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Wage Effects of Global Value Chains Participation and Position: An Industry-level Analysis[1]

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Abstract

We examine how participation and positioning in global value chains (GVC) affect wages. We also examine whether this relationship is conditioned by a country's development level and labour market regulation. The results show that participation and upstream specialisation in GVCs are associated with higher wages but only in developed countries. In developing countries, while GVC participation is associated with higher wages, upstream specialisation exerts downward pressure on wages. For analysis focusing on the role of labour market regulation, we find that GVC participation only exerts a positive effect on wages under stringent labour market regulation. Under flexible labour market conditions, it exerts downward pressure on wages but allows for the effective reallocation of GVC workers into knowledge-intensive and high value added upstream activities in the value chain that are more productive and wage rewarding. Additional analysis on the effects of GVCs along the wage distribution show that participation and upstream specialisation in GVCs are associated with higher wages across all wage segments in the developed countries. In developing countries, GVC participation only benefits higher wage earners and make low-wage earners worse-off. Even when upstream specialisation is associated with lower wages across all wage segments, low wage earners are disproportionately affected.

***Keywords*:** Wages; Global Value Chains; GVC Participation; Upstream Specialisation
***JEL Code*:** F14; F16; J16; P51

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1. Introduction

In June 2007, Apple introduced its first generation of iPhones (iPhone 2G). At that time, both the organisation of the production and the supply of the components of the iPhone operated at a much smaller scale than today. Since then, however, things have changed substantially. Today, from the Kenyan mines to Chinese factories, Apple buys many of the components for its iPhones from more than 200 suppliers around the world—including memory chip and processor from Korea, the modem and battery from China, the camera, LCD screen, and storage from Japan, glass screen and audio chips from within the United States, gyroscope from Switzerland and the accelerometer from Germany. While still designed in California, about half of all iPhones today are made by Foxconn, a Taiwanese company located in the Chinese city of Zhengzhou. Each day about 350, 000 workers of the company assembles, test, and package about 500,000 iPhones earning $1.90 per hour[2].

Similar patterns as to how Apple now organizes production for its iPhones can be observed across products produced by different producers in the low, middle, and high-tech manufacturing industries. This phenomenon that is now known as global value chains (GVCs) has changed the nature of cross-border trade, thanks to advances in transportation and communication technologies, and the reduction of barriers to trade that has made this possible. About 85 percent of world trade in 2016 was generated in GVCs and although the figure has declined in recent years it remains substantially high (Sampath & Valejo, 2018; WDR, 2020). The emergence of GVCs as a new way of organizing production has reinvigorated the interest of trade economists and policy-makers on the distributional and welfare consequences of cross-border trade, with particular attention paid to GVCs as opposed to focusing on aggregate trade flows (e.g. see Baldwin & Yan, 2014; Costinot *et al.,* 2012; Lopez Gonzalez *et al.,* 2015; Ma *et al.,* 2019). In this paper, we contribute to this debate by examining how participation and positioning in GVCs affect wages.

The motivation for our investigation is twofold. First, wage is an important component of income level and a determinant of social conditions of people in a polity, thereby making inquiring about its determinants of utmost policy importance. Second, the rise of GVCs has changed the nature of cross-border trade as trade now takes place mostly at a more granular level wherein individual firms across the globe are responsible for specific stages belonging to a supply chain. This implies

[2] https://www.nytimes.com/2016/12/29/technology/iphone-china-apple-stores.html 02/01/2021.

that countries can now access the global market and gain from trade by specializing in specific products or tasks within a value chain instead of having to develop an entire industry. While this would imply a net wage gain for workers in the GVCs participating firms and countries (Feenstra & Hansen, 1997; Grossmann & Rossi-Hansberg, 2008), there is suggestive evidence that workers in GVCs face a multitude of challenges among which include downward pressure on wages as jobs become increasingly contractual and seasonal, and firms cut costs through wages to remain competitive (Taglioni & Winkler, 2016). Moreover, there is a potential risk that countries with low initial production capabilities and little or no industrial capacity could be locked into low value-added stages of the value chain, providing primary and simple manufacturing products that have less scope for quality differentiation or productivity improvement that could translate into higher wages. Hence, the nature of the relationship between GVC and wages becomes a matter of empirical question.

To address our research objective, we use manufacturing industry-level data across 45 developed and developing countries. As an empirical measure of GVC participation, we follow recent developments in the GVC literature that measures the extent of GVC participation as the sum of the share of foreign value-added used in a country's exports (we call this backward GVC participation) and the share of country's domestic value-added that enters as an intermediate input in the value-added exported by other countries (we call this forward GVC participation) (see UNCTAD, 2013; Foster-McGregor *et al.,* 2015; Montalbano *et al.,* 2018; Wang *et al.,* 2019; Amendolagine *et al.,* 2019; Carril-Caccia & Pavlova, 2020; Ndubuisi & Owusu, 2021). However, because we are interested in the mechanisms through which participation in GVC affects wages, we also consider the independent effects of backward and forward GVC participation. Our measure of GVC position is inspired by Antras *et al.* (2012) and follows the extant literature that measures an industry's relative upstream position in value chains (Koopman *et al.,* 2011; Montalbano *et al.,* 2018; Gunnella *et al.,* 2019; Amendolagine *et al.,* 2020). Particularly, the variable measures the extent an industry is upstream or downstream in GVCs, depending on its specialisation (Koopman *et al.,* 2011). An industry is upstream if it primarily supplies inputs to others, while it lies downstream if it uses a large portion of intermediates from others to produce final goods for exports.

Our results show a positive association between GVC participation and wages, and this works both through backward and forward GVC participation. However, the effect along the backward GVC participation is stronger, suggesting that industries with higher backward integration in GVC stand to gain more. We also find that upstream specialisation in GVCs is associated with higher wages. To gain further insights into the nexus between GVC and wages, we extend our analysis in three directions. First, we examine the wage effects of GVC participation and position across two subsamples comprising developed and developed countries. The motivation for this analysis draws from the consensus in the literature that whereas developing countries have a comparative advantage in low-skilled tasks and activities in the value chain, developed countries, on the other hand, have a comparative advantage in high-skilled and knowledge-intensive tasks and activities that are highly productive (Foster-McGregor, 2015; Abreha *et al*., 2020). For this reason, the effect of GVC on wages is expected to differ in both country groups, mostly in favor of GVC workers in developed countries. Second, we examine the wage effects of GVC participation and position under two labour market conditions: flexible and stringent labour market regulation, respectively. The functioning of the labour market is key to ensuring the wage gains associated with GVC participation are equally distributed to the workers in GVC. As highlighted in Taglioni & Winkler (2016) the power imbalance between global lead firms and local firms in different value chains often force supplying firms to cut costs through wages to remain competitive in the value chain. This creates the need for efficient labour market regulations that ensure, on the one hand, that workers in GVC are less exploited, and are allowed to move into higher productivity and wage rewarding activities in the value chain, on the other hand (see Mensah *et al.,* 2018). Finally, we examine the effect of GVC participation and position along the wage distribution to underscore the wage earners that stand to gain more from an industry's involvement in GVC.

