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WHO BENEFITS FROM GLOBAL VALUE CHAIN PARTICIPATION? DOES FUNCTIONAL SPECIALIZATION MATTER?

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Who Benefits from Global Value Chain Participation? Does Functional Specialization Matter?

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Abstract:
Global value chain (GVC) participation has transformed many lines of business. The benefits it provides in terms of greater specialization and technology diffusion, however, do not spread identically across countries and industries. This paper shows that taking into account the functional specialization helps to explain how the benefits of GVC participation are distributed. Using data for 35 industries in 40 countries in 2000-2011, we estimate the impact of GVC participation on value added within a production function framework. The results indicate that there is heterogeneity in the effects of GVC participation, according to the functional specialization of the respective industry and its GVC partners. Participating in R&D-related GVCs is especially profitable for fabrication-oriented industries and low-developed countries. It follows that any GVC participation analysis will be incomplete if it fails to take the functional specialization of the GVC participants into consideration.

JEL: F02, F14, O33, O47
Keywords: global value chains, input-output analysis, technology diffusion, development

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1. Introduction

Global value chains (GVC) have integrated economies into global and complex production chains that offer new opportunities for upgrading (Kummritz et al., 2017). Knowledge spillovers and network effects have been shown to positively influence productivity (Frohm & Gunnella, 2017). However, GVC participation does not distribute its gains evenly across the board, even though the value added of the chain as a whole rises (Gereffi & Fernandez-Stark, 2016).

The past few decades have been marked by the integration of developing countries into the world economy at an unprecedented pace (World Bank, 2016) and this phenomenon raises questions about the heterogeneity of GVC participation. Kummritz (2015) showed that the effects of GVC participation are different for low and high-wage countries, with the latter benefiting more. Fagerberg et al. (2018) confirmed that countries with low capabilities appear to be particularly disadvantaged in this regard. These insights are not only relevant for developing countries: differences in technological development are also present among industries in the developed world.

This paper contributes to this line of research by exploring the heterogeneity of GVC effects in a novel and more detailed way. Using proxies for GVC participation and functional specialization, based on data from the World Input-Output Database (WIOD) and function specialization data collected by Timmer et al. (2019) on 35 industries in 40 countries during the period 2000-2011, we show that the benefits of GVC participation depend on the participants' functional specialization as well as the functional specialization of their GVC partners. Our results indicate that fabrication-focused industries profit from GVC participation more than industries specialized in other business functions and that this is largely because of their engagement with R&D-oriented GVC partners. Grouping countries according to their levels of economic development shows that GVC participation with R&D-oriented industries benefits low-developed countries the most and that fabrication-related GVC participation benefits those countries the least.

We aim to bridge two strands literature regarding GVCs: rather qualitative papers with strong foundations in management theory (e.g. Gereffi et al., 2005; Ernst & Kim, 2002) and empirical, exploratory works which make us of newly available data such as WIOD or firm-level data (e.g. Stöllinger, 2019; Timmer et al., 2018; Baldwin et al., 2014). These two strands have, to our belief, developed mostly independently, to the detriment of understanding the consequences GVCs have on distinct actors of the world economy.

Although we are careful not to make any inferences about causality, this paper’s results reveal where the benefits of GVC participation tend to be concentrated. These results call for a more nuanced view of the potential benefits of GVC participation and highlight the fact that latecomers to GVCs are in a significantly different position from those who run the show. National governments, as well as major international organizations, should take note that GVC participation effects are not uniform across all countries and industries and that they depend on the structure of the particular GVC. Some development policies should be adjusted in the light of these findings. The bottom line is functional specialization makes a difference to where the benefits of deepening globalization are felt.

The rest of the paper is structured as follows: section 2 introduces the theory, explains the key concepts, and formulates hypotheses; section 3 describes the data and methods; section 4 presents the empirical results and section 5 concludes.

2. Theory, concepts, and hypotheses

Trade theories were long focused primarily on trade in final goods, with the market the only exchange platform considered. With rapidly decreasing transaction and communication costs driven by advancing technology, however, more elaborate structures that are very different from the simple exporter-importer relation have proliferated. Production has increasingly been sliced into individual tasks which come together to make up a final product. The concept of trade in final goods has thus given way to the idea of trade in tasks (Grossman & Rossi-Hansberg, 2008). Trading tasks requires a greater degree of coordination, and so hierarchical models other than purely market-based models were adopted (Gereffi et al., 2005). GVC analysis focuses specifically on how the production process is sliced up and on the non-market interactions that this division produces.

This does not mean that classic trade theories are irrelevant. Countries do still exchange goods based on their relative competitive advantage (Ricardo, 1817), and they specialize in production intensive in their abundant factor (Heckscher, 1919; Ohlin, 1933). GVCs, like trade, are shaped by geographical and cultural proximity: firms naturally seek interactions with low transaction costs, both in terms of transportation and communication (Ernst, 2002). This long resulted in a rather limited set of potential trading partners. However, as advances in technology and the removal of legal obstacles decrease transaction costs, new trade opportunities arise all over the world (Seuring & Müller, 2007).

