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Global Value Chains: What are the Benefits and Why Do Countries Participate?

Prepared by Anna Ignatenko, Faezeh Raei, Borislava Mircheva

Authorized for distribution by Laura Papi

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Abstract

Over the last two decades, world trade and production have become increasingly organized around global value chains (GVC). Recent theoretical work has shown that countries can benefit from participation in GVCs through multiple channels. However, little is known empirically about the economic importance of supply chains. We use the Eora MRIO database to compute different measures of GVC participation for 189 countries and illustrate global patterns of supply chains as well as their evolution over time in order to contribute to this topic. We find that GVC-related trade, rather than conventional trade, has a positive impact on income per capita and productivity, however there is large heterogeneity and the gains appear more signifcant for upper-middle and high-income countries. We document that "moving up" to more high-tech sectors while participating in major supply chains does take place but is not universal, suggesting other factors matter. We confirm the findings of the standard gravity literature for GVC trade; highlighting the key role of institutional features such as contract enforcement and the quality of infrastructure as determinants of GVC participation.

Author's E-Mail Address: aignatenko@ucdavis.edu; fraei@imf.org; bmircheva@imf.org

CONTENTS

I. Introduction[1]

Over the last two decades, trade and production have become increasingly organized around

what is commonly referred to as global value chains (GVC) or global supply chains. The advances in information and transportation technologies as well as falling trade barriers have allowed firms to unbundle production into tasks performed at different locations to take advantage of different factor costs (Feenstra and Hanson 1997; Grossman and Rossi-Hansberg 2008). Such production fragmentation means that intermediate goods and services cross borders several times along the chain, often passing through many countries more than once. These complex global production arrangements have changed the nature of trade (Figure 1).
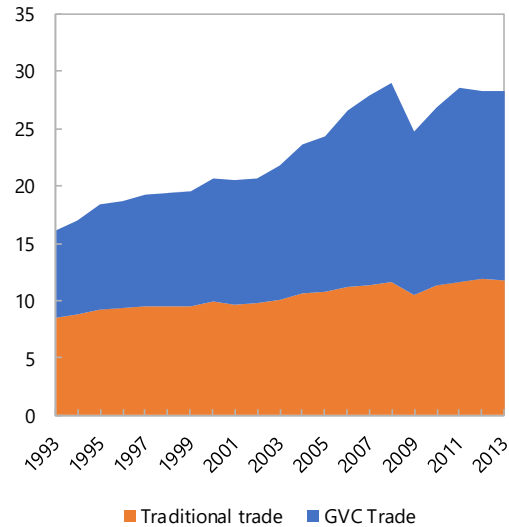
Although the welfare consequences of international trade have been largely studied in both the theoretical and empirical literature, effects of participation in GVCs remain less-explored.

Figure 1. Traditional and GVC Trade
(Percent of nominal world GDP)

Sources: Authors' calculations based on Eora database. Traditional trade comprises exports of goods and services that are produced in one country and absorbed in the destination.

In developed economies, GVCs provide access to more competitively priced inputs, higher variety, and the economies of scale (Baldwin and Lopez-Gonzalez, 2013). Meanwhile, for emerging economies GVCs are viewed as a fast track to industrialization. Baldwin (2011) argues that internationally fragmented production allows emerging economies to join existing supply chains instead of building them. With increased sophistication of goods, joining a supply chain removes the need to gain comparative advantage in a broad range of production stages domestically.

Theoretical literature offers support for these views. Studies have shown that productivity gains associated with offshoring and GVCs can arise through multiple channels: finer division of labor across countries (Grossman and Rossi-Hansberg 2008), availability of greater input varieties (Halpern, Koren, and Szeidl 2015), increased competition, learning externalities, and technology spillovers (Li and Liu (2014), Kee (2015)). While some of these gains are associated with conventional trade as well, welfare gains can theoretically be larger if one uses a multiple-sector framework and considers the input-output linkages (e.g., Caliendo and Parro 2015, Ossa 2015).

Empirical investigations of the aforementioned effects of GVC participation have been limited, but this area of research is expanding with increasing availability of data. Earlier

empirical work on GVCs documented the considerable rise in fragmentation of production. Seminal works by Hummels, Ishii, and Yi (2001) and Hummels, Rapoport and Yi (1998) show that GVCs are responsible for a large share of trade growth in world trade from 1970-1990s. Works by Johnson and Noguera (2012) and Baldwin and Lopez-Gonzales (2013) show that this growth accelerated further in 2000-09. The pace of expansion of supply chains slowed in the aftermath of global financial crisis, contributing to an important part of the trade slowdown in this period (IMF, 2016a). A key step in the analysis of GVCs was put forward by seminal works of Koopman and others (2014) and Wang and others (2013) who proposed methodologies to break-down gross trade flows to origins of value-added. Since then such data and methodology have become available to researchers through several initiatives. These include the Trade in Value-Added Statistics (covering 63 countries), the World Input Output Database (43 countries), and most recently the Eora Multi-Region Input-Output (MRIO) database (henceforth referred to as Eora (Lenzen and others, 2013) for 189 countries. With availability of these data, the focus is shifting to analyzing the impacts of GVCs on economic outcomes (Constantinescu and others, 2017; World Bank 2016, and 2017).

Covering countries across different income levels, the EORA database provides an opportunity for a more comprehensive study of the impact of GVCs on income growth and convergence. Although the narrative of convergence and growth through supply chains has been around for a while, especially for China and some Asian countries (Figure 2), a systematic study of such links has been incomplete due to data limitations. As will be discussed in section IV, so far uncovering a causal relation has been challenging given the smaller number of countries in other databases.

Figure 2. GVCs and Economic Development

1. GVC and Income per Capita

2. GVC and Convergence
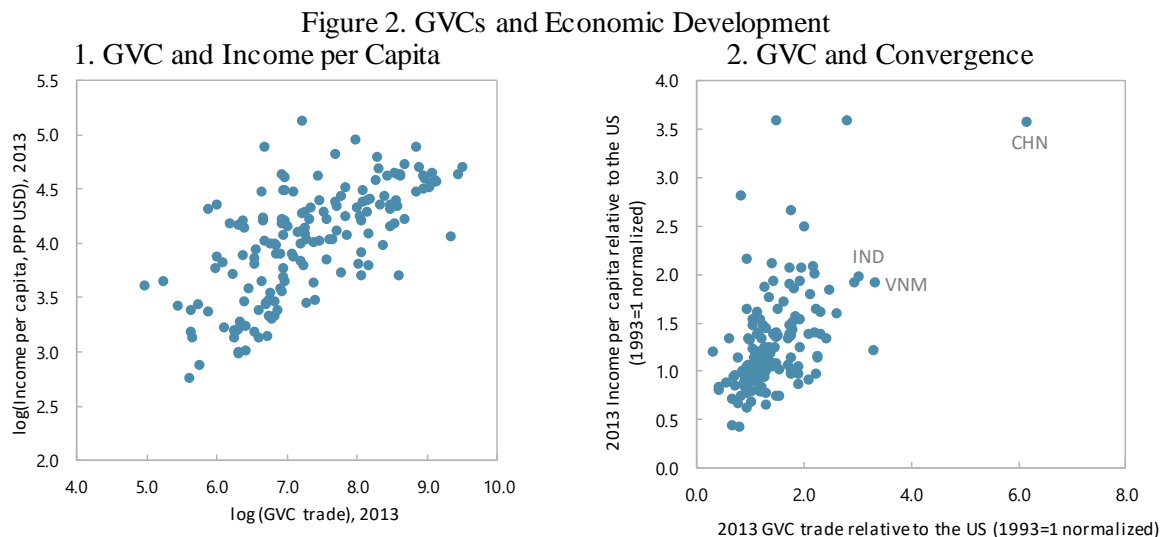
Sources: Authors' calculations and Eora database.

This paper contributes to the growing literature on the economic consequences of countries' participation in GVCs, by constructing indicators of GVC participation and position for 180 economies at the country, sectoral, and bilateral levels.

Our main findings are:

- Participation in GVCs has a positive impact on income per capita, as well as its components, investment and productivity.

- Importantly, we find that these gains are related to GVC trade and not to conventional trade. The results appear robust to endogeneity and reverse causality.

- The gains from GVC participation, however, are not automatic. There is large degree of heterogeneity. The upper-middle and high-income countries appear to be benefiting from such participation, while we find less robust effects for low and lower-middle income countries.

- The relationship between upstreamness in GVCs and economic development is not straightforward. While financial and business services tend to be upstream and high in value-added, the link is less clear in manufacturing.

- We document that "moving up" to more high-tech sectors as a result of participation in major supply chains does take place but is not universal, suggesting that gains are likely conditional on other factors.

- We also confirm the findings of the standard gravity literature for GVC trade; highlighting the key role of institutional features such as contract enforcement and the quality of infrastructure as determinants of GVC participation.

To our knowledge, this paper is one of few papers focusing on this angle. Several studies provide evidence that GVC participation such as the use of higher foreign value-added in exports is associated with the growth of domestic value-added in the participating sectors (Rahman and Zhao, 2013; Kummritz, 2016; World Bank, 2016). Nonetheless, it remains a moot question what the broader macroeconomic impacts are on income and whether they are economically significant. Our results are in line with previous findings and further shed light on the macroeconomic angles.

The rest of the paper is organized as follows: section II briefly describes the data and the methodology employed in calculating GVC participation measures. Section III present stylized facts. Section IV explores the empirical relationship between GVC participation and income, as well as its components. Section V explores the determinants of bilateral GVC participation and Section VI concludes.

II. DATA

The core dataset used for this study is the Eora Multi-Regional Input-Output (MRIO) database, which provides data on input-output linkages between 189 countries and 26 sectors (including services) over the period 1990-2013 (see Annex Table 1 for list of sectors). The input-output linkages data is used to compute several measures of GVC participation.

We adopt a methodology developed by Koopman and others (2011) and described in Aslam and others (2017) to decompose gross exports to value-added components based on the

location of value-added creation and its purpose. As illustrated in Figure 3, gross exports are decomposed into two broad components: the foreign value-added (FVA) embedded in gross exports of a country (backward linkages) and the domestic value-added in exports (DVA). The latter part is further decomposed into exports that are absorbed in the destination country and those that are further used as intermediate inputs for exports to third countries (forward linkages) or returned home.

