WORKING PAPER

Global Value Chains and Service Liberalisation: Do They Matter for Skill-Upgrading?

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Abstract

This study attempts to assess the effect of Global Value Chains (GVCs) and service liberalisation on skill-upgrading. It provides a bridge between two active literatures on GVCs and service liberalisation. Using comprehensive firm-level data from the World Bank Enterprise Survey, the contribution of this paper is twofold. First, it focusses on the effect of GVC integration on skill-upgrading in the presence of service restrictions. Second, it uses firm-level data on 141 developing economies. Our main findings suggest that integration in GVCs results in skill-upgrading, whilst service trade restrictions are associated with skill-downgrading. We argue that more restricted services weaken the channels by which GVCs stimulate the process of skill-upgrading. Therefore, skill-upgrading resulting from GVC participation is more pronounced when services are liberalised. Our results remain robust to any change in the measure of service protection, the measure of skill-upgrading and when we allow for the endogeneity of GVCs.

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Introduction

The process of trade liberalisation and market-oriented reforms that started in the early 1980s and intensified in the 1990s triggered the integration of developing countries into the global market. Their exports reached almost half that of total world exports (44% of merchandise trade in 2019 and 34% of commercial service trade, WTO, 2019) and their rapid economic growth, the so-called Great Convergence (Baldwin, 2016), has often been attributed to the increase in trade openness.

International production, trade and investment are progressively organised within a widely preeminent aspect of contemporary globalisation, namely Global Value Chains (GVCs). The emergence of GVCs has transformed the pattern of international trade by fragmenting the production process. In fact, goods and services are not produced any more in one country and production operations are increasingly restructured through outsourcing and offshoring of tasks. This is why trade in intermediates is estimated to account for two-thirds of international trade (Johnson and Noguera, 2012). In parallel, services are widely used during the production process across different stages of production. As a result of the information technology revolution and the reduction in communication costs, the unbundling of production and underlying embedded service inputs became increasingly important. Consequently, service trade restrictions are considered as barriers that limit the ability of firms to participate in GVCs and attenuate advantages related to production offshoring. Thus, this study aims at examining the effect of GVC participation and service liberalisation on skill-upgrading.

Skills and employment are issues widely discussed at both policy and academic levels, due to their effects on economic development and growth. Theoretical predictions show that GVCs promote the demand for skilled labour (Feenstra and Hanson, 1996) and increase their relative wage compared to unskilled labour (Acemoglu et al., 2015). In parallel, service liberalisation results in productivity gains due to access to wider varieties of service inputs and the transfer of embedded technological innovations. Thus, our paper associates two empirical literatures: the first on the effect of GVCs on employment via the productivity effect and the skill-composition effect; and the second on the effect of service liberalisation on productivity and participation in GVCs. As empirically estimated, GVC participation increases the productivity of unskilled workers (Egger and Egger, 2006) and results in a higher share of skilled labour and a higher skill premium due to skill complementarity (Chen et al., 2017). Moreover, entry of foreign-service providers and reforms in specific service sectors, such as telecommunications, banking, insurance and transport, increase firm productivity (Arnold et al., 2011 and 2015). Service trade agreements also have a positive effect on GVC trade, especially between developing and developed countries and between developing countries (Lee, 2017).

Although GVCs and service liberalisation play an important role in improving labour productivity and changing the composition of skills, the literature lacks an empirical investigation of the impact of GVCs when service trade liberalisation is taken into consideration. Accordingly, the objective of this paper is to examine the effect of GVCs and service liberalisation on skill-upgrading, using a large firm-level dataset for

developing economies. Hence, by providing a bridge between two active literatures on GVCs and service liberalisation, this focusses on the effect of GVCs on skill-upgrading in the presence of service trade restrictions.

Our main findings suggest two main conclusions. First, service restrictions, as measured by the service trade restrictiveness index (STRI), are associated with skill-downgrading. Second, GVC participation is associated with skill-upgrading and the higher the degree of integration in a GVC, the higher the upgrading effect. Therefore, the effect of GVCs on skill-upgrading is more pronounced when trade in services is liberalised. This result can be explained as follows. First, a GVC allows skill-upgrading to take place, as it makes possible the transfer of technical innovations embedded in foreign inputs, which is amplified under the liberalisation of trade in services. Second, integration into a GVC results in skill-upgrading, as it raises a firm's profitability, promotes the use of more technologically-advanced equipment and increases the demand for better management, which is more likely to happen under service trade liberalisation. Findings show that our baseline results are robust to the use of alternative measures of service trade protection and skill-upgrading and after allowing for endogeneity of GVCs.

The remainder of the paper is structured as follows. Section 2 highlights the theoretical and empirical studies on the effect of GVCs and service liberalisation. Section 3 describes the data and provides some stylised facts on the relation between GVCs, service liberalisation and skill-upgrading. Section 4 is devoted to the methodology. Section 5 focusses on analysing the results. Section 6 provides certain robustness checks. Section 7 provides the conclusion.

Literature Review

1. Theoretical Background

This paper is based on the theoretical literature examining skill-upgrading and technological change. In his seminal paper, Acemoglu (1998) developed a theoretical model to examine the implications of the skill-biased technological change that took place in the US in the 1970s. Predictions show that a rapid increase in the supply of college graduates increases the supply of skilled workers, resulting in the decline of the skill premium in the 1970s, but an increase in inequality during the following decade. Thus, the theory suggests that a larger supply of skilled workers decreases the skill premium in the short-run, but increases it in the long-run. As argued, a larger supply of skilled labour enhances worker productivity, as it enables larger skill-complementary technologies to exist. As a result, skill premium increases in the long-run. Previous studies show that technological change is biased towards skilled workers, due to information technologies (Nelson and Phelps, 1966) and machine skill complementarity (Griliches, 1969), suggesting that the level of technology affects the capital structure of an economy. In other words, greater technological progress can result in a larger investment in human capital rather than in tangible capital.

In the same vein, Acemoglu (2003), Acemoglu et al. (2015), Acemoglu and Zilibotti (2001), Gancia and Bonfiglioli (2008) and Feenstra and Hanson (2003) study the effect of international trade and offshoring on technological change. Acemoglu (2003) argues that international trade increases inequality between skilled and unskilled labour in the US, as well as in developing countries, due to the skill-biased technological change. Theoretical predictions suggest that the skill premium is determined by trade, technology and the relative supply of skilled labour. However, technology is endogenous in the sense that, with a constant technology, the skill premium can increase as a result of a rise in the relative supply of skilled labour that will induce technological change and will then stimulate the increase in the skill premium. By contrast, Acemoglu et al. (2015) point out that the effect of offshoring on technical change is ambiguous. Their findings show that offshoring results in skill-biased technological change and an increase in the relative wage of skilled labour in industrial countries, if the initial cost of offshoring is high. On the contrary, if the initial cost of offshoring is low, more offshoring opportunities result in technical change that is biased towards unskilled labour. These predictions are similar to those of Acemoglu and Zilibotti (2001), who suggest that total factor productivity differential between developed and developing countries arises due to the skill-mismatch between the level of labour skills and those required by new technologies in developing countries. Similarly, Gancia and Bonfiglioli (2008) show that international trade and offshoring increase the wage differential between developed and developing countries, as the weak protection of intellectual property rights in developing countries induces a shift of technological change towards developed countries. On the contrary, Feenstra and Hanson (2003) predict that integrating a GVC promotes the demand for high-skilled workers in developed as well as developing countries, due to the technological differential. They argue that developed countries have low-skilled outsourcing links, whilst developing countries have high-skilled outsourcing links. Accordingly, since developing countries are trapped in low end production stages and, due to the need to match the introduction of advanced foreign technology, the demand for better management is increased, suggesting an increase in the demand for high-skilled workers.

In line with this area of literature linking offshoring, international trade and skill-biased technological change, Ethier (1982) suggests that the liberalisation of trade in goods and services makes accessible a greater variety of inputs, resulting in productivity gains for downstream industries. In this respect, the literature presents a plethora of empirical studies focussing on the effects of GVCs on the skill structure of workers, wage composition, productivity and growth.

2. Empirical Literature

This research draws on two strands of the empirical literature. The first one is related to the effect of a GVC on employment and the second one focusses on the effects of service liberalisation on productivity and GVC participation.

GVCs are found to have an effect on employment via two channels: first, its effect on productivity and growth and, second, its effect on the skill composition of labour and wage structure. Gorg and Hanley (2005), Egger and Egger (2006), Girma and Goreg (2004) and Cigano and Shivardi (2004) suggest a positive effect of GVCs on labour productivity. Cigano and Shivardi (2004) estimate the effect of different sources of externalities on total factor productivity (TFP) and find that the specialisation effect, following international outsourcing, has a positive impact on TFP growth. Studying the case of Irish firms operating in the electronics industry, Gorg and Hanley (2005) argue that the effect of international outsourcing on productivity depends on the nature of outsourced inputs. Their findings suggest a positive effect of materials outsourcing on productivity, but no productivity gains associated with services outsourcing. This is explained by the relatively lower number of firms outsourcing services and the low intensity of service outsourcing compared to tangible outsourcing. Also, they conclude that this effect holds up for firms with low export intensity, in contrast to firms that are already heavily integrated in international markets which enables them to benefit from flexibility of international outsourcing.

Similarly, Girma and Gorg (2004) examine the case of manufacturing firms in United Kingdom and show that a higher intensity of international outsourcing results in labour productivity and total factor productivity gains and, consequently, higher wages. In a comparison between foreign-owned and domestic-owned firms, they conclude that the effect of outsourcing is more pronounced for the former than the latter. In fact, foreign-owned firms have a higher intensity of international outsourcing and they have more access to external providers via their relationships with different affiliates abroad. In addition, Egger and Egger (2006) point out that outsourcing leads to higher productivity for low-skilled workers in EU manufacturing firms. As argued, this result holds firm for the long-run, whilst the effect of outsourcing on productivity is negative in the short-run, as a result of European market imperfections that limit the immediate adjustment of employment and output.

Regarding the second channel by which GVCs affect employment, Chen et al. (2017), Head and Ries (2002), Hijzen et al. (2005), Feenstra and Hanson (2003), Shen and Zhang (2019) and Ma et al. (2019) find a positive effect of outsourcing on the relative demand and wages of high-skilled workers. Chen et al. (2017) examine the effect of input trade liberalisation on skill structure, using Chinese firm-level data. They show that a reduced input tariff, resulting from trade liberalisation, increases the skill premium, the firm's value added and profits for firms with a higher share of skilled workers due to "skill complementarity". They argue that the technology embedded in imported inputs, the greater profits generated and the increased demand for better management raise the demand for high-skilled workers. Furthermore, Head and Ries (2002) focus on the effect of offshoring on labour skill composition in Japanese firms. Their findings suggest that FDI directed to low-income countries results in an increase in the relative demand and wages of skilled labour. However, as FDI shifts toward high income countries, FDI in low-income countries leads to skill-downgrading. The main explanation is that low-skill activities are transferred to low-income countries, whilst high-skill activities are transferred to high-income countries. Similarly, Hijzen et al. (2005) point out that outsourcing results in a decrease in the

demand for unskilled workers in the UK, whilst research and development (R&D) appears to have a positive effect on the demand for high-skilled workers. Their main findings suggest that outsourcing and technological change, induced by R&D, are skill-biased. This is consistent with the results of Feenstra and Hanson (2003), suggesting that trade in intermediaries and skill-biased technological change has the same effect on the skill structure of labour demand. Both of them increase the demand and wages of high-skilled workers. This is also in line with the results of Aboushady and Zaki (2020) who examined the effect of innovation on the demand for skilled labour in the Middle East and North Africa region using firm-level data.