Our analysis accounting for differences in development level shows an unambiguous positive wage effect of GVC participation whilst the wage effect of upstream specialisation depends on a country's development level. In particular, whilst relative upstream specialisation is associated with a wage increase in developed countries, it exerts downward pressure on wages in developing countries. This result is driven in part by the difference in tasks and activities undertaken by both country groups in GVC. In developed countries, upstream and downstream activities are dominated by knowledge-intensive activities, requiring more non-replaceable skilled workers, and

are characterized by high productivity. However, upstream activities in developing countries are confined to primary inputs or basic manufacturing materials that are transformed elsewhere. These activities are also often of lower-productivity requiring less-skilled activities with low value-added outputs. For analysis focusing on the role of labour market regulation, we find that GVC participation only exerts a positive effect on wages under stringent labour market regulation. Under flexible labour market conditions, GVC participation exerts downward pressure on wages, while upstream specialisation is associated with higher wages. These results suggest that stricter labour market regulations that ensure the effective enforcement of minimum wage regulations are needed to ensure that the wage gains associated with GVC are evenly distributed across all participating firms and countries. Flexible labour market regulation, however, allows for the reallocation of GVC workers into higher productivity and wage rewarding activities in the value chain. Finally, the wage distribution analysis shows that participation and upstream specialisation in GVCs are associated with higher wages across all wage earners in the developed countries, although high wage earners stand to gain more. In developing countries, however, GVC participation makes low-wage earners worse-off but benefits high-wage earners. Upstream specialisation, on the other hand, exerts downward pressure on all wage earners, although low wage earners are affected more disproportionately.

Overall, our results show that GVC matters for improved wages. However, position in the value chain, the type of activities performed in the value chain, level of development, and labour market institutions is key in driving this relationship highlighting therefore how policies should be framed to maximize the wage gains of GVC for all. Our study contributes to the nascent literature on the wage effects of GVC. To our knowledge, three papers including Lopez Gonzalez *et al.* (2015), Parteka & Wolszczak-Derlacz (2019), and Lu *et al.* (2019) have empirically analysed the relationship. Lopez Gonzalez *et al.* (2015) examined the effect of GVC participation on aggregate wage inequality. To proxy GVC participation, the authors used the share of foreign value-added embodied in export which has become a standard measure of backward GVC participation in the literature. Employing a similar GVC measure, Parteka & Wolszczak-Derlacz (2019) found an inverse (but weak) relationship between the degree of industries' involvement in GVCs and individual workers' wages in a sample comprising the US and nine Eastern and Western European countries. Lastly, Lu *et al.* (2019) focus on manufacturing firms in China, while still using foreign

value-added share embodied in export as a measure of GVC participation. However, they find that GVC participation significantly increases wages at the firm-level. While these studies offered important insight on the nexus between GVC and wages, the mixed results call for further scrutiny. More importantly, they also face limitations in terms of the focus and measurement of GVC.

The contribution of our study in this literature is three-fold. Countries – or more specifically firms, participate in GVCs through backward participation and/or forward participation, suggesting that the focus on backward integration adopted in the above three papers give an incomplete picture of a country's overall GVC participation and its potential effect on wages. Hence, the first contribution of our paper is that we use an empirical GVC measure that accounts for a country's backward and forward integration in GVC. In this way, our paper presents more comprehensive evidence on the nexus between involvement in GVC and wages. It suffices to mention that the importance of such an approach has been highlighted by Shepherd (2013), noting that the labour market implication of both types of GVC integration may be different. Such an envisaged heterogeneous impact on labour market outcomes has been empirically shown in Banga (2016) and Dine (2019). However, both studies focus on employment and are limited to an individual country. Second, our study goes beyond the narrative of focusing only on the wage effect of GVC participation to examine whether an industry's position in the GVC significantly affects wages. The relatively large sample we use also enables us to differentiate between developed and developing countries. In which case, we can differentiate the type of upstream activities that take place in an industry, although in a crude way. Finally, we examine the role of labour market regulation in the determination of the wage effect of GVC participation and position. To our knowledge, while the importance of labour market regulations and how they influence the trade effects of labour market outcomes has been underscored in the broader trade literature focusing on gross trade (e.g., see Hasan *et al.,* 2012; Helpman *et al.,* 2012; Krishna *et al.,* 2014; Perugini & Pompei, 2017), the nascent literature on the wage effect of GVC is yet to consider the role of labour market institutions.

The remainder of the paper is organized as follows. In Section 2, we present the background literature. Section 3 presents the research methods, further discussing the data sources and the

computation of variables used in the analysis. We present and discuss the results in section 4, while section 5 concludes the paper.

2. Related Literature

The literature examining the wage effect of GVC is nascent. However, it is related to the erstwhile literature on the wage effects of exporting, importing, and/or offshoring. In this regard, the pioneering study on the nexus between exporting and wages can be traced to Bernard & Jenson (1995). Among others, their study showed that in the U.S. exporting firms pay higher wages than non-exporting firms. This wage premium persists even when production and nonproduction workers in exporting firms are compared to their counterparts in non-exporting firms. Following this seminal study, empirical analysis examining the relationship between wages and exporting have proliferated (e.g., see Schank *et al,* 2007; Shepherd, 2013 for an extensive literature review). In general, extant literature suggests an unambiguously positive relationship between exporting and wages, but with caveats in some cases[3]. Conceptually, several factors, including higher productivity, skill intensity, scale economies, and efficiency wages have been identified to drive this wage premium (see Schank *et al,* 2007; Munch & Skaksen, 2008; Martins & Opromolla, 2009; Schank *et al.,* 2010; Lu *et al.,* 2019).