Figure 3. Decomposition of Gross Exports into Value-added Exports
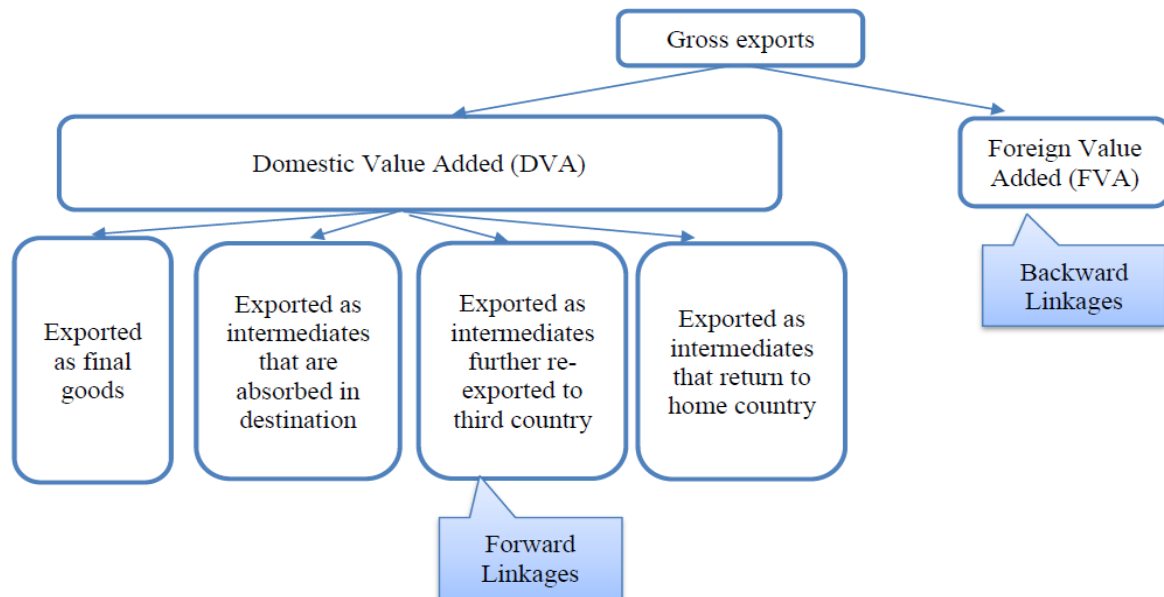
Sources: Koopman and others (2011), Rahman and Zhao (2013), Aslam and others (2017).

Based on this decomposition, the two measures of GVC *participation* (vertical specialization) are defined as: *Backward linkages* - the share of foreign value-added in total exports of a country; *Forward linkages* -s the domestic value-added embodied in intermediate exports that are further re-exported to third countries, expressed as a ratio of gross exports.

While backward linkages, also known as foreign value-added exports is a common measure of GVC integration, the forward linkages measure is less widely used and known. As we will discuss in section III, it is important to utilize both measures to understand the nature of vertical specialization. For example, as will be seen in Secttion III, forward linkages are more useful in understanding GVC participation of the service sector. Throughout the paper, GVC participation is defined as the sum of forward and backward linkages, unless otherwise stated.

In addition to GVC participation measures, we also calculate indices that measure countries' and sectors' *positions* in the value chains (Koopman and others, 2014; Antras and others, 2012). At the industry level, the *Upstreamness index* reflects the number of production stages, that the output of that industry has to go through before it reaches the final consumers. Intuitively, upstream industries contribute more value-added to other countries/sectors than

others contribute to them, or in other words, their value-added trickles down and travels down to other sectors before reaching the final consumers. On the other hand, the _**Downsteamness index**_ reflects the number of production stages embodied in a good produced within a sector. As a result, the larger this indicator is, the more complex the production process of the final product is. Consequently, Downstreamness can be considered a proxy for the complexity of the production technology for a specific final product. Of course, two countries can have identical values of the GVC position index in a sector while having very different degrees of participation in GVCs. Therefore, the position index should be used in conjunction with participation indices, which summarize the importance of GVCs in the economy.

In the next section, we provide some stylized facts regarding the participation and position of countries and sectors in GVCs.

III. STYLIZED FACTS

Figure 4 illustrates the rising trend in GVC participation—measured as the sum of the so-called forward and backward linkages in vertical specialization. Between 2000 and 2013, the share of exports that were involved in GVC trade increased from about 60 to 70 percent in Europe. Over the same period, this ratio increased on average by 5 percentage points in Asian and Western Hemisphere countries. Even though, there is significant heterogeneity across and within regions, Europe is highly integrated through GVCs, reflecting the European Union's (EU) status

Figure 4. GVC Participation Index
(Percent of exports, sum of forward and backward linkages)
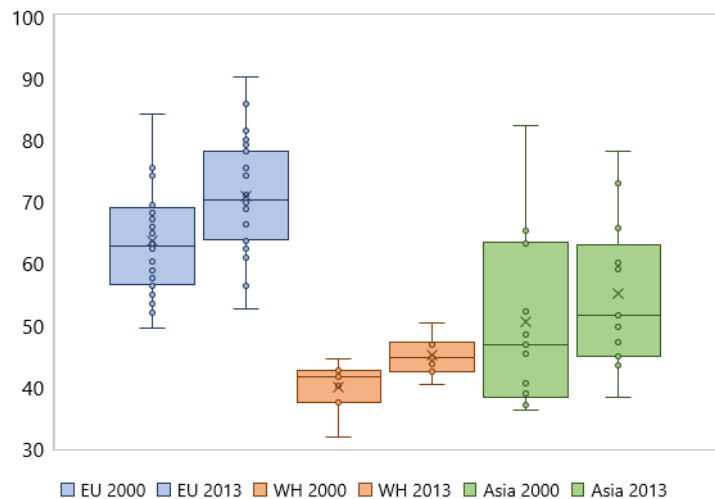
Sources: EORA Database; and IMF staff calculations.
Note: GVC = global value chain; WH = western hemisphere, comprising the US, Canada, Mexico, Argentina, Brazil, Chile, Colombia, Peru, Venezuela. Dots represent countries, and the box reflects the 25−75th percentiles.

as a single market and free trade zone. In addition, the foreign production linkages of the Euro Area are comparable in magnitude with those of other important trade blocks, including China, with an increasing participation of services in the value chains (Amador et al., 2015).

Figures 5 and 6 map the backward and forward linkages measures in 2013. Darker greens reflect higher values of GVC measures. A couple of points are worth noting. In Figure 5, Europe as a region stands out as highly integrated and so does southeast Asia. Small open countries tend to have more backward linkages. In Figure 6, the forward linkages paint a somewhat different picture. Commodity exporters such as Russia and countries in the Middle East and Africa exhibit high values of forward linkages measures, reflecting the fact that exports of commodities from these countries are inputs in other countries' production and

travel along GVCs. Countries with high forward linkages tend to be upstream in GVCs. However, countries with high forward linkages are not limited to commodity exporters. The United States exhibits high values in Figure 6 due to large exports of business and financial services that tend to be used as intermediate inputs in GVCs.

Figure 5. Intensity of Backward Linkages in the World
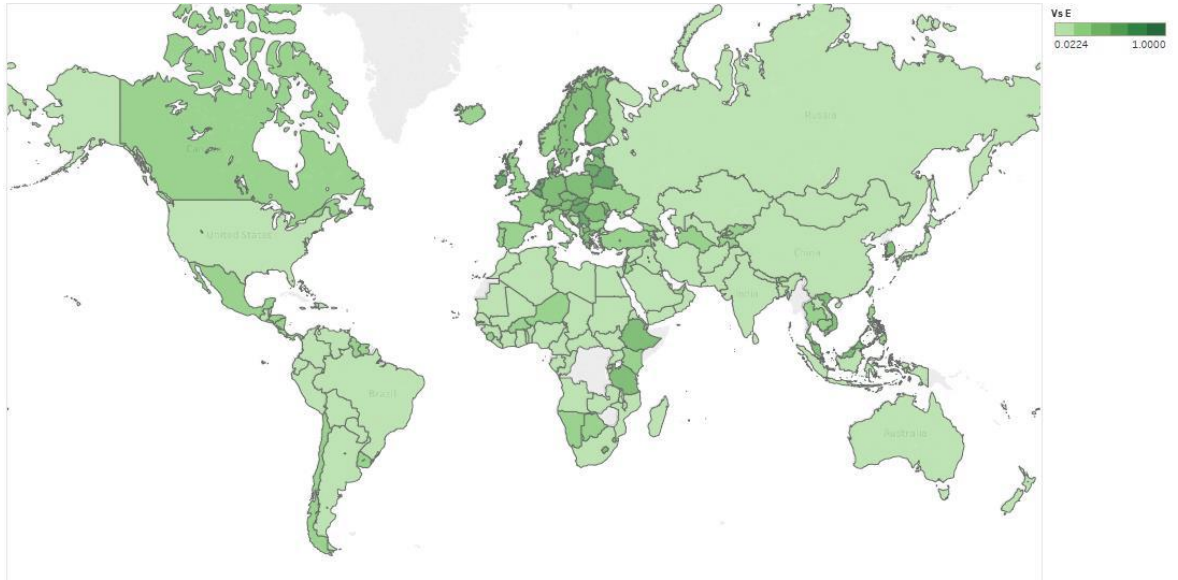
Source: Authors' calculations and Eora database.

Figure 6. Intensity of Forward Linkages in the World
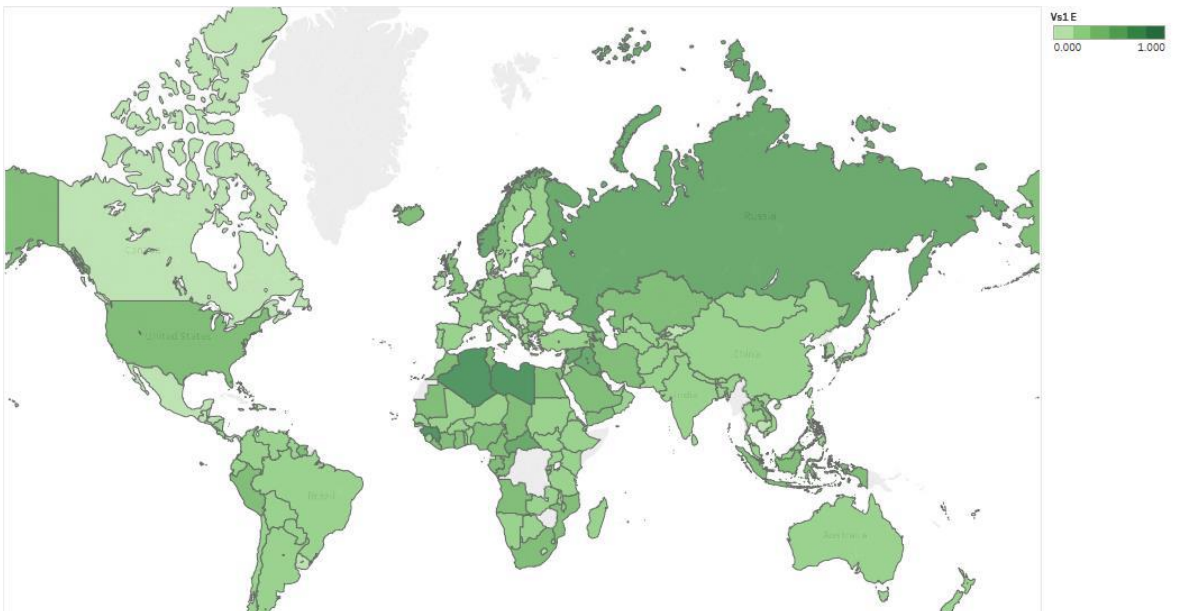
Source: Authors' calculations and Eora database.