Analyzing GVCs rather than just trade gives us the opportunity to study the non-market relations between participants. The benefits of GVC participation are – with the exception of economic gains caused by knowledge transfer, spillovers, and specialization – driven by participants' positions within the hierarchy of the GVC (Kaplinsky, 2000). It well might be that those GVC participants who occupy prominent positions in the GVC hierarchy in terms of their tasks and specialization within the GVC benefit more from the GVC than the rest. That is what we are interested in exploring in this paper.

2.1. Heterogeneity in the effects of GVC participation

Engaging firms with distinct capabilities in a GVC does not benefit all the firms in that GVC equally. The logic of technology gains suggests that firms with fewer capabilities will benefit the most from inter-firm cooperation (Blalock & Gertler, 2009), but this narrative misses a crucial reality. Firms with rare capabilities that offshore or outsource routine production tasks to other firms experience gains that cannot be explained in terms of technology improvements (Lee & Gereffi, 2015). This is made possible due to the uneven distribution of value added across the production process, described by the smiling curve (Shih, 1992). The firms that dominate a particular GVC can influence its architecture and position themselves in the GVC stages associated with the greatest value added, as they essentially govern the GVC. Consequently, firms with fewer capabilities are left responsible for tasks that are linked with very little value added.

Possessing demanded and rare capabilities is not only beneficial because the market rewards it. Capability disparity within a GVC defines its hierarchy and the value added distribution. Gereffi et al. (2005) identify five forms of GVC governance that largely depend on the capability disparity between the participating firms. When the disparity is high, companies form rigid hierarchical structures and shift a portion of their inter-firm interactions outside the market. When there is no capability disparity and there is no need for explicit coordination, GVCs are governed by the market. GVC participation thus does not only lead to technology transfer and specialization opportunities, but it also determines how much a firm can profit thanks to its hierarchical standing relative to its GVC partners.[1]

Relative capabilities can be observed even at the country or industry level using functional specialization. Using FDI data, Stöllinger (2019) shows that different countries focus on different business functions with richer countries like Germany and the UK focused on R&D and logistics and relatively poorer countries like Slovakia and Poland being active mainly in fabrication. Looking at industry-level data, Meng et al. (2020) reveal a similar pattern: industries far and close to the customer get a greater share of the final price than those in the middle. Another take is to measure upstreamness (Antras et al., 2012), i.e., the distance from the final customer, and relate this measure to economic performance. Descriptive analysis of Hagemejer & Ghodsi (2017) shows that despite the convergence of the new EU member states, they remained surprisingly upstream – they merely focused more on intermediate products. The relationship between this structural change and value added, however, remains opaque.

Such value added distribution along the stages of production is very similar to the “smile curve” we observe at the firm level. The lesson from firm-level data is thus transferable to the whole economy with a strong implication of functional specialization. Functional specialization and specialization in production stages are two distinct concepts, yet they often used interchangeably when moving from the firm (Rungi & Del Prete, 2018) to the economy-wide perspective (e.g. Mudambi, 2008). Stöllinger (2019) shows that the shape of the economy-wide smile curve is indeed similar to the firm-level curve, and Baldwin et al. (2014) provide evidence that it has become even curvier in recent years, with the service sector gradually increasing its value added share at the expense of manufacturing. The assumption made in this paper is that R&D business functions come as one of the first stages of production, whereas the marketing business function comes as the last. At the macro-level, it thus makes little difference whether we refer to functional specialization or specialization in production. What matters is the rare capabilities contained in those functions which define the hierarchy of the value chain and its value added distribution.

To increase one’s value added, one can either improve the productivity of the current tasks or move to the part of the value chain with greater value added. Humphrey and Schmitz (2002) call these two channels process upgrading and functional upgrading, respectively. Competent GVC partners can serve as sources of new technology improving efficiency. Ernst and Kim (2002) posit that GVCs can serve as a knowledge conduit between heterogeneous firms, both through the market (FDI, trade, and machinery) or through informal channels (technical standards, imitation). Saia et al. (2015) empirically support this claim by showing that international connectedness ensures contact with the global technology frontier and such contact positively influences the productivity of all engaged agents.

[1] Dominant firms have many opportunities to exert power within their GVC. One example is management of working capital: the dominant link in the GVC can force others to accept their preferred payment calendars (Kaplinsky, 2000).

Process upgrading leads to capability formation (Ernst & Kim, 2002), so a firm can acquire capabilities in stages with little value added and use them for subsequent functional upgrading. But functional upgrading is more difficult and is likely to meet with resistance from other players in the GVC as they protect their market share (Lee & Gereffi, 2015). This is of special importance for developing economies. Fagerberg et al. (2018), for example, find no evidence of GVC participation being linked to better economic performance, and on the contrary show that countries with underdeveloped capabilities may even suffer from GVC participation. It is possible that the technology gains GVC participation facilitates can be offset by unfavorable positioning within the GVC hierarchy.

This paper investigates the association between value added, functional specialization, and GVC participation. It is beyond its scope to discern functional upgrading as its dynamic nature is difficult to capture, but we hope to find evidence for process upgrading being related to a certain kind of GVC participation. GVC participation might induce process upgrading mainly through knowledge transfer. Knowledge, in turn, is transferable the easiest in a codifiable form (Hall, 2006). As the proportion of codifiable and tacit knowledge is, in our view, the greatest in fabrication as opposed to R&D and marketing, it follows that fabrication-oriented industries will benefit the most from GVC participation.