While the literature examining the nexus between export and wages suggests an unambiguously positive relationship, the relationship between import and wages is far more ambiguous and therefore remains an empirical question (Guadalupe, 2007). For example, whereas Revenga (1997) and Goldberg & Pavcnik (2005) find that reduction in import tariffs lowers wages, Pavcnik *et al.* (2004) and Trefler (2004) find an insignificant or near-zero effect of a decline in import tariffs on wages. Among others, this ambiguity arises from the fact that imports can induce competition in the product market, which in the presence of rent-sharing and trade union may not only deteriorate a firm's profit but also lead to wage compression (Kramarz, 2008). Arguing along this line, Martins & Opromolla (2009) note that while imports of intermediate goods may provide workers with hold-up opportunities when the firm has to purchase these inputs in advance, imports of finished goods by the firm or by its competitors may weaken the employees' bargaining position if these

[3] Such caveats largely relate to the differences in the skill structure of labor, which may lead to differential wage premiums between skilled and unskilled labor.

imports reduce the amount of outside job offers the worker may get when displaced. While this may suggest the wage effect of imports depends on the type of import with imported intermediate products having a positive effect on domestic wages[4], Amiti & Davis (2012) theoretically and empirically show that this effect may also depend on the firm's primary international activity. In particular, the results of their study confirmed that a reduction in output tariffs decreases wages in firms that are exclusively domestic economy-oriented, but indicate an insignificant wage effect in firms that export. However, a reduction in input tariffs has an insignificant effect on non-importing firms but increases wage levels in firms engaged in importing.

Closely linked to the literature on the wage effects of importing (especially as it concerns intermediate input) to which our study relates to is the literature on the wage effect of offshoring. This literature has also produced ambiguous results (see Cardoso *et al.,* 2020 for an extensive literature review). Unwittingly, these ambiguities are reflective of the contrasting mechanisms underscored in the extant theoretical models through which offshoring can affect wages.[5] For instance, Grossman & Rossi-Hansberg (2008) developed an outsourcing task model wherein the wage response to offshoring operates indirectly through three main channels: productivity effect, the price effect, and the labour supply effect. The outcome of the model suggests that if productivity gains due to outsourcing are large enough, they may result in wage gains for all domestic workers. However, if labour supply and relative price effects outweigh the productivity effect, then wages are likely to fall. Rodriguez-Clare (2010) borrowing insights from the Ricardian model developed a model on the wage response to offshoring in developed and developing countries and under different time horizons. The outcome of the model suggests significant increases in offshoring harms (benefits) developed (developing) countries, but only in the short run. However, in the long run, this may be the other way around since, in response to offshoring, resources tend to be reallocated towards either research in developed countries or production in developing countries (Cardoso *et al.,* 2020).

Although the wage effect of trade (i.e., export, import, and offshoring) is expansive, the literature examining the nexus between GVC and wages is nascent. As noted in the introduction, the few

[4] Martins & Opromolla (2009) find empirical support for this argument utilizing unique data from Portugal.
[5] For an extensive literature review see Franssen (2019).

extant studies in this literature include Lopez Gonzalez *et al.* (2015), Parteka & Wolszczak-Derlacz (2019), and Lu *et al.* (2019), face limitations in terms of their focus and measurement of GVC. They also show mixed results, which call for further scrutiny of the relationship between GVC and wages. Our study aims to fill these gaps, while further divulging the conditions that may shape the nature of the relationship between wages and an industry's/country's involvement in GVC and its relative position in the GVC.

3. How Wage Related is GVC?

The nature of the relationship between GVC and wages is ambiguous, hence the need for empirical investigation. In this section, we reframe from a general theory underpinning the nature of the relationship between GVC and wages. Instead, we highlight potential ways GVC and wages may be related and the potential country characteristics that influence this relationship. In this way, we set a premise that informs the empirical analysis conducted in the latter part of the paper.

GVC participation can affect wage positively through a productivity-enhancing effect, increase in labour demand, and reallocating labour to its most productive use. The emergence of GVC has made it easier for economies to participate in international trade by specializing in specific stages of the supply chain; hence avoiding the problems associated with developing whole industries. Along these lines, input suppliers stand to gain *ex-post* productivity differential through learning-by-exporting, knowledge, and technology flows in buyer-supplier relationships, and intense competition in the foreign market Montalbano *et al.* (2018).[6] On the other hand, input buyers get to specialize on core tasks while outsourcing tasks they have a less comparative advantage, a scenario that has also been documented in the literature to be associated with higher productivity (Amador & Cabral, 2015; Pahl & Timmer, 2020). As higher productivity is associated with higher profits and rent sharing, GVC participating economies are therefore more likely to pay higher wages. Moreover, the strict quality standards and specification requirements by most international buyers may lead upstream firms to also pay higher wages since they have an incentive to screen their workforce more thoroughly, leaving them with workers of higher average ability. It may also well be that they pay higher wages to reduce shirking and to increase care in production. Furthermore,

[6] Utilizing an industry-firm matched sample, the authors find found evidence of leaning-by-exporting for manufacturing firms in intense GVC participating industries.

because GVC participation exposes economies to bigger international markets and a consequent expansion of production scale, provided domestic labour supply remains constant, this expansion in production scale leads to an increase in labour demand and a subsequent rise in the wage level in the GVC participating industry.

Whilst the foregoing arguments are suggestive of a positive wage effect of GVC involvement, important caveats may apply. For instance, a power imbalance may exist in value chains leading to an oligopsonistic market condition wherein many suppliers compete for orders from few buyers. This leaves supplying firms unable to negotiate, creating downward pressures on wages as firms cut costs through wages to remain competitive in the market (Taglioni & Winkler, 2016). Besides, the envisioned wage increase due to productivity and market-scale effects associated with GVC involvement can only be realized under a well-functioning labour market condition such that workers are paid close to their marginal productivity. Stricter labour market regulations that also ensure minimum wage are living wage, and that also enforce them are imperative in this regard. The type of activities engaged by GVC participating industries especially those specialized in the upstream activities also matters. Engagement in upstream activities with little domestic value additions and supply of primary inputs offers less opportunity for wage increase no matter how intensive activities in those industries may be. Among others, this occurs because primary products have less scope for quality differentiation that could translate into wage gains. Unfortunately, most developing countries specialize in such low value-added activities and the supply of primary products (Foster-McGregor, 2015; Abreha *et al*., 2020). This is different for developed countries where upstream activities tend to be dominated by higher value-addition and knowledge-intensive activities, requiring more non-replaceable skilled workers, and are characterized by high productivity.