From the perspective of economic sectors, the rise of GVC trade in services and the so-called *servicification* of manufacturing exports has been an important trend. The share of services exports in total world exports increased by 5 percentage points over 2000-13 (Figure 7). More importantly, when measured in value-added terms, the share of services exports in world exports is almost twice as large as what official statistics on gross exports show (Figure 7). The difference between the two concepts reflects the fact that a part of manufacturing exports is value-added by the services sector. This is in line with the findings of IMF (2018) on the rise of *servicification* of manufacturing.

Figure 7. Share of Service Sector Exports in World Trade (Percent)
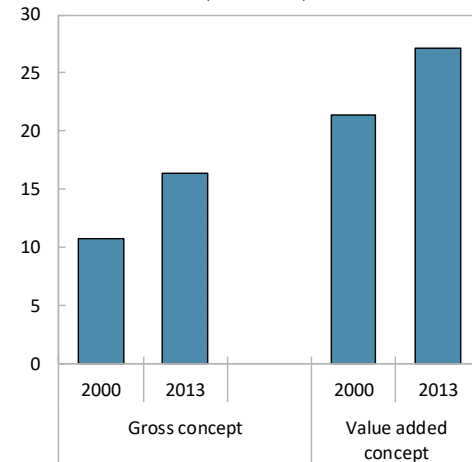
Source: Authors' calculations.

The nature of GVC participation by services and manufacturing sectors is markedly different, with services exhibiting more forward linkages. Table 1 provides a breakdown of world exports to major manufacturing and services sectors, by gross and value-added terms. Services, including business and financial services and wholesale trade, have very high forward linkages reflecting that they are intermediate inputs in their export destinations, and have limited backward linkages reflecting that the production of business and financial services uses limited foreign inputs. Similarly, they tend to have higher values in the upstream index (distance to final consumer) than the downstream index (steps embodied in production). On the other hand, the largest manufacturing sectors tend to have sizable foreign inputs (backward linkages). They tend to have a higher downstream index than upstream index (Table 1). It's worth noting that the level of upstream index is not significantly different between manufacturing and services.

Global supply chains are organized differently across countries and sectors. Breaking down total world exports to value-added created by country-sector pairs, Table 2 illustrates the top country-sector supply chains. Several interesting observations emerge. While the largest supply chains, from the perspective of gross exports, are China's and Germany's Electrical and Machinery sectors, the financial and business services of the US and Germany are the top value creating sectors. This conforms with studies at the product level that, for example, provide a breakdown of exports of iPhones by China to value-added created in China vs that attributed to design, research, and marketing in the US. It is also worth noting that GVCs of the same sector seem to be organized differently across countries. For example, the Electrical and Machinery sectors in China and Germany seem to have similar GVC participation indices. However, the position of the indices for China's Electrical and Machinery sector are larger, suggesting longer supply chains as evidenced in longer distance to the consumer (upstream index) and more steps embodied (downstream index). The auto supply chains (transport equipment) of Germany and the US also have different characteristics, with Germany's showing higher GVC content and more steps involved.

Given the large heterogeneity across countries and sectors in GVC participation and position, the next section formally explores the role of GVCs in raising income and productivity.

Table 1. GVC Participation and Position by Sector, 2013

	Share in World Exports		GVC Participation Index 1/		Position Index 2/	
	Value added concept	Gross concept	Backward linkage	Forward linkage	Downstream Index	Upstream Index
Manufacturing						
Electrical and Machinery	37.7	46.7	32	15	2.8	2.4
Petroleum and Chemical Products	15.0	15.3	33	25	2.6	3.1
Transport Equipment	5.2	8.1	37	10	3.0	2.0
Metal products	5.1	4.3	29	35	2.9	3.6
Textiles and Wearing Apparel	3.8	4.5	27	11	2.8	2.1
Food and Beverages	1.1	1.4	23	9	2.6	1.8
Wood and Paper	0.9	0.7	26	30	2.5	3.0
Other Manufacturing	0.4	0.6	28	7	2.8	1.8
Services						
Financial and Business Services	20.7	5.7	8	91	1.7	2.4
Transport	3.0	1.6	19	38	2.2	2.6
Wholesale Trade	1.7	0.6	10	88	1.8	2.3
Retail Trade	0.6	0.2	12	76	1.9	2.2
Post and Telecommunications	0.3	0.1	14	63	1.9	2.4
Hotels and Restraurants	0.2	0.1	13	23	2.1	1.6

Sources: Authors' calculations.
1/ Backward linkages refer to FVA in gross exports. Forward linkages refer to parts of DVA exports that are further re-exported. Both as share of gross exports.
2/ Downstream index refers to number of previous stages embodied in the exports of particular country or sector. Upstream index refers to number of additional steps to final consumer.

Table 2. Largest Global Supply Chains, 2013

		Share in World Exports		GVC Participation Index 1/		Position Index 2/	
		Value added concept	Gross concept	Backward linkage	Forward linkage	Downstream Index	Upstream Index
Country	Sector						
CHN	Electrical and Machinery	1.4	3.1	24	12	3.8	2.9
DEU	Electrical and Machinery	1.9	2.9	26	16	2.5	2.4
JPN	Electrical and Machinery	1.4	1.9	17	19	2.6	2.4
USA	Electrical and Machinery	1.2	1.9	18	19	2.5	2.2
DEU	Petroleum and Chemical Products	1.2	1.8	33	26	2.7	3.4
DEU	Transport Equipment	0.8	1.7	34	10	3.2	2.2
USA	Financial and Business Activities	3.9	1.7	3	66	1.6	2.2
CHN	Textiles and Wearing Apparel	1.0	1.6	14	8	3.4	2.7
USA	Petroleum and Chemical Products	0.9	1.4	24	25	2.5	2.7
ITA	Electrical and Machinery	0.8	1.3	28	13	2.4	2.0
FRA	Electrical and Machinery	0.7	1.1	27	17	2.4	2.3
CHN	Petroleum and Chemical Products	1.2	1.1	16	32	3.3	3.8
GBR	Electrical and Machinery	0.6	1.0	33	16	2.5	2.2
FRA	Petroleum and Chemical Products	0.6	1.0	36	24	2.5	2.9
DEU	Metal Products	0.9	0.9	28	42	2.8	3.8
KOR	Electrical and Machinery	0.5	0.9	45	13	3.7	3.2
JPN	Transport Equipment	0.4	0.8	16	5	3.1	2.1
DEU	Financial and Business Activities	2.6	0.8	7	98	1.7	2.6
CHE	Electrical and Machinery	0.6	0.8	25	19	2.2	2.2
USA	Transport Equipment	0.3	0.8	22	11	2.8	1.4

Sources: Authors' calculations.
1/ Backward linkages refer to FVA in gross exports. Forward linkages refer to parts of DVA exports that are further re-exported. Both as share of gross exports.
2/ Downstream index refers to number of previous stages embodied in the exports of particular country or sector. Upstream index refers to number of additional steps to final consumer.
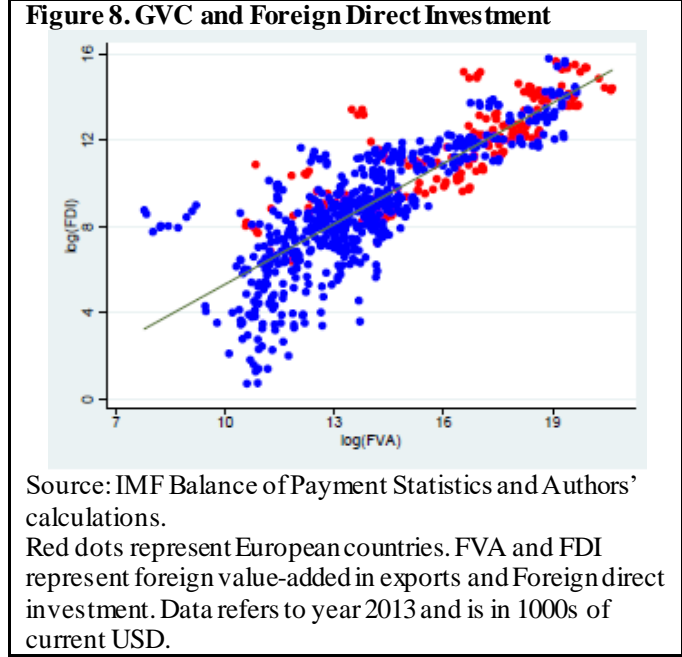
IV. GVC PARTICIPATION AND ECONOMIC OUTCOMES

GVC participation matters for economic development. Specifically, the ability of countries to prosper depends on their participation in the global economy, i.e. their role in GVCs (Gereffi and Lee, 2012). Furthermore, the trade, investment, and knowledge flows that underpin GVCs, provide mechanisms for rapid learning, innovation, and industrial upgrading (Cattaneo, Gereffi, Staritz 2010). In addition, GVC participation can provide local firms with better access to information, open new markets, and create opportunities for fast technological learning and skill acquisition. Montalbano and others (2018) confirm the positive relationship between participation in international activities and firm performance, where both the participation and position within GVCs matter. Similarly, a World Bank (2017) study shows that complex GVC-related cross-border production-sharing activities were the most important force driving globalization and the growth of global GDP during 1995–2008. A study by Kummritz (2016) illustrates that an increase in GVC participation leads to higher domestic value added but the effect is only significant for middle- and high-income countries. The results also highlight that both upstream suppliers of intermediates and downstream users of foreign inputs benefit from production networks equally. At the same time, results regarding the relationship between GVC participation and investment have been mixed. Liu (2015) finds that for many emerging economies, GVC participation attracts more investment. However, while involvement in GVCs may contribute to attracting investment, the relationship is not clear cut as investment crucially depends on broader policy and institutional framework (OECD, WTO, UNCTAD, 2013).

GVC participation has also been shown in the literature to have a positive effect on productivity. Specifically, productivity can be enhanced by the relocation of some of the parts of production within a GVC through various channels (Amiti and Wei, 2009; Schwörer, 2013). The basic argument is related to a firm's relocation of the least efficient production stages to concentrate on more productive core activities. Furthermore, firms take advantage of cheaper, better quality inputs through offshoring; it may also provoke efficiency upgrading through the reorganization of a firm's activity or induce technology transfer from foreign suppliers. Finally, as a cost saving phenomenon, offshoring should increase profits which in turn can be transferred into innovation activities. Criscuolo and Timmis (2017) point that participating in GVCs can stimulate productivity growth through the potential for firm specialization in core tasks, access to imported inputs, knowledge spillovers from foreign firms, and pro-competitive effects of foreign competition. By specializing in those core tasks, firms can reap productivity gains (Grossman and Rossi-Hansberg, 2008). Emerging evidence is also revealing how the liberalization of service markets, particularly the entry of new foreign service providers, can lead to substantial productivity gains in downstream manufacturing firms (Arnold and others, 2011 and 2016).