Hypothesis 1*: Increasing GVC participation benefits more fabrication-oriented industries.*

The global production networks exploit the ex-ante prospects of the respective comparative advantages, but once they are in place, new opportunities arise from the very structure of the networks. Not only is the existing technology diffused along supply chains (MacDuffie & Helper, 1997), but new systems are also used specifically for developing new technologies and disseminating them immediately within the network (Dyer & Nobeoka, 2000). The perspective of the fabrication-oriented industry is then enriched by distinguishing with what sort of other industries GVC participation happens. GVC participation leads to knowledge spillovers but that is likely to happen only across certain kinds of business functions such as R&D.

Hypothesis 2*: Fabrication-oriented industries benefit disproportionately from GVC integration with R&D-focused peers.*

It is not clear whether the power architecture follows the division between developed and developing countries. Horner & Nadvi (2018) claim that the notion of firms from the developed world dully outsourcing and offshoring their low-value-added activities to developing countries is outdated. GVC participation within the global South is on the rise and so are the capabilities of the engaged participants. Taking this argument to the extreme, we should observe the same effects from GVC participation no matter whether we look at GVC participation within the developed world, the developing world, or across the globe. What matters is only the specialization within the chain. Any remaining heterogeneity can be attributed to factors such as favorable path dependency, institutional quality, and human capital (Zhou, 2018).

Hypothesis 3*: High-developed countries do not reap disproportionate benefits from GVC participation.*

GVCs are traditionally thought of as covering most of the production process, from design and extraction of raw materials to sales and marketing. Such GVCs are structurally different from those that are within a single industry. For instance, collaboration between firms in the automotive industry requires greater cooperation than collaboration between the mining and smelting industries. Shorter, single-industry GVCs have proliferated in the past few decades as production has become more fragmented (Wakasugi, 2007).

As a result, we investigate whether GVC participation within a single industry has a distinct effect. Technological proximity offers greater opportunities for technology spillovers, but the need for intense coordination may result in tight hierarchical structures (Gereffi et al., 2005). The effects of technology spillovers and GVC hierarchy in intra-industry GVCs are intensified by foreign direct investment, which is particularly common within industry and is also associated with gains in value added (Liu et al., 2000). Controlling for functional specialization, intra-industry GVCs thus should provide more benefits than inter-industry ones.

Hypothesis 4: *Increases in* ***intra-industry GVC participation benefit the industries more*** *than increases in regular GVC participation.*

2.2. Empirical approaches to GVC analysis

The empirical research on GVCs has gained prominence in the last two decades. It builds on international trade statistics, customs statistics, and input-output tables (Amador and Cabral, 2014). The input-output approach we follow in this study was pioneered by Feenstra and Hanson (1996, 1999) who introduced a measure of foreign share in domestic production and so turned their attention to the global integration of production networks. Hummels et al. (2001) took this even further with their concept of vertical specialization, which describes production located in at least two countries and goods crossing borders at least twice.

As novel and useful as this approach was, it neglected possible discrepancies in value added at each stage of production and circular aspects of production. A new value-added approach by Johnson and Noguera (2012), building on Hummels et al. (2001), accounted for the possibility of exporting intermediate goods that are later part of imported final goods by introducing the value added share of gross exports. This improved estimates of bilateral trade quite significantly. The method was later formalized by Koopman et al. (2014) so that gross exports can be easily broken down into value added flows by matrix formulation.

Los et al. (2015) introduced yet another metric to measure international fragmentation. Building on Feenstra and Hanson (1999), they present the foreign value-added share, which accounts for the inter-industry circular flow of goods and avoids double-counting, similarly to Johnson and Noguera (2012). This measure enables researchers to investigate GVC participation within a single country or region or indeed on a global scale. It is thus suitable for detailed GVC analysis, as it can be sliced and diced at will, and has indeed been used extensively in recent empirical papers (see Blanchard et al., 2016 or Wolszczak-Derlacz et al., 2017). Specifically, Timmer et al. (2014) provide a detailed analysis of the development of GVC participation over time and of the way GVC participation affects capital and labor shares. Los et al. (2015), building on this work, show that although many GVCs are clustered within regions, the truly global ones have progressed far more than the regional ones.

Notwithstanding the convincing results, the methods used in this strand of research are not clear of criticism. Nomaler and Verspagen (2014) argue that this type of aggregated input-output analysis is significantly distorted. The aggregate nature of the input-output means that intra-industry circular flows are ignored. Take the manufacturing of the electrical equipment industry as an example: undoubtedly, electrical equipment is an input to this industry. This value added is lost in the aggregation because it happens within the same sector. Also, value-added-to-output ratios, which are used extensively when computing measures such as foreign value added depend on the GVC stage. The ratios in later stages are smaller as the gross output is greater, which in turn overestimates the contribution to value added from sectors engaged in the last stages of production.