4. Data and Research Design

4.1. Main Variables

Our study utilizes a panel data covering seven manufacturing industries in forty-five developed and developing countries for the period 2000-2015. The industries and countries included in the sample are based on available data. The two main variables in our analysis are wages and GVC indicators. We source data on wages from the UNIDO Industrial and Statistical Database (UNIDO

INDSTATS 2, 2020). We interpolate some missing data points in the data. The original series of the data are expressed in basic nominal values, we, therefore, use the US industry value-added deflator to express them in constant terms. Data for Our GVC indicators are sourced from Ndubuisi & Owusu (2021)[7] and discussed in more detail below. The variables are computed using the EORA MRIO I-O database (Lenzen *et al.,* 2013). The decomposition methods use to arrive at the data follow Hummels *et al.* (2001), Koopman *et al.* (2011), Koopman *et al.* (2014), and Aslam *et al.* (2017). We define GVC participation of each industry j in a given country i in the cross-national trade of intermediate goods as:

$$GVC\ Participation_{j,i,t} = \left(\frac{FVA_{jit}}{TE_{jit}}\right) + \left(\frac{DVX_{jit}}{TE_{jit}}\right) \qquad (1)$$

where FVA_{jit} is the share of foreign value-added used in a country's export in an industry, DVX_{jit} is the share of a country's domestic value-added that enters as inputs in the exports of other countries, while TE_{jit} is country i gross export in industry j. The term $\frac{FVA_{jit}}{TE_{jit}}$ captures the extent of the industry's backward GVC participation, while $\frac{DVX_{jit}}{TE_{jit}}$ captures the extent of the industry's forward GVC participation. Hence, unlike in Lu *et al.* (2019) and Parteka & Wolszczak-Derlacz (2019), our GVC participation indicator captures a country-industry pair overall involvement in GVC which has become common in the literature (see UNCTAD, 2013; Foster-McGregor *et al*., 2015; Montalbano *et al.,* 2018; Wang *et al.,* 2019; Amendolagine *et al.,* 2019; Carril-Caccia & Pavlova, 2020; Ndubuisi & Owuso, 2021). In particular, Equation 1 is considered a standard measure of GVC participation in the nascent GVC literature as it acknowledges that country-industry pair participate in GVC either as "buyers" and/or "sellers" of intermediate inputs, with higher values of the resulting index indicating more intensive participation in the GVC. However, because we are interested in the mechanisms through which GVC participation impacts wages, we also consider the individual effects of backward and forward GVC participation.

As our empirical measure of GVC position, we follow the extant literature that measures an industry's relative upstreamness position in the value chain (Koopman *et al.,* 2011; Montalbano *et*

[7] See Ndubuisi & Owusu (2021) for a detailed discussion on this.

al., 2018; Gunnella *et al.,* 2019; Amendolagine *et al.,* 2020). In particular, we measure the relative position of j in country i within the GVCs as the log-difference between the upstream and the downstream component of the GVC participation index.

$$GVC\ Position_{jit} = \ln\left(1 + \frac{DVX_{jit}}{TE_{jit}}\right) - \ln\left(1 + \frac{FVA_{jit}}{TE_{jit}}\right) \qquad (2)$$

where all variables are as defined before, positive values of the resulting index in Equation 2 indicate upstream specialisation in the GVC, while negative values denote downstream specialisation. In which case, Equation 2 measures an industry's position in vertically fragmented production chains with higher values indicating that the industry has an upstream specialisation in the GVC phases of the production process which are remote from final demand, whilst lower values of the index indicates downstream specialisation in the GVC phases close to final demand.

In our empirical model, we would also control for time-varying industry characteristics using labour productivity and import penetration. We source employment and value-added data used to compute labour productivity from UNIDO INDSTATS 2. Following extant studies (e.g., see Bernard *et al*., 2006; Mion & Zhu, 2013), we compute import penetration as $\frac{TI_{j,i,t}}{TI_{j,i,t}+Q_{j,i,t}-TE_{j,i,t}}$. Export ($TE_{j,i,t}$) and import ($TI_{j,i,t}$) data are sourced from the EORA MRIO I-O database, while data on output ($Q_{j,i,t}$) is sourced from UNIDO INDSTATS 2.

4.2. Model Specification and Estimation Strategies

To examine the wage effects of GVC participation and position the baseline equation that guides our analysis is the following:

$$lnWages_{jit} = \beta_0 + \beta_1 GVC\ Participation_{jit} + \beta_2 GVC\ Position_{jit} + X'_{jit}\tau + \gamma_{ji} + \gamma_t + \varepsilon_{jit} \qquad (3)$$

where γ_{ji} is country-industry pair dummies that captures time-invariant industry characteristics and industry specific shocks, γ_t captures macroeconomic shocks that are common across countries

and industries, but vary over time, while ε_{jit} is the error term. $lnWages_{jit}$ is the logarithm of industry j wage in country i at period t. X'_{jit} is a vector of control variables. It comprises industry-level labour productivity and import penetration. In line with our research objective, our parameters of interest are β_1 and β_2. It can be argued that industries do not adjust immediately to changes in their business conditions due to the existence of adjustment costs. Such conditions could be those entailed in GVC requiring adjustment. To account for this phenomenon, we assume they are symmetric and reformulate our baseline wage equation as thus:

$$lnWages_{jit} = \alpha_0 + (1-\lambda)lnWages_{jit-1} + \alpha_1 GVC\ Participation_{jit} + \alpha_2 GVC\ Position_{jit} + X'_{jit}\tau + \gamma_{ji} + \gamma_t + \varepsilon_{jit} \quad (4)$$

All variables in Equation 4 are as previously defined, α_1 and α_2 are now the parameters of interest. Appropriate estimation of Equation 4 due to the inclusion of the lagged dependent variables requires the adoption of dynamic panel estimators such as the Difference or System General Moments Methods (GMM) approach. Such empirical methods also enable us to overcome the envisioned endogeneity in our specification. In particular, our variables of interest as specified in Equations 3 and 4 are potentially subject to simultaneity and omitted variable bias. While we argue that GVC participation increase wages, it may well be that lower labour cost leads to GVC participation. This conjecture is consistent with anecdotal evidence from China wherein the rising labour cost is beginning to shift production stages (once outsourced to firms in China due to cheap labour) to other developing countries with cheaper labour. Further, while the inclusion of country-industry pair fixed effects and time-effects expunge endogeneity bias that may arise from country-industry pair (un)observed heterogeneity and macroeconomic shocks that are common across countries and industries, we cannot entirely rule out confounding factors due to omitted time-varying factors in our specification. As the system GMM can address these concerns and those related to wage adjustment cost, we adopt it as our preferred estimation strategy. The method was developed by Arellano & Bover (1995) and Blundell & Bond (1998) and is superior to alternative dynamic panel data estimators such as the difference GMM (Bond *et al,* 2001; Soto, 2009; Roodman, 2009a). However, in the baseline results, we also show the results of the static model (i.e. Equation 3), using the fixed-effects model.