Our empirical study of the effect of GVC participation on countries' economic performance is motivated by facts illustrated earlier in Figure 2. Specifically, measures of GVC participation are positively correlated with income per capita. Moreover, changes in GVC participation are associated with income convergence (Figure 2, panel 2). Although instructive, these are simple correlations that do not detect the channels through which participation in global value chains can impact countries' income per capita.

In fact, the theoretical literature suggests that these positive correlations could arise for several reasons, including productivity effects of GVC and investment boosting. Figure 8 is suggestive of this last mechanism - it shows that bilateral GVC participation measures and bilateral FDI volumes are positively related. However, since GVC participation could also encourage domestic investment, we will further study its effect on total investment.

In this section we provide a more formal econometric analysis of the relationship between GVC participation and income per capita, as well as the main factors that contribute to the formation of GDP per capita - productivity, investment, and human capital.

Figure 8. GVC and Foreign Direct Investment

Source: IMF Balance of Payment Statistics and Authors' calculations.
Red dots represent European countries. FVA and FDI represent foreign value-added in exports and Foreign direct investment. Data refers to year 2013 and is in 1000s of current USD.

A. Theoretical Framework

The regression framework is motivated in a simple theoretical setting. Following Frankel and Romer (1999), the methodology relies on a production function and its decomposition. For a country i, gross output Y_i can be expressed in a Cobb-Douglas production function with equation (1), where V_i is domestic value-added and X_i is foreign value-added:

$$Y_i = V_i^{1-\alpha} X_i^{\alpha} \tag{1}$$

At the same time, country i's domestic value-added (GDP) is produced using capital, labor, and human capital. This can be expressed with equation (2) where K_i and N_i denote a country's endowment in capital and labor, A_i is labor augmenting productivity, S_i represents the workers' average years of schooling and $\Phi(S_i)$ is a piecewise linear function that transforms years of schooling into human capital.

$$V_i = K_i^{\beta} (e^{\Phi(S_i)} A_i N_i)^{1-\beta} \tag{2}$$

Following Frankel and Romer (1999), equation (2) can be rewritten as:

$$V_i = (\frac{K_i}{V_i})^{\frac{\alpha_i}{1-\alpha_i}} e^{\Phi(S_i)} A_i N_i \tag{3}$$

Dividing both sides by N_i and taking logs, presents the following decomposition of country i's GDP per capita:

$$log \frac{V_i}{N_i} = \frac{\alpha_i}{1-\alpha_i} log \frac{K_i}{V_i} + \Phi(S_i) + logA_i \tag{4}$$

To estimate empirically the effect of GVC participation on income per capita, the reduced form equation (5) is used, where $share_{i(t-1)}$ represents the range of lagged trade and GVC participation related variables:

$$\log\left(\frac{V}{N}\right)_{it} = \alpha + \sum_{i=1}^{n} \beta_i \, share_{i(t-1)} + \gamma X_{it} + \eta_t + \eta_{it} \tag{5}$$

We study separately the effect of final goods trade and intermediate goods trade as well as GVC-related intermediate goods trade and trade in intermediate goods that are absorbed in the country and are therefore not related to GVC. We use lagged trade variables to address endogeneity associated with reverse causality. In addition, we control for country characteristics such as population and area, per Frankel and Romer (1999), to reflect the effect of internal trade (as opposed to international trade) on a country's income per capita.

Furthermore, we study the channels through which GVC participation impacts welfare. In order to do so, we regress each of the contributing components of economic growth on the same range of lagged trade and GVC participation measures. For those specifications, we use the human capital index developed by Barro and Lee (2010) and we calculate productivity as a residual.

B. Empirical Evidence

Our results confirm that GVC participation is related positively to income per capita. Specifically, we find that it is mostly trade in intermediate goods as well as the share of GVC related trade flows, rather than conventional trade, that contribute to a country's income per capita (see columns 1 and 2 respectively in Table 2). Investment is also affected positively by GVC-related trade flows. Human capital and productivity mirror this relationship.

Table 3 below summarizes our main findings. Column (1) reports the results from a regression exploring the relationship between (lagged) shares of final and intermediate goods trade in a country's GDP and income per capita. It suggests that it is mostly trade in intermediate goods that contributes to a country's income per capita. In column (2) we distinguish between GVC-related and non-GVC-related trade. GVC-related trade is defined as imports and exports that either embed foreign value-added or are exports of domestic value-added that are re-exported in other countries' exports. GVC-non-related trade is, in turn, defined as imports and exports that get directly absorbed in other countries. The OLS results suggest that it is mostly the share of GVC-related trade flows in a country's GDP that is positively related to income per capita.

In columns (3) - (5), we study the channels through which GVC participation and trade could affect income per capita. Interestingly, our results suggest that although the GVC-related trade share positively affects investment, the non-GVC-related trade share has a negative impact on it. This result could be explained by the competition effect of international trade: once a country opens up to trade, it faces tougher competition from abroad, which makes some (less productive) firms leave the market, which might cause investment to go down.

Table 3. GVC Participation and Income per Capita								
(1) $\text{Log}(\frac{Y}{N})$	(2) $\text{Log}(\frac{Y}{N})$	(3) $\text{Log}(\frac{I}{N})$	(4) Human capital	(5) Productivity	(6) Small Sample $\text{Log}(\frac{Y}{N})$	(7) Income class $\text{Log}(\frac{Y}{N})$	(8) Upstream $\text{Log}(\frac{Y}{N})$	(9) IV $\text{Log}(\frac{Y}{N})$
Share of final trade in GDP	0.143 (0.728)								
Share of Intermed. trade in GDP	1.610*** (0.339)								
log(population)	-0.041 (0.068)	-0.060 (0.069)	-0.007 (0.020)	-0.024 (0.043)	-0.059 (0.051)	0.019 (0.052)	-108 (0.58)	-0.069 (0.697)	-0.055 (0.074)
log(area)	-0.012 (0.061)	-0.013 (0.060)	0.007 (0.013)	0.028 (0.036)	-0.030 (0.047)	0.043 (0.50)	0.0145 (0.064)	-0.0130 (0.065)	-0.016 (0.077)
Share of regular trade in GDP		0.227 (0.458)	-0.07*** (0.002)	0.402 (0.302)	-0.351 (0.489)	.617 (.531)	-0.0383 (0.387)	0.301 (0.549)	0.520 (0.738)
Share of GVC-trade in GDP		2.738** (1.148)	0.367*** (0.103)	1.366* (0.750)	1.869* (1.107)	-.409 (0.990)		2.080** (1.030)	2.011** (1.011)
GVC-trade*(Low Income)							-0.947 (0.3875)		
GVC-trade*(Low Middle Income)							1.413* (0.915)		
GVC-trade*(High Middle Income)							2.143** (0.855)		
GVC-trade*(High Income)							2.848*** (0.948)		
Upstream Index								-0.370 (0.2561)	
Downstream Index								0.102 (0.229)	
Constant	9.459*	9.674***	2.943***	1.562***	6.573***	9.939***	10.160***	9.758***	9.674***
Observations	3,049	3,049	3,045	2,777	2,625	970	2,770	1,165	2,320
R-squared	0.172	0.183	0.042	0.261	0.072	0.170	0.160	0.275	0.132

Clustered robust standard errors in parentheses; Country and year fixed effects are included.
***, **, and * denotes significance at 1, 5, and 10 percent.
In column (9), the instrument for share of GVC-trade in GDP is the average of the value-added originating from Germany, Japan, and the United States that is embodies in the exports of three countries of most similar income level to the country in question. F-statistics for the weakness of the instrument exceed the Stock-Yogo (2002) critical values. A similar exercise when IV is based on three neighboring countries to the country in question is also conducted. Results are similar to column (9).

However, further exploration of this result is needed. Columns (4) and (5) show that the GVC-related trade share also positively affects human capital and productivity, measured as a residual in the income decomposition equation. In column (6), we find that the results of column (1) can't be replicated if we restrict the sample to 50 countries typically available in other databases of value-added, highlighting the importance of the larger Eora database for studying GVCs.

In columns (7) and (8) we explore if income gains from GVC trade depend on a country's income level or its position in GVCs. Column (7) replicates the regression in column (1) but instead we interact the variable GVC-trade with dummy variables for 4 categories of income level:low, low-middle, high-middle, and high income as defined by the World Bank. GVC-trade appears to positively impact income in high-middle and high-income countries, but the impact for low income and low-middle income countries is either insignificant or significant but not robust to changes in the specification. This finding is consistent with the thinking in Rodrik (2018) that GVCs and new technologies exhibit features (such as being biased towards skills and other capabilities) that limit the upside and may even undermine developing countries' economic performance. It is also consistent with the policy literature that cautions that gains from GVCs are not automatic and depend on other supporting factors (OECD, WTO, UNCTAD, 2013).

In column (8), we include measures of the position in GVCs, but do not find any significant effects for either downstream or upstream indices either individually or combined. For the regression in column (8) we exclude commodity exporter countries which tend to have higher upstream position to better capture the idea of upstreamness related to services (design, R&D, marketing) rather than commodities (including those countries leads to coefficient of upstream index being negative and significant).

In terms of economic significance of the findings, an increase in the share of GVC trade in GDP by 10 percentage points (from median country in distribution to 75 percentile) would represent an increase in income levels by 15 to 30 percent (based on coefficients in columns 2 and 7 of Table 3), representing an economic meaningful impact.

To ensure that the results are not due to endogeneity or reverse causality, we also employ an Instrumental Variable approach (IV). The concerns for endogeneity arise as GVC participation itself can be driven by income levels or its correlates such as better institutions and quality of infrastructure, for example. We adopt an IV approach in the spirit of Baldwin and Lopez-Gonzalez (2013), Autor, Dorn and Hanson (2013) and used in Constantinescu and others (2017). We construct an instrument to strip out parts of GVC participation that are driven by the overall income level and its correlates such as infrastructure quality and business environment. In particular, for each country c and year t, the instrument is computed as the average foreign value added from the United States, Japan and Germany embodied in exports of industry s of three countries in the sample that are closest in income level or geography to country c. This identification strategy is similar to the approach used in the seminal work of Autor, Dorn and Hanson. (2013) who instrument the growth of US imports of Chinese goods with the penetration of Chinese goods in other high-income markets. The results of the IV approach, reported in Column (9) are broadly similar in terms of significance and magnitude.

