates GVC insertion. However, relying on lowering wages is considered a low-road path to increase competitiveness in GVCs, keeping

developing countries in lower value-added stages of production where economic activity may increase but accompanied by falling economic returns (Kaplinsky, 2000). Long term competitiveness depends on product-based competition rather than price competition which is discouraged by low wage competition and its continuous downward pressure on profit margins (Tarling and Wilkinson, 1997).

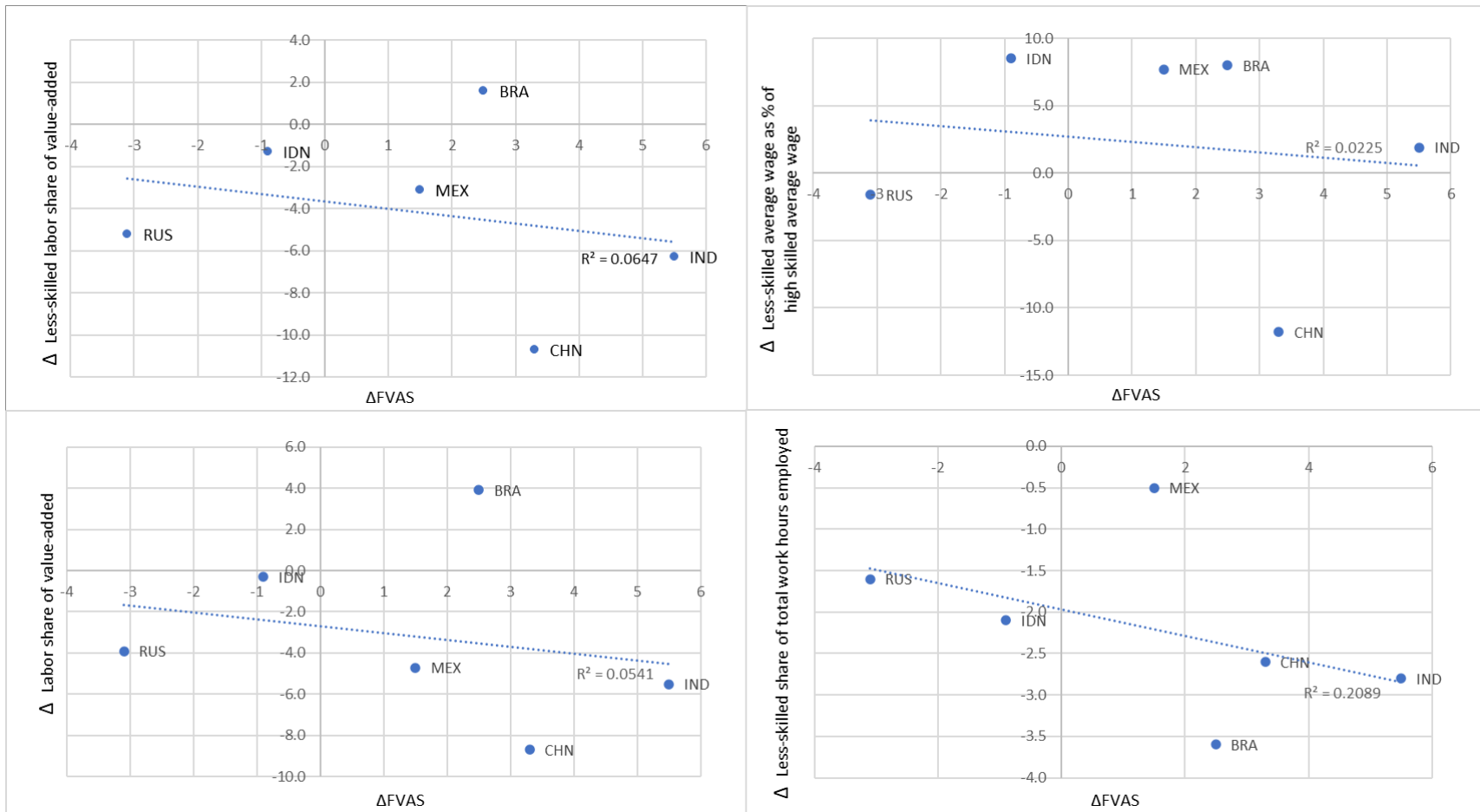
The association between the changes in the foreign value-added share and the evolution of the less skilled labor share is less clear (Figure 2.2). The change in the relative hours worked had the strongest association to the growth in foreign value-added share, among the less-skilled share components. However, Brazil had a higher loss of less-skilled participation in employment in manufacturing GVCs than China and India where the foreign value-added share experienced a greater increase. Mexico, is on the opposite side, having lower less-skilled relative employment losses than countries with lower FVAS growth.

Figure 2.1: The level of foreign value-added share and the level of less-skilled labor relative income and employment - 2009



Source: authors' calculation on based on data from WIOD Release 2013.

Figure 2.2: The evolution of the foreign value-added share and of the less-skilled labor relative income and employment – 1995-2009



Source: authors' calculation based on data from WIOD Release 2013.

As GVC integration is not the unique determinant over these variables, we did not expect indeed to find a strong linear association. Other factors that act upon the less-skilled labor share of value-added and its components are the institutions and economic conditions that regulate labor markets and influence labor bargaining power and those that shape industrial policy and trade strategy influencing the configuration of the countries productive structure within GVCs. The latter will be analyzed in subsection 2.3.2. In the remaining of this subsection, we look at labor market and social protection indexes that are linked to workers bargain power and to the wage determination for Brazil and the other selected developing countries.

In classical theory of wages, the ‘normal’ wage level (wage paid to an adult laborer without particular skills) at a certain country is connected to the subsistence level of consumption, which is given by the norms and convention in the country in a historical period (Stirati, 1994). The institutional minimum wages is a particular political norm that set the minimum remuneration that society considers sufficient for a fair living (Medeiros, 2015). The minimum wages are especially significant in determining the average wage in developing countries. Given its heterogeneities and structural unemployment, a large part of workers has poor contractual power and high employment turn over, lacking a career plan and union coverage. Hence, the average wage of the less-skilled labor is strongly influenced by the evolution of minimum wages. The minimum wage in Brazil was relatively high in 1995 and experience a strong real absolute increase, more than doubling in the 2000`s (Table 2.7). In 2009, Brazil still had the higher minimum wage across the selected countries, despite they were all facing significant increases in minimum wages through the same period. However, in the other countries, even though minimum wages were increasing, the less-skilled labor share of value-added was decreasing as labor incomes grew at slower pace than labor income and the increase in the less-skilled average wages was not enough to compensate the drop in less-skilled labor relative employment. In China and Russia, even the relative less-skilled to high-skilled wages were decreasing in manufacturing GVCs. The ILO database did not have the comparable data for Mexico, but the OECD data on real minimum wages in 2019-dollar PPP shows a decrease in Mexico’s real minimum wage from 1995 to 2009.

Table 2.7: Minimum wages (Dollar PPP 2011)

	BRA	CHN	IDN	IND	RUS
1995	119	63	93		31
1996	118	67	102		27
1997	121	72	112		26
1998	129	78	80		21
1999	132	105	79		12
2000	141	111	97	120	17
2001	162	120	120	119	51
2002	169	131	136	128	45
2003	181	133	149	127	54
2004	189	154	159	165	58
2005	211	166	165	164	60
2006	243	186	179	160	81
2007	262	208	192	155	160
2008	281	224	201	180	153
2009	299	225	214	202	272
Δ	180	162	121	82	241

Source: International Labour Organization (ILO)

The normal wage level may persistently rise with changes in social, economic and institutional factors that determine the relative power of works to employers in the process of wage bargaining (Stirati, 1994). One of these factors is the worker's capacity for collective organization and action. Productive fragmentation is related to a decrease in Union power by disarticulating workers collective organization. Araújo et al., (2001) points to a decreasing articulation capacity of labor unions in Brazil in 1990s following the liberalizing reforms including privatization, reduction in trade tariffs, and labor market flexibilization. As we observe in Table 2.8, Trade Union activity substantially decreased in Brazil in the late 1990s, stabilized at a lower level in the early 2000s and increased again during the last years of the decade. In general, we observe a tendency of reduction in the number of strikes and lockouts in the developing countries analyzed.

Table 2.8 Number of strikes and lockouts

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
BRA	1056	1258	630	546	508	525	416	298	340	302	299	320	316	411	518
IDN	276	346	234												
IND	1066	1166	1305	1097	927	771	674	579	552	477	456	430	389	423	391
MEX	96	51	39	33	32	26	35	45	44	38	50	55	28	21	19
RUS	8856	8278	17007	11162	7285	817	291	80	67	5933	2575	6	7	4	

Source: International Labour Organization (ILO)

Table 2.9: Trade union density

	2000	2001	2002	2004	2005	2006	2007	2008	2009
BRA				18.5	18.9	19.1	18.2	18.6	18.1
CHN								30.4	32.7
IDN		36.4	27.1			9.9	9.2	8.7	9.8
IND				13.8					12.9
MEX			17.2		16.9	16.3	16.7	15.6	15.3
RUS						43.7	41.4	39.2	38.5

Source: International Labour Organization (ILO)

Table 2.9 shows that Trade Union density in Brazil had a minor decrease from the first to the last year of available information. The Trade Union density is also stable in the late 2000s in Brazil. Compared to the other countries, Russia and China had much higher Trade Union density with a decreasing trend in the first. However, in China and Russia, as a legacy of the state-socialist past, Trade Unions are less autonomous organizations and face difficulties in gaining independence from the state, often assuming the role of guarantors of social stability in detriment of protecting labor rights (Clarke, 2005). Trade Unions density also decreased in Indonesia and Mexico from 2001 to 2009. Hence, we observe that while worker's collective organization and action decreased in Brazil during the 1990's similarly to what was happening in the other countries it was more stable in 2000s which may have contributed to increasing wages above the institutional minimum allowing the increase in labor share of value-added.

The threat of unemployment in capitalist societies is one important mechanism to discipline labor. Citing Hume (1987, p. 390): "the fear of punishment will never draw so much labor from a slave, as the dread of being turn-off and not getting another service will from a freeman".

Government social spending are expenses with unemployment benefits, pension and other social security that protects the most vulnerable and diminishes the fear of losing a job. Hence, government spending in social protection may contribute to enhance workers bargain power. Brazil contrasts with the other countries by having a higher level of government spending in social protection since 1995 (Table 2.10). From 1995 to 2010, Russia and Mexico experienced significant increases in government spending in social protection. Although increases in social spending were also observed in China and India, together with Indonesia, these countries present relatively low levels of government spending in social protection. Rodrik (2007) shows that international economic integration increases the demand for social protection and, at the same time, reduces government capacity to afford social programs and makes it more difficult to tax capital incomes increasing the workers share of contributions. The Brazilian lower degree of trade openness may also have allowed the higher and increasing rate of social protection during the period which also contributed to protect workers and diminish their weakness in the process of wage bargaining.

Table 2.10: Government spending in social protection as % of GDP

	1995	2000	2005	2010	2011
BRA	15.5	14.2	15.5	16.4	
CHN	3.2	4.7	2.7	6.7	
IDN	1.6	1.8	2.0	0.9	
IND	1.5	1.6	1.5		2.6
MEX	-	6.9	7.6	10.4	
RUS	11.1	9.4	11.8	16.6	

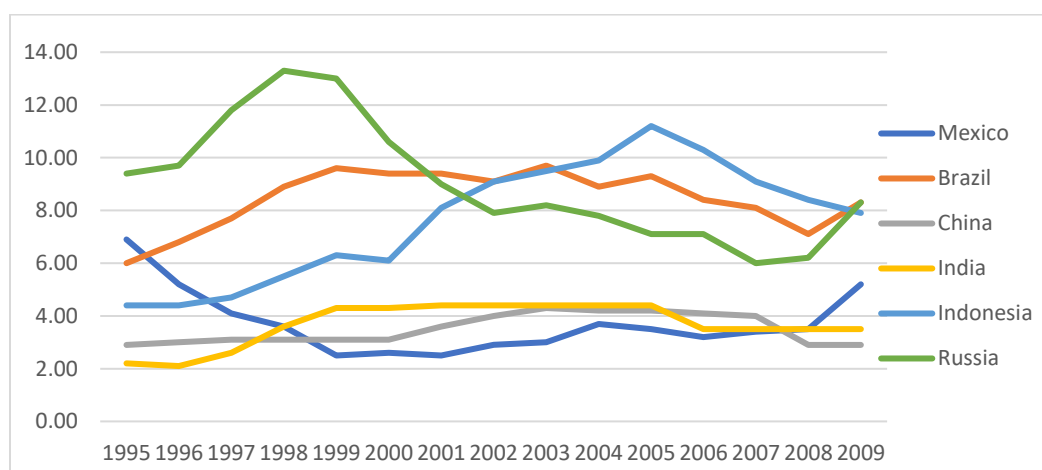
Source: International Labour Organization (ILO)

Differently from marginalist theory, the classical theory of wages does not establish a straight inverse relationship between wages and the level of unemployment (Stirati, 1994). However, the economic condition of the country and the associated shortage of labor or unemployment influence wages as the existence of unemployment is what pressures real normal wages to its subsistence level (Stirati, 1994). Figure 2.11 illustrates the evolution of unemployment rates by country. The unemployment rate increased in Brazil from 1995 to 1999 and in the other countries, except Mexico. Menezes-Filho and Muendler (2011) and Gaddis and Pieters (2014) find evidence that trade liberalization in Brazil in the 1990s increased unemployment and reduced the

rate of labor force participation. From 2003 to 2008, the trend in Brazil was of reduction in the unemployment rate, in a period of economic prosperity with higher rates of economic growth since the early 1980's.