As noted in the introduction, in addition to examining the wage effect of an industry's involvement in GVC, we consider how a country's development level and labour market regulation influence the nexus between GVC and wages. We also examine the effect of an industry's involvement in GVC along the wage distribution. To this end, we perform three complementary exercises. First, we split our sample into developed and developing countries, and re-estimate Equation 4 using system GMM for the resulting two subsamples. Second, we re-estimate Equation 4 using system GMM for two subsamples only that this time we focus on stringent and flexible market conditions. Our approach in studying the differential wage response to an industry's involvement in GVC is inspired by Hijzen & Swaim (2010). To achieve this dichotomy, we utilize the mean value of the sample's labour market regulation (LMR) intensity. The LMR index is sourced from the Fraser Institute and has become common in the literature as an empirical measure of LMR (e.g., Haltiwanger *et al.,* 2014; Aleksynska & Cazes, 2016; Mensah *et al.,* 2018). The index is measured on a scale of from 0 to 10, with higher values of the index reflecting rigid labour market conditions.

Finally, to examine the effect of an industry's involvement in GVC along the wage distribution, we enrich the system GMM results with Quantile regression. The advantage of this approach over the fixed-effect model and system GMM is that it allows us to see whether the wage response to intense GVC participation and upstream specialisation differs across different segments of the wage distribution, which can influence tailor-made policies. This differs from the panel fixed-effects model or system GMM that only tell us about the average wage effects of GVC participation and position. Method wise, the Quantile regression is also deemed robust to outliers and sample heterogeneity. It is also more flexible on assumptions about the parametric distribution of the error term (Greene, 2003). Hence, it can also be considered as a robustness exercise to the system GMM (which is our preferred estimator, albeit it is not the main purpose for which it is employed in our analysis). More formally[8], the general form of the quantile regression we estimate can be expressed as follows

$$Quant(y_i|x'_i) = x'_i\delta + \mu_i \qquad (5)$$

[8] For purposes of exposition, time and industry subscripts are omitted.

where x'_i is the vector of exogenous variables (as described for Equation 3) affecting the distribution of the outcome variable (i.e., wages), δ is the parameter to be estimated corresponding to θ^{th} conditional quantile (also known as decile) of the wages. Accordingly, the θ^{th}quantile estimator of wages is obtained by solving for the optimisation problem expressed as follows:

$$\min_{\theta \in \Theta} \left[\sum_{i:y_i \geq x'_i \delta} \theta |y_i - x'_i \delta| + \sum_{i:y_i < x'_i \delta} (1-\theta) |y_i - x'_i \delta| \right] \quad (6)$$

where $0 < \theta < 1$. Unlike the Ordinary Least Squares (OLS) that minimizes the sum of squared residuals, the Quantile regression is based on minimizing the weighted sum of absolute deviations, such that each decile is estimated by approximately weighting the residuals.

Table 1. Basic Summary Statistics

Variable	Obs	Mean	Std. Dev	Min	Max
Wages	5,040	11.08774	1.927405	4.725002	18.11236
GVC Participation	5,040	0.458751	0.165118	0.083362	0.993011
Backward GVC Participation	5,040	0.296988	0.143439	0.047722	0.840654
Forward GVC Participation	5,040	0.161763	0.111912	0.01537	0.856745
GVC Position	5,040	-0.10858	0.151001	-0.56353	0.495344
Labour Productivity	5,012	12.26854	2.36562	6.600981	38.67944

Table 2. Correlation Analysis

	Wages	Gvc Part.	Backward GVC Part.	Forward GVC Part.	GVC Pos.	Labour Productivity	Import Pen.
Wages	1.000						
GVC Part.	-0.012	1.000					
Backward GVC Part.	-0.046	0.744	1.000				
Forward GVC Part.	0.041	0.518	-0.1856	1.000			
GVC pos.	0.057	-0.213	-0.8101	0.723	1.000		
Labour productivity	0.835	-0.066	-0.119	0.055	0.119	1.000	
Import Pen.	-0.657	0.262	0.3664	-0.084	-0.311	-0.791	1.000

4.3. Descriptive Statistics

Table 1 shows the basic summary statistics of the variables used in our analysis, while Table 2 shows the pairwise correlation. In Table 2, the GVC participation index shows a weak negative correlation with GVC position of about -0.2%. This is not surprising since an industry with an upstream specialisation can have a low GVC participation intensity if that industry focuses only on supplying knowledge intensive or high value added inputs for others and/or provides manufacturing intermediate. This justifies the inclusion of both variables in a single regression as they both capture different involvement in GVC. Table 3 reports the averages of the GVC variables over the sample period in each industry. Interesting patterns emerge when examining the table particularly for the two subsamples of developed and developing countries. On average, the table suggests that developed countries are more integrated into GVC than developing countries and this tends to persist across all the industries. Similar patterns also emerge when we consider the two subcomponents of the GVC participation i.e., the backward and forward GVC participation. Regarding the GVC position, there is a clear evidence of downstream specialisation for the subsample comprising developed countries. Developing countries on the other hand, specialize in upstream activities.

Table 3. Summary Statistics of GVC Variables

	Full Sample				Developed Countries				Developing Countries			
Industry	GVC Part.	Backward Part.	Forward Part.	GVC Pos.	GVC Part.	Backward Part.	Forward Part.	GVC Pos.	GVC Part.	Backward Part.	Forward Part.	GVC Pos.
Electrical & Machinery	0.47	0.34	0.13	-0.16	0.50	0.37	0.13	-0.19	0.42	0.29	0.14	-0.12
Food & Beverages	0.27	0.21	0.06	-0.13	0.32	0.26	0.06	-0.16	0.20	0.13	0.06	-0.06
Metal Products	0.60	0.30	0.30	-0.01	0.64	0.32	0.31	-0.01	0.55	0.26	0.29	0.03
Petroleum, Chemical and Non-Metallic	0.52	0.32	0.20	-0.09	0.56	0.38	0.18	-0.16	0.44	0.21	0.23	0.01
Textiles & Wearing Apparel	0.39	0.29	0.10	-0.15	0.46	0.35	0.11	-0.19	0.28	0.20	0.07	-0.11
Transport Equipment	0.47	0.37	0.11	-0.21	0.50	0.40	0.09	-0.25	0.43	0.31	0.12	-0.15
Wood & Paper	0.48	0.25	0.23	-0.02	0.52	0.28	0.23	-0.04	0.40	0.19	0.22	0.02

5. Empirical Results

This section proceeds in three steps. First, we present the regression results on the wage effects of GVC participation and position for the full sample. The second section examines the wage effects of GVC participation and position when split the sample into developed and developing countries, or into countries under flexible and stringent labour market regulation regimes. The last section examines the wage distribution effects of GVC participation and position.