Nevertheless, Shen and Zhang (2019) and Ma et al. (2019) predict that the effect of GVCs on the skill structure depends on the position of a country in GVCs. In this respect, Shen and Zhang (2019) focus on the case of China, one of the largest countries integrated at the low-end of GVCs. Their results confirm that low-end integration has a negative effect on skill-biased technological change. In fact, due to low-skilled technological diffusion, low-skilled activities absorb high-skilled workers, which result in an insufficient supply of skilled labour for high-skilled industries. Moreover, Ma et al. (2019) argue that a higher position in GVCs improves the skill structure of both developed and developing countries but the mechanism is different. Whilst an increase in the position in a GVC has a positive and direct effect on high-skilled labour in developed countries, it induces a greater demand for high-skilled and medium-skilled workers in developing countries, which is consistent with Feenstra and Hanson's (1996) theoretical predictions.

The second strand of the literature is related to service trade liberalisation and its effect on productivity and GVC participation. Arnold et al. (2008), Arnold et al. (2011), Arnold et al. (2016) find that service liberalisation enhances productivity, whilst Debaere et al. (2013), Lee (2019) and Thangavelu et al. (2017) suggest that service liberalisation facilitates the integration of firms in GVCs. In this respect, Arnold et al. (2008) conclude there is a positive effect of service inputs on the productivity of African manufacturing firms. Their findings show that the higher service performance of the communication, electronics and financial service sectors, the greater the firm's productivity. Moreover, they argue that service inputs play a key role in improving the performance of downstream industries, hence stimulating growth and the reduction in poverty. Similarly, Arnold et al. (2011) examine the impact of foreign providers, privatisation and competition as different aspects of service liberalisation on the productivity of manufacturing firms in the Czech Republic. Their main results are analogous to Arnold et al. (2008), showing a positive relation between service reforms and the performance of downstream industries. The entry of foreign-service providers appears to be the main channel via which firms increase their productivity. Arnold et al. (2016) also find a positive impact of reforms in the telecommunications, banking, insurance and transport sectors on the productivity of Indian manufacturing firms. By disentangling the effect of each service sector, results show that reforms in the banking, transport and telecommunications sectors have a stronger positive effect on firm productivity than reforms in the insurance sector. They argue that liberalisation of the banking sector allows a more efficient allocation of capital, the telecommunication sector generates new ways of communication and facilitates the

diffusion of technology, whilst reforms to the transport sector reduce the cost of transportation.

Regarding service liberalisation and GVC participation, Debaere et al. (2013) show that the availability of services encourages Irish firms to source inputs from abroad, hence increasing participation in GVCs and stimulating trade flows. They conclude that the availability of local services is of special importance for small firms as they are less able to attract foreign-service providers and will depend mainly on local services. On the contrary, the availability of local services is less critical for large firms and multinationals, as they are more likely to access foreign-service providers. Similarly, Lee (2019) finds a positive and significant effect of service trade agreements on trade in GVCs, but this effect is heterogeneous by a country's income level and the type of service provision. Findings suggest that the positive effect of service agreements on GVC trade is significant between developing and developed countries (South-North) and between developing countries (South-South). They argue that service trade barriers are higher in developing countries, making a service agreement more effective for them. In contrast, the effect of service agreements on GVC trade between developed countries (North-North) appears to be insignificant, as developed countries already have a low level of service trade restrictions. Finally, the effect is insignificant on GVC trade from developed to developing countries because service agreements reduce the cost of GVC participation and result in a comparative advantage for developing countries - but not necessarily for developed ones.

Although the literature on services and GVCs focusses mainly on the effect of services on GVCs, Thangavelu et al. (2017) study the impact of participation in GVCs on service activities in Asian countries. Their findings show that the more a country is involved in GVCs, the more service activities shift from local to foreign firms. Also, upstream countries tend to outsource labour-intensive activities and keep technology-intensive activities at home.

Given the well-documented literature on GVCs and service liberalisation, this study provides a bridge between these two active literatures. On the one hand, there is growing evidence that GVC participation results in positive effects on productivity and growth, as well as the demand for skilled workers via skill-complementarity effects. On the other, whilst the literature on the effect of service trade liberalisation and skill-upgrading is scarce, the former is found to have positive effects on productivity and on the likelihood of GVC participation. Thus, this study aims at examining the effect of GVC participation and service trade liberalisation on skill-upgrading, using a comprehensive firm-level dataset from the World Bank Enterprise Surveys (WBES).

Data and Stylised Facts

1. Data

Firm-level data comes from the World Bank Enterprise Surveys that offer an extensive array of economic data on 149,172 firms in developing countries. The surveys cover a broad range of business environment topics, along with standard topics. Whilst firms operating in the manufacturing or service sectors are the main targetted business sector of the surveys, this study focusses purely on firms in the manufacturing sector.

Therefore, the sample used in this study comprises 81,257 manufacturing firms in 141 developing economies for the available years of the survey between 2006 and 2019. Given that the WBES include data on exporting and importing firms, as well as data on firms that have international certification and foreign ownership, this survey is used to construct measures of different degrees of a GVC (Dovis and Zaki, 2020).

To measure service restrictiveness, the service trade restiveness index (STRI) is used. The STRI values come from Jafari and Tarr (2014) who construct an index of service restrictiveness based on discriminatory regulatory barriers against foreign suppliers of services. This dataset is available for 105 countries and 11 service sectors: accounting, legal, air transport, rail transport, road transport, maritime transport, banking, insurance, fixed line, mobile line and retail. Service sectors in the database by Jafari and Tarr are grouped into 5 service sectors: transport (air, rail, road and maritime transport), financial services (banking and insurance), telecommunications (fixed line and mobile line), retail and other services (accounting and legal services). Moreover, 13 manufacturing sectors are taken into account in the study: basic metal, fabricated metal, plastic and rubber, chemical products, non-metallic mineral products, textile and garments, food, wood and furniture, motor vehicles, printing and publishing, machinery and equipment, electronics and other manufacturing.

The measure of service restrictiveness is calculated by multiplying the STRI of each service sector by its corresponding weight in each manufacturing sector. The share of each service sector comes from the Input-Output table from the World Input Output Database. If, for a specific country, its input-output table is not available, we rely on the "Rest of the World" table to extract the weight of each service in the manufacturing sector.

2. Stylised Facts

This part aims at describing the relationship between GVC participation, service trade liberalisation and skill-upgrading. As a matter of fact, trade in intermediates represents two-thirds of international trade. This is the result of the fragmentation of the production process that makes firms more integrated in global production networks.

In this respect, we follow Dovis and Zaki (2020), who suggest four definitions of a GVC using four dimensions: (1) export status, (2) import status, (3) international

certification and (4) foreign ownership. First, the least strict definition encompasses firms that export and import simultaneously. The second and third definitions are substitutes and include firms that export, import and have either international certification or a share of capital owned by a foreign investor. Fourth, the strictest definition includes firms that have all four dimensions. We use the World Bank Enterprise Surveys (Table 1A in Appendix 1) to construct the four measures of a GVC.

Table 1 provides summary statistics for the four definitions of a GVC where 21.9% of firms in the sample are exporters and importers simultaneously, 10.4% and 5.5% are exporters, importers and either received an international certification or have a share of capital owned by foreign firms, respectively. Finally, 3.2% are engaged in two-way trade, have a share of foreign ownership and received an international certification. The rest of the firms are either domestic, or only exporting or importing, as will be shown later. Moreover, Table A2 and A3 in Appendix 3 provide summary statistics for our variables. The average firm has 47.5% of its workers as skilled workers and faces an average weighted STRI of 11.7%. Also, 39.4% of firms in the sample are small firms, 36.2% are medium firms and 24.3% are large firms.

Table 1: Firms in a GVC - different definitions

GVC	Observations	% total number of firms
Two-way	17,329	21.9
Two-way and international certification	8,315	10.4
Two-way and foreign ownership	4,444	5.5
All	2,573	3.2

Source: Constructed by the authors.

A more detailed look shows that 21% of firms at the world level export and import simultaneously, whilst 40% of firms are domestic that neither export nor import (Figure 1). Furthermore, the share of domestic firms in East Asia and the Pacific (54%), in South Asia (53%) and in Sub-Saharan Africa (42%) is higher than the share of other firms in these regions and even higher than the share of domestic firms at the world level (41%). Interestingly, the share of importing firms is higher than the share of domestic firms in Latin America and the Caribbean and it is slightly lower than the share of domestic firms in the Middle East and North Africa (MENA). Also, the share of importing firms is lowest in East Asia and the Pacific where China is ranked first in terms of the number of manufacturing firms, representing 16.1% of all firms in this region. Given the industrial upgrading in China that results in the substitution of imported intermediate inputs by domestically produced inputs (GVC Development Report, 2019) and the large share of Chinese firms in the East Asia and Pacific region, the share of importing firms is the second lowest in the world and the share of domestic firms is the highest compared to other regions. By contrast, the higher share of importers in Latin America and the Caribbean suggests that this region depends mainly on imported intermediate inputs for production. In addition, the

share of exporters is the lowest share across all regions, which is in line with the findings of Freud and Pierola (2015), suggesting that export activity is dominated by the top five firms in LAC countries.

Figure 1: Share of domestic firms, one-way firms and two-way firms - by region
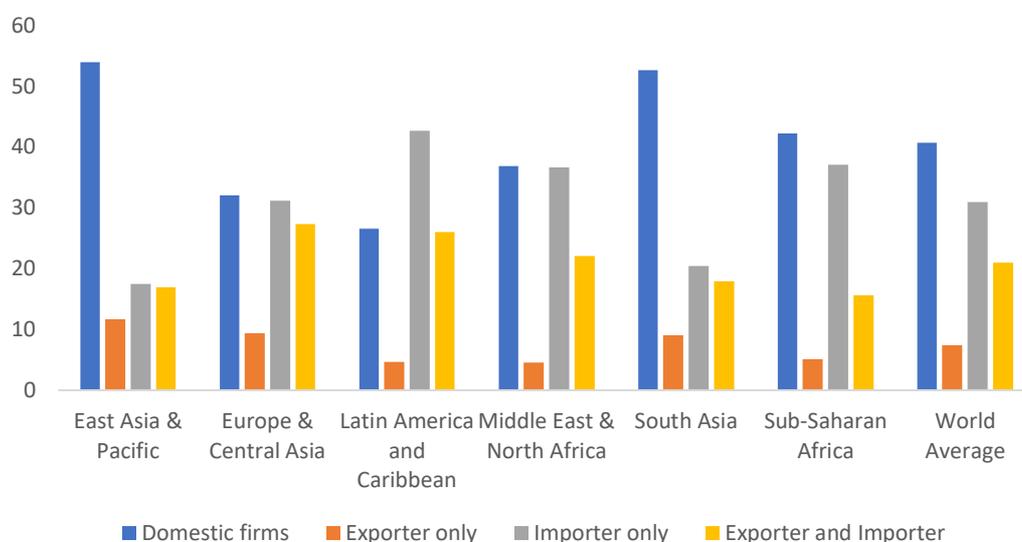

Source: Constructed by the author using firm-level data from the World Bank Enterprise Survey.