The level of unemployment in Brazil was one of the highest between the selected developing countries and almost twice the index in Mexico, India and China. Yet, Brazil had a higher labor share of value-added and experienced an increase in this variable while it was falling in the other countries. Feng et. al. (2017) find that the unemployment rate in China actually rose highly above what is reported by official statistics in the second half of the 1990's from 4% to above 10% in 2001 and fell to around 9% in 2009. And while Indonesia and India had low unemployment rates, informal employment was relatively high in these countries (Table 2.12). Informal workers are generally less benefited by minimum wages increases, are not covered by collective action and are subject to lower wages and work conditions.

Figure 2.11: Unemployment rate evolution



Source: International Labour Organization (ILO)

Table 2.12: Informal employment as a percent of employment (%)

	2005	2008	2009	2010	2011
BRA			42.21		
IDN			72.52		
IND				83.59	
MEX	53.24	52.49	53.74	54.17	
RUS					9.08

Source: International Labour Organization (ILO)

Table 2.13: Unemployment rate by educational attainment

		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Δ
BRA	Advanced	2	3	3	4	4		4	4	4	4	4	4	4	4	4	4	2
	Intermediate	6	7	8	10	11		10	11	11	11	11	10	10	9	10	10	4
	Basic	8	9	10	12	12		12	11	12	11	11	10	9	9	10	10	2
	None	4	4	4	5	5		5	4	5	4	4	4	4	4	4	4	-
IDN	Advanced		12	10	13	13	10	13	10	14	14	11	10	13	12	9		-3
	Intermediate		13	13	17	16	14	14	15	14	15	18	16	17	14	12		-1
	Basic		4	4	6	5	5	4	5	5	5	6	6	6	6	5		1
	None		1	1	6	1	1	1	2	2	3	2	2	2	2	2		1
IND	Advanced						10						9				7	-3
	Basic						4						3				2	-2
	Intermediate						9						8				7	-2
	None						1						1				1	0
MEX	Advanced								4	5	5	4	4	4	4	5		1
	Intermediate								4	5	6	5	5	5	5	7		1
	Basic								3	4	4	4	4	4	4	6		3
	None								1	2	2	2	2	2	2	3		3
RUS	Advanced															6		-
	Intermediate															11		-
	Basic															18		-
	None															-		-

Source: International Labour Organization (ILO)

Table 2.13 presents the unemployment rate by educational attainment. The unemployment rate greatly differs for each educational attainment, with the less-skilled labor facing a higher unemployment rate in Brazil since 1995. While those that attended the advanced educational level had a 4% unemployment rate, the workers with intermediate or basic level attainment levels had a 10% rate of unemployment in 2009. This difference in the rate of unemployment between workers with different educational levels can be another explanation for the higher wage inequality in Brazil between the less-skilled and high-skilled workers. Also, the unemployment rate had a worse evolution among the less-skilled labor between the first and last year of available information in all countries.

We observed in the section that the Brazilian backwards participation in Global Value Chains measured by the share of foreign value-added to domestically completed final manufacturing outputs was relatively low. Meanwhile, the less-skilled labor share of value-added to manufacturing GVCs was above the average in Brazil in both foreign and domestically completed GVCs. This is explained by the above average total labor share of value-added to GVCs. The evolution of the less-skilled labor share of value-added was better than the observed across the other countries. The total labor share of value-added increased in domestically completed GVCs in Brazil, while it decreased in the other countries. This increase, however, was not evenly captured between workers with different skill levels. The explanation for the decrease in the less-skilled labor share of labor income in Brazil was the decrease in the share of hours worked by the less-skilled labor, since the relative wages of the less-skilled workers increased from 1995 to 2009 in the manufacturing GVCs. In Brazil, the combination of minimum wage increases, the high level of government spending in social protection and a stabilized level of workers collective organization and action strengthened worker's position in the wage bargain during the 2000's, contributing to the rise in the less-skilled labor share of the value-added, despite the persistent high level of structural unemployment, especially among the less-skilled.

2.3.2. Productive fragmentation, vertical specialization and the less-skilled labor share of value-added

The less-skilled labor share of value-added within a GVC depends on the value-added generated on the different activities involved in the production of the final output and the share of income captured by the less-skilled in each of these activities. Table 2.12 presents the less-skilled value-added share in each of these industries. Tables 2.13 and 2.14 show the countries' GVC participation in terms of the sectors involved in the production of the many stages of final manufacturing outputs completed both inside the country or in a foreign location. The services sectors were aggregated in less-knowledge intensive and knowledge intensive (ANNEX 2.I).

Common to most the developing countries in our sample was the increase in the importance of value-added to foreign completed GVCs produced in the sector 'Mining and quarrying' and the reduction of the share of value-added produced in the 'Textiles' sector. The stages of production held in the sector 'Mining and quarrying' pay among the lowest share of their value-added to the less-skilled labor while 'Textiles' are among the highest. Hence, these movements can partially explain the worse evolution of the less-skilled labor share of value-added in foreign completed GVCs.

The increase in importance of the value-added in "Knowledge intensive services" both in domestic and foreign completed GVCs in most of these countries are another factor contributing to the decrease of the less-skilled labor share, since this activity also have a small and decreasing participation of the less-skilled labor in their value-added. However, in Brazil its increase in value-added participation was small, only 1 percentage points, both in domestic and foreign completed GVCs.

Table 2.12: Less-skilled labor share of value-added by industry

	BRA			CHN		IDN		IND		MEX		RUS		AVG		
	1995	2009	Δ	1995	2009	1995	2009	1995	2009	1995	2009	1995	2009	1995	2009	Δ
Agriculture, hunting, forestry and fishing	36	30	-6	87	95	18	20	24	17	16	13	41	45	34	34	0
Mining and quarrying	28	20	-8	46	33	14	11	39	20	5	3	49	42	30	23	-7
Food, beverages and tobacco	36	51	15	27	29	22	22	28	23	24	18	37	39	26	26	0
Textiles and textile	22	43	21	46	41	28	25	26	35	34	38	62	51	37	36	0
Leather, leather and footwear	58	65	7	54	42	38	42	32	32	37	36	62	51	41	38	-2
Wood and of wood and cork	29	37	8	45	35	26	23	19	30	24	26	45	34	28	29	0
Pulp, paper, paper , printing and publishing	37	33	-4	53	32	24	26	21	17	18	18	42	41	29	27	-2
Coke, refined petroleum and nuclear fuel	17	12	-5	20	26	14	22	4	2	13	12	18	20	12	16	5
Chemicals and chemical	31	31	0	35	26	36	31	14	6	20	17	26	35	25	25	0
Rubber and plastics	39	41	3	41	32	33	35	15	23	35	32	76	40	37	32	-5
Other non-metallic mineral	33	36	3	47	34	28	28	26	17	24	17	44	34	31	26	-5
Basic metals and fabricated metal	31	31	0	47	26	21	27	27	10	21	13	44	38	30	24	-6
Machinery, nec	46	49	3	43	34	40	36	44	18	69	39	58	53	45	35	-10
Electrical and optical equipment	34	40	6	40	29	24	22	27	12	38	37	57	48	34	30	-4
Transport equipment	48	52	4	39	35	28	29	23	6	28	28	64	37	34	29	-5
Manufacturing nec; recycling	25	28	3	34	21	26	28	25	32	33	36	49	48	31	32	2
Electricity, gas and water supply	30	13	-17	26	20	20	26	21	23	21	21	18	16	20	20	0
Construction	26	36	10	68	49	48	32	70	65	30	34	61	39	48	40	-8
Less knowledge intensive services (LKIS) ¹	35	36	1	44	20	23	24	21	17	19	17	34	35	25	21	-4
Knowledge intensive services (KIS) ¹	23	16	-7	30	22	22	19	14	9	27	21	33	30	24	19	-6

Source: authors' calculation based on data from WIOD Release 2013.

Note: ¹ average of activities weighted by the value-added to manufacturing GVCs

Table 2.13: Industry composition of the value-added to manufacturing GVCs foreign completed (%)

	BRA			CHN		IDN		IND		MEX		RUS		Average		
	1995	2009	Δ	1995	2009	1995	2009	1995	2009	1995	2009	1995	2009	1995	2009	Δ
Agriculture, hunting, forestry and fishing	14	19	5	14	7	10	12	20	13	6	4	2	1	10	7	-3
Mining and quarrying	4	11	7	7	6	23	38	6	10	19	28	24	31	16	23	7
Food , beverages and tobacco	5	5	0	2	2	3	9	1	1	1	1	0	0	1	3	1
Textiles and textile	2	1	-1	11	6	9	3	7	2	1	1	0	0	6	2	-3
Leather, leather and footwear	1	1	0	1	1	1	0	2	0	0	0	0	0	1	0	-1
Wood and of wood and cork	1	1	0	1	1	4	1	1	0	1	0	1	0	2	0	-1
Pulp, paper, paper printing and publishing	4	3	-1	2	1	4	2	2	0	2	1	2	1	2	1	-1
Coke, refined petroleum and nuclear fuel	1	2	1	1	1	4	5	1	2	0	1	1	5	1	3	1
Chemicals and chemical	6	4	-2	5	6	6	4	7	6	3	3	4	2	5	4	-1
Rubber and plastics	2	2	0	3	3	4	3	1	1	1	1	0	0	2	2	0
Other non-metallic mineral	1	1	0	2	1	0	0	3	1	1	1	1	0	1	1	-1
Basic metals and fabricated metal	14	8	-6	9	9	3	2	6	8	8	9	12	6	8	7	-1
Machinery, nec	2	1	-1	3	4	1	1	1	2	1	1	1	1	1	2	0
Electrical and optical equipment	2	2	0	9	13	2	3	3	5	4	6	1	1	4	6	2
Transport equipment	5	2	-3	2	3	1	2	2	3	7	8	1	0	3	3	1
Manufacturing nec; recycling	0	0	0	1	1	0	0	2	3	3	1	0	0	1	1	0
Electricity, gas and water supply	3	3	0	3	3	0	0	4	2	1	1	5	4	3	2	-1
Construction	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0
Less knowledge intensive services (LKIS)	19	21	2	18	18	14	10	24	21	31	24	42	36	26	22	-4
Knowledge intensive services (KIS)	13	14	1	8	14	9	3	8	18	9	9	4	9	8	11	3
HH Index	11	13	2	10	10	11	19	13	12	16	17	26	24	15	16	1

Source: authors' calculation based on data from WIOD Release 2013.

Table 2.14: Industry composition of the value-added to manufacturing GVCs completed domestically (%)

	BRA			CHN		IDN		IND		MEX		RUS		Average		
	1995	2009	Δ	1995	2009	1995	2009	1995	2009	1995	2009	1995	2009	1995	2009	Δ
Agriculture, hunting, forestry and fishing	10	9	-1	17	13	19	19	17	13	8	6	12	9	15	12	-3
Mining and quarrying	2	3	1	4	4	1	6	3	3	11	10	4	4	5	5	1
Food, beverages and tobacco	11	10	-1	10	9	18	22	5	5	17	23	18	22	14	16	3
Textiles and textile	8	5	-3	9	6	10	6	8	7	3	3	3	1	7	5	-2
Leather, leather and footwear	2	1	-1	2	2	2	1	1	1	1	1	0	0	1	1	0
Wood and of wood and cork	1	0	-1	1	1	1	1	1	1	0	0	1	0	1	1	0
Pulp, paper, paper , printing and publishing	2	2	0	2	1	2	1	2	1	3	2	2	2	2	1	-1
Coke, refined petroleum and nuclear fuel	2	4	2	1	1	2	2	2	2	2	2	1	6	2	3	1
Chemicals and chemical	6	7	1	5	4	5	4	4	5	6	4	3	2	5	4	-1
Rubber and plastics	2	2	0	2	2	2	1	1	1	1	1	1	1	1	1	0
Other non-metallic mineral	1	0	-1	3	1	1	0	1	0	2	2	2	1	2	1	-1
Basic metals and fabricated metal	5	5	0	7	7	1	0	7	6	4	3	5	4	5	4	-1
Machinery, nec	4	5	1	6	7	2	1	4	4	1	1	6	5	4	4	0
Electrical and optical equipment	6	4	-2	6	9	6	8	3	4	5	4	4	3	5	6	1
Transport equipment	6	7	1	4	5	12	9	5	5	8	8	7	6	7	7	-1
Manufacturing nec; recycling	3	3	0	1	1	2	2	2	4	1	2	2	2	2	2	1
Electricity, gas and water supply	2	3	1	2	3	0	1	4	2	1	1	4	3	2	2	0
Construction	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Less knowledge intensive services (LKIS)	16	19	3	12	12	11	12	21	23	16	16	20	21	16	17	1
Knowledge intensive services (KIS)	10	11	1	6	10	5	4	8	11	9	10	3	8	6	9	2
HH Index	8	9	1	9	8	12	13	10	10	10	12	11	12	10	11	1

Source: authors' calculation based on data from WIOD Release 2013.