Table 4. Wage Effects of GVC Participation and Position

	Fixed Effect		System GMM				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Wage_{ijt-1}			0.8583***	0.8406***	0.8708***	0.8685***	0.8477***
			(0.014)	(0.018)	(0.014)	(0.009)	(0.010)
GVC Participation	0.7765***	0.5504***	0.2915***	0.1692**			
	(0.227)	(0.063)	(0.057)	(0.066)			
GVC Position	0.3595	0.5819***	0.9643***	0.8618***	0.5020**	0.5045***	
	(0.768)	(0.205)	(0.226)	(0.179)	(0.220)	(0.187)	
Forward GVC Participation					0.0932***		0.0568*
					(0.034)		(0.031)
Backward GVC Participation						0.1377***	0.1060***
						(0.038)	(0.026)
Import Penetration		-0.0345***		0.0284**	0.0306***	0.0202***	0.0163**
		(0.008)		(0.014)	(0.011)	(0.006)	(0.007)
Labour Productivity		0.2405***		0.0398**	0.0218**	0.0147**	0.0132*
		(0.008)		(0.016)	(0.010)	(0.006)	(0.008)
Observations	5,040	5,012	4,725	4,699	4,699	4,699	4,699
R-squared	0.027	0.259					
Number of Groups	315	314	315	314	314	314	314
Number instruments			47	58	45	84	84
AR1(p-value)			0.0189	0.0175	0.0181	0.0186	0.0190
AR2(p-value)			0.395	0.382	0.380	0.385	0.389

Note: This table presents the results on the wage effects of GVC participation and position using manufacturing industry-level data across 45 developed and developing countries. The dependent variable in each column is the log real wage, and each column contains unreported constant terms. Robust standard errors in parentheses, while significance levels are given by *** p<0.01, ** p<0.05, * p<0.10. The system GMM is estimated two-step and all independent variables are treated as endogenous.

4.1. Baseline Result

Table 4 shows the main results of our analysis with columns 1 and 2 presenting the regression results of the static model using the panel fixed-effect estimator. In both models, the estimated coefficients of GVC participation is positive and statistically significant at 1%, suggesting that GVC participation increases wage. Next columns 3 and 4 report the regression results using the

system GMM, which is our preferred estimator. In the regression, we treat all explanatory and control variables as endogenous. The estimated coefficient of GVC participation remains positive and statistically significant in both columns at the 1% significant level. Particularly, the estimated coefficient of GVC participation in column 4 suggests that a one percent increase in GVC participation would increase the wage by approximately 0.17%. Turning to the results for GVC position, we find that the estimated coefficient of upstream specialisation is positive and statistically significant at conventional significance levels—columns (3-4), a finding that suggests that the wage effect of GVC is higher for countries and industries that specialize in the upstream activities or stages of the value chain. Assessment of the validity of the system GMM estimates is achieved using the second-order autocorrelation test and the over-identification restriction test for which the tests are reported on the last panel of Table 4. Regarding the second-order autocorrelation test, the p-value of AR(2) in the second to the last the last row in the table are statistically insignificant at all conventional significance levels, thereby suggesting the absence of second-order autocorrelation which is what we want. The p-values of the Hansen-J test are also statistically insignificant at all conventional significance levels, thereby suggesting that the internally generated instruments for the endogenized variables are exogenous. We are confident in the validity of our instruments. Hence, the two validity tests hint at a proper specification of our model.

Countries and industries may participate intensively in GVC through either backward or forward GVC participation. To this end, columns 5 to 7 show the regression results when we independently consider the effect of backward and forward GVC participation. In all cases, we observe a significantly positive effect of backward and forward GVC participation although stronger through the backward GVC participation as suggested by both the size of the estimated coefficients in columns 5 and 7, and the statistical significance level when we jointly introduce the coefficients in column 7. Nonetheless, the statistically significant coefficient for the forward GVC participation in column 7 (although smaller) when the variable is jointly included with backward GVC participation in a regression suggest that previous studies that only focused on backward GVC participation measure may have given a less than complete picture of the true wage effect of GVC participation.

4.2. Heterogeneous Wage effects of GVC Participation and Position

The results reported in Table 4 assume that independent of the type of activities engaged in GVC by the participating countries/industries, a country's labour market conditions, and the level of development, GVC participation and the industry's upstreamness position in GVC will have an unambiguously positive effect on wages. We relax this assumption in this section and explore the heterogeneous wage response to changes in our two GVC indicators under different country development levels and labour market conditions. The results for these exercises are reported in Table 5. In particular, columns 1 and 2 show the regression results of wage response to variations in GVC participation and relative upstream specialisation when we split the sample into developing (i.e., column 1) and developed countries (i.e., column 2). In column 1, we find that GVC participation has a positive effect on wages, while relative upstream specialisation is associated with lower wages compared to industries downstream. However, both GVC participation and relative upstream specialisation in developed countries as shown in column 2 exerts a positive effect on wage. Notice also that the size of the estimated coefficient of GVC participation in Column 2 is higher than that in column 1, and also more statistically significant, suggesting a stronger wage effect for developed countries. This result supports our initial arguments in the previous section. In particular, upstream and downstream activities in developed countries tend to be dominated by knowledge-intensive activities, requiring more non-replaceable skilled workers, and are characterized by high productivity. In developing countries, however, it is most often the case that their upstream activities are confined to primary inputs or basic manufacturing materials that are transformed elsewhere. More importantly, those activities are also often of lower-productivity requiring less-skilled activities with output with low-value addition. Akin to this, the nature and type of upstream activities that takes place in these countries has created oligopsonistic markets—where many suppliers compete for orders from few international buyers, leaving supplying firms unable to negotiate from a position of strength and a consequent downward pressures on wages and working conditions as input supplying firms in these countries cut costs through wage reduction to remain competitive.