In terms of international certification, only 23% of firms in the world have an internationally recognised certification, according to Figure 2. The share of firms with international certification is highest in South Asia (33%) and is slightly higher than the world average in East Asia and the Pacific (26%) and in Europe and Central Asia (27%). Furthermore, Figure 2 shows that the share of firms having foreign capital at the world level is 11%. In Sub-Saharan Africa (SSA), this share represents 17%, which is above the world average and the highest in the world. For East Asia and the Pacific and Latin America and the Caribbean, this share is slightly higher than the world average (13% and 12%, respectively). By contrast, the share of firms owning foreign capital is lowest in South Asia (1.96%). An observation worth mentioning is that Dovis and Zaki (2020) suggest that internationally certified firms are more likely to attract foreign investment because foreign investors seek to secure their transactions across borders. Surprisingly, South Asia has the highest share of firms with international certification and the lowest share of firms with foreign capital. This could be explained by the existence of barriers to the entry of foreign capital in South Asia. Moreover, only 3% of firms at the world level export and import simultaneously, received an international certification and have a share of their capital that is owned by foreign firms. This means that there are some obstacles preventing firms in almost all regions from acquiring foreign capital or/and international certification, thus preventing them from participating in GVCs. In fact, Figure A1 in Appendix 2 suggests that the largest share of firms in Sub-Saharan Africa and Latin America and Caribbean find that access to finance is their biggest obstacle. In MENA and South Asia, the largest share of firms

consider that political instability and electricity, respectively is their biggest obstacle. For East Asia and the Pacific and Europe and Central Asia, informal sector practices and tax rates are the biggest obstacle according to the largest share of firms, respectively.

Figure 2: Share of certified firms, firms with foreign capital and firms integrated in GVCs - by region
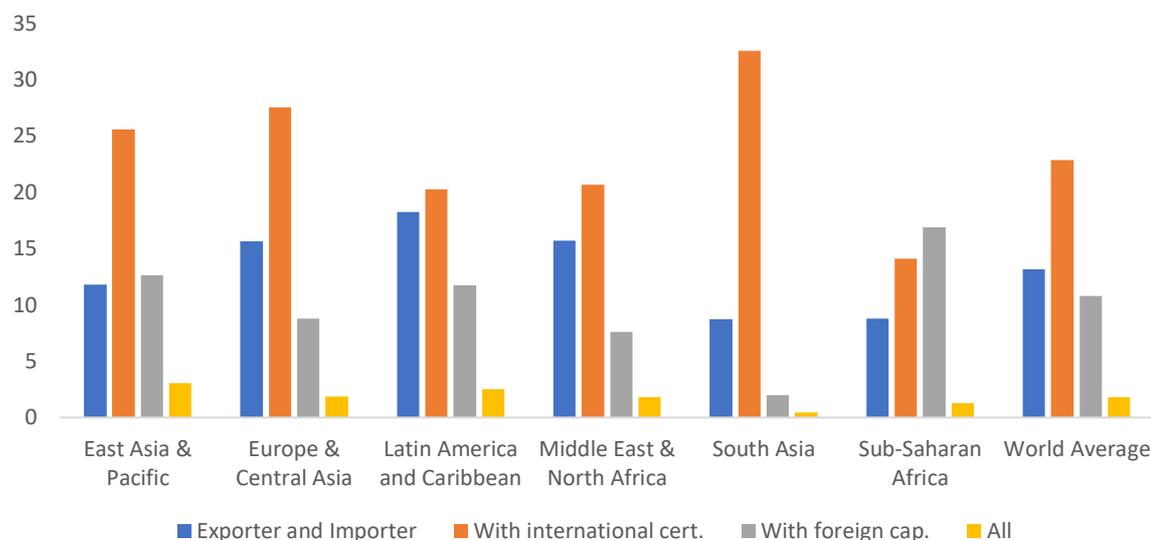
Source: Constructed by the author using firm-level data from the World Bank Enterprise Survey.

In terms of service trade, recent trends show an increase in the share of trade in services to GDP. Figure 3 suggests that trade in services and trade in goods represents almost 10% and 32%, respectively of world GDP. In other words, the contribution of trade in services to world GDP is a third of the contribution made by trade in goods. Furthermore, South Asia has the highest share of trade in services in GDP (12.3%), whilst the MENA region has the highest share in terms of trade in goods (41.4%). Despite the increasing share of services, the service sector remains relatively protected in many emerging countries.

In fact, Figure 4 shows that the MENA region and South Asia have the most protected service sectors, as predicted by their overall STRI (46.6 and 40.8, respectively), above the world average STRI (33.9). Yet, whilst countries of the MENA region have undertaken many reforms to liberalise their service sectors, the overall average of this region remains the largest. Conversely, the service sectors in Sub-Saharan Africa, Latin America and the Caribbean, Europe and Central Asia and East Asia and the Pacific are relatively liberalised, as their STRI (32.4, 27.1, 24.3 and 32.4, respectively) are all below the world average. However, although the STRI gives an indication about service protection, this index has been criticised for lacking economic sense. In this respect, Fontagne, Mitaritonna and Signoret (2016) estimated the ad-valorem equivalent of tariffs on services (AVE). The regional average AVE for South Asia (93.7) and Latin America and the Caribbean (80.5) is higher than the world average AVE (66.0). The other version of AVE estimated by Jafari and Tarr (2014)

shows that South Asia (64.9) and Sub-Saharan Africa (73.7) have relatively more protected service sectors compared to other regions.

Figure 3: Average share of trade in goods and services (% GDP)

Source: Constructed by the author using data of the World Bank.

Figure 4: Regional average service restrictiveness measures
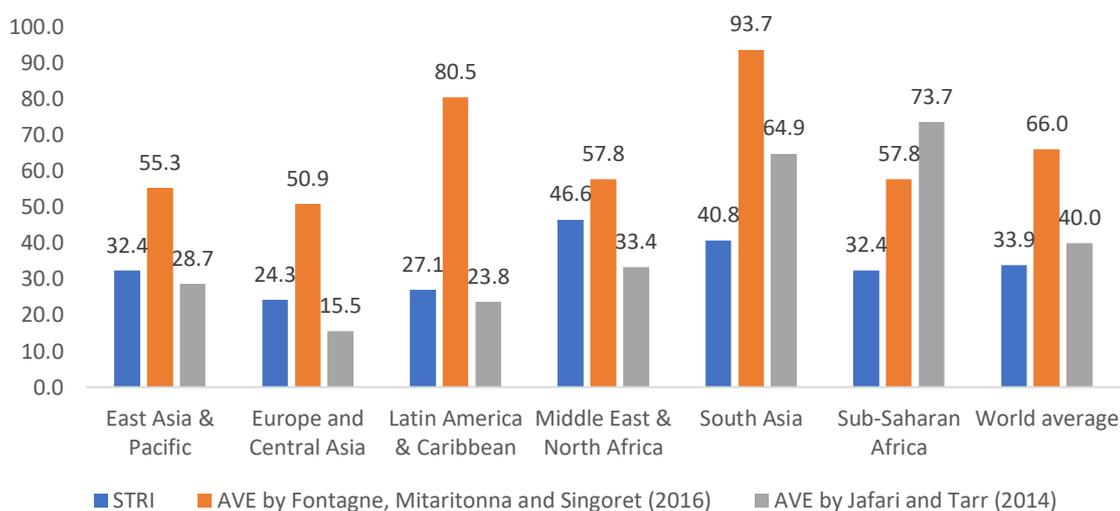
Source: Constructed by the author using the data of Jafari et Tarr (2014) and Fontagne, Maritonna and Singoret (2016). Note: The STRI index ranges from 0 to 100 with 100 being completely closed to foreign competition. Fontagne, Mitaritonna, and Signoret (2016) estimated the ad valorem equivalent of restrictions in trade in services using GTAP data.

Nevertheless, the overall regional average STRI and AVE hides heterogeneity across different sectors. First, Figure 5 shows that the most protected sectors at the world level are "Professional Services" (51.5) followed by "Transport" (38.8) in all regions except Sub-Saharan Africa. However, the least protected sectors are

"Wholesale and Retail" (20.0) and "Finance" (25.0), as predicted by the STRI. Furthermore, the MENA region is ranked first in terms of service trade protection in all sectors, namely the STRI of "Professional Services" and "Transport" is above 50. Second, Figure 6 shows that the most protected service sectors at the world level are "Other Financial Intermediation" (131.5) and "Construction" (85.5), as predicted by the AVE estimated by Fontagne, Maritonna and Singoret (2016). Moreover, the AVE of "Construction" exceeds 100 in Latin America and the Caribbean and in South Asia. In addition, the AVE also exceeds 100 for "Information and Communication" in South Asia. Third, as predicted by the AVE estimated by Jafari and Tarr (2014), Figure 7 shows that "Telecommunications" (94.0) is the most protected service sector at the world level, especially in Sub-Saharan Africa and South Asia where it exceeds 100. It is followed by "Professional Services" (40.4) and "Transport" (40.7) whilst "Retail" (3.3) is the most liberalised service sector across all regions.