In the Brazilian case, the productive structure of value-added to the GVCs which have the last stage completed abroad is more concentrated. In 2009, 65% of all Brazilian value-added to foreign completed manufacturing GVCs was produced within four non-manufacturing sectors: 'Agricultures, hunting, forest, and fishing', 'Mining and quarrying', 'Less knowledge intensive services' and 'Knowledge intensive services'. In 1995, these four sectors accounted for 50% of all value-added. All these sectors augmented their importance in total value-added to foreign completed GVC's but 'Mining and quarrying' stands out with an increase from 4% to 11%. The sector with higher losses of value-added participation in foreign completed manufacturing GVCs were the 'Basic metals and fabricated metal' and 'Transport equipment'. The reduction in the last went in the opposite direction observed, in general, for the other countries.

The weight of 'Mining and quarrying' in total value-added is much smaller for domestically completed GVCs, only 3% compared to the 11% in the foreign completed. While 'Food, beverages and tobacco' is 10% of total value-added to domestically completed GVCs, compared to 5% in the last case. This can also explain the higher Brazilian less-skilled labor share of value-added in domestic GVCs as 'Food, beverages and tobacco' had one of the highest less-skilled labor participation in value-added.

The changes between 1995 and 2009 of the sectoral structure of value-added to domestically completed manufacturing GVCs in Brazil were smaller than the observed change for the abroad completed GVCs. These changes were also small compared to the other developing countries. The sector with larger changes in relative participation were the 'Textile' that went from 8% to 5% of total value-added and the 'Less knowledge intensive services' that went from 16% to 19%. While China, Indonesia, Russia and Turkey experienced more significant changes in the sectoral structure of the value-added to domestically completed GVCs, their structural change was also more pronounced for the value-added to foreign completed chains.

Table 2.15 presents the value-added participation in GVCs of the manufacturing sectors aggregated by technology intensity categories (Furtado and Carvalho, 2005) (ANNEX 2.II). The Brazilian participation of the value-added generated in manufacturing sectors of high and medium-high technology intensity together decreased in foreign value-added GVCs and was stable in domestically completed GVCs. In domestically completed GVCs, only China had significant increases in the share of higher technology intensive manufacturing sectors in value-added. In

foreign completed GVCs, Brazil and Russia were the only economies where the more technology intensive sectors diminished their importance. But even though China, India, Indonesia and Mexico managed to increase their participation in foreign value chains with increasing participation of sectors that are more technology intensive, the labor share of income was shrinking in these countries. This reinforces the idea that economic upgrading is not a sufficient condition for GVC insertion to result in a better position for most workers within the country. Those employed in stages and tasks held in the growing higher value-added sectors that are associated with higher rents are likely to capture some of these rents. However, if the overall workers bargain power is weakened, their incomes will grow below profits. And the mass of workers employed in the lower value-added stages may only have less power to bargain for decreasing or stagnant rents.

On the other hand, it is concerning that the more technology intensive sectors diminished their participation in the Brazilian foreign value-added to GVCs. Moreover, that it was associated to the growth in participation of extractive industries and agriculture and the decreasing participation of manufacturing as a whole. First, this pattern of specialization goes in the direction of commodities where price competition prevails, have weaker backward and forward linkages and lower income elasticities, innovation content and potential for upgrading. Second, the less-skilled labor share of value-added in more technology intensive sectors in Brazil was above the country's average observed in both domestically and foreign completed GVCs. Thus, the decreasing relative size of these sectors change the overall distribution of the Brazilian value-added against the less-skilled workers.

2.15: Productive structure and the less-skilled labor share by technology intensity

	BRA			CHN		IDN		IND		MEX		RUS		AVG		
	1995	2009	Δ	1995	2009	1995	2009	1995	2009	1995	2009	1995	2009	1995	2009	Δ
Value-added to manufacturing GVCs foreign completed (%)																
Low	28	20	-8	29	22	24	17	24	15	17	14	16	7	22	15	-3
Medium-Low	9	8	-1	9	10	14	12	9	9	4	5	5	7	8	9	1
Medium-High	7	3	-4	5	7	2	3	3	5	8	9	2	1	4	5	1
High	2	2	0	9	13	2	3	3	5	4	6	1	1	4	6	2
Total Manufacturing	46	33	-13	52	52	42	35	39	34	33	34	24	16	38	34	-4
Value-added to manufacturing GVCs completed domestically (%)																
Low	33	26	-7	35	28	37	33	27	25	31	36	33	32	33	31	-4
Medium-Low	10	13	3	8	7	9	7	7	8	9	7	5	9	8	8	0
Medium-High	10	12	2	10	12	14	10	9	9	9	9	13	11	11	10	-1
High	6	4	-2	6	9	6	8	3	4	5	4	4	3	5	6	1
Total Manufacturing	59	55	-4	59	56	66	58	46	46	54	56	55	55	56	54	-4
Less-skilled labor share of value-added																
Low	32	42	10	41	32	25	24	26	24	25	20	43	40	32	28	-4
Medium-Low	29	27	-3	35	28	30	29	12	7	21	18	31	25	26	21	-4
Medium-High	47	51	4	41	34	29	30	32	11	33	30	61	45	40	30	-10
High	34	40	6	40	29	24	22	27	12	38	37	57	48	37	30	-8

Source: authors' calculation based on data from WIOD Release 2013.

Conclusions

The relative low degree of GVC insertion has been pointed as a constraining factor over Brazilian productivity and economic growth. However, while increasing integration to these globally fragmented production system does not ensure economic growth it has also been associated to a worsening condition of the less-skilled workers in developing countries. In this context, this essay aimed to identify the distinctive features of the Brazilian insertion in manufacturing GVCs and its possible associations with the less-skilled labor share of value-added between 1995 and 2009, in a comparative perspective with other middle-income developing countries.

The Brazilian participation in GVCs as an importer of intermediate inputs was indeed low relative to other developing countries in our sample. However, its participation in sourcing intermediates does not lag behind the other middle-income developing countries, except for China which is an outlier. On the other hand, the less-skilled labor share of value-added in GVCs in Brazil was above the average of the group of middle-income countries analyzed in both foreign and domestically completed GVCs. While the share of labor income in domestically completed GVCs increased relative to the share of capital income in Brazil, this increase was not evenly captured between workers with different skill levels. The share of labor income captured by the less-skilled decreased between 1995 and 2009 in Brazil. The reduction of the less skilled labor income share was observed in the other countries in our sample for both inside and outside completed manufacturing GVCs, except Mexico. The average wage of the less-skilled workers relative to the high skilled increased in Brazil between 1995 and 2009. The explanation for the decrease in the less-skilled labor share of labor income in Brazil was the decrease in their share of hours employed.

We find that the level of foreign value-added to domestically completed GVCs, a measure of GVC insertion by importing intermediate inputs, was negatively associated to the labor share of value-added. Although we leave further investigation of this causality to future research, the association is compatible with the hypothesis that trade opening and productive fragmentation decreases the relative position of workers in the wage bargaining process. The combination of minimum wage increases, the high level of government spending in social protection and a stabilized level of workers collective organization and action strengthened less-skilled worker's

position during the 2000's contributing to the rise in the less-skilled labor share of the value-added, despite the persistent high level of structural unemployment, especially among the less-skilled. While the minimum wage increase was not a particular feature of Brazil, it is questionable to what extent government spending in social protection and the collective action of workers would have materialized in a more internationally integrated context.

Regarding vertical specialization, we found important differences between chains completed domestically and those completed abroad. In Brazil, the value-added composition was more concentrated and experienced more significant changes in foreign complete GVCs, partially explaining the lower and worse evolution of less-skilled labor share of value-added in these chains. 'Mining and quarrying', a sector with a low less-skilled labor share of value-added stands out with an increase from 4% to 11% in the participation to total value-added to foreign completed chains from 1995 to 2009. The rise in the weight of "Mining and Quarrying" was also observed in most of the countries analyzed. The changes between 1995 and 2009 of the sectoral structure of value-added to domestically completed manufacturing GVCs in Brazil were small compared to the abroad completed GVCs and compared to the observed for the other developing countries in their domestically completed chains.

The consequence of lagging behind the production fragmentation process would be the weakening of competitiveness in international trade and lower productivity growth. It can be argued that increasing imports of intermediate inputs may reduce the domestic costs of production and promote technological spillovers, contributing for a country to move to higher value-added stages of production. We observed that China, India, Indonesia, and Mexico had an increasing participation of more technology-intensive manufacturing sectors and knowledge intensive services in the value-added to foreign completed GVCs. While the opposite occurred in Brazil for the manufacturing sectors and little change was observed in the weight of knowledge intensive services. However, simply reducing import tariffs to increase international trade flows does not guarantee the growth in higher value-added tasks or sectors. And even in the cases where we observed a structural change towards more technology intensive sectors, the income share of the less-skilled workers was diminishing.

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ANNEX 2.I – SERVICES AGGREGATION

Classification	WIOD activity
Less knowledge intensive services (LKIS)	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel
	Wholesale trade and commission trade, except of motor vehicles and motorcycles
	Retail trade, except of motor vehicles and motorcycles; repair of household goods
	Hotels and restaurants
	Other Inland transport
	Other Supporting and auxiliary transport activities; activities of travel agencies
	Real estate activities
	Other community, social and personal services
	Private households with employed persons
	Knowledge intensive services (KIS)
Other Air transport	
Post and telecommunications	
Financial intermediation	
Renting of m&eq and other business activities	
Public admin and defence; compulsory social security	
Education	
Health and social work	

Source: adapted from Eurostat (2016).

ANNEX 2.II – MANUFACTURING AGGREGATION

Classification	WIOD activity
Low	Food , beverages and tobacco
	Textiles and textile
	Leather, leather and footwear
	Wood and of wood and cork
	Pulp, paper, paper printing and publishing
	Other non-metallic mineral
	Basic metals and fabricated metal
	Manufacturing nec; recycling
Medium-Low	Coke, refined petroleum and nuclear fuel
	Chemicals and chemical
	Rubber and plastics
Medium-High	Machinery, nec
	Transport equipment
High	Electrical and optical equipment

Source: adapted from Furtado and Carvalho (2005).

Essay 3. The Main Determinants of the Evolution of the Income Share of Less-Skilled Labor in Manufacturing Global Value Chains: the Brazilian case in a comparative perspective

3.1. Introduction

A study by Timmer et. al. (2014), covering 560 production chains, found that between 1995 and 2009, following an increase in fragmentation of production, there was a shift in the functional distribution of the value-added generated in Global Value Chains (GVCs) in favor of high skilled labor and capital, in both developed and developing countries. This result is predicted by mainstream international trade theory for the developed countries, largely based on Heckscher-Ohlin (HO) model of comparative advantage. According to this model, commercial openness is associated to the tendency of an increase the relative price of products more intensive in the factor relatively more abundant in a country. Consequently, within the model mechanisms, demand should shift in favor of the more abundant factor and its relative remuneration should increase. Hence, the same result of a decreasing less-skilled labor share of value-added was not expected to developing countries that are more less-skilled labor abundant (Wood, 1995).

In line with the results of Timmer et. al. (2014), empirical works that analyze the post trade liberalizing period in developing countries, in general, falsifies what is predicted by the HO model and the Stolper-Samuelson theorem that greater international integration is associated to the tendency of an increased relative demand for less skilled labor and its relative wage in developing countries (Revinga, 1997, Feliciano, 2001, Wacziarg and Wallack, 2004, Meschi et. al., 2011). In the post-trade liberalizing period, the evolution of the relative demand for labor in terms of skill categories varies according to the sectors most exposed and vulnerable to international competition (Hanson and Harrison, 1999; Currie and Harrison, 1997, Amiti and Cameron, 2011).

The relative demand for more skilled labor in developing countries after trade liberalization that occurred mainly intra-firm and intra-sector is associated to the increase of international trade, via skill upgrading through technological spill overs (Giovanetti and Menezes-Filho, 2007; Fanjzylber and Fernandes, 2009; Meschi et. al., 2011; Crinò, 2012). The main hypothesis is that outsourcing from developed countries may act as a channel for technological diffusion, as the

imported inputs carry technologies which are domestically non-existing (Grossman and Helpman, 1991).