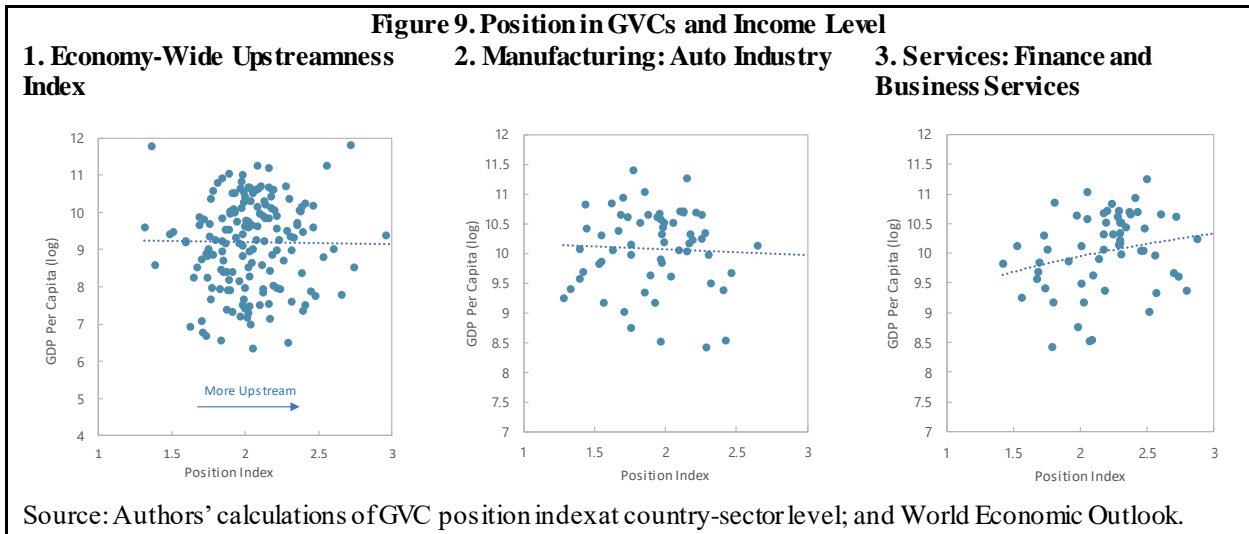**Does GVC Participation Lead to Moving up Value Chains?**

Given that GVC trade is shown to lead to higher income and productivity gains, a natural question is whether this gain takes place through higher productivity gains within sectors of a country or through a change in the sectoral composition of the economy? While both could be at play, due to the lack of employment data at the sectoral level, we are unable to test

whether productivity at the sector level increases with GVC participation. The second channel, i.e. a shift in the sectoral composition, is particularly interesting, as often in the policy arena there is a concern that GVC participation for low and middle-income countries may remain limited to "low wage" sectors which are often referred to as downstream sectors (Kummritz (2016) and Helpman et al. (2012)).

Here, we briefly explore how GVC participation relates to the loosely defined concept of "moving up value chains."

First, it is useful to note that "moving up", if understood as moving to upstream sectors, is not necessarily a characteristic of higher income countries. As shown in Table 2, and illustrated in Figure 8 below, there is no strong link between countries' income levels and their position in GVCs. High income countries can participate in various stages of production, particularly in manufacturing (Figure 8, panel 2). As such, the position index doesn't appear to be a relevant indicator to gauge the "moving up" question.

Figure 9. Position in GVCs and Income Level

1. Economy-Wide Upstreamness Index

2. Manufacturing: Auto Industry

3. Services: Finance and Business Services

Source: Authors' calculations of GVC position index at country-sector level; and World Economic Outlook.

A more useful indicator to explore the "moving up" concern, is to examine how the share of high-tech sectors in value-added exports of a country has changed over time. Figure 10, panel 1 shows that the share of labor-intensive manufacturing in value-added exports has decreased over time for many countries in Asia and Latin America. This conforms with the narrative of many Asian counties starting off with GVC trade in labor intensive sectors initially and then expanding to other sectors. For European countries, the labor-intensive share in total manufacturing of GVC exports has been relatively stable over time, closer to the 45-degree line in Figure 10, panel 1. For many countries, there has been a rise in the share of services exports in total value-added exports (Figure 10, panel 2), most drastically evidenced in the US, Japan, Germany, and China, while the change in the rest of the countries has been more modest.

Using bilateral value-added export data, we also examine how the participation in any of the major global supply chains (listed in Table 3) has affected the sectoral composition of a participant country. For example, consider Germany's auto supply chain. We breakdown the FVA in Germany's auto exports to value-added by participant country and sectors. Figure 11, panel 1 shows the contribution of different low and high-tech manufacturing and services to Germany's auto supply chain in 2013. For each country contributing to this supply chain, we calculate the ratio of hi(low) tech services (manufacturing) in its contribution and normalize it by the value of that ratio in year 2000. The results for all participant countries are illustrated in Figure 11, panel 2. On average, the ratios are clustered around 1, reflecting that the relative importance of each sector has on average remained the same over time. Nonetheless, there is large heterogeneity in each category. For example, China's and Denmark's contribution to the German auto supply chain show a shift towards more high-tech services. Regarding the manufacturing sector, Russia's contribution to the German auto supply chain became more intensive in low-tech manufacturing (due to mining and quarrying sector). For the Czech Republic, Hungary, Poland, and Slovak Republic the ratios have remained close to 1, reflecting broadly similar sectoral composition over time. For Romania, there has been a shift away from low-tech to more high-tech manufacturing.

Figure 10. Does Sectoral Pattern of Value-Added Exports Change Over Time?

1. Share of Labor Intensive Manufacturing in Total Manufacturing Value-Added Exports
(Percent)
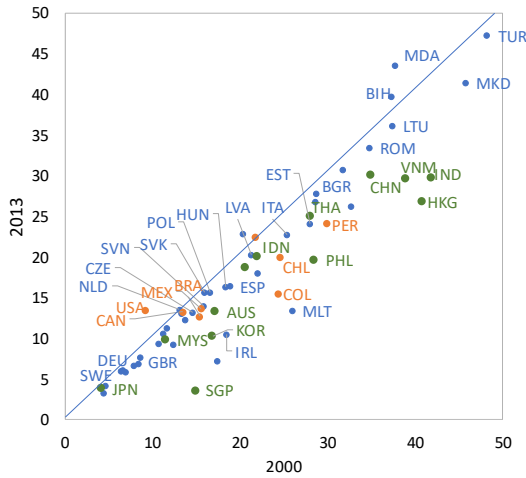
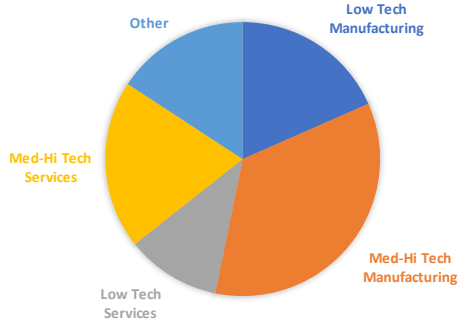**2. Share of Services in Value-Added Exports**
(Percent)
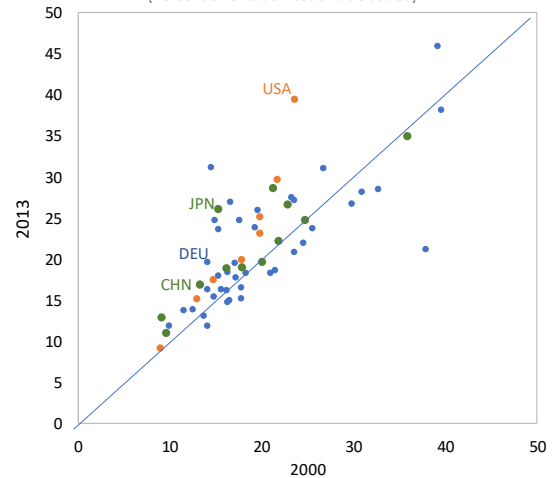
Sources: Authors' calculations. Labor intensive manufacturing comprise Textile and Wearing Apparel, Wood and Paper, Mining and Quarrying, and Food and Beverages.

Figure 11. Does Exposure to Major Supply Chains Lead to Higher-Tech Exports?

FVA Contributions by Sector

Germany: Auto Supply Chain

Ratio of High and Low Tech Sectors in Value-added Exports by Participants in the Supply Chain, 2013
(Ratio in 2000=1 normalized)
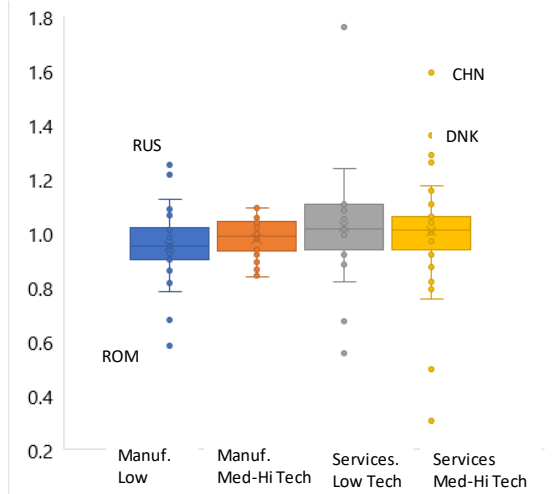
Sources: Authors' calculations. Low, medium and high-tech sectors are defined based on OCED (2011) by matching Eora sectors to similar SITC sectors. See Annex Table 1 for list of sectors in each category. "Other" in pie chart represent sectors for which a clear technology intensity was not defined.
On the right chart, dots represent countries and the box the 25-75th percentile range of distribution.

A similar analysis for other major supply chains is summarized in Annex Figure 1.

Overall, it appears that "moving up" the value-chain in the form of a sectoral shift to services or more high-tech manufacturing has taken place, however there is large heterogeneity across countries. This shift is more modest in European countries and is starker in some Asian

countries. This finding, however, should be treated with some caution as shifts to high tech sectors could have also taken place within much narrower sub-sectors that are not visible through the lens of 26 sectoral composition in this study. Further research using more granular data could provide more insights.

With this, we shift our focus to the final analysis of the paper, on determinants of GVC participation.

V. DETERMINANTS OF BILATERAL GVC PARTICIPATION

The factors determining a country's participation in a global supply chain are important from a policy making perspective. The analysis from the previous section suggests that countries with higher GVC participation have higher income per capita as well as investment, human capital, and productivity. However, it is also important to understand how countries can increase their participation in global value chains. For example, Kowalski and others (2015) identify geography, size of the market, and level of development as the key determinants of GVC participation. Trade and investment policy reforms as well as improvements of logistics and customs, intellectual property protection, infrastructure and institutions can also play an active role in determining GVC participation[2]. This section investigates what determines a country's participation in a global supply chain.

A. Empirical Strategy

We rely on the structural gravity equation which can be written as follows:

$$\log(FVA_{ijt}) = \beta X_{ijt} + \eta_{it} + \eta_{jt} + \varepsilon_{ijt} \tag{6}$$

In equation (6), X_{ij} represents the country-pair characteristics such as distance, common language, common currency, and colonial ties, η_{it} is time varying source-country fixed effects and η_{jt} is time varying destination-country fixed effects. We also include two policy variables. One is an indicator of a preferential trade agreement between two countries and the other one captures exchange rate volatility.