Another issue is the very nature of the input-output data. Because the original data is the supply and use tables which are infrequent, its longitudinal dimension is obtained using an estimation method (Temurshoev & Timmer, 2011). Such a procedure exploits data from National Accounts Statistics and comes up with harmonized, comparable time series. Despite the method's quality, one can still argue that the data are not direct observation which can skew its analysis. Unfortunately, to our knowledge, no remedy exists at the moment.

3. Data and methods

Our analysis is based on data from the World Input-Output Database (Timmer et al., 2015). Release 2016 provides a panel of 54 industries in 43 countries over the period 2000-2014. We use input-output tables to calculate foreign value added share measures (FVAS) and socio-economic accounts for value added, capital, and labor employed. All the currencies are converted to US dollars and use 2010 prices. For the FVAS calculation, we closely follow Los et al. (2015). FVAS reveals how much of the total value added of the particular GVC is produced abroad – a measure of international integration. Based on the input-output tables, it is calculated in the following way:

$$FVAS(c,j) = \frac{\sum_{k \neq j} VA(k)(c,j)}{\sum_{k} VA(k)(c,j)}, \tag{1}$$

where *VA* stands for value added, *c* for the country, *j* for the industry, *k* for the GVC partner. The value added created in each industry within each country is given by the vector $\boldsymbol{g}$:

$$\boldsymbol{g} = \widehat{\boldsymbol{v}}(\boldsymbol{I} - \boldsymbol{A})^{-\mathbf{1}}(\boldsymbol{Fe}) \tag{2}$$

In this equation, $\widehat{\boldsymbol{v}}$ is a matrix with value added over gross output on its diagonal, $(\boldsymbol{I} - \boldsymbol{A})^{-\mathbf{1}}$ is the standard Leontief inverse, $\boldsymbol{F}$ is the matrix of the final output, and $\boldsymbol{e}$ is the summation vector. The choice of matrix $\boldsymbol{F}$ determines which value chain we consider. For each industry-country pair, we thus have a vector of value added produced in each of the other pairs which adds up to the gross output. In other words, the vector shows the income shares of each industry's final product in all country-industry pairs Such vectors can then be sliced and diced at will.

We use data on business functions assembled by Timmer et al. (2018). The dataset provides information on workers' income shares for fabrication, R&D, marketing, and management. The dataset spans across 35 industries, 40 countries over years 1999-2011. Merging this dataset with WIOD[2], we can relate functional specialization with GVC participation, specifically FVAS. This enables us to determine the FVAS related to certain business function. For instance, we calculate how much FVAS of each industry comes from fabrication by multiplying the particular FVAS value with the fabrication share in that industry. The equation below shows the calculation of FVAS related to fabrication in country *c*, industry *j*, where

[2] Because the granularity of WIOD is greater, we assume that the business function distribution is the same two industries in WIOD which are the subset an industry in Timmer et al. (2019) business function dataset.

$FS_{d,j}^{FAB}$ is fabrication functional specialization in country *d,* industry *j,* and $VA_{d,j}(c,i)$ is the value added produced in country *d*, industry *j* for the final product of country *c*, industry *i*.

$$FAB\_FVAS(c,i) = \frac{\sum_{d \neq c,j} FS_{d,j}^{FAB} VA_{d,j}(c,i)}{\sum_{d,j} VA_{d,j}(c,i)} \tag{3}$$

The same procedure is used to calculate FVAS related to R&D and marketing functional specialization. The business functions measure the relative intensities so they all add up to 1. Increasing specialization in R&D is always offset by decreasing specialization in the remaining business functions. We drop management business function[3] because we want the functional specialization to copy the specialization in production stages as closely as possible. Since management is essential for every stage of production, it does not fit this framework.[4] Slicing the FVAS in this way provides additional insights into how the heterogeneity of a GVC affects value added. Table 1 below provides the summary statistics of the key variables. The panel is unbalanced because a few industries in a few countries are missing in the dataset.

Table 1: *Aggregate summary statistics*

	N	MEAN	SD	MIN	MAX
Capital stock (USD millions)	23,023	*1,075*	*7,134*	*0*	*183,308*
Labor (FTE)	23,023	*384*	*1,336*	*0*	*24,966*
Value Added (USD millions)	23,023	*351*	*1,174*	*0*	*21,379*
R&D Business Function	23,023	*0.181*	*0.15*	*0*	*1*
Fabrication Business Function	23,023	*0.315*	*0.253*	*0*	*1*
Marketing Business Function	23,023	*0.341*	*0.217*	*0*	*1*
FVAS total	23,023	*0.209*	*0.16*	*0*	*0.936*
o/w FVAS related to R&D	23,023	*0.035*	*0.03*	*0*	*0.27*
FVAS related to Fabrication	23,023	*0.066*	*0.061*	*0*	*0.37*
FVAS related to Marketing	23,023	*0.07*	*0.056*	*0*	*0.431*

Source: Author's computations

We base our estimation on the Cobb-Douglas production function where technology (*A*) is assumed to be a function of foreign value added share and the relative intra-industry productivity. As such, this specification is similar to Kummritz et al. (2017) – we use value added as the dependent variable because it captures changes in productivity as well as changes in factor utilization as well as gross profits of firms and workers' wages. The aim is to exploratively relate GVC participation and functional specialization to value added and try to control for the omitted variables by an extensive fixed effects structure. The basis of our estimation lies in the general production function:

[3] Dropping management, we also rescale the rest income shares so that they add up to one without management.
[4] Management business function entails professions such as legislators, artists or librarians which are impossible to place in any of the production stages. That is why we decided to omit this business function asnd rescale the rest accordingly.

$$Y(A,F) = A(FVAS, \dots)F(K,L) \tag{4}$$

Logarithmic transformation provides the usual regression equation:

$$y_{cjt} = A_{cj} + \beta_1 FVAS_{cjt} + \beta_2 k_{cjt} + \beta_3 l_{cjt} + \beta_4 RND_{cjt} + \beta_4 FAB_{cjt} + \beta_4 MAR_{cjt} + \lambda_t + u_{cjt} \tag{5}$$

where y is the logarithm of value added, A is a constant describing the level of employed technology (country-industry fixed effects), $FVAS$ is the foreign value added share, k is a logarithm of nominal capital stock, l is a logarithm of total hours worked, RND, FAB and MAR are the income shares for the respective business function, and λ represents the common time dummies. The subscripts *c, j, t* stand for country, industry, and year, respectively.

Adding the three business functions, we aim to investigate the distribution of value added along the production stages. The empirical literature shows, that the value added is the lowest in the fabrication stage (Rungi & Del Prete, 2018). To test the hypotheses 1, we thus let our measure of GVC participation, FVAS, interact with fabrication business function. This tells us, whether the distribution curve flattens as the result of GVC participation or whether it curves even more. In other words, the positive interaction would suggest that GVC participation results in process upgrading beneficial to fabrication-oriented industries. The potential omitted variable bias is mitigated by the country-industry and time fixed effects. Different levels of productivity between the sectors as well as the development and common shocks are accounted for by the dummy structures employed in the estimation.

To test the second hypothesis, FVAS is split into that related to fabrication, R&D, and marketing:

$$\begin{aligned} y_{cjt} = A_{cj} + \beta_1 RND_{cjt} + \beta_2 FAB_{cjt} + \beta_3 MAR_{cjt} + \beta_4 R\&D\_FVAS_{cjt} \\ + \beta_5 FAB\_FVAS_{cjt} + \beta_6 MAR\_FVAS_{cjt} + \beta_7 k_{cjt} + \beta_8 l_{cjt} + \lambda_t + u_{cjt} \end{aligned} \tag{6}$$

Once again letting the fabrication business function interact with the now split FVAS shows how different kinds of GVC participation are related to the value-added distribution along the production stages. If the interaction term is positive, it is a piece of evidence for the specific GVC participation helping fabrication-oriented industries in process upgrading, possibly through knowledge transfer. For instance, we would expect that this effect is especially pronounced when participating in GVCs with R&D-oriented partners. To the best of my knowledge, GVC participation effects have not previously been examined in this way.

To test the third hypothesis about country heterogeneity, we split the set of 40 countries into three groups according to their level of economic development. The groups of low-developed, medium-developed, and high-developed countries are included in the appendix. The high-developed group consists of Western countries, Japan, Korea, and Taiwan. Countries from Southern Europe and most post-communist countries from the medium-developed group and the remaining countries are included in the low-developed group. This division mostly mirrors that of the World Bank (2019), where the countries are divided into groups based on income or that of the International Monetary Fund (2019) with advanced and emerging and developing country groups. Because the division changes in the period we cover, we employ our own grouping. Our approach also reflects the fact that our data sample consists primarily of developed economies.

Table 2 below breaks down the summary statistics according to the country groups. The average general GVC participation (FVAS) is similar across the country groups[5] but splitting it reveals a pattern. Low-developed countries are less integrated with R&D-oriented and marketing-oriented GVCs. This suggests low-developed countries are mainly active in manufacturing industries as suppliers. Medium-developed countries are even more participating with fabrication-focused GVCs, but they increase their exposure to GVC partners focused on marketing and R&D. This is a hint of them being further from the pure fabrication process, either closer to the final customer or design and development of the product. Lastly, the high-developed countries reduce their GVC participation solely in fabrication and marketing-related GVCs which indicates that those functions are mainly served domestically.

***Table 2**: Mean values of GVC participation related to specific business functions, by country development group*

	Low-developed countries	*Medium-developed countries*	*High-developed countries*
FVAS total	0.183	0.232	0.209
o/w FVAS related to R&D	0.031	0.042	0.043
FVAS related to fabrication	0.087	0.098	0.080
FVAS related to marketing	0.065	0.092	0.086

Source: Author's computations

4. Econometric results

We use the standard approach of demeaning variables using the within transformation. The country-industry fixed effects are thus implicitly present in the model. The variables in interactions are centered, so that the interactions have clearer interpretation. We further add the time effects to control for the common time development and country-industry effects to account for any additional individual effects. In all the regression results we present clustered standard errors. The estimated coefficients thus describe the association of a unit increase in GVC participation with a percentage change in value added. The different levels of GVC participation are controlled for by fixed effects. Admittedly, this specification does not identify any causal effect of GVC participation on value added. Growing industries may increasingly participate in GVCs while GVC participation may bring about more value added. To identify a causal effect, however, we would need an exogenous shock, which is difficult to find in this context. This paper thus offers only an explorative analysis pointing to potential causal links, without directly inferring causality.[6]

[5] FVAS rose over time for all three development groups. This finding is consistent with the evidence from Los et al. (2015) and World Bank Group (2017). Only during the great financial crisis did global economic integration experience a severe drop.