There is also evidence that the changes in relative prices, induced by trade liberalization, influenced the relative wages of more and less skilled workers (Behrman et. al., 2000, Robbins, 1997, Attanasio et. al., 2004, Beyer, Rojas and Vergara, 1999, Galiani e Sanguinetti, 2003, Harrison and Hanson, 1999, Gonzaga et. al., 2006, Ferreira et. al., 2010, Mishra and Kumar, 2005). The main channel is the transmission of the reduction in mark-ups to wages, due to an increase in competition. The direction of the associated change in wage inequality is mixed: when the industries that use less-skilled labor more intensively are the most affected, with larger tariff cuts or greater competing import penetration, the aggregate ratio of skilled to unskilled labor wages tend to increase and vice-versa. In the post-liberalizing period, there is no evidence of a generalized increase in the relative prices of low-skilled labor-intensive goods in developing countries, as predicted by standard trade theory.

In the most recent period, on the other hand, empirical investigations that goes beyond trade liberalization and uses the GVC approach reinforces the thesis that, in a commercially more integrated world, the competitive pressure exerted on low value-added stages of production held in developing countries, have perverse effects on mark-ups, labor bargaining power, wages, and employment conditions of the less-skilled workers (Anner, 2019, Rainbird and Ramirez, 2012, Rossi, 2013, Nadvi et. al., 2004). According to this mechanism developing countries GVC integration in lower value-added stages of production may increase wage inequality between the less skilled and high skilled workers.

The empirical results also corroborate the hypothesis that the increase of the international integration contributes to the reduction in the bargaining power of workers, especially the less skilled, with a negative impact on the total labor share of national incomes (Feliciano, 2001, Oyvat, 2011, Jayadev, 2007). This is explained by the disarticulating effect of productive fragmentation on labor unions as production split in stages and workers are dissociated from the final product which they contribute for (Nathan and Sarkar, 2011) and to the increasing threat to capital reallocation given by a higher capital mobility (Rodrik, 2007).

Economic upgrading related to structural change towards the production of goods and services with higher value-added seems to be a necessary but not sufficient condition for the benefits of global integration to be diffused in the labor market (Bernhardt and Milberg, 2011;

Bernhardt and Pollak, 2015). However, economic upgrading depends on many economic and institutional factors as the previous production structure of the country (Corrêa, 2016; Costa, Castilho and Anyul, 2017), industrial development policies (Lee, Szapiro and Mao, 2018; Ravenhill, 2014), geopolitics and trade agreements (Pereira, 2014) and the form of governance of the value chain by the lead firms (Humphrey and Schmitz, 2002; Gereffi and Lee, 2014).

This essay aims to investigate which were the main determinants of the evolution, from 1995 to 2009, of the less-skilled labor share of value-added generated in Brazil and incorporated to manufacturing Global Value Chains. We define less-skilled workers as those who completed up to middle school. We observe a sharp decrease in the share of population over 15 years old that completed up to the primary degree accompanied by an increase in the share of population that completed secondary and tertiary degrees (ANNEX 3.I). Once the increase in the rate of secondary level completion was very strong in the period, the change in the employment structure between primary and secondary level workers could be only due the increase in the level of education with no significant change in terms of the tasks that were carried out by those workers.

We split the components of the less-skilled labor share of income between those influenced by intra-sectoral changes in the income share of less-skilled labor and by changes in the sectoral composition of value-added to manufacturing GVCs. As domestic activities are heterogeneous in terms of the quantity and mix of labor input used per value-added and the share of value-added captured by these workers, when the weights of the sectors in value-added change, we expect a change in the quantity and composition of labor demand and in the aggregated less-skilled labor share of income. In order to measure the effects of both intra-sectoral and structural changes on less-skilled labor, we will apply a structural decomposition of the growth in less-skilled labor share of income isolating the effects of: (i) intra-sectoral changes in the less-skilled share of labor income; (ii) intrasectoral changes in the labor share of value-added; (iv) changes in intermediate and final goods' trade pattern; (v) technological changes; (vi) changes in the relation between value-added and intermediate use; (vii) changes in the quantities of final demand.

3.2. Methodology and Data Base

3.2.1. Methodology: the structural decomposition of the change in the value-added share of less-skilled labor

We use a multi-country input-output database to track a countries value-added in GVCs. The input-output database structure is illustrated in Figure 1, where each Z is a $N \times N$ matrix with the values of intermediate use of each industry-country in the columns. The main diagonal Z matrices are the matrices of domestic intermediate uses by industries. Each F^c is a $N \times 5$ final demand matrix by final demand category by country of destination. Again, the main diagonal F matrices represent domestic final demands. The sum over a row gives the total output (x^c) of an industry in a specific country. And total output x^c minus the sum of intermediate inputs for a given industry-country gives the value-added (v^c).

Figure 2.1: World Input-Output Table Structure

	Intermediate Use (Z) (N columns per country)			Final Use (F) (3 columns per country)			Output (x)
	1	...	C	1	...	C	
N Industries, Country 1	Z^{11}	$Z^{1\cdot}$	Z^{1C}	F^{11}	$F^{1\cdot}$	F^{1C}	x^1
...	$Z^{\cdot 1}$	$Z^{\cdot \cdot}$	$Z^{\cdot C}$	$F^{\cdot 1}$	$F^{\cdot \cdot}$	$F^{\cdot C}$	x^{\cdot}
N Industries, Country C	Z^{C1}	$Z^{C\cdot}$	Z^{CC}	F^{C1}	$F^{C\cdot}$	F^{CC}	x^C
Value-added (μ^c)	$(\mu^1)'$	$(\mu^{\cdot})'$	$(\mu^C)'$				
Output (x^c)	$(x^1)'$	$(x^{\cdot})'$	$(x^C)'$				

Source: adapted from Los et. al. (2014).

Next, we describe the structural decomposition that we will apply to measure the structural determinants of the evolution of less-skilled labor share of total hours worked by people engaged in all stages of production linked to manufacturing GVCs in Brazil. We consider the definitions below:

π_l : less-skilled labor share of total value-added (scalar)

w_l : less-skilled labor compensation (scalar)

v_l : total value-added (scalar)

ω : column vector of industry-country less-skilled labor share of labor income (NCx1 vector);

γ : column vector of industry-country relative average compensation of less-skilled to average compensation of labor engaged (NCx1 vector)

θ : column vector of industry-country relatives hours worked by less-skilled people engaged to total hours worked by people engaged (NCx1 vector)

α : column vector of industry-country labor share of value-added (NCx1 vector);

μ : column vector of industry value-added per unit of output (NCx1 vector);

A : matrix of intermediate inputs coefficients (NCxNC matrix)

$L = (I - A)^{-1}$: Leontief inverse matrix (NCxNC matrix)

f : column vector of worldwide total final demand for each industry-country (NCx1 vector)

e : summation vector consisting of ones (NCx1 vector)

The share of less-skilled labor in value-added is measured in Equation 1 below:

$$(1) \quad \pi_l = \frac{w_l}{v} = \frac{\omega' \hat{\alpha} \hat{\mu} (I - A)^{-1} \hat{f} e}{\mu' (I - A)^{-1} \hat{f} e}$$

In Equation 1 and henceforward the symbol (^) indicates diagonal matrices with the respective vector in the main diagonal.

The matrix A can be expressed as the product of two distinct terms:

$$(2) \quad A = T^A \circ A^*$$

Where:

A^* : input coefficient of industry i used in the production of industry j in country r , obtained by dividing the sum of the value of intermediate inputs of sector i in all countries per output in each country-industry.

T^A : matrix $NC \times NC$ representing the shares of each country in aggregate inputs produced in industry i used in the production of each industry-country.

\circ : Hadamard product of elementwise multiplication

We will also split total final demand for each industry j of country r in four terms:

$$(3) \quad f = (T^D \circ f^D + T^W \circ f^W)$$

Where:

f^D : column vector ($NC \times 1$) constructed by stacking C identical ($N \times 1$) vectors of domestic final demand for manufacturing goods of each industry.

T^D : column vector of each country share in the supply of domestic final manufacturing goods of each industry ($NC \times 1$ vector).

f^W : column vector constructed by stacking C identical ($N \times 1$) vectors of external final demand for manufacturing goods of each industry ($NC \times 1$ vector).

T^W : column vector of each country share in the supply of domestic final manufacturing goods of each industry ($NC \times 1$ vector).

Substituting Equations 2 and 3 in 1, we arrive at:

$$(4) \quad \pi_l = \frac{\omega' \hat{\alpha} \hat{\mu} (I - T^A \circ A^*)^{-1} (T^D \circ f^D + \widehat{T^W \circ f^W}) e}{e' \hat{\mu} (I - T^A \circ A^*)^{-1} (T^D \circ f^D + \widehat{T^W \circ f^W}) e}$$

Where e is a summation row vector ($1 \times NC$) with all values set to 1.

Splitting intermediate and final goods into trade patterns indicators and their amount and composition, we are to write the growth of the value-added share of less-skilled labor as:

$$(5) \quad \frac{\pi_{l1}}{\pi_{l0}} = \frac{w_{l1}}{w_{l0}} \times \frac{v_0}{v_1}$$

$$= \left[\frac{\omega'_1 \hat{\alpha}_1 \hat{\mu}_1 (I - T_1^A \circ A_1^*)^{-1} (T_1^D \circ \widehat{f_1^D} + T_1^W \circ f_1^W) e}{\omega'_0 \hat{\alpha}_0 \hat{\mu}_0 (I - T_0^A \circ A_0^*)^{-1} (T_0^D \circ \widehat{f_0^D} + T_0^{W\circ} \circ e)} \right]$$

$$* \left[\frac{e' \hat{\mu}_0 (I - T_0^A \circ A_1^*)^{-1} (T_0^D \circ \widehat{f_0^D} + T_0^W \circ f_0^W) e}{e' \hat{\mu}_1 (I - T_1^A \circ A_1^*)^{-1} (T_1^D \circ \widehat{f_1^D} + T_1^W \circ f_1^W) e} \right]$$

Allowing for changes in each term in Equation 5, keeping the other terms constant, we obtain its contribution to the growth ratio in less-skilled labor share of employment. In Equation 5, the subscripts 1 and 0 refer to the initial and final periods of observation. However, as pointed out by Dietzenbacher and Los (2000), changes in $\hat{\mu}$ and A^* are not independent for each industry-country because the sum of value-added coefficients and total input coefficients equal 1. Hence, the supposition that when one of these terms change, the other is kept constant will bias the result. To deal with this problem, we follow Dietzenbacher and Los (2000) recommendation and define:

$$(6) \quad \tilde{A}_1 = A_1^* \hat{s}_1^{-1} \hat{s}_0$$

$$(7) \quad s'_i = e' A_i^* ; i = \{0,1\}$$

Where, s_i is a $NC \times 1$ column vector with the values of total input used in the production in each industry-country in the period i . The matrix \tilde{A}_1 has the same input composition as matrix A_1^* but the same size of total input per gross output as matrix A_0^* . In this manner, a change from matrix A_0^* to matrix \tilde{A}_1 represents a change in the input composition and a change from matrix \tilde{A}_1 to A_1^* represents changes in the ratio of intermediate use to total output.

Using the definition in Equation 6, we decompose the growth in less-skilled labor share of income in manufacturing GCVs using the multiplicative form (Equation 8) adapted from the decomposition used by Dietzenbacher et. al. (2000) to analyze the evolution of labor productivity.

$$(8) \quad \frac{\pi_{l1}}{\pi_{l0}} = [8.1] \times [8.2] \times [8.3] \times [8.4] \times [8.5] \times [8.6] \times [8.7] \times [8.8] \times [8.9]^*$$

$$[8.1] \left[\frac{\omega'_1 \hat{\alpha}_1 \hat{\mu}_1 L_1 \hat{f}_1 e}{\omega'_0 \hat{\alpha}_1 \hat{\mu}_1 L_1 \hat{f}_1 e} \times \frac{e' \hat{\mu}_1 L_1 \hat{f}_1 e}{e' \hat{\mu}_1 L_1 \hat{f}_1 e} \right]$$

$$[8.2] \left[\frac{\omega'_0 \hat{\alpha}_1 \hat{\mu}_1 L_1 \hat{f}_1 e}{\omega'_0 \hat{\alpha}_0 \hat{\mu}_1 L_1 \hat{f}_1 e} \times \frac{e' \hat{\mu}_1 L_1 \hat{f}_1 e}{e' \hat{\mu}_1 L_1 \hat{f}_1 e} \right]$$

$$[8.3] \left[\frac{\omega'_0 \hat{\alpha}_0 \hat{\mu}_1 (I - T_1 \circ A_1^*)^{-1} \hat{f}_1 e}{\omega'_0 \hat{\alpha}_0 \hat{\mu}_1 (I - T_0 \circ A_1^*)^{-1} \hat{f}_1 e} \times \frac{e' \hat{\mu}_1 (I - T_0 \circ A_1^*)^{-1} \hat{f}_1 e}{e' \hat{\mu}_1 (I - T_1 \circ A_1^*)^{-1} \hat{f}_1 e} \right]$$