Figure 5: Regional average STRI, by sector
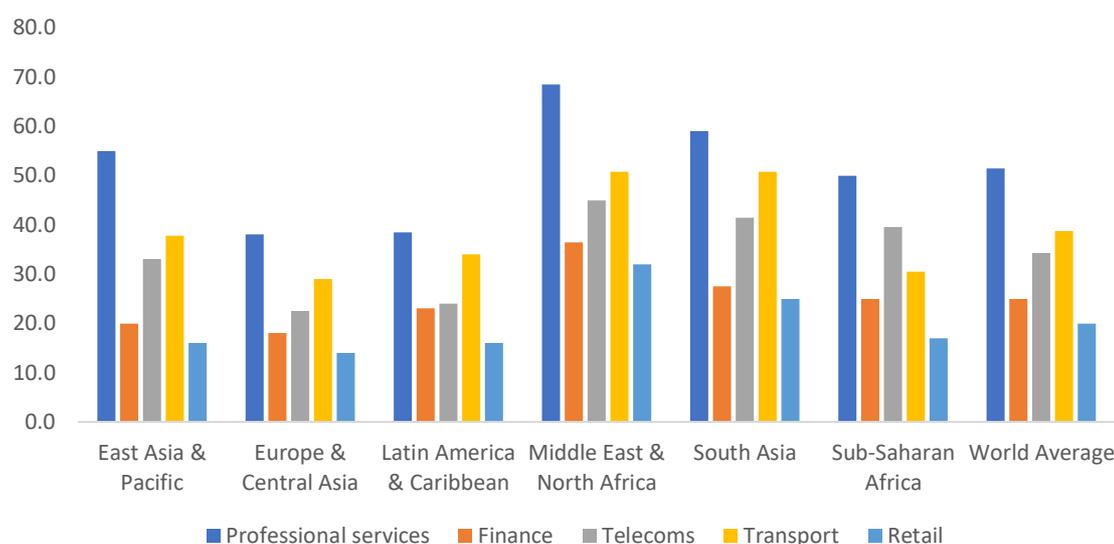
Source: Constructed by the author using data of Jafari et Tarr (2014).

Note: The STRI index ranges from 0 to 100 with 100 being completely closed to foreign competition.

Figure 6: Regional average AVE, by sector

- Communications
- Construction
- Insurance
- Other Business Services
- Other Financial Intermediation
- Other Services (government)
- Wholesale and Retail
- Water and Transport
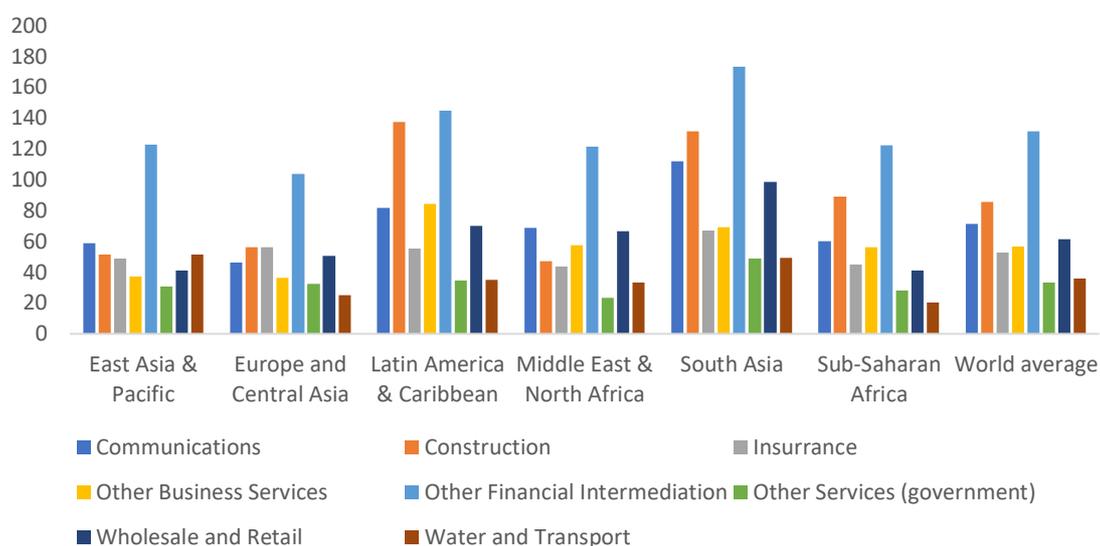
Source: Constructed by the author using data from Fontagne, Mitaritonna, and Signoret (2016).

Note: Fontagne, Mitaritonna, and Signoret (2016) estimated the ad-valorem equivalent of restrictions in trade in services for 117 countries and 9 service sectors using GTAP data.

Figure 7: Regional average AVE, by sector

- Professional services
- Financial services
- Telecoms
- Transport
- Retail
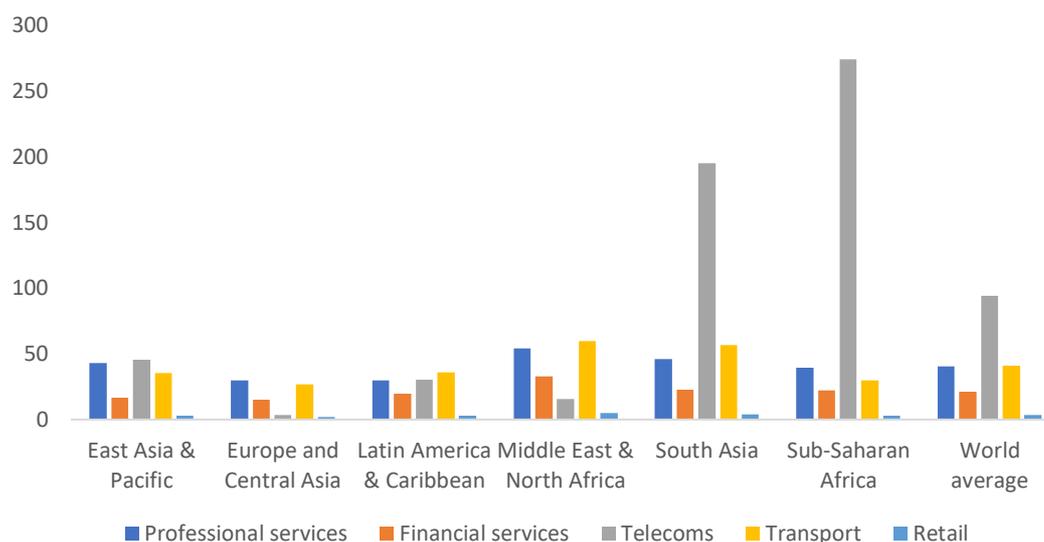
Source: Constructed by the author using data of Jafari and Tarr (2014).

It is important to note that customs and trade regulations (see Figure A1 in Appendix 2) including service trade restrictions are an important obstacle to the participation of firms in GVCs. This is consistent with the findings of Figure 8. Regions with the most protected service sector (STRI above the median) have a lower share of firms that export, import, have international certification and foreign capital, compared to regions with less protected service sectors. In fact, 2.5% of firms in

regions with the least protected service sectors are integrated in GVCs versus 1.2% in regions with the most protected service sectors. In addition, a higher share of domestic firms that neither export nor import is observed in regions with the most protected service sectors. The negative relationship between service restrictiveness and GVC participation could be explained by the fact that services enable and facilitate fragmentation of the production process, resulting in a reallocation of production stages and ensuring that the supply chain functions well (Deadroff, 2001 and Egger et al., 2015).

Figure 8: Share of domestic firms and firms in GVCs by degree of service protection
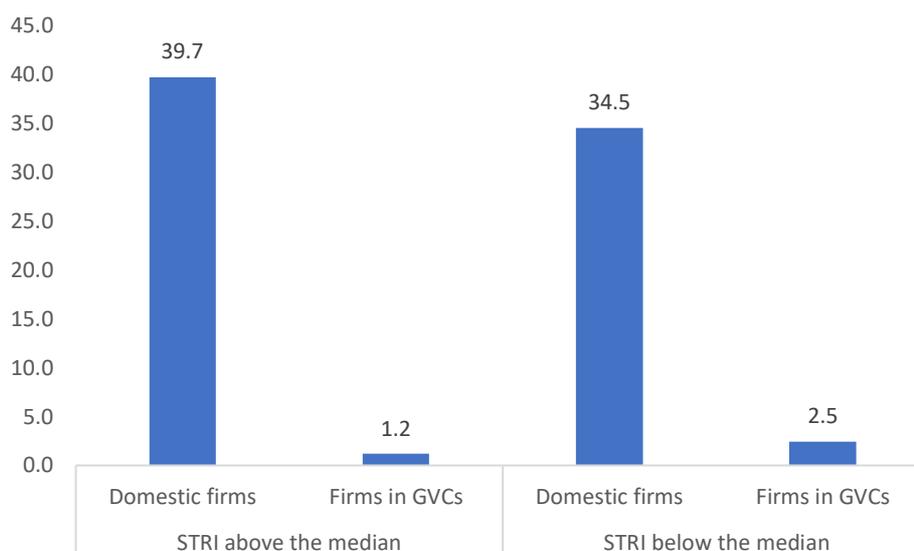
Source: Constructed by the author using firm-level data from the World Bank Enterprise Survey.

Note: Firms integrated in GVCs are those who export, import, received an international certification and have a share of their capital owned by a foreign organisation.

As per skilled labour, we use the number of full-time non-production (white-collar) workers as a proxy for the number of skilled workers. In this respect, Figure 9 shows that the share of skilled labour is lowest in Sub-Saharan Africa (20.9%) and highest in Latin America and the Caribbean (27.7%). Moreover, it is below the world average in East Asia and the Pacific (22.8%), in South Asia (21.9%) and slightly higher in Europe and Central Asia (25.4%) and in the MENA region (25.7%).

Besides this, the share of skilled labour is positively correlated with the highest degree of integration in GVCs, as is shown in Figure 10. Latin America and the Caribbean exhibits the highest share of skilled labour and have the largest share of firms that export, import, have international certification and foreign capital. Furthermore, South Asia and Sub-Saharan Africa have the lowest share of skilled labour and they have the lowest shares of firms integrated in GVCs. This is because participation in GVCs enables countries to have access to new production techniques and advanced technologies, resulting in a spillover effect on the improvement of

domestic technology and, consequently, higher demand for skilled labour (Ma et al., 2019).

Figure 9: Share of skilled labour, by region
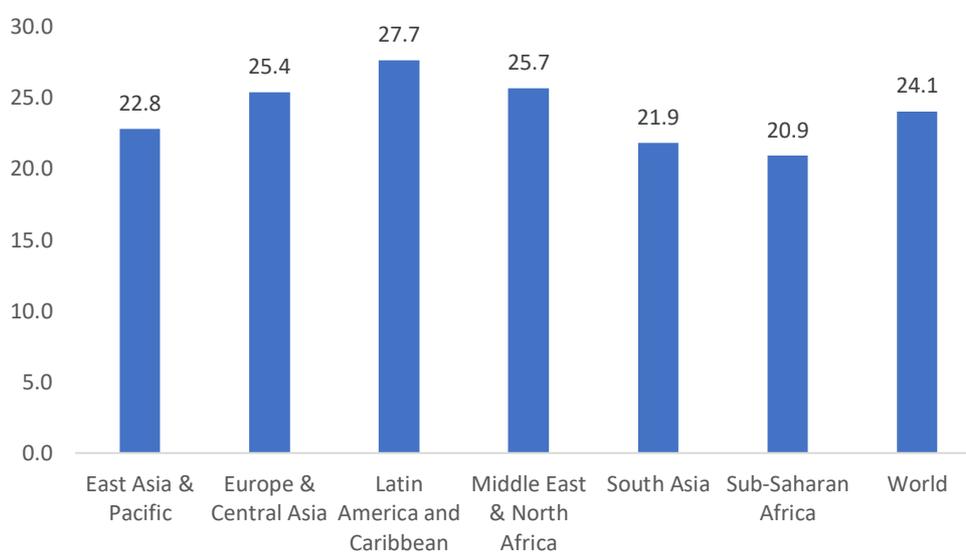
Source: Constructed by the author using firm-level data from the World Bank Enterprise Survey.