[6] Using covariates distinct from GVC participation (yet linked to it), such as foreign direct investment, would make these estimates more precise. But merging the WIOD dataset with another dataset would mean losing observations which, we believe, is not feasible as the aim is to cover as many countries and industries as possible

4.1. GVC participation and value added

Table 3 presents the benchmark results. In column 1, the total FVAS has a positive impact on value added, irrespective of the trading partner and its functional specialization within the value chain. This is in line with Kordalska et al. (2016).[7] Adding functional specialization of the industry using the intensity of R&D, fabrication, and marketing business functions, column 2 hints that the industries focusing on marketing produce relatively less value added holding the other factors of production constant. This is somewhat surprising considering the industry-level smiling curve. However, as Rehnberg & Ponte (2017) show, the distribution of value added is, at the industry level, rather of a smirk shape, so the drop in the final production stage becomes somewhat less shocking. The results do not change when both GVC participation and functional specialization is considered (column 3).

As we hypothesize that GVC participation should also link to value added through functional specialization, we let it interact with the fabrication business function. Results in column 4 show that fabrication specialization is profitable only if it is accompanied by sufficient GVC participation. Isolated manufacturing industries seem to lag behind those who form the fabric of the GVCs.

***Table 3**: Benchmark results*

	(1)	(2)	(3)	(4)
Capital	**0.57*** **	**0.57*** **	**0.57*** **	**0.56*** **
	(0.01)	(0.01)	(0.01)	(0.01)
Labor	**0.26*** **	**0.25*** **	**0.25*** **	**0.25*** **
	(0.01)	(0.01)	(0.01)	(0.01)
FVAS	**0.55*** **	**-**	**0.62*** **	**0.56*** **
	(0.04)	-	(0.04)	(0.05)
R&D business function	-	-0.02	-0.02	-0.02
	-	(0.02)	(0.02)	(0.02)
Fabrication business function	-	0.01	0.00	**-0.11***
	-	(0.02)	(0.01)	(0.04)
Marketing business function	-	**-0.06****	**-0.06*** **	**-0.06*** **
	-	(0.02)	(0.02)	(0.02)
Fabrication business function x FVAS	-	-	-	**0.16***
	-	-	-	(0.06)
Time effects	Yes	Yes	Yes	Yes
Country-industry effects	Yes	Yes	Yes	Yes
Observations	23,023	23,023	23,023	23,023
Adjusted R-squared	0.53	0.52	0.53	0.53

*** $p<0.01$, ** $p<0.05$, * $p<0.1$.

to get the utmost precise picture of the interlinkages in the world economy. However, fixed effects partially mitigate the omitted variable bias.

[7] However, Kordalska et al. use foreign value added as the independent variable, whereas this study uses foreign value added share. This study is primarily interested in how relative GVC participation affects productivity. Rising overall foreign value added does not say much about the effects of GVC participation intensity. FVAS, contrarily, captures directly how much of the total value added is contributed by different foreign partners.

However, such an approach neglects the FVAS composition. Distinguishing between R&D-related and fabrication-related GVC participation uncovers heterogeneity of the interplay between GVC participation and value added. The results in column 1 of Table 4 show that the perks of GVC participation are considerably lower in the case of marketing-related links. An alternative view is that fabrication-related GVC participation provides disproportionate benefits (Rungi & Del Prete, 2018) and that R&D-related GVC links stimulate knowledge-transfer. Also, it could be a hint for less value added being associated with tasks such as assembling which precede distribution and marketing as shown by Stöllinger et al. (2019). Indeed, this is often identified as a problem for countries successful at manufacturing, but lacking the distribution channels (e.g. suppliers of the German automotive industry).

Further, we would like to see how GVC participation interacts with the fabrication business function. Do fabricated-oriented industries profit from knowledge spillovers if they are exposed to trade partners engaged in R&D? Letting the now split FVAS interact with the fabrication business functions, it is apparent that it is indeed only the R&D-related GVC participation which makes fabrication competitive (column 2). A possible explanation is that the interaction with more advanced trade partners induces knowledge transfer and thus process upgrading. GVC participation with partners focused on other business functions does not interact with the relationship between value added and the fabrication business function in any discernible way (columns 2 and 3).