$$[8.4] \left[\frac{\omega'_0 \hat{\alpha}_0 \hat{\mu}_1 (I - T_0 \circ A_1^*)^{-1} \hat{f}_1 e}{\omega'_0 \hat{\alpha}_0 \hat{\mu}_0 (I - T_0 \circ \tilde{A}_1^*)^{-1} \hat{f}_1 e} \times \frac{e' \hat{\mu}_0 (I - T_0 \circ \tilde{A}_1^*)^{-1} \hat{f}_1 e}{e' \hat{\mu}_1 (I - T_0 \circ A_1^*)^{-1} \hat{f}_1 e} \right]$$

$$[8.5] \left[\frac{\omega'_0 \hat{\alpha}_0 \hat{\mu}_0 (I - T_0 \circ \tilde{A}_1^*)^{-1} \hat{f}_1 e}{\omega'_0 \hat{\alpha}_0 \hat{\mu}_0 (I - T_0 \circ A_0^*)^{-1} \hat{f}_1 e} \times \frac{e' \hat{\mu}_0 (I - T_0 \circ A_0^*)^{-1} \hat{f}_1 e}{e' \hat{\mu}_0 (I - T_0 \circ \tilde{A}_1^*)^{-1} \hat{f}_1 e} \right]$$

$$[8.6] \left[\frac{\omega'_0 \hat{\alpha}_0 \hat{\mu}_0 L_0 (T_1^D \circ f_1^D + \widehat{T_1^W} \circ f_1^W) e}{\omega'_0 \hat{\alpha}_0 \hat{\mu}_0 L_0 (T_0^D \circ f_1^D + \widehat{T_1^W} \circ f_1^W) e} \times \frac{e' \hat{\mu}_0 L_0 (T_0^D \circ f_1^D + \widehat{T_1^W} \circ f_1^W) e}{e' \hat{\mu}_0 L_0 (T_1^D \circ f_1^D + \widehat{T_1^W} \circ f_1^W) e} \right]$$

$$[8.7] \left[\frac{\omega'_0 \hat{\alpha}_0 \hat{\mu}_0 L_0 (T_0^D \circ f_1^D + \widehat{T_1^W} \circ f_1^W) e}{\omega'_0 \hat{\alpha}_0 \hat{\mu}_0 L_0 (T_0^D \circ f_0^D + \widehat{T_1^W} \circ f_1^W) e} \times \frac{e' \hat{\mu}_0 L_0 (T_0^D \circ f_0^D + \widehat{T_1^W} \circ f_1^W) e}{e' \hat{\mu}_0 L_0 (T_0^D \circ f_1^D + \widehat{T_1^W} \circ f_1^W) e} \right]$$

$$[8.8] \left[\frac{\omega'_0 \hat{\alpha}_0 \hat{\mu}_0 L_0 (T_0^D \circ f_0^D + \widehat{T_1^W} \circ f_1^W) e}{\omega'_0 \hat{\alpha}_0 \hat{\mu}_0 L_0 (T_0^D \circ f_0^D + \widehat{T_0^W} \circ f_1^W) e} \times \frac{e' \hat{\mu}_0 L_0 (T_0^D \circ f_0^D + \widehat{T_0^W} \circ f_1^W) e}{e' \hat{\mu}_0 L_0 (T_0^D \circ f_0^D + \widehat{T_1^W} \circ f_1^W) e} \right]$$

$$[8.9] \left[\frac{\omega'_0 \hat{\alpha}_0 \hat{\mu}_0 L_0 (T_0^D \circ f_0^D + \widehat{T_0^W} \circ f_1^W) e}{\omega'_0 \hat{\alpha}_0 \hat{\mu}_0 L_0 (T_0^D \circ f_0^D + \widehat{T_0^W} \circ f_0^W) e} \times \frac{e' \hat{\mu}_0 L_0 (T_0^D \circ f_0^D + \widehat{T_0^W} \circ f_0^W) e}{e' \hat{\mu}_0 L_0 (T_0^D \circ f_0^D + \widehat{T_0^W} \circ f_1^W) e} \right]$$

The term [8.1] measures the impact of intra-sectoral changes less skilled labor share of labor income in manufacturing GVCs. Expression [8.2] measures the contribution of the changes in the intra-sectoral labor share of income relative to the capital share of income. Expression [8.3] represents the effects of changes in the trade pattern of intermediate inputs. The term [8.4] measures the contribution of the changes in the composition of output values between intermediate

inputs and value-added. Expression [8.5] indicates the effects of changes in the sectoral compositions of intermediate inputs. Expression [8.6] reflects changes in the trade pattern of final goods that supply domestic demand. The term [8.7] measures the contribution of changes in the amount and composition of domestic demand. While the terms [8.8] and [8.9] are the analogous for terms [8.6] and [8.7], reflecting the changes in trade pattern and amount and composition of foreign final demand, respectively.

The structural change decomposition described in Equation 8 is not unique. There are many different and possible forms of decomposition, depending on how we weight the variables in the computation of each effect. The ideal manner to deal with the multiple possibilities is to compute the average and standard deviation of all possible mechanism. However, Dietzenbacher and Los (1998) find the average of two decompositions symmetric with reversed weights are generally very proximate to the average of all decomposition. Thus, we will also compute a second decomposition with the reversed weights:

$$(9) \quad \frac{\pi_{l1}}{\pi_{l0}} = [9.1] \times [9.2] \times [9.3] \times [9.4] \times [9.5] \times [9.6] \times [9.7] \times [9.8] \times [9.9]$$

$$[9.1] \left[\frac{\omega'_1 \hat{\alpha}_0 \hat{\mu}_0 L_0 \hat{f}_0 e}{\omega'_0 \hat{\alpha}_0 \hat{\mu}_0 L_0 \hat{f}_0 e} \times \frac{e' \hat{\mu}_0 L_0 \hat{f}_0 e}{e' \hat{\mu}_0 L_0 \hat{f}_0 e} \right]$$

$$[9.2] \left[\frac{\omega'_1 \hat{\alpha}_1 \hat{\mu}_0 L_0 \hat{f}_0 e}{\omega'_1 \hat{\alpha}_0 \hat{\mu}_0 L_0 \hat{f}_0 e} \times \frac{e' \hat{\mu}_0 L_0 \hat{f}_0 e}{e' \hat{\mu}_0 L_0 \hat{f}_0 e} \right]$$

$$[9.3] \left[\frac{\omega'_1 \hat{\alpha}_1 \hat{\mu}_0 (I - T_1 \circ A_0^*)^{-1} \hat{f}_0 e}{\omega'_1 \hat{\alpha}_1 \hat{\mu}_0 (I - T_0 \circ A_0^*)^{-1} \hat{f}_0 e} \times \frac{e' \hat{\mu}_0 (I - T_0 \circ A_0^*)^{-1} \hat{f}_0 e}{e' \hat{\mu}_1 (I - T_1 \circ A_0^*)^{-1} \hat{f}_0 e} \right]$$

$$[9.4] \left[\frac{\omega'_1 \hat{\alpha}_1 \hat{\mu}_1 (I - T_1 \circ A_1^*)^{-1} \hat{f}_0 e}{\omega'_1 \hat{\alpha}_1 \hat{\mu}_0 (I - T_1 \circ \tilde{A}_1^*)^{-1} \hat{f}_0 e} \times \frac{e' \hat{\mu}_0 (I - T_1 \circ \tilde{A}_0^*)^{-1} \hat{f}_0 e}{e' \hat{\mu}_1 (I - T_1 \circ A_1^*)^{-1} \hat{f}_0 e} \right]$$

$$[9.5] \left[\frac{\omega'_1 \hat{\alpha}_1 \hat{\mu}_0 (I - T_1 \circ \tilde{A}_1^*)^{-1} \hat{f}_0 e}{\omega'_1 \hat{\alpha}_1 \hat{\mu}_0 (I - T_1 \circ A_0^*)^{-1} \hat{f}_0 e} \times \frac{e' \hat{\mu}_1 (I - T_1 \circ A_1^*)^{-1} \hat{f}_0 e}{e' \hat{\mu}_0 (I - T_1 \circ \tilde{A}_0^*)^{-1} \hat{f}_0 e} \right]$$

$$[9.6] \left[\frac{\omega'_1 \hat{\alpha}_1 \hat{\mu}_1 L_1 (T_1^D \circ f_0^D + \widehat{T_0^W} \circ f_0^W) e}{\omega'_1 \hat{\alpha}_1 \hat{\mu}_1 L_1 (T_0^D \circ f_0^D + \widehat{T_0^W} \circ f_0^W) e} \times \frac{e' \hat{\mu}_1 L_1 (T_0^D \circ f_0^D + \widehat{T_0^W} \circ f_0^W) e}{e' \hat{\mu}_1 L_1 (T_1^D \circ f_0^D + \widehat{T_0^W} \circ f_0^W) e} \right]$$

$$[9.7] \left[\frac{\omega'_1 \hat{\alpha}_1 \hat{\mu}_1 L_1(T_1^D \circ f_1^D + \widehat{T_0^W} \circ f_0^W) e}{\omega'_1 \hat{\alpha}_1 \hat{\mu}_1 L_1(T_1^D \circ f_0^D + \widehat{T_0^W} \circ f_0^W) e} \times \frac{e' \hat{\mu}_1 L_1(T_1^D \circ f_0^D + \widehat{T_0^W} \circ f_0^W) e}{e' \hat{\mu}_1 L_1(T_1^D \circ f_1^D + \widehat{T_0^W} \circ f_0^W) e} \right]$$

$$[9.8] \left[\frac{\omega'_1 \hat{\alpha}_1 \hat{\mu}_1 L_1(T_1^D \circ f_1^D + \widehat{T_1^W} \circ f_0^W) e}{\omega'_1 \hat{\alpha}_1 \hat{\mu}_1 L_1(T_1^D \circ f_1^D + \widehat{T_0^W} \circ f_0^W) e} \times \frac{e' \hat{\mu}_1 L_1(T_1^D \circ f_1^D + \widehat{T_0^W} \circ f_0^W) e}{e' \hat{\mu}_1 L_1(T_1^D \circ f_1^D + \widehat{T_1^W} \circ f_0^W) e} \right]$$

$$[9.9] \left[\frac{\omega'_1 \hat{\alpha}_1 \hat{\mu}_1 L_1(T_1^D \circ f_1^D + \widehat{T_1^W} \circ f_1^W) e}{\omega'_1 \hat{\alpha}_1 \hat{\mu}_1 L_1(T_1^D \circ f_1^D + \widehat{T_1^W} \circ f_0^W) e} \times \frac{e' \hat{\mu}_1 L_1(T_1^D \circ f_1^D + \widehat{T_1^W} \circ f_0^W) e}{e' \hat{\mu}_1 L_1(T_1^D \circ f_1^D + \widehat{T_1^W} \circ f_1^W) e} \right]$$

3.2.2. Data base description

Our data source is the World Input-Output Database (WIOD) Release 2013 that tracks the value of intermediate goods flows between 35 activities (N) including 14 manufacturing industries of 40 countries (C). Although there is a more recent release of WIOD covering the years from 2000 to 2016 we chose to use the previous release because the socio-economic accounts that integrate the WIOD Release 2013 contain industry-level data on the labor share of value-added and hours worked by skill-categories: (i) low skill, for workers with education attainment below high school; (ii) medium skill, for workers that completed high school, including professional qualification but below college graduation; (iii) high skill, for workers that completed tertiary or higher levels of education. Labor income is attributed for each skill level including self-employed and family workers for which an imputation was made in the necessary cases. Capital income is defined as a residual of value-added after the subtraction of labor income.

3.3. Decomposition results

The aggregate decomposition results are presented in Tables 3.1 and 3.2. The first column below each country gives the average effect considering Equations 8 and 9. The second column gives the standard deviation. Table 3.1 shows the aggregate decomposition results for the growth of the less-skilled labor share of value-added to domestically completed GVCs and Table 3.2

shows the same results for foreign completed GVCs. The total line presents the total less-skilled labor share of value-added percentage change between 1995 and 2009.

Table 3.1: Decomposition of the growth of less skilled labor share of value-added in manufacturing Global Value in Chains completed inside the country from 1995 to 2009

<i>Effect</i>	BRA		CHN		IDN		IND		MEX		RUS	
	V	StD	V	StD	V	StD	V	StD	V	StD	V	StD
(1-2) Intra-sector	5.8	2.4	-17.9	1.5	-0.2	0.1	-26.7	0.3	-16.0	0.8	-7.2	0.7
(3-9) Vertical specialization	-0.9	2.3	-5.5	1.7	-5.2	0.1	0.2	0.3	2.5	1.0	-5.4	0.7
Total	4.8	-	-22.5	-	-5.4	-	-26.5	-	-13.9	-	-12.2	-

Source: authors' calculation based on data from WIOD Release 2013.

Table 3.2: Decomposition of the growth of the less skilled labor share of value-added in manufacturing Global Value in Chains completed outside country from 1995 to 2009

<i>Effect</i>	BRA		CHN		IDN		IND		MEX		RUS	
	V	StD	V	StD	V	StD	V	StD	V	StD	V	StD
(1-2) Intra-sector	-4.3	3.1	-24.7	3.2	-3.4	3.9	-30.7	0.6	-15.0	1.3	-6.2	0.6
(3-9) Vertical specialization	-4.0	3.1	-12.1	3.7	-10.5	5.3	-5.7	0.5	-6.4	1.4	-0.9	0.7
Total	-8.3	-	-33.9	-	-13.5	-	-34.8	-	-20.4	-	-7.0	-

Source: authors' calculation based on data from WIOD Release 2013.