In addition, we investigate the time-invariant characteristics that contribute to a country's participation in GVCs. In order to do so we use time-varying source and destination fixed effects and estimate equation (7) where η_{it} is either source or destination fixed effects estimated in equation (6).

$$\eta_{it} = \log(GDP_{it}) + \alpha X_i + +\eta_t + \varepsilon_{it} \tag{7}$$

B. Results

Table 3 shows the results of an OLS estimation of equation (6). Columns (1) and (2) suggest that physical proximity as well as standard country-pair characteristics such as common

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[2] Another line of research seeks to explore whether determinants of participation in low and high-tech manufacturing are different (see Cheng and others, 2015), and finds that certain variables such as human capital matter more for high-tech manufacturing.

border, common language, and colonial linkages are important determinants of GVC participation measured with foreign value-added. Columns (3) and (4) include additional policy-related variables in the gravity equation specification, i.e. preferential trade agreement indicator, exchange rate volatility, and common currency indicator. The results suggest that having the same currency or at least lower exchange rate volatility increases countries' bilateral value chain participation.

Taking advantage of the Eora dataset, which allows us to calculate bilateral GVC participation at the industry level as well, we estimate equation (6) at the industry level for the year 2013. Instead of time-fixed effects we include source country-sector and destination country-sector fixed effects, which helps control for country-sector heterogeneity. We find that at the industry level, geographical proximity is more important for the manufacturing industry. International trade of goods and services from upstream industries is more sensitive to distance compared to goods closer to final demand.
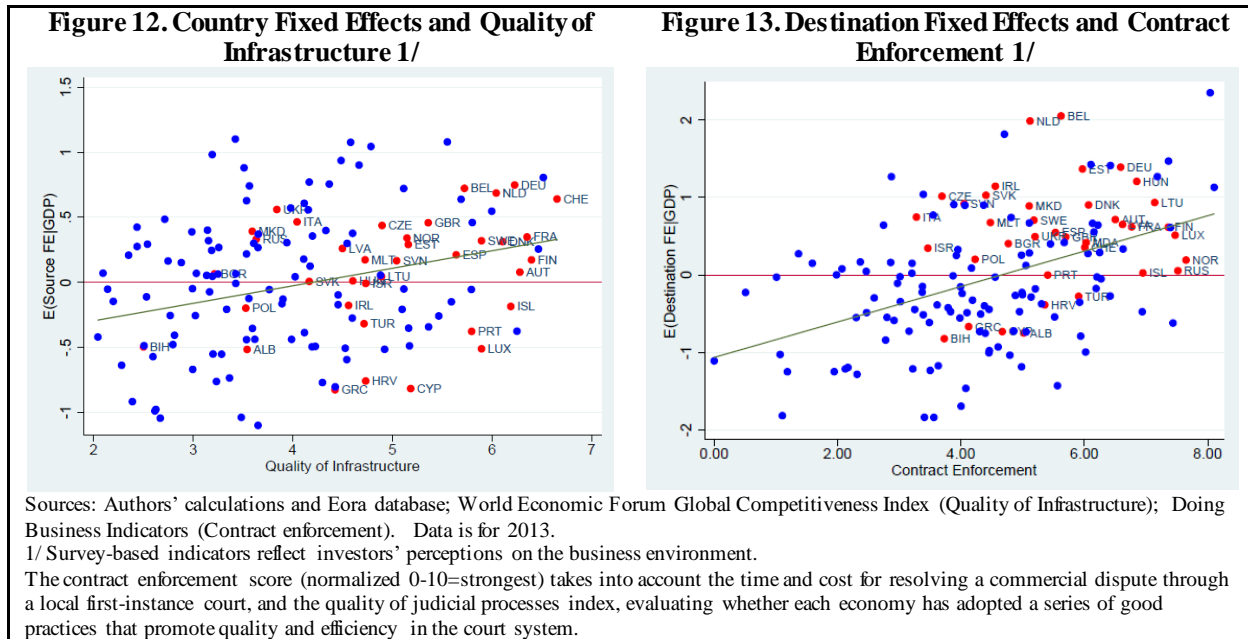
The country fixed effects obtained from regression (6) help us to gauge which countries participate in GVCs above or below average. For example, Figures 12 and 13 show that among European countries, Turkey, Albania, and Bosnia and Herzegovina tend to have lower GVC participation than implied by fundamentals. We also explore which institutional and country characteristics help explain the country fixed effects. We examine specification (7), using the source-country fixed effects on the left side and a large set of structural and institutional variables on the right side. Results for the most significant variables are reported in Table 5.

Strong institutional characteristics, such as the business environment and good infrastructure affect countries' participation in GVCs as well. A high degree of contract enforcement as well as the rule of law facilitate a country's participation in a global value chain both on the exporting and importing side (Tables 5 and 6). Similarly, the ease of doing business, proxied by the number of procedures needed to set up a business, as well as the overall quality of infrastructure, play a role as determinants of GVC participation (Figures 12 and 13). However, high labor costs in the exporting country decreases its competitiveness and thus participation in GVC, while this is not a factor for countries on the importing side.

Table 4. Determinants of Bilateral GVC Participation				
Log (distance)	-1.010***	-0.752***	-0.579***	-0.574***
	(0.019)	(0.013)	(0.013)	(0.013)
Common border	1.823***	1.390***	1.386***	
	(0.071)	(0.096)	(0.078)	(0.078)
Common language		0.349***	0.266***	0.261***
		(0.025)	(0.022)	(0.022)
Common colonial history		0.402***	0.494***	0.513***
		(0.097)	(0.096)	(0.095)
Common currency			1.513***	1.416***
			(0.107)	(0.106)
Preferential Trade Agreement			0.648***	0.627***
			(0.024)	(0.024)
Exchange rate volatility				-1.183***
				(0.207)
Country-Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	544,170	544,170	544,170	537,775
R-squared	0.899	0.907	0.913	0.913

Table 5. Time Invariant Exporting Country Characteristics and GVC Participation							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log(GDP)	0.740***	0.753***	0.705***	0.742***	0.742***	0.841***	0.826***
	(0.024)	(0.022)	(0.028)	(0.025)	(0.025)	(0.037)	(0.042)
Contract enforcement		0.085***					
		(0.027)					
Rule of law			0.167***				
			(0.062)				
Business entry procedures				-0.024*			
				(0.014)			
Unit labor costs (lag)					-0.411**		
					(0.169)		
Human capital (lag)						0.564**	
						(0.243)	
Infrastructure quality							0.075
							(0.085)
Constant	-2.74***	-3.16***	-2.65***	-2.24***	-2.24***	-2.80***	-3.35**
Observations	531,527	482,021	528,316	288,499	288,499	114,067	98,350
R-squared	0.854	0.905	0.860	0.843	0.843	0.924	0.934
Source: Authors' calculations.							
Source: Authors' calculations.							

Table 6. Time Invariant Import Country Characteristics and GVC Participation							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log(GDP)	0.782***	0.770***	0.685***	0.783***	0.721***	0.781***	0.725***
	(0.035)	(0.031)	(0.035)	(0.033)	(0.032)	(0.066)	(0.035)
Contract enforcement		0.231***					
		(0.040)					
Rule of law			0.501***				
			(0.079)				
Business entry procedures				-0.088*			
				(0.020)			
Unit labor costs (lag)					0.016		
Human capital (lag)						0.926***	
						(0.121)	
Infrastructure quality							0.412***
							(0.064)
Constant	-2.036***	-3.123***	-1.763***	-1.406***	-3.626***	-1.696***	-4.060***
Observations	531,581	481,785	528,390	288,605	462,710	113,306	371,482
R-squared	0.765	0.836	0.815	0.785	0.841	0.821	0.854
Source: Authors' calculations.							

Figure 12. Country Fixed Effects and Quality of Infrastructure 1/

Figure 13. Destination Fixed Effects and Contract Enforcement 1/

Sources: Authors' calculations and Eora database; World Economic Forum Global Competitiveness Index (Quality of Infrastructure); Doing Business Indicators (Contract enforcement). Data is for 2013.

1/ Survey-based indicators reflect investors' perceptions on the business environment.

The contract enforcement score (normalized 0-10=strongest) takes into account the time and cost for resolving a commercial dispute through a local first-instance court, and the quality of judicial processes index, evaluating whether each economy has adopted a series of good practices that promote quality and efficiency in the court system.

VI. CONCLUDING REMARKS

This paper uses the new comprehensive Eora MRIO Database to uncover the extent to which both developed and emerging economies participate in global value chains and to estimate the determinants and consequences of GVC participation. In doing so, we first construct different measures of GVC participation as well as the industry and country position in the value chain, using a recently developed methodology consistent with the theoretical literature.

We document that the manufacturing and services sectors participate differently in GVCs. In addition, both forward and backward measures of participation need to be considered to obtain a better picture of a country's GVC participation. We also document that there is a great degree of heterogeneity in GVC participation as well as position measures across countries and industries. We exploit this heterogeneity to study the relationship between GVC participation and income per capita as well as its determinants (investment rate, human capital and productivity).

Our results suggest that participation in global value chains, rather than conventional trade, can positively effect countries' economic performance, although the gains can be heterogenous. The upper middle and high-income countries appear to be benefiting from such participation, while we don't find robust effects for low and lower-middle income countries.

While GVC participation raises productivity and income levels, "moving up" to more hi-tech sectors does not appear to be automatic and frequent. We document that for many countries that contribute to major global supply chains, there is little shift in the sectoral composition of their participation. Here too, there is large heterogeneity. Specifically, there are cases of large transformations in Asia (less so in Europe) and notably moves to high-tech services by the US, China, Germany, and Japan.

We find that standard gravity variables explain a country's participation in GVCs. In addition, the quality of institutions, quality of infrastructure, and unit labor costs are important determinants of GVC participation. We find that upstream sectors and services are more sensitive to trade barriers.

What does this mean for policy? Beyond the usual call for better infrastructure, connectivity, and improving institutions, given the gradual rise of services in GVC trade, it is also important to better understand barriers to services trade and the type of reforms and trade agreements that could potentially facilitate it.