Note: the share of skilled labour is measured as the percentage share of non-production, full-time workers amongst the total number of full-time workers. The number of non-production workers is used as a proxy for the number of skilled workers.

Figure 10: Share of firms in GVCs and share of skilled labour, by region
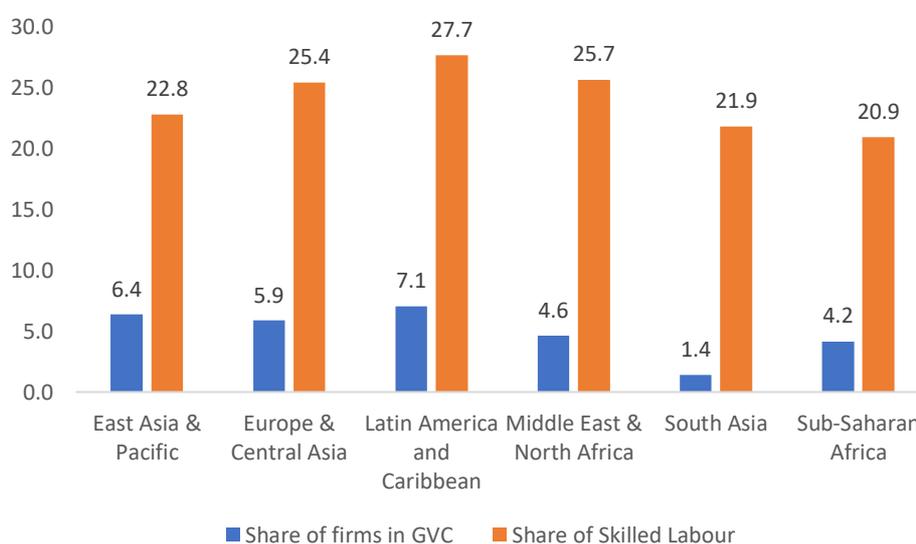
Source: Constructed by the author using firm-level data from the World Bank Enterprise Survey.

Note: Firms in GVCs are firms that export, import, have international certification and foreign capital.

Finally, Figure 11 suggests that domestic firms have a lower share of skilled workers than firms integrated in GVCs in its strictest definition, regardless of the

degree of service protection. Furthermore, domestic firms in regions with relatively high protected service sectors have a lower share of skilled workers (20.1%) compared to their counterparts in regions with relatively more liberalised service sectors (23.7%). In addition, a higher degree of GVC participation is associated with a larger share of skilled workers, regardless of the degree of service protection. In fact, firms integrated in two-way trade have a share of skilled workers that is lower than firms that are integrated in two-way trade and have either international certification or foreign ownership, which is also lower than the share of skilled workers in firms that cover all the dimensions. Moreover, firms that export, import, have foreign ownership and international certification, in regions with the most protected service sectors, have a slightly lower share of skilled workers (24.3%) compared to their counterparts in regions with less protected service sectors (24.7%).

Figure 11: Share of skilled workers in domestic firms and firms in GVCs, by degree of service protection.
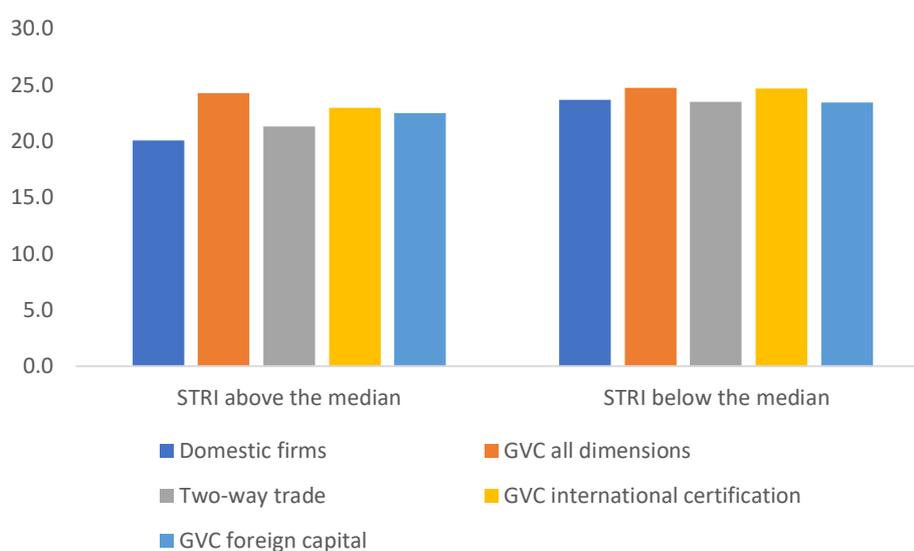
Source: Constructed by the author using firm-level data from the World Bank Enterprise Survey.

In a nutshell, it isn't only GVC participation that is associated with a higher share of skilled-workers; service liberalisation also plays an important role. Hence, this study aims at testing the relationship empirically between service liberalisation and GVC participation on one side and skill-upgrading on the other.

Methodology

Based on the literature on GVCs and service liberalisation, this study aims at identifying the impact of GVC participation on skill-upgrading in the presence of service trade restrictions, as follows:

$$skill_{i,j,r,k,t} = \alpha_0 + \alpha_1 Serv.Prot_{j,k,t} + \alpha_2 GVC_{i,j,r,k,t} + \alpha_3 X_{i,j,r,k,t} + \delta_t + \delta_j + \delta_r + \varepsilon_{i,j,r,k,t} \quad (1)$$

with i, j, r, k and t respectively, the firm, the country, the firm's region, the industry and the year. "Skill" is measured as the ratio of non-production, full-time workers and the total number of full-time workers where the number of non-production workers is used as a proxy for the number of skilled workers. In addition, X is a vector of plant characteristics that are expected to influence the share of skilled workers in the firm, such as firm size and firm age. In addition to plant characteristics, country and region dummies are included to allow for time-invariant country-specific and region-specific characteristics (δ_j and δ_r). Moreover, year dummies (δ_t) are included to allow for common shocks within the firms of all countries that could be correlated with skill-upgrading and $\varepsilon_{i,j,r,k,t}$ is the error term.

The expected effect of firm size on skill-upgrading is ambiguous. In fact, Schumpeter (1942) predicts that skilled labour is the necessary input for innovative activities, whilst theoretical predictions suggest two contradictory effects of a firm's size on innovative activities. On one side, small and medium firms tend to be more innovative as they have a more flexible environment for taking quick decisions, as well as less red-tape procedures making them more capable of adaptation and change (Chandy and Tellis, 2000; Dean et al., 1998; Nord and Tucker, 1987). On the other side, large firms are more likely to innovate as they have more financial and technical capabilities to finance innovations and economies of scope, enabling them to spread the risk of failure and cover its cost (Hitt, Hoskisson and Ireland, 1990). Since skilled labour is the main input for innovation, the share of skilled labour is higher in small firms, according to the first set of theories, but greater in large firms, according to the second set of theories. Firm size is captured by three dummy variables that differentiate between small firms (less than 20 employees), medium firms (between 21 and 99 employees) and large firms (more than 100 employees).

Similarly, the effect of a firm's age on the share of skilled workers is found to be ambiguous. On the one hand, older firms are more capital-intensive than newly established firms and capital-skill complementarities will result in a greater demand for skilled-workers in older firms (Damanpour, 2010and Heyman, 2007). On the other hand, newly established firms have a higher probability of failure and greater risk of exiting the market. As a result, they avoid large capital intensive investments and have a large share of skilled workers as a substitute (Cefis and Marsili, 2006 and Duffy et al., 2004). The age of the firm is calculated by taking the logarithm of the difference between the date when the establishment started operations and the date of the most recent available survey » (2019).

Also, the variable "*ser.prot*" captures service restrictiveness faced by the manufacturing sector k in country j and year t. This variable is the weighted average of

service restrictiveness measures across all service sectors where each service is weighted by its share of the manufacturing sector. Following Karam and Zaki (2020), the effect of service restrictiveness on the manufacturing sector depends on the intensity of the service used in the production of the manufacturing of goods. More precisely, the STRI of sector s in country j and year t are multiplied by the share of service s in manufacturing sector k in country j and year t to get the weighted STRI, as follows:

$$Serv.Prot_{k,j,t} = \sum_s (STRI_{s,j,t}.\ share_{s,k,j,t}) \qquad\qquad (2)$$

The main explanatory variable of interest is "GVC" that takes the value of 1, if the firm is part of a GVC and zero otherwise.

In addition, we extend our analysis, as follows. In order to examine the heterogeneous effect of GVCs in the presence of service restrictions, the sample is divided into two sub-samples, based on the median value of the share of skilled-workers. This distinguishes the differential effect between low-skilled firms and high skilled-firms.

Finally, some empirical remarks are worth mentioning. First, errors are clustered by country, region, sector and year, in order to correct for the potential correlation between unobserved components within clusters. Second, since the panel dimension of the firm-level dataset is extremely small, we run our regressions using the pooled-OLS estimation technique and we introduce several fixed effects to allow for unobservables. Third, to test the robustness of our results, we conducted three checks. First, an alternative measure of service restrictions is used, namely the AVE that was previously presented. Second, we also use an additional measure of skill-upgrading. The third robustness check is an attempt to solve the problem of endogeneity of GVCs by applying an instrumental-variable approach.

Empirical Findings

Table 2 presents the relationship between service restrictions, GVC participation and skill- upgrading. Column 1 shows that the STRI is negatively correlated with values of skill-upgrading. Assuming that skilled workers are an essential input for innovative activities (Schumpeter, 1942) and that service inputs are important for innovation, then service liberalisation will be associated with skill-upgrading, due to the likelihood of having greater innovative capacities. There are three main channels by which service liberalisation enables firms to innovate and then raise their demand for skilled-workers (Arnold et al., 2011). First, service liberalisation provides manufacturing firms with access to more technologically-advanced service inputs which stimulate innovative activities. Second, it enables firms to access new service inputs that were previously restricted, which enhances the performance of those firms. Third, the efficiency of existing service inputs may improve, since service

liberalisation increases free-entry threats, encouraging existing service providers to enhance the quality of their services, in order to preserve their market share. Therefore, service liberalisation is positively correlated with skill-upgrading via its positive correlation with innovation.