***Table 4**: FVAS split by partner's business function*

	(1)	(2)	(3)	(4)
Capital	**0.56*** **	**0.56*** **	**0.56*** **	**0.56*** **
	(0.01)	(0.01)	(0.01)	(0.01)
Labor	**0.26*** **	**0.26*** **	**0.26*** **	**0.26*** **
	(0.01)	(0.01)	(0.01)	(0.01)
R&D business function	**0.27*** **	**0.25*** **	**0.26*** **	**0.27*** **
	(0.06)	(0.06)	(0.06)	(0.06)
Fabrication business function	**0.28*** **	**-0.85** **	**0.52*** **	0.25
	(0.05)	(0.30)	(0.15)	(0.18)
Marketing business function	**0.19*** **	**0.18** **	**0.18** **	**0.19** **
	(0.06)	(0.06)	(0.06)	(0.06)
FVAS from R&D	**0.91*** **	**0.57** **	**0.86*** **	**0.91*** **
	(0.18)	(0.20)	(0.18)	(0.18)
FVAS from Fabrication	**1.06*** **	**0.93*** **	**1.23*** **	**1.04*** **
	(0.10)	(0.11)	(0.16)	(0.11)
FVAS from Marketing	**0.46*** **	**0.50*** **	**0.43** **	**0.45*** **
	(0.12)	(0.13)	(0.13)	(0.13)
Fabrication business function	-	**1.15*** **	-	-
x FVAS from R&D	-	(0.30)	-	-
Fabrication business function	-	-	-0.26	-
x FVAS from Fabrication	-	-	(0.16)	-
Fabrication business function	-	-	-	0.04
x FVAS from Marketing	-	-	-	(0.18)
Time effects	Yes	Yes	Yes	Yes
Country-industry effects	Yes	Yes	Yes	Yes
Observations	23,023	23,023	23,023	23,023

Adjusted R-squared	0.53	0.52	0.53	0.53

*** p<0.01, ** p<0.05, * p<0.1.

4.2. Intra-industry GVCs and functional specialization

To test whether intra-industry GVC participation is more beneficial than the inter-industry kind, we calculate an FVAS measure that only captures GVC participation within the given industry. The results in column 1 of Table 5 suggest a strong positive association between intra-industry GVC participation and value-added. The association is stronger than the GVC participation of the inter-industry kind. Interactions with the fabrication business function (column 2) reveal that this difference is even more pronounced for industries not active in fabrication which is in line with our previous results. Surprisingly, this effect is not observed in the case of intra-industry GVC participation (column 3) suggesting that process upgrading happens mainly across industries. Knowledge transfer from a different industry (at our level of granularity) seems to be more consequential than knowledge transfer within an industry.

Table 5*: Intra-industry GVC participation*

	(1)	(2)	(3)
Capital	**0.56***** (0.01)	**0.56***** (0.01)	**0.56***** (0.01)
Labor	**0.25***** (0.02)	**0.25***** (0.02)	**0.25***** (0.02)
R&D business function	0.04 (0.06)	0.04 (0.6)	0.04 (0.06)
Fabrication business function	0.05 (0.06)	-0.5 (0.07)	0.05 (0.06)
Marketing business function	0.00 (0.06)	-0.00 (0.07)	0.00 (0.06)
FVAS_rest	**0.80***** (0.05)	**0.74***** (0.05)	**0.80***** (0.05)
FVAS_intra	**1.95***** (0.18)	**1.98***** (0.18)	**1.99***** (0.24)
FVAS_rest x Fabrication business function	- -	**0.14**** (0.06)	- -
FVAS_intra x Fabrication business function	- -	- -	-0.09 (0.28)
Time effects	Yes	Yes	Yes
Country-industry effects	Yes	Yes	Yes
Observations	23,023	23,023	23,023
Adjusted R-squared	0.53	0.53	0.53

*** p<0.01, ** p<0.05, * p<0.1.

4.3. Does country development matter?

Focusing only on the inter-industry GVC relations neglects other potentially important source of FVAS effects heterogeneity – country heterogeneity. Path dependency also plays a role as GVC participants from developed countries may enjoy greater value added due to their traditionally favorable position on the market. Following Kummritz (2015) we suspect these effects to be distinct in highly, more, and low-developed countries. We, therefore, make use of a nested model in which FVAS measures interact with a development group dummy.

The results in column 1 of Table 6 show that returns to the general GVC participation are the same across the board. These results are in line with those reported by Kummritz et al. (2017), who found that country development status did not influence GVC participation effects. However, if we distinguish between the business function of the GVC partner, country development matters as column 2 shows. The R&D-related GVC participation is linked to more value added for low-developed countries than for more and high-developed countries. It is perhaps no surprise that GVC participation with R&D-oriented partners gives the most benefit to the low-developed countries as those countries can profit from knowledge transfer. Contrarily, fabrication-related GVC participation is beneficial more for more and high-developed countries. This hints at the fact that outsourcing production to countries with cheap labor is profitable mainly for these two development groups – the receiving side of the outsourcing does not profit as much as the dominant players of the GVC.