VII.   ANNEX

Table 1. List of Sectors	
1 Agriculture	14 Construction
2 Fishing	15 Maintenance and Repair
3 Mining and Quarrying	16 Wholesale Trade
4 Beverage	17 Retail Trade
5 Textiles and Wearing Apparel	18 Hotels and Restraurants
6 Wood and Paper	19 Transport
7 Petroleum, Chemical and Non-Metallic Mineral Products	20 Post and Telecommunications
8 Metal Products	21 Finacial Intermediation and Business Activities
9 Electrical and Machinery	22 Public Administration
10 Transport Equipment	23 Education, Health and Other Services
11 Other Manufacturing	24 Private Households
12 Recycling	25 Others
13 Electricity, Gas and Water	26 Re-export & Re-import

In Figure 11 and Annex Figure 1, the Eora sectors listed above are grouped into low and mid-to-high-tech sectors according to OECD (2011) as follows:
Low-tech manufacturing: 3,4,5,6
Mid to high-tech manufacturing: 7,8,9,10
Low-tech services: 16,19
Mid to high-tech services: 20, 21

Table 2. List of Largest Country-Sector Pairs by Export

| Country | Sector | Share in World Exports | | GVC Participation Index 1/ | | Position Index 2/ | |
		Gross concept	Value added concept	Backward linkage	Forward linkage	Downstream Index	Upstream Index
CHN	Electrical and Machinery	3.1	1.4	24	12	3.8	2.9
DEU	Electrical and Machinery	2.9	1.9	26	16	2.5	2.4
JPN	Electrical and Machinery	1.9	1.4	17	19	2.6	2.4
USA	Electrical and Machinery	1.9	1.2	18	19	2.5	2.2
DEU	Petroleum and Chemical Products	1.8	1.2	33	26	2.7	3.4
DEU	Transport Equipment	1.7	0.8	34	10	3.2	2.2
USA	Finacial and Business Services	1.7	3.9	3	66	1.6	2.2
CHN	Textiles and Wearing Apparel	1.6	1.0	14	8	3.4	2.7
USA	Petroleum and Chemical Products	1.4	0.9	24	25	2.5	2.7
ITA	Electrical and Machinery	1.3	0.8	28	13	2.4	2.0
FRA	Electrical and Machinery	1.1	0.7	27	17	2.4	2.3
CHN	Petroleum and Chemical Products	1.1	1.2	16	32	3.3	3.8
GBR	Electrical and Machinery	1.0	0.6	33	16	2.5	2.2
FRA	Petroleum and Chemical Products	1.0	0.6	36	24	2.5	2.9
DEU	Metal Products	0.9	0.9	28	42	2.8	3.8
KOR	Electrical and Machinery	0.9	0.5	45	13	3.7	3.2
JPN	Transport Equipment	0.8	0.4	16	5	3.1	2.1
DEU	Finacial and Business Services	0.8	2.6	7	98	1.7	2.6
CHE	Electrical and Machinery	0.8	0.6	25	19	2.2	2.2
USA	Transport Equipment	0.8	0.3	22	11	2.8	1.4
SGP	Electrical and Machinery	0.8	0.3	71	9	3.2	2.5
KOR	Metal Products	0.7	0.3	41	11	3.9	4.4
ITA	Petroleum and Chemical Products	0.7	0.5	39	23	2.6	2.7
GBR	Petroleum and Chemical Products	0.7	0.4	29	23	2.5	2.9
CHN	Metal Products	0.7	0.7	18	34	3.7	4.1
NLD	Petroleum and Chemical Products	0.7	0.4	44	29	2.4	3.3
BEL	Petroleum and Chemical Products	0.7	0.4	49	26	2.6	3.3
MYS	Electrical and Machinery	0.7	0.4	42	19	2.7	2.7
ITA	Textiles and Wearing Apparel	0.7	0.5	28	14	2.4	1.9
FRA	Transport Equipment	0.7	0.3	38	12	3.0	2.0
USA	Transport	0.6	0.7	8	27	2.0	2.4
MEX	Electrical and Machinery	0.6	0.3	42	7	2.5	2.1
JPN	Petroleum and Chemical Products	0.6	0.6	30	27	2.6	3.2
CAN	Electrical and Machinery	0.6	0.4	34	9	2.4	2.2
CAN	Transport Equipment	0.6	0.3	45	3	2.8	1.7
CHN	Other Manufacturing	0.6	0.2	16	5	3.4	2.2
RUS	Mining and Quarrying	0.5	0.3	7	34	2.2	3.8
NLD	Electrical and Machinery	0.5	0.3	37	20	2.4	2.3
HKG	Electrical and Machinery	0.5	0.2	64	11	3.2	2.8
USA	Wholesale Trade	0.5	0.8	4	61	1.7	2.1
ESP	Transport Equipment	0.5	0.2	53	9	3.3	2.2
RUS	Petroleum and Chemical Products	0.5	0.6	9	49	2.1	3.3
CAN	Mining and Quarrying	0.5	0.7	8	33	1.5	3.4
JPN	Wholesale Trade	0.5	0.8	8	47	1.6	2.2
JPN	Metal Products	0.4	0.5	23	33	2.9	3.8
RUS	Metal Products	0.4	0.5	12	50	2.2	3.6
ESP	Petroleum and Chemical Products	0.4	0.3	41	22	2.6	2.9
ESP	Electrical and Machinery	0.4	0.3	29	16	2.5	2.3
DEU	Transport	0.4	0.6	20	41	2.4	3.2
CHN	Finacial and Business Services	0.4	1.3	8	72	2.2	2.8

Figure 1. Does Exposure to Major Supply Chains Lead to Higher-Tech Exports?
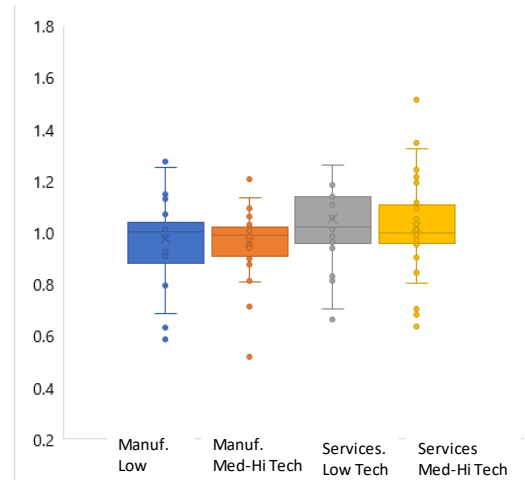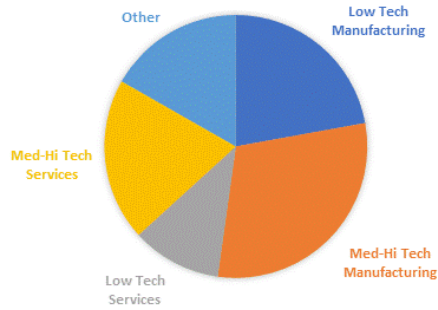
FVA Contributions by Sector
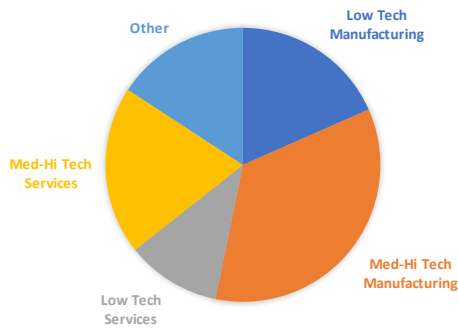
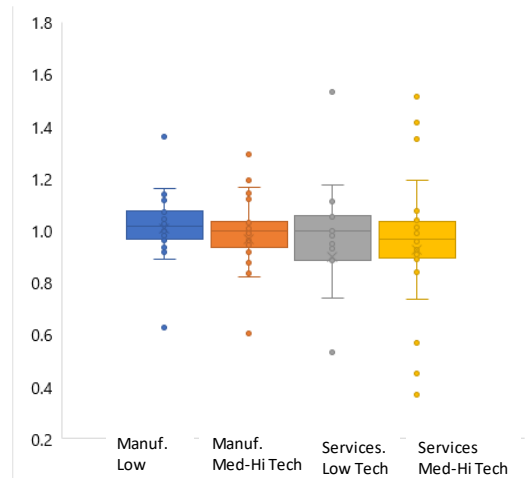**Ratio of High and Low Tech Sectors in Value-added Exports by Participants in the Supply Chain, 2013**
(Ratio in 2000=1 normalized)
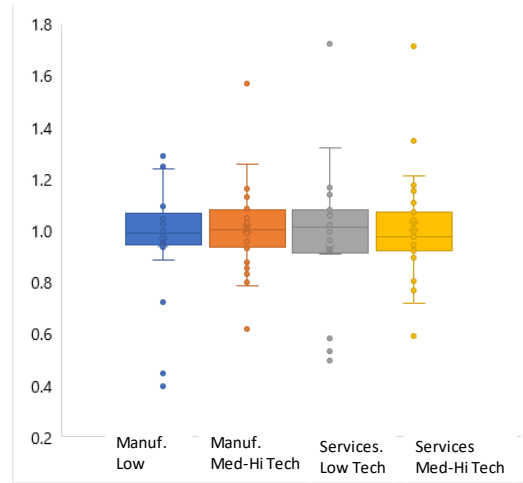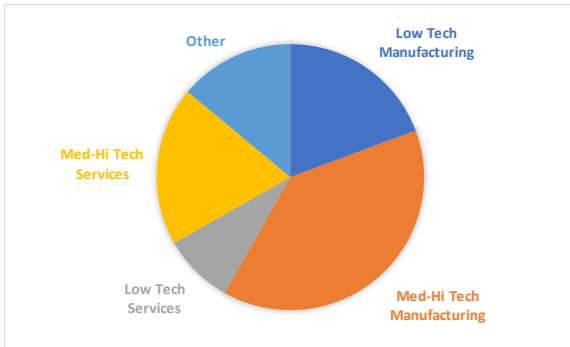
Germany: Auto Supply Chain
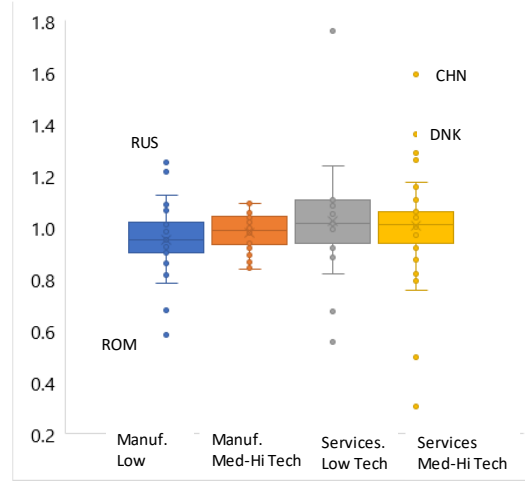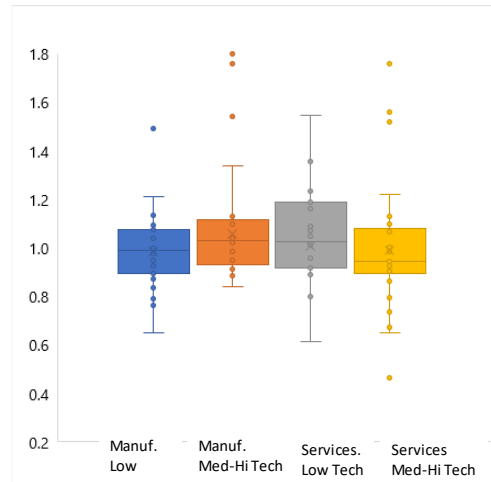