The Brazilian less-skilled labor share of value-added increased in the GVCs in which the last stage of production is carried inside the country territory, contrary to the observed in the other countries. In domestically completed GVCs the intra-sector effect was the main influence over the evolution of the Brazilian less-skilled labor share of value-added. The intra-sector effect corresponds to Terms 1 and 2 of Equations 8 and 9 and accounts for the intra-industries changes in the functional distribution of value-added between labor groups and capital. This effect was also the more relevant in the other selected emerging countries, except Indonesia. However, in the other countries, it went in the opposite direction, reducing the less-skilled labor share of value-added.

The vertical specialization effect corresponds to Terms 3 to 9 in Equations 8 and 9 which are related to the structural change of value-added. It had only a modest effect on the less-skilled labor share of Brazilian value-added in domestically completed GVCs. The standard deviation was bigger than the effect value. Whether this effect was positive or negative, depended on the decomposition chosen. The small impact of the vertical specialization in Brazil is explained by the

fact that the Brazilian value-added structure in domestically completed GVCs did not present significant changes during the period (Table 3.iv - Annex 3.II). The sector with larger changes in relative participation were the ‘Textile’, that went from 8% to 5% of total value-added, and the ‘Less knowledge intensive services’, that went from 16% to 19%.

The terms related to structural change were generally higher in the other selected countries. These terms contributed to a further reduction of the less-skilled labor share in China, Indonesia, and Russia. This result is the opposite of the predicted by the traditional HO theory. Since these countries are more less-skilled labor abundant in global terms, vertical specialization given by trade integration was supposed to go towards sectors which are more less-skilled labor intensive and tend to have a higher less-skilled labor share of value-added. The decrease in importance of the ‘Textile’ sector contributed to the decrease in the less-skilled labor share of value-added in most of these countries. This is a sector with a relatively high less skilled labor share of value-added. On the other hand, the increase in importance of the value-added in “Knowledge intensive services” in domestic GVCs in most of these countries contributed to the decrease of the less-skilled labor share, since this activity also have a small and decreasing participation of the less-skilled labor in their value-added. However, in Brazil its increase in value-added participation was small, only 1 percentage point.

Considering the GVCs completed abroad, the evolution of the less-skilled labor share in Brazil was negative, following the general trend also found in Timmer et. al. (2014) for developed and developing countries. The terms related to structural change were more significant for the evolution of the Brazilian less-skilled labor share of value-added to the foreign completed GVCs. The intra-sector effect becomes negative and the absolute value of the vertical specialization effect is bigger. This is due the higher and increasing weight of “Agriculture, hunting, forestry and fishing” and ‘Mining and quarrying’ in total value-added to foreign completed manufacturing GVCs (Table 3.v – Annex 3.II). These two sectors had above average less-skilled labor share of value-added and experienced a sharp decrease in the less-skilled labor share of value-added between 1995 and 2009 (Table 3.ii – Annex 3.II).

We observe that in foreign completed GVCs, the evolution of the less-skilled labor share was generally worse. Hence, GVC insertion as a producer of intermediate inputs for GVCs for which the final product is completed abroad had a stronger negative impact for the less-skilled labor. Generally, sectors that are more relevant in the supply for these chains experienced stronger

decreases on the less-skilled labor share of value-added and vertical specialization was more intensively towards sectors with lower less-skilled labor share. While China, Indonesia and Russia experienced more significant changes in the sectoral structure of the value-added to domestically completed GVCs, their structural change was even more pronounced for the value-added in foreign completed chains. Common to most the developing countries in our sample was the increase in the importance of value-added to foreign completed GVCs produced in the sector ‘Mining and quarrying’ and the reduction of the share of value-added produced in the ‘Textiles’ sector. The stages of production held in the sector ‘Mining and quarrying’ pay among the lowest share of their value-added to the less-skilled labor while ‘Textiles’ are among the highest. The prices of ‘Mining and quarrying’ sector increased during the 2000s influenced by an increase in world demand for those products that characterized the “*commodities boom*”. These price increases contributed both to the gain of importance of this sector in the productive structure measured in nominal terms and to the decrease in the share of value-added appropriated by workers that did not capture the profit gains. Hence, these movements can partially explain the worse evolution of the less-skilled labor share of value-added in foreign completed GVCs.

Table 3.3 and 3.4 split the intra-sector effect in two effects (Terms 1 and 2 of Equations 9 and 9) which we name here as the ‘Less-skilled share of labor income’ and the ‘Labor share of value-added’ effects. The first measures how the evolution of the intra-sector distribution of labor income between skill categories affected the total less-skilled labor share of GVCs value-added. The second measures the effects of the evolution of the distribution of value-added between capital and labor.

Table 3.3: Intra-sectoral effects over the growth of less skilled labor share of value-added in manufacturing Global Value in Chains completed inside the country from 1995 to 2009

<i>Effect</i>	BRA		CHN		IDN		IND		MEX		RUS	
	V	StD	V	StD	V	StD	V	StD	V	StD	V	StD
1. Less-skilled share of labor income	-4.0	0.2	-5.0	0.3	-4.8	0.6	-11.8	0.6	2.4	0.1	-2.5	0.1
2. Labor share of value-added	10.3	2.7	-13.6	1.4	4.8	0.7	-16.9	0.4	-17.9	0.8	-4.8	0.8

Source: authors' calculation based on data from WIOD Release 2013.

Table 3.4: Intra-sectoral effects over the growth of the less skilled labor share of value-added in manufacturing Global Value in Chains completed outside country from 1995 to 2009

<i>Effect</i>	BRA		CHN		IDN		IND		MEX		RUS	
	V	StD	V	StD	V	StD	V	StD	V	StD	V	StD
1. Less-skilled share of labor income	-5.6	0.1	-6.3	0.9	-6.0	1.0	-11.7	0.4	2.9	0.1	-4.5	0.3
2. Labor share of value-added	1.3	3.2	-19.7	2.6	2.8	1.1	-21.5	3.6	-17.3	1.3	-1.7	0.4

Source: authors' calculation based on data from WIOD Release 2013.

Within the intra-sector effect for domestically completed GVCs in Brazil, the factor with the highest impact on the less-skilled labor share of value-added was the total labor share of value-added. The better distribution of value-added between capital and labor in domestically completed GVCs more than compensated the decrease in the less-skilled labor share of labor income. The liberalizing reforms that occurred in Brazil in the 1990s that included privatization, reduction in trade tariffs, and labor market flexibilization led to a decreasing articulation capacity of labor unions and decreasing labor bargain power during this decade (Araújo et al., 2001). However, after 2004, important changes in the conduction of social policy in Brazil with government income transfer programs and the reduction in labor informality increased labor bargain power. This, associated to the substantial real increases of minimum wages, allowed the expansion of labor incomes, especially in the sectors that are more less-skilled labor intensive (Medeiros, 2015, Rugitsky and Carvalho, 2014) increasing the total labor share of the country's value-added to a level above the observed in 1995 (Dias and Urraca-Ruiz, 2019). This effect is also observed in the value-added distribution between labor and capital in domestic manufacturing GVCs.

For the majority of the developing countries analyzed, the variation in the labor share of value-added was the main determinant of the less skilled labor share of value-added in domestically completed manufacturing GVCs. Differently from the observed in Brazil, the intra-

sector evolution of the labor share of value-added had a negative impact on the less-skilled labor share of value-added, except in Indonesia. While these countries also experienced significant increases in minimum wages during the period, labor bargaining power over the value-added generated within productive sectors was decreasing from 1995 to 2009. One hypothesis is that a stronger GVC integration favored by lower import tariffs on intermediate inputs and translated in a higher foreign value-added to domestic GVCs contributed to weaken labor bargain power by posing a threat to capital relocation of productive stages that occur within the country.

Considering the foreign completed GVCs, the labor share of value-added effect is significantly smaller in Brazil. This explains why the intra-sector effect becomes negative in Brazil for the foreign completed GVCs. This difference occurs because the labor share of value-added had a worse evolution on sectors that have a higher value-added participation in foreign completed GVCs as Agriculture and Mining (Table 3.iii – Annex 3.II). The less-skilled labor share of labor income effect is bigger in Brazil for foreign completed GVCs, also contributing for the worse evolution of the less-skilled labor share in those chains.

Table 3.5: Evolution of the less-skilled labor average wage to high-skilled average wage and of the less-skilled labor share of total employment (%)

	Domestically completed		Foreign completed	
	Relative Wages	Relative Employment	Relative Wages	Relative Employment
BRA	38	-3	51	-4
CHN	-41	-3	-19	-3
IDN	49	-2	62	-2
IND	6	-4	12	-3
MEX	25	-1	25	-1
RUS	-10	-3	-4	-2
Average	-12	-3	3	-2

Source: authors' calculation based on data from WIOD Release 2013.

The less-skilled labor share of labor income can vary because of changes in the employment structure or because of changes in relative wages. In Brazil, both in domestic and foreign completed GVCs, the less-skilled share of labor income decreased because of the reduction of less-skilled participation in total employment (Table 3.5). The average wage of the Brazilian less-skilled workers to the high skilled increased from 1995 to 2009 in manufacturing GVCs. The

negative evolution of the relative less-skilled hours worked was a characteristic common to all the countries. While the less-skilled relative average wage decreased in China and Russia.

In many case studies, in different developing countries and different GVCs, it was observed that developing countries GVC insertion in lower value-added stages of production, which are price competitive, allied to the pressure to meet standards set by lead firms, exerts a downward pressure on rents that are transferred more intensively to the less-skilled workers wages and jobs. We do not observe a generalized fall in relative wages of the less-skilled labor in developing countries engaged in production activities of manufacturing GVCs. Labor regulation and a strong increase in minimum wages during the last decade may have alleviate this competitive pressure over less-skilled wages. However, the less-skilled labor received a decreasing share of labor income. That happened because they lost job participation. International trade integration in GVCs may not be the only force destructing less-skilled jobs: less-skilled labor-saving technological change not causally related to international trade is a well-known important driver of this process. But GVC participation in developing countries contributes to this fall in different ways: from technological spill overs carried in imported inputs to reducing permanent less-skilled jobs to comply with the competitive pressures caused by the asymmetric power relation over these chains.

Tables 3.6 and 3.7 splits the ‘Vertical specialization effect’ in its components – Terms 3 to 9 in Equation 9 and 10. In domestically completed GVCs each component was also individually small in Brazil. The ‘Value-added effect’ was the most relevant and contributed to 1.1% decrease in the less-skilled labor share of value-added. This effect measures the change in the composition of the final value of a stage of production between value-added and intermediate inputs. Productive fragmentation increases the importance of intermediate inputs. The way it affects the less-skilled labor share of value-added to manufacturing GVCs within a country depends on the sectors most affected by the composition change. If these are the sectors more less-skilled labor intensive, the effect is expected to be negative because the value-added participation of these sectors will decrease. The importance of value-added relative to intermediate inputs value may also decrease because of competitive pressures over the output of a productive stage, reducing its price. Or yet, value-added participation in the output value can increase because of a rise in the prices of a stage output in relation to its intermediary inputs. What we observe in Brazil is that value-added grew relatively to intermediate inputs value in activities that are high-skilled labor intensive in domestically completed GVCs. This could mean that within the productive stages performed in

Brazil for the domestically completed GVCs: (i) activities with higher less-skilled labor share experience greater fragmentation; or (ii) activities with higher less-skilled labor share experienced worse output price evolution.

Table 3.6: Vertical specialization effects over the growth of less skilled labor share of value-added in manufacturing Global Value in Chains completed inside the country from 1995 to 2009

<i>Effect</i>	BRA		CHN		IDN		IND		MEX		RUS	
	V	StD	V	StD	V	StD	V	StD	V	StD	V	StD
3. Inputs trade pattern	0.4	0.1	-0.3	0.2	-0.8	1.1	1.0	0.1	0.5	0.1	-0.2	0.2
4. Value-added	-1.1	0.3	1.1	0.3	-0.3	0.3	-0.6	0.8	0.7	0.2	-2.1	0.7
5. Inputs composition	-0.8	0.8	-1.3	0.2	-3.0	0.6	0.9	0.6	1.9	0.3	-1.2	0.4
6. Domestic final demand trade pattern	-0.7	1.0	-3.9	3.5	-1.2	1.2	-1.1	2.2	-0.3	1.9	-1.9	1.8
7. Domestic final demand changes	0.3	0.3	1.5	0.6	-1.1	0.7	-0.9	0.0	-4.0	0.5	2.2	1.3
8. Foreign final demand trade pattern	0.2	0.3	-3.0	1.1	0.9	0.6	0.5	0.5	2.4	0.5	-0.2	0.2
9.Foreign final demand changes	0.7	0.4	0.4	0.4	0.3	0.4	0.5	2.6	1.5	2.7	-2.0	3.1

Source: authors' calculation based on data from WIOD Release 2013.