The results of columns 2, 4, 6 and 8 show that GVC participation is associated with skill-upgrading. Whilst two-way trade is insignificant, higher degrees of GVC integration are associated with higher skill-upgrading. More precisely, two-way trade integration and international certification, as well as two-way trade and foreign ownership, are associated with a 1.39% and 0.65% increase in the share of skilled-workers, respectively. The highest degree of integration involving the four elements is associated with a 1.79% increase in skill-upgrading. In other words, not only is GVC participation associated with a higher share of skilled-workers, but also higher degrees of integration are positively correlated with larger values of skill-upgrading. In fact, participation in GVCs and the resultant skill-upgrading are explained through four main channels. First, participation in GVCs enables firms to access a broader variety and, potentially, more efficient goods and services used as intermediate inputs, improving the total factor of productivity. Second, technological advancements embedded in imported inputs increase the demand for skilled workers as a result of skill-complementarity (Acemoglu, 2003). Third, GVC participation increases the demand for better management, in order to increase firm efficiency, which raises the demand for skilled workers (Feenstra and Hanson, 1996). Fourth, GVC participation allows firms to expand their markets and use more efficient inputs, increasinge their profits. Thus, firms are more able to employ skilled workers.

Taking into account service restrictions, columns 3, 5, 7 and 9 show that GVC integration is associated with higher skill-upgrading compared to domestic firms. Also, service restrictions are still associated with a skill-downgrading effect. Moreover, the correlation between GVCs and skill-upgrading is greater when service restrictions are included, especially for two-way trade and foreign ownership and for the highest degree of GVC integration. Thus, skill-upgrading associated with GVC participation is more pronounced when service trade is liberalised. Two arguments serve to explain this result. First, whilst GVC participation allows skill-upgrading to take place via technical transfer, service restrictions make firms less able to take advantage of technical advancements embedded in foreign-service inputs, which partially attenuates the skill-upgrading resulting from GVCs. More precisely, service trade liberalisation enables firms to benefit from the transfer of technological advancements made possible by GVC participation. Second, as mentioned earlier, integration in GVCs results in larger profits, greater demand for better management and the use of more technologically-advanced equipment. The resulting skill-complementarities enable the process of skill-upgrading to take place. These channels are more effective when service trade is liberalised. In fact, to increase the quality of management, or to adapt to advanced equipment and production techniques, more efficient service inputs are required. Accordingly, service liberalisation improves skill-upgrading resulting from GVC participation. To sum up, by accessing foreign-service inputs, the benefits of GVC participation, in terms of skill-upgrading, are more pronounced.

As per our controls, in line with the theoretical predictions, medium and large firms tend to have a lower share of skilled workers. Assuming that skilled workers are the main input for innovative activities, medium and large firms have more bureaucratic inertia and less flexible structures compared to small firms, which reduce their ability to implement changes and hinder the process of innovation, consistent with the findings of Chandy and Tellis (2000), Dean et al. (1998) and Nord and Tucker (1987). Hence, medium and large firms become less attractive for skilled workers compared to small firms. Furthermore, the age of the firm is positively correlated with the share of skilled workers. As predicted by Damanpour (2010) and Heyman (2007), older firms are more capital-intensive than newly established firms and capital-skill complementarities require a larger share of skilled workers.

To examine the heterogeneous effect of service restrictions and GVC participation on skill-upgrading between high-skilled firms and low-skilled firms, the sample is divided into two sub-samples, based on the median share of skilled workers[3]. Firms are considered high-skilled if their share of skilled workers is equal or greater than the median[4] share of skilled workers. Results are reported in Table 3. As mentioned earlier, higher service restrictions are associated with skill-downgrading for all firms, but are more pronounced for low-skilled firms. Service liberalisation allows firms to have access to a broader variety of service inputs resulting in productivity gains (Ethier, 1982). Accordingly, as high-skilled firms are already relatively more efficient and more productive than low-skilled firms, service liberalisation is associated with higher skill gains for low-skilled firms than for high-skilled firms.

Furthermore, integration in GVCs, as measured by two-way trade, foreign ownership and international certification, is associated with a greater share of skilled workers for high-skilled firms than low-skilled firms. More precisely, the highest degree of integration is associated with a 1.29% increase in the share of skilled-workers in high-skilled firms. whilst it is associated a with 0.47% gain amongst low-skilled firms. According to the Melitz model (2003), heterogeneous firms are sorted into three main categories: the most productive firms use skill-intensive technologies in production and exports, the middle group uses low-skilled intensive technologies and exports and the least productive firms only serve the domestic market, using low-skilled intensive technology. Since domestic firms are excluded from the four definitions of GVCs, we will assume that low-skilled firms that are part of a GVC correspond to the middle category in the Melitz model and high-skilled firms correspond to the upper category in the Melitz model. This model predicts that upper and middle firms will switch to skilled technologies once they export (Abousahdy and Zaki, 2020). Those predictions are consistent with our results, suggesting that high-skilled firms and low-skilled firms switch to skilled technologies once they are part of GVCs. In other words, the integration of high-skilled and low-skilled firms in GVCs is associated with positive skill-upgrading. However, the demand for high-skilled

[3]The median share of skilled-workers is 21.4%. High-skilled firms are those who have a share of skilled workers equal to 21.4% or higher. Low-skilled firms are those who have a share of skilled workers lower than 21.4%.

[4] We opt for the median since it is more robust than the mean

workers will increase by a lower amount in low-skilled firms, compared to high-skilled firms. As mentioned earlier, one channel by which GVC participation enables firms to upgrade their skills is technological transfer. On the one hand, the skill-mismatch between the level of skills in low-skilled firms and the level of skills required to adopt new technologies results in lower skill-upgrading in low-skilled firms. On the other hand, assuming that low-skilled firms are less productive and less efficient than high-skilled firms, the former are less able to adopt these new technologies. As low-skilled firms do not have the financial capabilities or the skill requirement to cope with technological transfer, the demand for skilled-workers increases by a lower amount, compared to high-skilled firms. In fact, high-skilled firms already have the skill-requirements and the financial capabilities that enable them to adopt newly-advanced technologies. Therefore, the highest degree of GVC participation is associated with a larger increase in the share of skilled-workers for high-skilled firms than for low-skilled firms.

In summary, our baseline results suggest that GVC participation is associated with skill-upgrading, which is more pronounced when service trade is liberalised. Moreover, this finding is more evident for high-skilled firms than low skilled-firms. In addition, the higher the degree of integration in GVCs the greater the associated skill-upgrading. To test the robustness of our findings, several robustness checks are conducted.

Table 2: Empirical results-Whole sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Ln(skill)	Ln(skill)	Ln(skill)	Ln(skill)	Ln(skill)	Ln(skill)	Ln(skill)	Ln(skill)	Ln(skill)
Medium	-0.00777***	-0.00917***	-0.00811***	-0.0104***	-0.00893***	-0.00951***	-0.00817***	-0.00972***	-0.00822***
	(0.00164)	(0.00155)	(0.00165)	(0.00155)	(0.00165)	(0.00154)	(0.00164)	(0.00154)	(0.00164)
Large	-0.0277***	-0.0295***	-0.0279***	-0.0341***	-0.0313***	-0.0310***	-0.0291***	-0.0318***	-0.0293***
	(0.00272)	(0.00239)	(0.00264)	(0.00251)	(0.00280)	(0.00249)	(0.00278)	(0.00249)	(0.00278)
Ln(age)	0.0104***	0.0105***	0.0106***	0.00997***	0.0101***	0.0101***	0.0104***	0.0100***	0.0102***
	(0.00148)	(0.00130)	(0.00147)	(0.00131)	(0.00149)	(0.00130)	(0.00147)	(0.00130)	(0.00147)
Ln(STRI)	**-0.0175***		**-0.0170***		**-0.0173***		**-0.0179***		**-0.0175***
	(0.00621)		**(0.00624)**		**(0.00616)**		**(0.00618)**		**(0.00616)**
Two-way		**-0.00255**	**0.000266**						
		(0.00181)	**(0.00197)**						
GVC cert.				**0.0139***	**0.0127***				
				(0.00202)	**(0.00227)**				
GVC for.						**0.00650**	**0.0133***		
						(0.00306)	**(0.00332)**		
GVC all								**0.0178***	**0.0198***
								(0.00345)	**(0.00391)**
Constant	0.151***	0.131***	0.150***	0.140***	0.215	0.218	0.161***	0.234***	0.0548
	(0.0489)	(0.0248)	(0.0494)	(0.0245)		(79.35)	(0.0485)	(0.0219)	(178.4)
Observations	56,726	70,703	55,517	70,704	55,593	71,613	56,348	71,684	56,428
R-squared	0.157	0.147	0.157	0.148	0.158	0.147	0.157	0.147	0.158

(i) Robust standard errors in parentheses. (ii) *** p<0.01, ** p<0.05, * p<0.1. (iii) All regressions include country, year and region dummies.   (iv) Standard errors are clustered by country, year, sector and region.

Table 3: Empirical results by skill-level of firms

	High-skilled firms				Low-skilled firms			
	Ln(skill)	Ln(skill)	Ln(skill)	Ln(skill)	Ln(skill)	Ln(skill)	Ln(skill)	Ln(skill)
Medium	-0.00809***	-0.00901***	-0.00901***	-0.00889***	0.00653***	0.00644***	0.00678***	0.00676***
	(0.00165)	(0.00164)	(0.00162)	(0.00162)	(0.00119)	(0.00120)	(0.00119)	(0.00119)
Large	-0.00146	-0.00303	-0.00461**	-0.00388*	-0.00458***	-0.00548***	-0.00396**	-0.00441**
	(0.00242)	(0.00244)	(0.00234)	(0.00233)	(0.00174)	(0.00184)	(0.00187)	(0.00185)
Ln(age)	0.00237	0.00208	0.00205	0.00179	0.00300***	0.00277***	0.00291***	0.00289***
	(0.00147)	(0.00147)	(0.00146)	(0.00145)	(0.000853)	(0.000848)	(0.000839)	(0.000835)
Ln(STRI)	**-0.00469**	**-0.00481**	**-0.00528**	**-0.00527**	**-0.00791*****	**-0.00796*****	**-0.00782*****	**-0.00768*****
	(0.00556)	**(0.00548)**	**(0.00548)**	**(0.00546)**	**(0.00198)**	**(0.00198)**	**(0.00197)**	**(0.00197)**
Two-way	**-0.00360***				**0.00187**			
	(0.00195)				**(0.00115)**			
GVC cert.		**0.000645**				**0.00578*****		
		(0.00236)				**(0.00123)**		
GVC for.			**0.0135*****				**0.000655**	
			(0.00358)				**(0.00176)**	
GVC all				**0.0129*****				**0.00469****
				(0.00434)				**(0.00210)**
Constant	0.273***	0.285***	0.240***	0.347	0.139***	0.123***	0.139***	0.0949***
	(0.0381)	(0.0376)	(0.0259)	(197.8)	(0.00584)	(0.0342)	(0.00581)	(0.0154)
Observations	27,411	27,386	27,752	27,775	28,106	28,207	28,596	28,653
R-squared	0.115	0.115	0.116	0.116	0.167	0.169	0.167	0.169

(i) Robust standard errors in parentheses. (ii) *** p<0.01, ** p<0.05, * p<0.1. (iii) All regressions include country, year and region dummies. (iv) Standard errors are clustered by country, year, sector and region.