Table 5. Heterogeneous Wage Effects of GVC Participation and Position

	Developing Countries	Developed Countries	Stringent LMR	Flexible LMR
	(1)	(2)	(3)	(4)
$Wage_{ijt-1}$	0.8682***	0.8410***	0.9720***	0.9005***
	(0.016)	(0.013)	(0.016)	(0.011)
GVC Participation	0.1095*	0.2703***	0.1819**	-0.1542***
	(0.056)	(0.051)	(0.078)	(0.048)
GVC Position	-0.2585*	1.0032***	0.4738	1.0229***
	(0.134)	(0.269)	(0.295)	(0.198)
Labour Productivity	0.0988***	0.0051	-0.0179	0.0497***
	(0.020)	(0.006)	(0.014)	(0.010)
Import Penetration	-0.0036	0.0150**	-0.0200**	0.0462***
	(0.012)	(0.007)	(0.010)	(0.010)
Observations	1,770	2,929	2,247	2,452
Number of Groups	118	196	216	265
Number instruments	50	40	30	69
AR1(p-value)	7.01e-05	0.199	0.118	0.0257
AR2(p-value)	0.366	0.583	0.828	0.316

Note: This table presents the results on wage effects of GVC participation and position using manufacturing industry-level data across 45 developed and developing countries. The dependent variable in each column is the log real wage, and each column contains unreported constant terms. Estimation in all the columns is achieved using the two-step system GMM, wherein we endogenize all explanatory variables in our model. Columns 1 and 2 show the results for two subsamples comprising developing and developed countries. Columns 3 and 4 show the results for two subsamples under two respective labour market conditions: Flexible and Stringent labour market conditions. We use the mean values of the labour market regulation index for all the countries in our sample as a cut-off. Robust standard errors in parentheses, while significance levels are given by *** p<0.01, ** p<0.05, * p<0.10.

Next, columns 3 and 4 show the regression result under different labour market conditions with column 3 showing the results for wage effect of GVC participation and position under stringent labour market conditions, while column 4 shows the result under flexible labour market conditions. As noted in section 3, we achieved this dichotomy using the labour market regulation (LMR) index from the Fraser Institute. Beginning with column 3, we find that intense GVC participation has a significantly positive effect on wages under stringent labour market regulation. In column 4 however, intense GVC participation exerts downward pressure on wages under flexible labour market regulations. These results suggest that labour market regulations that ensure enforcement of contracts are quintessential for the wage benefits of GVC documented in our full sample to be realized. However, one has to be cautious here. Indeed, when labour market regulations are too rigid, such that firms are forced to pay higher wages and the dismissal costs are humongous, this may come at the expense of a higher unemployment rate i.e. firms pay higher wages but keep a small workforce leading to the aggregate unemployment rate. Thus, policies that aim to use labour

market regulations to capture greater wage gains may do so cautiously. In this regard, a pragmatic policy that is likely to yield the desired outcome would be the one that ensures a careful balance of the existing unemployment rate and labour market regulation. Among others, policies that also upgrade the skill level of workforce, and by implication increase, the workers outside option may be deemed panacea. Finally, we find that the wage benefit for upstream specialisation is only realized under flexible labour market conditions. This result suggests that whiles stricter LMR is needed for equitable distribution of the rents from GVC, flexible LMR are also needed to ensure the effective reallocation of workers into most productive upstream value chain activities where they will be more productive and earn more.

4.3. Distribution Wage Effects of GVC Participation and Position

Thus far, our analysis has focused on the average wage effect of GVC participation and position. Following our discussion in the methodology section, we further complement our analysis with a Quantile regression to better understand the effect of GVC participation and position along the different wage distribution. Results for this exercise are presented in Tables 6-8. Beginning with Table 6 that presents the regression results for the full sample, they are somewhat consistent with the baseline results that suggest higher wages are associated with more intense GVC participation and upstream specialisation. This time, however, the conclusion comes with an additional caveat. Whereas all wage earners belonging to the various wage distribution benefits from intense GVC participation and upstream specialisation, further scrutiny of the results shows that higher wage earners benefit the most as suggested by the increase in the size of the estimated coefficients of our GVC variables as we move from the 20^{th} decile to the 90^{th} decile.

Table 6. Quantile Regression: Full Sample

	Q=0.10	Q=0.20	Q=0.30	Q=0.40	Q=0.50	Q=0.60	Q=0.70	Q=0.80	Q=0.90
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GVC Participation	0.1560***	0.2086***	0.2428***	0.3316***	0.3539***	0.4383***	0.5255***	0.6143***	0.6662***
	(0.021)	(0.022)	(0.027)	(0.030)	(0.018)	(0.034)	(0.028)	(0.033)	(0.054)
GVC Position	0.6440***	0.5622***	0.4882***	0.5368***	0.5182***	0.6005***	0.8895***	0.8932***	1.0834***
	(0.090)	(0.048)	(0.069)	(0.076)	(0.044)	(0.115)	(0.067)	(0.061)	(0.084)
Labour Productivity	0.5024***	0.4935***	0.5185***	0.5386***	0.5512***	0.5476***	0.5467***	0.5465***	0.5617***
	(0.001)	(0.007)	(0.006)	(0.010)	(0.004)	(0.005)	(0.006)	(0.006)	(0.008)
Import Penetration	-0.0024**	-0.0077*	-0.0065*	-0.0004	0.0058**	0.0005	0.0007	0.0053	0.0092
	(0.001)	(0.004)	(0.004)	(0.005)	(0.002)	(0.004)	(0.003)	(0.005)	(0.009)
Observations	5,012	5,012	5,012	5,012	5,012	5,012	5,012	5,012	5,012

Note: This table presents Quantile regression results on the wage effects of GVC participation and position for a subsample of developed and developing countries. The dependent variable in each column is the log real wage, and each column contains unreported constant terms. Robust standard errors in parentheses, while significance levels are given by *** p<0.01, ** p<0.05, * p<0.10

Next, Tables 7 and 8 show the Quantile regression results for two subsamples comprising developed and developing countries, respectively. Important heterogeneities emerge from these results. Importantly, whereas the Quantile regression results for the subsample of developed countries are somewhat similar to those of the full sample, results for the subsample comprising developing countries differ largely. In particular, for the GVC participation variable in Table 8, we find that low-wage earners are disproportionately disadvantaged from an industry's intense GVC participation. As most developing countries participate in GVC as input suppliers, one potential explanation for this may be the higher quality standards and specification requirement by lead international buyers to avoid production line delays and quality debasements caused by problems in the supply base that results in increased mechanisation of the production process in the GVC participating industries/firms in these countries. If we attribute low-wage earners as unskilled labour, an assumption which is not alien to the literature, increased mechanisation will lead to a relative decline in the demand of unskilled labour, and consequent downward pressure on the factor returns. Turning now to the upstream specialisation, we find that upstream specialisation in developing countries exerts a downward pressure on all types of wage earners although the effect is worse for low wage earners. In line with our previous discussion, a potential explanation could be largely attributed to the type of upstream activities, industries, and labour conditions in these developing countries that are utterly different from those of the developed countries.