Table 3.7: Vertical specialization effects over the growth of less skilled labor share of value-added in manufacturing Global Value in Chains foreign completed from 1995 to 2009

<i>Effect</i>	BRA		CHN		IDN		IND		MEX		RUS	
	V	StD	V	StD	V	StD	V	StD	V	StD	V	StD
3. Inputs trade pattern	-1.5	1.3	-10.3	3.2	1.3	2.2	-7.8	1.3	10.8	0.8	0.0	0.3
4. Value-added	-1.0	0.4	0.3	0.5	-2.8	1.4	0.8	0.6	-1.0	1.4	-0.4	0.4
5. Inputs composition	-1.1	1.0	-1.8	0.0	-8.9	0.6	1.7	5.0	-6.3	0.2	-0.6	0.6
6. Domestic final demand trade pattern	5.3	6.0	9.1	5.6	5.1	12.1	5.8	4.5	-4.5	10.8	-2.4	5.4
7. Domestic final demand changes	0.3	0.3	1.5	0.6	-1.1	0.0	-0.9	0.7	-4.0	0.5	2.2	1.3
8. Foreign final demand trade pattern	0.2	0.3	-3.0	1.1	0.9	0.5	0.5	0.6	2.4	0.5	-0.2	0.2
9.Foreign final demand changes	-5.6	5.3	-7.1	6.5	-3.6	10.2	-5.2	3.9	-1.8	10.7	0.9	4.3

Source: authors' calculation based on data from WIOD Release 2013.

The direction of Effects 5 to 8 to domestically completed GVCs in Brazil varied depending on the decomposition (Equation 8 or 9) applied to the domestically GVCs. The 'Inputs trade pattern effect' had small but positive effects over the less-skilled labor share meaning Brazil offshored intermediate productive stages that had lower less-skilled labor share. 'Foreign final demand changes effect' also had small but positive effects over the less-skilled labor share. Hence, changes in the amount and composition of foreign final demand caused a structural change in Brazil

towards sectors with higher less-skilled labor share of value-added within domestically completed GVCs.

In foreign completed GVCs the ‘Vertical specialization’ were individually mostly higher and with a greater negative impact on the less-skilled labor share of value-added. The domestic final demand trade pattern, on the contrary, becomes positive. Hence, changes in trade partners that supply domestic final demand in Brazil increased the value-added in Brazilian intermediate productive stages that have higher less-skilled labor share. While changes in the amount and composition of final demand in foreign countries for foreign completed manufacturing goods had the opposite effect (‘Foreign final demand changes effect’). The ‘Inputs trade pattern’ effect also changed its direction. Hence, changes in the Brazilian participation in the supply of intermediate inputs to foreign completed chains decreased value-added participation of intermediate stages that have higher less-skilled labor share of value-added in Brazil.

It is not easy to track a common trend of the ‘Vertical specialization effects’ among the developing countries. The relative importance and direction of each effect varied among these countries. In domestically completed GVCs, the domestic final demand trade pattern effect was generally negative and relatively high, but this effect had also a high standard deviation. The ‘Inputs composition effect’ related to the sectoral participation in total intermediate input use value was generally significant with a lower standard deviation. This effect is associated to technical change but may also reflect changes in relative prices. In foreign completed GVCs, the ‘Inputs trade pattern effect’ is also among the most important effects in China, Indonesia and Mexico, positive in the first two, and negative in the latter. While ‘Domestic trade pattern effect’ and ‘Foreign final demand changes effect’ were significantly high but also with a high standard deviation. The first was positive in most countries except Mexico and Russia and second mostly negative, except in Russia.

Conclusions

The objective of this essay was to investigate which were the main determinants of the evolution, from 1995 to 2009, of the less-skilled labor share of value-added generated in Brazil and incorporated to manufacturing Global Value Chains, in a comparative perspective with other countries. To achieve this goal we applied a structural decomposition of the growth in less-skilled

labor share of income isolating the effects of intra-sectoral changes in the less-skilled labor share of value-added and the effect of vertical specialization. The intra-sectoral effects were further split between (i) intra-sectoral changes in the less-skilled share of labor income; (ii) intra-sectoral changes in the labor share of value-added. The vertical specialization effects were disaggregated between: (iv) changes in intermediate and final goods' trade pattern; (v) technological changes; (vi) changes in the relation between value-added and intermediate use; (vii) changes in the quantities of final demand. We also analyzed separately the GVCs that are completed within the countries territory to those completed abroad.

The evolution of the less-skilled labor share of value-added to manufacturing GVCs showed a different direction in Brazil in GVCs completed within the country territory and GVCs that are completed abroad. We observe that in foreign completed GVCs, the evolution of the less-skilled labor share was generally worse for the developing countries analyzed. Global Value Chain insertion as a producer of intermediate inputs for GVCs for which the final product is completed abroad had a stronger negative impact for the less-skilled labor. Generally, sectors that are more relevant in the supply for these chains experienced stronger decreases on the less-skilled labor share of value-added and vertical specialization was more intensively towards sectors with lower less-skilled labor share.

Contrary to the observed in the other countries, the Brazilian less-skilled labor share of value-added increased in the GVCs in which the last stage of production is carried inside the country territory. In domestically completed GVCs the intra-sector effect was the main influence over the evolution of the Brazilian less-skilled labor share of value-added. Within the intra-sector effect for domestically completed GVCs in Brazil, the factor with the highest impact on the less-skilled labor share of value-added was the total labor share of value-added. The better distribution of value-added between capital and labor in domestically completed GVCs more than compensated the decrease in the less-skilled labor share of labor income. In Brazil, both in domestic and foreign completed GVCs, the less-skilled share of labor income decreased because of the reduction of less-skilled participation in total employment. The average wage of the Brazilian less-skilled workers to the high skilled increased from 1995 to 2009 in manufacturing GVCs.

The vertical specialization had only a modest effect on the less-skilled labor share of Brazilian value-added in domestically completed GVCs. The small impact of the vertical

specialization in Brazil is explained by the fact that the Brazilian value-added structure in domestically completed GVCs did not present significant changes during the period. The terms related to structural change were generally higher in the other selected countries. These terms contributed to a further reduction of the less-skilled labor share in China, Indonesia, and Russia. This result is the opposite of the predicted by the traditional HO theory. Since these countries are more less-skilled labor abundant in global terms, vertical specialization given by trade integration was supposed to go towards sectors which are more less-skilled labor intensive and tend to have a higher less-skilled labor share of value-added.

Considering the GVCs completed abroad, the evolution of the less-skilled labor share in Brazil was negative, following the general trend also found in Timmer et. al. (2014) for developed and developing chains. The terms related to structural change were more significant for the evolution of the Brazilian less-skilled labor share of value-added to the foreign completed GVCs. The intra-sector effect becomes negative and the absolute value of the vertical specialization effect is bigger. This is due the higher and increasing weight of “Agriculture, hunting, forestry and fishing” and ‘Mining and quarrying’ in total value-added to foreign completed manufacturing GVCs. These two sectors had above average less-skilled labor share of value-added and experienced a sharp decrease in the less-skilled labor share of value-added between 1995 and 2009. Considering the foreign completed GVCs, the labor share of value-added effect is significantly smaller in Brazil. This explains why the intra-sector effect becomes negative in Brazil for the foreign completed GVCs. This difference occurs because the labor share of value-added had a worse evolution on sectors that have a higher value-added participation in foreign completed GVCs as Agriculture and Mining.

Regarding these results, we find no support for the HO theory that developing countries increasing integration to GVCs are associated to vertical specialization in sector that are more less-skilled intensive. On the other hand, given the determinant impact of the evolution of the total labor share of value-added, our results support that the effects of productive fragmentation over labor bargaining power is one important factor driving down the less-skilled labor share of GVCs value-added. This fall is aggravated by the decrease in the less-skilled participation in total GVC employment.

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ANNEX 3.I – EDUCATION ATTAINMENT

Table 3.i: Highest level completed (% 15+)

	Primary or none		Secondary		Tertiary	
	1995	2010	1995	2010	1995	2010
BRA	84	64.3	12.3	30.1	3.7	5.6
CHN	71.5	72.7	26.6	24.6	1.9	2.7
IDN	88.2	71.6	10.7	24.8	1.2	3.7
IND	87.1	66.5	9.6	28.7	3.4	4.9
MEX	75	64	19.9	26.2	5.1	9.8
RUS	34.5	17.3	52.2	58.3	13.3	24.7

Fonte: Barro and Lee (2013).

ANNEX 3.II – INDUSTRY DATA ON VALUE-ADDED STRUCTURE AND THE LESS-SKILLED LABOR SHARE OF VALUE-ADDED

Table 3.ii: Less-skilled labor share of value-added by industry

	BRA			CHN		IDN		IND		MEX		RUS		AVG		
	1995	2009	Δ	1995	2009	1995	2009	1995	2009	1995	2009	1995	2009	1995	2009	Δ
Agriculture, hunting, forestry and fishing	36	30	-6	87	95	18	20	24	17	16	13	41	45	34	34	0
Mining and quarrying	28	20	-8	46	33	14	11	39	20	5	3	49	42	30	23	-7
Food, beverages and tobacco	36	51	15	27	29	22	22	28	23	24	18	37	39	26	26	0
Textiles and textile	22	43	21	46	41	28	25	26	35	34	38	62	51	37	36	0
Leather, leather and footwear	58	65	7	54	42	38	42	32	32	37	36	62	51	41	38	-2
Wood and of wood and cork	29	37	8	45	35	26	23	19	30	24	26	45	34	28	29	0
Pulp, paper, paper , printing and publishing	37	33	-4	53	32	24	26	21	17	18	18	42	41	29	27	-2
Coke, refined petroleum and nuclear fuel	17	12	-5	20	26	14	22	4	2	13	12	18	20	12	16	5
Chemicals and chemical	31	31	0	35	26	36	31	14	6	20	17	26	35	25	25	0
Rubber and plastics	39	41	3	41	32	33	35	15	23	35	32	76	40	37	32	-5
Other non-metallic mineral	33	36	3	47	34	28	28	26	17	24	17	44	34	31	26	-5
Basic metals and fabricated metal	31	31	0	47	26	21	27	27	10	21	13	44	38	30	24	-6
Machinery, nec	46	49	3	43	34	40	36	44	18	69	39	58	53	45	35	-10
Electrical and optical equipment	34	40	6	40	29	24	22	27	12	38	37	57	48	34	30	-4
Transport equipment	48	52	4	39	35	28	29	23	6	28	28	64	37	34	29	-5
Manufacturing nec; recycling	25	28	3	34	21	26	28	25	32	33	36	49	48	31	32	2
Electricity, gas and water supply	30	13	-17	26	20	20	26	21	23	21	21	18	16	20	20	0
Construction	26	36	10	68	49	48	32	70	65	30	34	61	39	48	40	-8
Less knowledge intensive services (LKIS) ¹	35	36	1	44	20	23	24	21	17	19	17	34	35	25	21	-4
Knowledge intensive services (KIS) ¹	23	16	-7	30	22	22	19	14	9	27	21	33	30	24	19	-6

Source: WIOD Release 2013.

Note: ¹ average of activities weighted by the value-added to manufacturing GVCs – aggregation adapted from Eurostat (2016).

Table 3.iii: Labor share of value-added by industry

	BRA			CHN		IDN		IND		MEX		RUS		AVG		
	1995	2009	Δ	1995	2009	1995	2009	1995	2009	1995	2009	1995	2009	1995	2009	Δ
Agriculture, hunting, forestry and fishing	40	33	-6	88	95	18	21	25	18	17	13	46	51	38	40	1
Mining and quarrying	41	36	-5	46	35	16	14	45	27	7	5	56	51	34	26	-8
Food, beverages and tobacco	44	61	17	28	30	25	25	31	26	28	20	40	43	30	29	-2
Textiles and textile	28	52	25	46	42	31	28	28	40	36	40	68	57	42	41	0
Leather, leather and footwear	72	79	7	54	42	42	48	35	37	42	40	68	57	48	45	-3
Wood and of wood and cork	41	54	13	46	36	29	26	20	31	31	33	53	41	36	33	-2
Pulp, paper, paper , printing and publishing	52	48	-4	53	34	26	29	27	30	27	27	49	49	37	34	-3
Coke, refined petroleum and nuclear fuel	24	18	-6	21	29	15	25	6	5	22	20	21	23	17	21	4
Chemicals and chemical	44	46	2	36	29	39	35	23	16	35	29	31	42	33	30	-3
Rubber and plastics	55	60	5	42	33	37	40	20	31	41	37	89	48	46	38	-8
Other non-metallic mineral	47	53	5	48	35	31	32	28	20	35	24	52	41	38	30	-8
Basic metals and fabricated metal	44	45	1	49	28	23	31	33	14	29	18	51	46	37	27	-10
Machinery, nec	65	72	7	44	37	44	41	56	34	78	44	68	63	58	44	-14
Electrical and optical equipment	52	59	8	42	33	27	25	44	24	45	43	67	57	45	36	-9
Transport equipment	72	77	5	41	39	31	33	31	14	32	31	75	44	42	32	-10
Manufacturing nec; recycling	37	41	5	34	22	28	32	26	35	38	42	54	53	36	37	1
Electricity, gas and water supply	48	25	-23	28	25	23	32	27	43	35	30	20	20	26	30	4
Construction	31	43	12	69	51	53	37	75	71	45	38	71	46	62	49	-14
Less knowledge intensive services (LKIS) ¹	42	47	5	46	25	25	35	25	21	25	22	41	44	32	29	-3
Knowledge intensive services (KIS) ¹	48	44	-4	35	33	38	27	41	30	38	31	49	53	40	35	-5

Source: WIOD Release 2013.