Robustness Checks

1. Alternative Measures of Service Restrictiveness

As mentioned earlier, another measure of service protection is used to construct the service restrictiveness variable, namely the ad-valorem tariff equivalent (AVE) of services (AVE). Moreover, two different versions of this variable are used; the first is estimated by Jafari and Tarr (2014) and the second is estimated by Fontagne, Mitaritonna and Singoret (2016).

Similar to the STRI, the AVE estimated by Jafari and Tarr (2014) is grouped into the same 5 service sectors as follows: transport (air, rail, road and maritime transport), financial services (banking and insurance), telecommunications (fixed line and mobile line), retail and other services (accounting and legal services). Yet, service sectors in the database by Fontagne, Mitaritonna and Singoret (2016) are grouped into 6 service sectors: transport (water transport and transport), financial services (insurance and other financial intermediation services), telecommunication, retail, construction and other services (other business services and other government services). The measure of service restrictiveness is calculated by multiplying the AVE of each service by its corresponding weight in the manufacturing sector from the Input-Output tables.

Table 4 provides similar results to the ones reported earlier, suggesting that the baseline results are robust. Although the AVE estimated by Jafari and Tarr (2014) is insignificant, higher values of the AVE estimated by Fontagne, Mitaritonna and Singoret (2016) are associated with a lower share of skilled workers. Also, GVC integration is associated with higher skill-upgrading, except for firms integrated in two-way trade only. On average, whilst service restrictions are associated with a 0.03% decrease in the share of skilled-workers, GVC participation is associated with a 9.52% increase in the share of skilled-workers using the two versions of AVE. Alternatively, the skill-upgrading associated with GVC integration is more pronounced when the latter is accompanied by service trade liberalisation. The main conclusion ensures that, in the presence of service liberalisation, firms have access to potentially more efficient service inputs which strengthen channels by which GVC participation induces skill-upgrading.

Table 4: Robustness checks-Other measure of service protection

	AVE by Fontagne, Mitaritonna and Singoret (2016)				AVE by Jafari and Tarr (2014)			
	Ln(skill)	Ln(skill)	Ln(skill)	Ln(skill)	Ln(skill)	Ln(skill)	Ln(skill)	Ln(skill)
Medium	-0.0105***	-0.0121***	-0.0114***	-0.0112***	-0.00806***	-0.00892***	-0.00815***	-0.00821***
	(0.00322)	(0.00323)	(0.00321)	(0.00320)	(0.00166)	(0.00165)	(0.00165)	(0.00164)
Large	-0.0314***	-0.0370***	-0.0361***	-0.0361***	-0.0280***	-0.0315***	-0.0293***	-0.0295***
	(0.00641)	(0.00683)	(0.00693)	(0.00687)	(0.00264)	(0.00280)	(0.00278)	(0.00278)
Ln(age)	0.0163***	0.0164***	0.0166***	0.0165***	0.0108***	0.0103***	0.0106***	0.0104***
	(0.00328)	(0.00333)	(0.00335)	(0.00333)	(0.00147)	(0.00149)	(0.00147)	(0.00148)
Ln(AVE)	**-0.0385*****	**-0.0388*****	**-0.0411*****	**-0.0393*****	**-0.000268**	**-0.000256**	**-0.000279**	**-0.000278**
	(0.0136)	**(0.0137)**	**(0.0136)**	**(0.0136)**	**(0.000251)**	**(0.000249)**	**(0.000245)**	**(0.000245)**
Two-way	**-0.00650***				**-0.000107**			
	(0.00349)				**(0.00199)**			
GVC cert.		**0.00861****				**0.0126*****		
		(0.00370)				**(0.00228)**		
GVC for.			**0.0175*****				**0.0129*****	
			(0.00565)				**(0.00335)**	
GVC all				**0.0199*****				**0.0195*****
				(0.00644)				**(0.00393)**
Constant	0.370***	0.380***	0.384***	0.381***	0.113**	0.214	0.122***	0.0280
	(0.0599)	(0.0479)	(0.0477)	(0.0478)	(0.0476)	(360.4)	(0.0468)	
Observations	14,716	14,665	14,743	14,779	55,517	55,593	56,348	56,428
R-squared	0.159	0.157	0.159	0.158	0.156	0.157	0.156	0.157

(i) Robust standard errors in parentheses. (ii) *** p<0.01, ** p<0.05, * p<0.1. (iii) All regressions include country, year and region dummies. (iv) Standard errors are clustered by country, year, sector and region.

2. Other Measure of Skill-Upgrading

In this robustness test, skill-upgrading is measured as the logarithm of the relative supply of non-production and production workers. The former is used as a proxy for the number of skilled workers, as in the baseline regressions, whilst the latter is used as a proxy for the number of unskilled workers. Results in Table 5 support the baseline findings. More precisely, whilst service restrictions are associated with a lower supply of non-production workers relative to production workers, participation in GVCs is associated with a relative higher supply of non-production workers. In line with the baseline results, skill-upgrading resulting from GVC participation is more pronounced when service trade is liberalised.

Table 5: Robustness checks-Other measure of skill-upgrading

	(1)	(2)	(3)	(4)
	ln(skill)	ln(skill)	ln(skill)	ln(skill)
Medium	-0.00801**	-0.00965***	-0.00860**	-0.00845**
	(0.00361)	(0.00358)	(0.00356)	(0.00356)
Large	-0.0350***	-0.0411***	-0.0397***	-0.0388***
	(0.00561)	(0.00572)	(0.00561)	(0.00558)
ln(age)	0.0224***	0.0212***	0.0220***	0.0212***
	(0.00334)	(0.00334)	(0.00330)	(0.00331)
ln(STRI)	**-0.0330****	**-0.0338****	**-0.0355****	**-0.0346****
	(0.0152)	**(0.0150)**	**(0.0151)**	**(0.0150)**
Two-way	**-0.00209**			
	(0.00481)			
GVC cert.		**0.0220****		
		(0.00581)		
GVC for.			**0.0383****	
			(0.00905)	
GVC all				**0.0470****
				(0.0108)
Constant	0.100	0.373	0.266***	0.214
	(0.110)		(0.0594)	(806.8)
Observations	55,296	55,367	56,122	56,200
R-squared	0.122	0.123	0.123	0.123

(i) Robust standard errors in parentheses. (ii) *** p<0.01, ** p<0.05, * p<0.1. (iii) All regressions include country, year and region dummies. (iv) Standard errors are clustered by country, year, sector and region.

3. Allowance for the Endogeneity of GVCs

Our measures of GVCs might be endogenous and the estimated coefficients could be biased. The main reason for endogeneity is the reverse causality, as GVC participation could be the result of skill-upgrading. In other words, firms with a higher share of skilled-workers are more efficient which, in turn, influences their integration in GVCs. Therefore, a direct way of solving the problem of endogeneity is to select an appropriate instrumental variable. An instrumental variable requires itself to be highly correlated with the endogenous variable, but also to be uncorrelated, or at least not directly correlated, with the error term. We used two instrumental variables to allow for endogeneity: first, obstacles to accessing finance and second, the speed of internet connection in a firm's premises. On one side, El-Said et al. (2015) and Dovis and Zaki (2020) suggest that limited access to finance restricts the capacity of firms to innovate and is negatively associated with their trade performance, which prevents them from

becoming more efficient and reduces their likelihood of integrating into a GVC. On the other side, e-commerce facilitates firm integration into GVCs because it enables producers to access more diversified commercial activities, since economic development is becoming knowledge-driven (Panagariya, 2000). In addition, virtual integration through internet-oriented value chains enables the cost-free exchange of information (Gereffi, 2001).

First, from the World Bank Enterprise Survey, "obstacles to accessing finance" there is a categorical variable suggesting that obstacles are absent, minor, moderate, major or very severe. Thus, we created a dummy variable that equals one, if obstacles to accessing finance are "major" or "very severe" and zero otherwise. Second, high-speed internet connectivity is a dummy variable that equals one, if the firm has high speed internet connection and zero otherwise.

We argue that "obstacles to accessing finance" and "speed of internet connection in a firm's premises" are appropriate instruments for measures of GVCs, for two reasons. First, each instrument is strong, as it is highly correlated with the endogenous variable, as shown in the first stage regression and summary statistics. In fact, obstacles to accessing finance have a negative and significant effect on GVC participation, which is consistent with the literature and the first stage is significant at 1% (Tables A4 and A5 in Appendix4). In addition, using high speed internet connectivity, the first stage is significant at 1% and the high speed of internet significantly increases the likelihood of firms participating in GVCs, which is in line with the literature (Tables A6-A9 in Appendix 4). Second, in the second stage regression, both instruments are considered valid, as they seem to be uncorrelated with the error term. In fact, obstacles to accessing finance are determined in the business environment exogeneously and are not affected by the share of skilled workers in the firm. Moreover, the speed of internet connectivity is an exogenous infrastructural variable that is unlikely to be affected by a firm's share of skilled workers.

Results of the second stage regression using obstacles to accessing finance and the speed of internet connection as instruments for a GVC are reported in Table 6. Coefficients of GVCs are larger than in the baseline results and they remain positive and significant, suggesting that our results are robust. Whilst older firms have a higher share of skilled-workers, medium and large firms have a lower share of skilled workers than small firms, which is consistent with the baseline results. Furthermore, a 1% increase in service trade restrictions reduces the share of skilled-workers by 0.034%, whilst GVC participation increases the share of skilled-workers by 88.8% when using access to finance as an instrument. More efficient service inputs are required in order to increase the quality of management, to adopt advanced technologies and to cope with new production techniques. Therefore, service trade restrictions hinder the process of skill-upgrading resulting from participation in GVCs. From another perspective, the skill-upgrading effect is greater for firms integrated in GVCs, especially when service trade is liberalised.

In summary, the robustness checks conducted suggest that our baseline findings are robust. More precisely, our results are robust after changing the measure

of service restrictions, the measure of skill-upgrading and after using the instrumental variable approach. It is reassuring that GVC participation enables the process of skill-upgrading to take place and this effect is more pronounced when trade in services is liberalised.