Table 7. Quantile Regression: Developed Countries

	Q=0.10	Q=0.20	Q=0.30	Q=0.40	Q=0.50	Q=0.60	Q=0.70	Q=0.80	Q=0.90
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GVC Participation	0.2709***	0.2831***	0.3138***	0.3717***	0.4306***	0.4978***	0.5629***	0.6686***	0.7204***
	(0.056)	(0.016)	(0.037)	(0.029)	(0.052)	(0.034)	(0.035)	(0.067)	(0.088)
GVC Position	0.5053***	0.5802***	0.4265***	0.4581***	0.3269***	0.3009***	0.4501***	0.6263***	0.8755***
	(0.131)	(0.020)	(0.095)	(0.066)	(0.122)	(0.102)	(0.116)	(0.135)	(0.039)
Labour Productivity	0.4795***	0.4813***	0.4976***	0.5027***	0.5084***	0.5179***	0.5247***	0.5367***	0.5432***
	(0.004)	(0.008)	(0.013)	(0.012)	(0.021)	(0.011)	(0.018)	(0.008)	(0.029)
Import Penetration	-0.0064***	-0.0110***	-0.0177***	-0.0145***	-0.0191***	-0.0233***	-0.0174***	-0.0254*	-0.0206***
	(0.002)	(0.004)	(0.006)	(0.004)	(0.006)	(0.004)	(0.005)	(0.014)	(0.003)
Observations	3,124	3,124	3,124	3,124	3,124	3,124	3,124	3,124	3,124

Note: This table presents Quantile regression results on the wage effects of GVC participation and position for a subsample of developed countries. The dependent variable in each column is the log real wage, and each column contains unreported constant terms. Robust standard errors in parentheses, while significance levels are given by *** p<0.01, ** p<0.05, * p<0.10

Table 8. Quantile Regression: Developing Countries

	Q=0.10	Q=0.20	Q=0.30	Q=0.40	Q=0.50	Q=0.60	Q=0.70	Q=0.80	Q=0.90
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GVC Participation	-0.4275***	-0.0775*	0.0477	0.0961***	0.1434***	0.1473***	0.2457***	0.2494***	0.2821***
	(0.062)	(0.046)	(0.035)	(0.037)	(0.036)	(0.036)	(0.034)	(0.026)	(0.060)
GVC Position	-3.8831***	-1.7920***	-1.4094***	-1.1303***	-0.9563***	-0.8903***	-0.5032***	-0.6017***	-0.7400***
	(0.374)	(0.184)	(0.135)	(0.115)	(0.112)	(0.130)	(0.112)	(0.098)	(0.099)
Labour Productivity	0.7867***	0.8164***	0.8056***	0.7991***	0.7762***	0.7867***	0.7657***	0.7521***	0.7243***
	(0.018)	(0.015)	(0.014)	(0.013)	(0.013)	(0.013)	(0.013)	(0.011)	(0.012)
Import Penetration	-0.1114***	-0.0797***	-0.0841***	-0.0817***	-0.1024***	-0.0907***	-0.1072***	-0.1219***	-0.1343***
	(0.013)	(0.015)	(0.013)	(0.012)	(0.013)	(0.013)	(0.013)	(0.012)	(0.013)
Observations	1,888	1,888	1,888	1,888	1,888	1,888	1,888	1,888	1,888

Note: This table presents Quantile regression results on the wage effects of GVC participation and position for a subsample of developing countries. The dependent variable in each column is the log real wage, and each column contains unreported constant terms. Robust standard errors in parentheses, while significance levels are given by *** p<0.01, ** p<0.05, * p<0.10

6. Conclusion

In this paper, we examined the wage effects of GVC participation and position using manufacturing industry-level data across 45 developed and developing countries between 2000—2015. Exploring the cross-country differences of our large sample, we also examine the wage effects of GVC participation and position in developed and developing countries, and in countries with rigid and flexible market conditions. Our full sample analysis reveals that GVC participation and upstream specialisation (i.e., our measure of GVC position) is an important determinant of industry-level wage, with the result showing a positive wage response to an industry's intense GVC participation and upstream specialisation. However, further analysis suggests that whilst intense GVC participation has an unambiguously positive effect on wages in both developed and developing countries, the wage gain from upstream specialisation only materializes in developed countries. In fact, upstream specialisation exerts downward pressure on wages in developing countries. We also find that intense GVC participation (position) only exerts a positive effect on wages under stringent (flexible) labour market regulation. Put together, our analysis on the role of labour market regulation indicates that whilst stringent labour market regulation ensures equal distribution of rents from intense GVC participation, a flexible LMR is also needed to ensure the effective reallocation of workers into knowledge-intensive and high value added upstream activities in the value chain where they will be more productive and earn more. Finally, our analysis on the wage distribution effects of GVC participation shows that higher wage earners benefit the most from intense GVC participation regardless of the level of development of the country. And while upstream specialisation exerts upward pressure on all wages earners in developed countries, the reverse is true for developing countries.

Overall, our study suggests that an industry's engagement in GVC along with its position in GVCs are important determinants of wages. However, how wage responds to this involvement in GVC depends on a host of other things viz-a-viz the country's development level, labour market conditions, and the characteristics of the wage earners. From a policy perspective, our study highlights the importance of taking into accounts these heterogeneities to arrive at more detailed and relevant policy conclusions. Along this line, different policy implications can be deduced from our analysis. First, our findings that relative upstream specialisation in developing countries exerts a negative effect on wages calls for the need for policies that not only increase the domestic value-

added content in their exports but also enable these countries to increase value capture in the upstream activities they are engaged in. Along this line, deliberate national policies that strengthen the country's national innovation system as a means of building domestic capabilities are of utmost importance. Second, our analysis suggests that intense GVC participation only exerts a positive effect on wage under stringent labour market regulation suggesting that stricter labour market regulations that ensure the effective enforcement of minimum wage regulations are needed to ensure that the wage gains associated with GVC are evenly distributed across all participating firms and countries. Yet, we call for caution in the use of stringent labour market regulation to capture greater wage gains since this may come at the cost of economy-wide unemployment. Moreover, flexible labour market may also offer gains to countries with upstream specialisation by reallocating labour to their most productive use. Third, our Quantile regression results showing that the wage effects of GVC participation and position are unevenly distributed across different wage earners raises concerns of inequality and calls for complementary policies that mitigate any such effect of an industry's involvement in GVC.

Although there have been declines in GVC related trade in recent times (WDR, 2020), it is unlikely that the organisation of global trade in GVC is leaving us anytime soon. Unquestionably, the economic benefits of GVC are humongous which have led to different studies clamoring for a reduction in input and output tariffs on the one side and improved governance structure of GVC that enables firms and countries to participate more intensively (e.g., see Gereffi, 2014; Montalbano *et al.,* 2018; Amendolagine *et al.,* 2020; Ndubuisi & Owusu, 2021). Our study contributes to this nascent literature making a case, however, for a more carefully designed policies that ensure the economic benefits of GVC do not come at a welfare cost.

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