Note: ¹ average of activities weighted by the value-added to manufacturing GVCs -- aggregation adapted from Eurostat (2016).

Table 3.iv: Industry composition of the value-added to manufacturing GVCs completed domestically (%)

	BRA			CHN		IDN		IND		MEX		RUS		Average		
	1995	2009	Δ	1995	2009	1995	2009	1995	2009	1995	2009	1995	2009	1995	2009	Δ
Agriculture, hunting, forestry and fishing	10	9	-1	17	13	19	19	17	13	8	6	12	9	15	12	-3
Mining and quarrying	2	3	1	4	4	1	6	3	3	11	10	4	4	5	5	1
Food, beverages and tobacco	11	10	-1	10	9	18	22	5	5	17	23	18	22	14	16	3
Textiles and textile	8	5	-3	9	6	10	6	8	7	3	3	3	1	7	5	-2
Leather, leather and footwear	2	1	-1	2	2	2	1	1	1	1	1	0	0	1	1	0
Wood and of wood and cork	1	0	-1	1	1	1	1	1	1	0	0	1	0	1	1	0
Pulp, paper, paper , printing and publishing	2	2	0	2	1	2	1	2	1	3	2	2	2	2	1	-1
Coke, refined petroleum and nuclear fuel	2	4	2	1	1	2	2	2	2	2	2	1	6	2	3	1
Chemicals and chemical	6	7	1	5	4	5	4	4	5	6	4	3	2	5	4	-1
Rubber and plastics	2	2	0	2	2	2	1	1	1	1	1	1	1	1	1	0
Other non-metallic mineral	1	0	-1	3	1	1	0	1	0	2	2	2	1	2	1	-1
Basic metals and fabricated metal	5	5	0	7	7	1	0	7	6	4	3	5	4	5	4	-1
Machinery, nec	4	5	1	6	7	2	1	4	4	1	1	6	5	4	4	0
Electrical and optical equipment	6	4	-2	6	9	6	8	3	4	5	4	4	3	5	6	1
Transport equipment	6	7	1	4	5	12	9	5	5	8	8	7	6	7	7	-1
Manufacturing nec; recycling	3	3	0	1	1	2	2	2	4	1	2	2	2	2	2	1
Electricity, gas and water supply	2	3	1	2	3	0	1	4	2	1	1	4	3	2	2	0
Construction	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Less knowledge intensive services (LKIS) ¹	16	19	3	12	12	11	12	21	23	16	16	20	21	16	17	1
Knowledge intensive services (KIS) ¹	10	11	1	6	10	5	4	8	11	9	10	3	8	6	9	2

Source: authors' calculation based on data from WIOD Release 2013.

Note: ¹aggregation adapted from Eurostat (2016).

Table 3.v: Industry composition of the value-added to manufacturing GVCs foreign completed (%)

	BRA			CHN		IDN		IND		MEX		RUS		Average		
	1995	2009	Δ	1995	2009	1995	2009	1995	2009	1995	2009	1995	2009	1995	2009	Δ
Agriculture, hunting, forestry and fishing	14	19	5	14	7	10	12	20	13	6	4	2	1	10	7	-3
Mining and quarrying	4	11	7	7	6	23	38	6	10	19	28	24	31	16	23	7
Food , beverages and tobacco	5	5	0	2	2	3	9	1	1	1	1	0	0	1	3	1
Textiles and textile	2	1	-1	11	6	9	3	7	2	1	1	0	0	6	2	-3
Leather, leather and footwear	1	1	0	1	1	1	0	2	0	0	0	0	0	1	0	-1
Wood and of wood and cork	1	1	0	1	1	4	1	1	0	1	0	1	0	2	0	-1
Pulp, paper, paper printing and publishing	4	3	-1	2	1	4	2	2	0	2	1	2	1	2	1	-1
Coke, refined petroleum and nuclear fuel	1	2	1	1	1	4	5	1	2	0	1	1	5	1	3	1
Chemicals and chemical	6	4	-2	5	6	6	4	7	6	3	3	4	2	5	4	-1
Rubber and plastics	2	2	0	3	3	4	3	1	1	1	1	0	0	2	2	0
Other non-metallic mineral	1	1	0	2	1	0	0	3	1	1	1	1	0	1	1	-1
Basic metals and fabricated metal	14	8	-6	9	9	3	2	6	8	8	9	12	6	8	7	-1
Machinery, nec	2	1	-1	3	4	1	1	1	2	1	1	1	1	1	2	0
Electrical and optical equipment	2	2	0	9	13	2	3	3	5	4	6	1	1	4	6	2
Transport equipment	5	2	-3	2	3	1	2	2	3	7	8	1	0	3	3	1
Manufacturing nec; recycling	0	0	0	1	1	0	0	2	3	3	1	0	0	1	1	0
Electricity, gas and water supply	3	3	0	3	3	0	0	4	2	1	1	5	4	3	2	-1
Construction	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0
Less knowledge intensive services (LKIS) ¹	19	21	2	18	18	14	10	24	21	31	24	42	36	26	22	-4
Knowledge intensive services (KIS) ¹	13	14	1	8	14	9	3	8	18	9	9	4	9	8	11	3

Source: authors' calculation based on data from WIOD Release 2013.

Note: ¹ aggregation adapted from Eurostat (2016).

Concluding remarks

The main objective of this research was to investigate the determinants of the evolution of less-skilled workers share of Brazilian value-added to manufacturing GVCs, in a comparative perspective with other middle-income countries (China, India, Indonesia, Mexico and Russia). This objective was initially motivated by a comprehensive study held by Timmer et. al. (2014), covering 560 production chains, that found that between 1995 and 2009, there was a shift in the functional distribution of the value-added in GVCs in favor of high skilled labor and capital, in both developed and developing countries. This finding was considered by the authors a paradox regarding the mainstream international trade theory largely based on Heckscher-Ohlin model. This theory predicts that international trade integration would also favor the less-skilled workers in developing countries, reducing unemployment, inequality, and poverty. Concurrently, international organizations, as World Bank and OECD, have consistently prescribed trade liberalization and higher GVC integration as means to increase developing country's productivity, economic growth, job generation and living standards. Thus, to understand the circumstances and channels through which productive fragmentation affect the poorer is one important step so that international economic integration can be conducted in favor of an inclusive economic growth.

Our results show that the Brazilian participation in GVCs increased from 1995 to 2009. Brazilian GVC participation sourcing intermediates inputs to products finished abroad was around average while its participation as an importer of intermediate inputs was indeed low relative to other developing countries in our sample. On the other hand, the less-skilled labor share of value-added in GVCs in Brazil was above the average of the group of middle-income countries analyzed in both foreign and domestically completed GVCs. This was explained by the above average total labor share of value-added to GVCs.

The evolution of the less-skilled labor share of value-added was better than the observed across the other countries. Vertical specialization effects were less significant in Brazil, as the Brazilian production structure linked to manufacturing GVCs were more rigid, especially for the domestically completed chains. But contrary to the predictions of the HO theory, vertical specialization generally went towards less-skilled labor-intensive sectors in the developing countries analyzed. The main factor behind the distinctive evolution of the less-skilled labor share

of value-added in Brazil was the more favorable evolution of the intra-sector total labor incomes relative to capital incomes. We also found that the level of foreign value-added share in domestically completed GVCs was negatively associated to the labor share of value in these GVCs among the developing countries analyzed. This result is compatible with hypothesis that GVC integration reduces labor bargaining power. However, further investigation about the causality between these variables is left for future research.

In Brazil, real minimum wage increases, the high level of government spending in social protection and a stabilized level of workers collective organization and action strengthened worker's position during the 2000's contributing to the rise in the less-skilled labor share of the value-added, despite the persistent high level of structural unemployment, especially among the less-skilled. Strong real minimum wage increases from 1995 to 2009 was not an exclusive feature of Brazil and may explain why the less-skilled labor average wages increased relative to the high skilled average in the other countries. Hence, we did not find that a generalized increase in wage inequality, as expected by the hypothesis that GVC insertion in lower-value stages of production affect more intensively the wages of the poor. Wage inequality increased only in China and Russia.

However, while the lower level of trade opening in Brazil may have contributed to sustain a higher level of workers bargain power, in the 2000s, it did not help the generation of job positions lost in the 1990s and the Brazilian unemployment remained high through this decade, especially for the less skilled. In manufacturing GVCs, the less-skilled labor share of labor incomes in Brazil decreased because of the reduction in the share of hours worked by the less-skilled labor. The decrease in the intra-sector participation of less-skilled labor in total employment was also observed in all the other countries, but it was particularly high for Brazil in the domestically completed GVCs.

The consequence of lagging behind the productive fragmentation process would be the weakening of competitiveness in international trade by not accessing the opportunities for knowledge absorption and the lower costs given by a deeper international division of production tasks. Missing the opportunity to integrate, Brazil would be missing the opportunity to grow, create jobs and to increase living standards of its citizens. However, there are problems with this reasoning: (i) there is not a one direction link between trade or GVC integration and job generation and growth; (ii) increasing productivity and economic growth does not guarantee better living standards for all. During the 1990s, trade opening in Brazil was associated to increasing

unemployment. Besides, even in cases where GVC insertion increases productivity and is accompanied by an increase in the participation of more technology intensive sectors that are associated to higher value-added, workers were receiving a decreasing piece of the pie. Developing countries face two major challenges for an effective GVC insertion: (i) increasing their capacity to generate, capture and protect rents within their production activities; (ii) ensuring that the increased rents are more evenly distributed among labor segments and capital.

The integration of middle-income countries to these fragmented production networks exerts degrading pressures on labor markets that need to be counterbalanced by an economic development strategy and social policies to strengthen workers bargain power. Furthermore, the fact that there is a potential compensation for the main disadvantaged in the path of economic integration does not mean that these will be compensated in practice (Antras et al., 2017). Mayer and Pickles (2010) advocate for the role of governance institutions in promoting better working conditions. The authors refer to institutions of governance as public institutions related to government policies and regulations; in the form of social norms and standards established by companies; international and non-governmental organizations, social movements and consumer demand for social responsibility. However, Nadvi (2008) reports that even after a decade of collective action among global buyers, government and international institutions for the prevention and monitoring of child labor, cluster production and supply and production of soccer balls in Pakistan remained prone to the use of labor child. Riisgaard (2009) shows that the adoption of private labor standards by leading companies in the flower industry had limited impact on working conditions. Private standards treat working conditions as independent of the governance structure of the value chain, where cost cutting strategies and rigid supply deadline requirements promote work flexibility rather than organization.

Income redistribution cannot be dissociated to redistribution of power. Selwyn (2013) argues that advances for workers in GVCs must come from the collective action of firms, states and international organizations. The author advocates a "bottom-up" approach in which changes in working conditions are conditioned by the relative power of workers and, therefore, labor organizations play a central role. However, empowering labor organizations in the context of globally fragmented production systems is a paradox if we consider that the systematic value accumulation away from labor as a structural element of GVCs. As argued by Baglioni et. al. (2019, p. 4) "*GVCs are not technical divisions of labor [where developing countries 'learn to make*

things’], but extended, political organizations founded on the continuous expansion and capture of value away from labor and weaker capitals”. Baglioni et. al. (2019) points that GVCs governance and knowledge concentrations through power relations are among the root causes of this movement of value away from labor. It creates an uneven development, redistributing value to corporate executives and asset owners and deteriorating the conditions for working class collective empowering. In this analysis, GVC integration as a path to inclusive economic growth becomes an illusion.

It is not within the scope of this thesis to give policy solutions to this paradox, but to shed light on the limitations of GVC integration as a pathway to foster an inclusive economic growth in Brazil. One import limitation of this study concerns the database. We used world input-output databases in order to have a more comprehensive picture of the labor market changes within the fragmented production systems, contrasting with most studies on the social consequences of GVC insertion that rely on study cases. But the world input-output data is still very aggregated at the industry level to distinguish tasks as assembly or product design within a stage of production. Another limitation is that it only had data on the distribution of income between labor skill categories until 2009. Further research includes updating the analysis for the more recent period when the data becomes available. Additional issues we would like to address are: (i) the causality between GVC insertion and labor incomes and jobs, which is still little explored at the country level in the GVC literature; (ii) the behavior of less-skilled labor incomes and jobs within GVCs in absolute terms, as we narrowed the scope of this study to their relative position.

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