Table 6*: Using country development group dummy as an interaction term with FVAS*

	(1)	(2)	(3)	(4)
Capital	**0.57***** (0.01)	**0.57***** (0.01)	**0.57***** (0.01)	**0.57***** (0.01)
Labor	**0.25***** (0.01)	**0.25***** (0.01)	**0.25***** (0.01)	**0.25***** (0.01)
R&D business function	0.04 (0.05)	**0.29***** (0.06)	**0.27***** (0.06)	**0.27***** (0.06)
Fabrication business function	0.05 (0.05)	**0.28***** (0.06)	**0.28***** (0.06)	**0.28***** (0.06)
Marketing business function	0.00 (0.06)	**0.20**** (0.06)	**0.19**** (0.06)	**0.19**** (0.06)
FVAS	**0.64***** (0.07)	- -	- -	- -
FVAS x low_developed	0.02 (0.09)	- -	- -	- -
FVAS x high_developed	-0.05 (0.08)	- -	- -	- -
FVAS from R&D	- -	**0.86***** (0.22)	**0.91***** (0.18)	**0.91***** (0.22)
FVAS from Fabrication	- -	**0.98***** (0.10)	**1.23***** (0.14)	**1.04***** (0.11)
FVAS from Marketing	- -	**0.45***** (0.13)	**0.46***** (0.12)	**0.43**** (0.16)
FVAS from R&D x low_developed	- -	**0.91**** (0.31)	- -	- -
FVAS from Fabrication x low_developed	- -	- -	**-0.42*** (0.20)	- -
FVAS from Marketing x low_developed	- -	- -	- -	0.11 (0.26)
FVAS from R&D x high_developed	- -	-0.04 (0.20)	- -	- -
FVAS from Fabrication x high_developed	- -	- -	-0.14 (0.17)	- -
FVAS from Marketing x high_developed	- -	- -	- -	0.03 (017)
Time effects	Yes	Yes	Yes	Yes
Country-industry effects	Yes	Yes	Yes	Yes
Observations	23,023	23,023	23,023	23,023
Adjusted R-squared	0.53	0.53	0.53	0.53

*** $p<0.01$, ** $p<0.05$, * $p<0.1$.

5. Conclusion

In this paper we have analyzed the interplay between GVC participation and value added, illustrating the heterogeneity of GVC participation effects depending on stages of production which were proxied by functional specialization. There is a strong positive association between value added and GVC participation – this effect is even more important for fabrication-oriented industries. This likely stems from the closer links in a more rigid hierarchy present in manufacturing sectors (Gereffi et al., 2005) which induces technology gains (Ernst & Kim, 2002) and results in process upgrading.

By distinguishing between FVAS related to R&D, fabrication, and marketing business function of the GVC partners, we have revealed the second dimension of heterogeneity in GVC participation effects. Because the structure of GVC participation changes across the production process, the aggregate effects may mask the true consequences of GVC hierarchy and technology gains. Deepening GVC participation with a partner focused on marketing provides significantly fewer benefits than R&D and fabrication-related GVC participation suggesting the unfavorable position of industries engaged in late fabrication stages, such as assembly. GVC hierarchy and severe competition in such tasks is the culprit of the uneven value added distribution (Gereffi et al., 2005).

Furthermore, countries could be particularly affected by GVC participation based on their development. By allotting the covered countries to groups of highly, more, and low-developed economies, we were able to show that whereas low-developed countries benefit from R&D-related GVC participation more than others, the opposite is true for fabrication-related GVC participation. Yet again, these findings support both the notion of technology transfer from countries with more competencies to those with fewer competencies. Fabrication-related GVC participation is less profitable for the low-developed countries likely because of their relatively weak competitive advantage of cheap labor in this particular business function. Generally, we did not find evidence supporting or the hypothesis of the global North benefiting more greatly from GVC participation than the global South.

Although it is tempting to use these findings in the evaluation of trade policies, they must be interpreted with caution. As we discussed above, these results do not imply causality. This study also the broadest possible picture (as many countries as possible) at the expense of a more detailed view of individual regions and industries. Indeed, if one looks closely, more adverse effects of trade in general, localized in terms of geography or demography arise. There is growing evidence (e.g., Acemoglu et al., 2015; Autor et al., 2014) that the negative effects of trade integration are non-negligible and concentrated. Moreover, we have only inspected the interplay between GVC participation and process upgrading. The long-term policies should, however, consider moving up in the value chains (functional upgrading) as well.

Except for looking deeper into the functional upgrading of industries and countries, it is also worthwhile to investigate the heterogeneity of the GVC effects among income groups of individuals. Examining the association between wage distribution and GVC participation should be the next step in this line of research. Similarly, expanding the data sample to cover more developing economies is a crucial step to informed development policy. More can be also said about the drivers of the heterogeneity of GVC participation effects. As an example, R&D expenditures may stimulate technology gains from GVC participation through greater absorption capacity (Mancusi, 2008). Policy would then be able to focus on increasing the benefits of GVC participation as well as on mitigating the potential harm it causes.

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Appendix

A1. Country division

Low-developed	Medium-developed	High-developed
Bulgaria	Croatia	Australia
Brazil	Cyprus	Austria
China	Czechia	Belgium
Indonesia	Estonia	Canada
India	Greece	Switzerland
Mexico	Hungary	Germany
Romania	Italy	Finland
Russia	Lithuania	France
Turkey	Latvia	The United Kingdom
	Malta	Ireland
	Poland	Japan
	Portugal	Korea
	Slovakia	Luxembourg
	Slovenia	The Netherlands
	Spain	Norway
		Sweden
		Taiwan
		USA

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