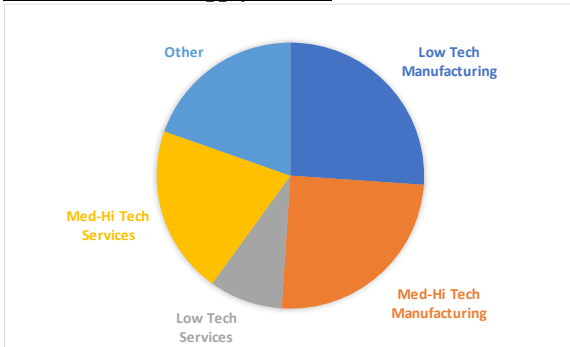## Germany: Chemical Products Supply Chain

US: Electrical and Machinery Supply Chain
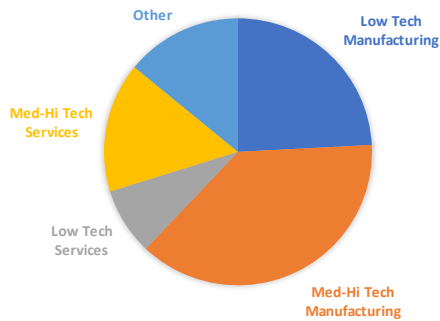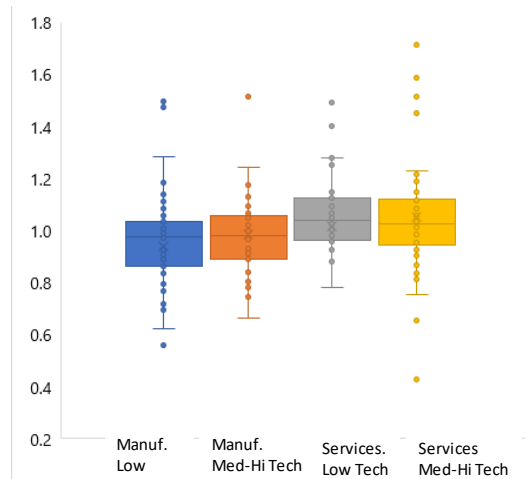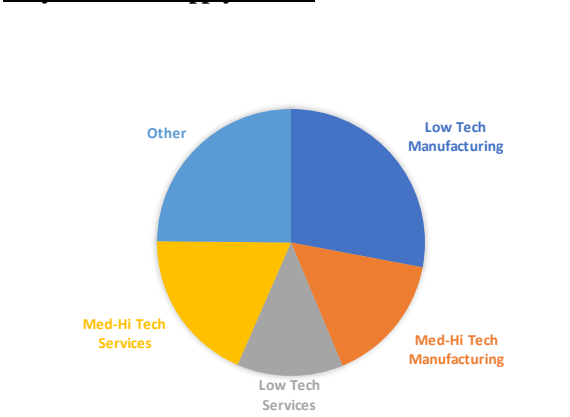
China: Electrical and Machinery Supply Chain

China: Textile Supply Chain

Italy: Textile Supply Chain

Sources: Authors' calculations. Low, medium and high-tech sectors are defined based on OCED (2011) by matching Eora sectors to similar SITC sectors. See Annex Table 1 for list of sectors in each category. "Other" in pie chart represent sectors for which a clear technology intensity was not defined.

VIII. REFERENCES

Amador, J., Cappariello, R. and Stehrer, R., 2015. Global Value Chains: A View from the Euro Area. *Asian Economic Journal*, *29*(2), pp.99–120.

Amiti, M. and Wei, S.J., 2009. Does service offshoring lead to job losses? Evidence from the United States. In *International Trade in Services and Intangibles in the Era of Globalization* (pp. 227–243). University of Chicago Press.

Antràs, Pol, Davin Chor, Thibault Fally, and Russell Hillberry. "Measuring the upstreamness of production and trade flows." American Economic Review 102, no. 3 (2012): 412–16.

Arnold, J.M., B.S. Javorcik and A. Mattoo . 2011. "Does services liberalization benefit manufacturing firms?: Evidence from the Czech Republic", Journal of International Economics, Vol. 85, No. 1, pp. 136–146.

Arnold, J.M., B.S. Javorcik, M. Lipscomb and A. Mattoo . 2016. "Services Reform and Manufacturing Performance: Evidence from India", Economic Journal, Vol. 126, Issue 590, pp. 1–39.

Aslam, Aqib, Natalija Novta, and Fabiano Rodrigues-Bastos. 2017. Calculating Trade in Value-added. International Monetary Fund.

Baldwin, R. and Venables, A.J., 2013. Spiders and snakes: offshoring and agglomeration in the global economy. Journal of International Economics, 90(2), pp. 245–254.

Baldwin, Richard. 2011. Trade and industrialisation after globalisation's 2nd unbundling: How building and joining a supply chain are different and why it matters (No. w17716). National Bureau of Economic Research.

Baldwin, Richard, and Javier Lopez-Gonzalez. 2013. Supply-chain trade: A portrait of global patterns and several testable hypotheses. (No. w18957). National Bureau of Economic Research.

Cattaneo, O., Gereffi, G. and Staritz, C. eds., 2010. *Global value chains in a postcrisis world: a development perspective*. The World Bank.

Caliendo, L. and Parro, F., 2015. Estimates of the Trade and Welfare Effects of NAFTA. *The Review of Economic Studies*, *82*(1), pp. 1–44.

Cheng, K., Rehman. S., Seneviratne, D., and Zhang, S. 2015. "Reaping the Benefits from Global Value Chains" IMF Working Paper WP/15/204.

Constantinescu, Cristina, Aaditya Mattoo, and Michele Ruta. 2017. Does *vertical specialization increase productivity?*. World Bank, 2017.

Criscuolo, C. and Timmis, J., 2017. The Relationship Between Global Value Chains and Productivity. *International Productivity Monitor*, *32*, pp. 61–83.

Feenstra, Robert C. 2017. "Statistics to Measure Offshoring and its Impact." NBER Working Paper No. 23067, National Bureau of Economic Research, Cambridge, MA.

Feenstra, Robert C., and Gordon H. Hanson. 1997. Productivity Measurement and the Impact of Trade and Technology on Wages: Estimates for the US, 1972–1990. No. w6052. National Bureau of Economic Research.

Gereffi, G. and Lee, J., 2012. Why the world suddenly cares about global supply chains. *Journal of supply chain management*, *48*(3), pp. 24–32.

Grossman, G.M. and Rossi-Hansberg, E., 2008. Trading tasks: A simple theory of offshoring. American Economic Review, 98(5), pp. 1978–97.

Halpern, L., Koren, M. and Szeidl, A., 2015. Imported inputs and productivity. American Economic Review, 105(12), pp. 3660–3703.

Hummels, David, Jun Ishii, and Kei-Mu Yi. 2001. "The Nature and Growth of Vertical Specialization in World Trade." *Journal of International Economics* 54(91): 75–96.

Hummels, D., Rapoport, D. and Yi, K., 1997. Globalization and the changing nature of world trade. *University of Chicago, Federal Reserve Bank of New York and Rice University, Diciembre*.

Koopman, Robert, Zhi Wang, and Shang-Jin Wei. 2014. "Tracing Value-Added and Double Counting in Gross Exports." *American Economic Review* 104(2): 459–494.

Koopman, Robert, William Powers, Zhi Wang, and Shang-Jin Wei. 2010. "Give Credit Where Credit Is Due: Tracing Value-added in Global Production Chains." NBER Working Paper No. 16426, National Bureau of Economic Research, Cambridge, MA.

Koopman, R., Wang, Z. and Wei, S.J., 2008. *How much of Chinese exports is really made in China? Assessing domestic value-added when processing trade is pervasive* (No. w14109). National Bureau of Economic Research.

Kowalski, P., Gonzalez, J.L., Ragoussis, A. and Ugarte, C., 2015. Participation of developing countries in global value chains. OECD Trade Policy Papers, No. 179, OECD Publishing, Paris. http://dx.doi.org/10.1787/5js33lfw0xxn-en

Kummritz, Victor, 2016. Do Global Value Chains Cause Industrial Development? Centre for Trade and Economic Integration, The Graduate Institute;

Lenzen, M., Moran, D., Kanemoto, K. and Geschke, A., 2013. Building Eora: a global multi-region input–output database at high country and sector resolution. *Economic Systems Research*, *25*(1), pp. 20–49.

Montalbano, P., Nenci, S. and Pietrobelli, C., 2018. Opening and linking up: firms, GVCs, and productivity in Latin America. *Small Business Economics*, *50*(4), pp. 917–935.

International Monetary Fund (IMF). 2015a. Chapter 3, *Regional Economic Outlook: Subsaharan Africa*, April, International Monetary Fund, Washington DC.

——————. 2015b. Chapter 4, *Regional Economic Outlook: Western Hemisphere*, October, International Monetary Fund, Washington DC.

——————. 2016a. Chapter 4, *Regional Economic Outlook: Western Hemisphere*, April, International Monetary Fund, Washington DC.

——————. 2016b. Chapter 2, *World Economic Outlook*, October, International Monetary Fund, Washington DC.

——————. 2018. Chapter 3, *World Economic Outlook*, October, International Monetary Fund, Washington DC.

Organization for Economic Cooperation and Development (OECD), WTO, UNCTAD. 2013. Implications of Global Value Chains for Trade, Investment, Development, and Jobs. http://www.oecd.org/trade/G20-Global-Value-Chains-2013.pdf

Organization for Economic Cooperation and Development (OECD). "2011. ISIC REV. 3 Technology Intensity Definition." https://www.oecd.org/sti/ind/48350231.pdf

Ossa, R., 2014. Trade wars and trade talks with data. *American Economic Review*, *104*(12), pp. 4104–46.

Rahman, Jesmin, and Mr Tianli Zhao. 2013. Export Performance in Europe: What Do We Know from Supply Links?. No. 13–62. International Monetary Fund.

Rodrik, D., 2018. *New Technologies, Global Value Chains, and Developing Economies* (No. w25164). National Bureau of Economic Research.

Schwörer, T., 2013. Offshoring, domestic outsourcing and productivity: evidence for a number of European countries. *Review of World Economics*, *149*(1), pp. 131–149.

Stock, J.H. and Yogo, M., 2002. Testing for weak instruments in linear IV regression. National Bureau of Economic Research. NBER Technical Working Paper No. 284.

Wang, Z., Wei, S.J. and Zhu, K., 2013. *Quantifying international production sharing at the bilateral and sector levels* (No. w19677). National Bureau of Economic Research.

World Bank, 2016. Making Global Value Chains Work for Development. Washington, DC. https://doi.org/10.1596/978-1-4648-0157-0

World Bank. 2017. Measuring and Analyzing the Impact of GVSs on Economic Development. World Bank, Washington DC.