Table 6: Robustness checks-Instrumental variable approach

	Obstacles to accessing finance					High speed internet connection			
	ln(skill)	ln(skill)	ln(skill)	ln(skill)		ln(skill)	ln(skill)	ln(skill)	ln(skill)
Medium	-0.0853**	-0.0415***	-0.0249***	-0.0231***		-0.0484***	-0.0499***	-0.0477***	-0.0506***
	(0.0356)	(0.0113)	(0.00499)	(0.00515)		(0.00864)	(0.0105)	(0.0106)	(0.0137)
Large	-0.255**	-0.167***	-0.0975***	-0.114***		-0.125***	-0.165***	-0.185***	-0.240***
	(0.104)	(0.0479)	(0.0204)	(0.0288)		(0.0225)	(0.0380)	(0.0455)	(0.0710)
ln(age)	0.000441	-0.00852	0.0143***	0.00618**		0.00837**	-0.00383	0.0261***	0.00970
	(0.00577)	(0.00705)	(0.00225)	(0.00269)		(0.00384)	(0.00752)	(0.00702)	(0.00983)
ln(STRI)	-0.0555***	-0.0244***	-0.0313***	-0.0286***		0.0153	0.0137	0.0143	-0.00168
	(0.0209)	(0.00728)	(0.00784)	(0.00772)		(0.0102)	(0.0101)	(0.00944)	(0.0140)
Two-way	0.613**					0.218***			
	(0.285)					(0.0585)			
GVC cert.		0.526***					0.387***		
		(0.183)					(0.119)		
GVC for.			0.505***					0.853***	
			(0.147)					(0.265)	
GVC all				0.900***					1.584***
				(0.304)					(0.559)
Constant	0.454***	0.387***	0.325***	0.335***		0.204***	0.261***	0.145***	0.301***
	(0.111)	(0.0612)	(0.0459)	(0.0489)		(0.0349)	(0.0473)	(0.0338)	(0.0782)
Observations	53,737	53,811	54,553	54,631		11,043	10,953	11,067	11,060

(i) Robust standard errors in parentheses. (ii) *** p<0.01, ** p<0.05, * p<0.1. (iii) All regressions include country, year and region dummies. (iv) Standard errors are clustered by country, year, sector and region.

Conclusion:

With the ongoing debate on GVCs and the increased importance of service inputs, recent studies have emerged highlighting the effect of GVCs and service liberalisation on employment and productivity. As shown in the empirical literature, GVC participation plays a role in affecting the skill composition and enhancing labour productivity. Furthermore, the literature highlights the positive effect of service liberalisation on productivity and the ability of firms to participate in GVCs. However, the effect of GVC and service liberalisation on skill-upgrading is neglected, although the share of skilled labour across all regions did not exceed 30%. At the same time, there is an apparent heterogeneity across regions in terms of service restrictions, whilst the share of domestic firms exceeds 30% in all regions. Accordingly, the relationship between GVCs and service liberalisation on one side and skill-upgrading on the other seems to have important implications.

This study focusses on examining the effect of GVC and service liberalisation on skill-upgrading. Hence, it provides a bridge between two active literatures on GVC and service liberalisation. Using a comprehensive firm-level data from the World Bank Enterprise Survey, this study contributes to the literature by taking into account service restrictiveness indices and measures of GVCs simultaneously. Our main findings suggest that the effect of GVC participation on skill-upgrading is more pronounced when service trade is liberalised. Indeed, GVCs enable the transfer of technical innovations embedded in foreign goods and services. However, this channel is weakened if service liberalisation is not achieved, because the latter hinders the transfer of technical advancements embedded in foreign-service inputs. In addition, GVC integration results in higher profits, increases the demand for better management, makes more efficient equipment accessible and induces technological transfer from abroad, which increases a firm's share of skilled-workers. These channels are strengthened if service liberalisation is achieved, since access to more efficient service inputs make it more feasible for firms to increase the quality of management and adapt to new production techniques. Therefore, the skill-upgrading effect of GVC participation is more pronounced when trade in services is liberalised.

The findings have important policy implications. Governments should promote the extensive and intensive margins of GVC participation. More precisely, it should encourage domestic firms to participate in GVCs, but also incentivise firms that are already part of a GVC to be more and more integrated. In fact, increasing the GVC participation of firms can be an effective policy if adopted for the purpose of boosting a country's level of skills and the employment structure, as a result. Furthermore, it is particularly important to remove barriers to the participation of firms in GVCs by improving the business environment and the infrastructure. Policies that stimulate the intensive and extensive margins of GVC integration should be accompanied by other measures of service trade liberalisation, in order to deepen the skill-upgrading effect of GVCs.

The analysis in this paper can be extended in a number of different directions. In what follows, we suggest three possible extensions. First, it would be instructive to differentiate between firms integrated in low-end and high-end GVCs, in order to

analyse the effect of a firm's position in a GVC based on the level of skills in the presence of service protection. Second, it would be interesting to explore the effects of change in unskilled workers in low-skilled firms on the skill-upgrading of high-skilled firms, by incorporating production offshoring and service liberalisation. Studies that analyse these aspects of the underlying problem will provide additional insights into the nexus between GVCs, service liberalisation and skill-upgrading. Third, examining the role of service trade liberalisation on GVCs in times of crisis, especially epidemic outbreaks, is a promising future avenue of research. In fact, Ivanov (2020) highlights that the Coronavirus crisis is a unique type of GVC disruption and Ismaeel and Alzubi (2020) point out the role of information technology in enhancing a firm's effectiveness, in light of the coronavirus crisis.

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Appendix 1: List of Countries, Years and Number of Firms

Table A1: Countries, years and the corresponding number of firms in the sample

Country	Survey years	Number of firms	Percent of firms
Afghanistan	2008, 2014	263	0.32
Albania	2007, 2013 and 2019	368	0.45
Angola	2006 and 2010	351	0.43
Antigua and Barbuda	2010	34	0.04
Argentina	2006, 2010 and 2017	2,192	2.7
Armenia	2009 and 2013	224	0.28
Azerbaijan	2009 and 2013	241	0.3
Bahamas	2010	42	0.05
Bangladesh	2007 and 2013	2,480	3.05
Barbados	2010	71	0.09
Belarus	2008, 2013 and 2018	551	0.68
Belize	2010	72	0.09
Benin	2009 and 2016	142	0.17
Bhutan	2009 and 2015	178	0.22
Bolivia	2006, 2010 and 2017	683	0.84
Bosnia and Herzegovina	2009, 2013 and 2019	377	0.46
Botswana	2006 and 2010	199	0.24
Brazil	2009	1,483	1.83
Bulgaria	2007, 2009 and 2013	846	1.04
Burkina Faso	2009	95	0.12
Burundi	2006 and 2014	162	0.2
Cambodia	2013 and 2016	320	0.39
Cameroon	2009 and 2016	209	0.26
Cape Verde	2009	68	0.08
Central African Republic	2011	37	0.05
Chad	2009 and 2018	134	0.16
Chile	2006 and 2010	1,476	1.82
China	2012	1,691	2.08
Colombia	2006, 2010 and 2017	1,926	2.37
Congo	2009	38	0.05
Costa Rica	2010	322	0.4
Croatia	2007, 2013 and 2019	681	0.84
Cyprus	2019	80	0.1
Czech Republic	2009 and 2013	224	0.28
Côte d'Ivoire	2009 and 2016	315	0.39
DRC	2006, 2010 and 2013	520	0.64
Djibouti	2013	62	0.08

Dominica	10	28	0.03
Dominican Republic	2010 and 2016	233	0.29
Ecuador	2006, 2010 and 2017	623	0.77
Egypt	2013 and 2016	3,195	3.93
El Salvador	2006, 2010 and 2016	1,020	1.26
Eritrea	2009	102	0.13
Estonia	2009 and 2013	175	0.22
Eswatini	2006 and 2016	145	0.18
Ethiopia	2011 and 2015	704	0.87
Fiji	2009	49	0.06
Gabon	2009	37	0.05
Gambia	2006 and 2018	109	0.13
Georgia	2008 and 2013	233	0.29
Ghana	2007 and 2013	669	0.82
Greece	2018	315	0.39
Grenada	2010	25	0.03
Guatemala	2006, 2010 and 2017	827	1.02
Guinea	2006 and 2016	162	0.2
Guinea Bissau	2006	50	0.06
Guyana	2010	72	0.09
Honduras	2006, 2010 and 2016	545	0.67
Hungary	2009 and 2013	214	0.26
India	2014	7,163	8.82
Indonesia	2009 and 2015	2,256	2.78
Iraq	2011	475	0.58
Israel	2013	201	0.25
Italy	2019	461	0.57
Jamaica	2010	121	0.15
Jordan	2013	335	0.41
Kazakhstan	2009 and 2013	386	0.48
Kenya	2007, 2013 and 2018	1,265	1.56
Kosovo	2009 and 2013	176	0.22
Kyrgyz Republic	2009, 2013 and 2019	345	0.42
Latvia	2009 and 2013	210	0.26
Lebanon	2013	239	0.29
Lesotho	2009 and 2016	139	0.17
Liberia	2009 and 2017	148	0.18
Lithuania	2009 and 2013	208	0.26
Madagascar	2009 and 2013	469	0.58
Malawi	2009 and 2014	271	0.33
Malaysia	2015	585	0.72
Mali	2007, 2010 and 2016	562	0.69

Malta	2019	83	0.1
Mauritania	2006 and 2014	132	0.16
Mauritius	2009	223	0.27
Mexico	2006 and 2010	2,336	2.87
Micronesia	2009	9	0.01
Moldova	2009, 2013 and 2019	356	0.44
Mongolia	2009, 2013 and 2019	369	0.45
Montenegro	2009, 2013 and 2019	153	0.19
Morocco	2013	187	0.23
Mozambique	2007 and 2018	628	0.77
Myanmar	2014 and 2016	720	0.89
Namibia	2006 and 2014	287	0.35
Nepal	2009 and 2013	380	0.47
Nicaragua	2006, 2010 and 2016	620	0.76
Niger	2009 and 2017	103	0.13
Nigeria	2007 and 2014	2,375	2.92
North Macedonia	2009 and 2013	254	0.31
Pakistan	2007 and 2013	1,870	2.3
Panama	2006 and 2010	433	0.53
Paraguay	2006, 2010 and 2017	726	0.89
Peru	2006, 2010 and 2017	1,672	2.06
Philippines	2009 and 2015	2,023	2.49
Poland	2009 and 2013	343	0.42
Romania	2009 and 2013	367	0.45
Russia	2009, 2012 and 2019	2,982	3.67
Rwanda	2006 and 2011	140	0.17
Samoa	2009	28	0.03
Senegal	2007 and 2014	508	0.63
Serbia	2009, 2013 and 2019	380	0.47
Sierra Leone	2009 and 2017	145	0.18
Slovak Republic	2009 and 2013	194	0.24
Slovenia	2009 and 2013	191	0.24
Solomon Islands	2015	42	0.05
South Africa	2007	680	0.84
South Sudan	2014	89	0.11
Sri Lanka	2011	362	0.45
St. Kitts and Nevis	2010	29	0.04
St. Lucia	2010	63	0.08
St. Vincent and Grenadines	2010	49	0.06
Sudan	2014	85	0.1
Surinam	2010 and 2018	156	0.19
Sweden	2014	337	0.41

Tajikistan	2008, 2013 and 2019	399	0.49
Tanzania	2006 and 2013	713	0.88
Thailand	2016	726	0.89
Timor-Leste	2009 and 2015	123	0.15
Togo	2009 and 2016	81	0.1
Tonga	2009	54	0.07
Trinidad and Tobago	2010	123	0.15
Tunisia	2013	330	0.41
Turkey	2008, 2013 and 2019	3,069	3.78
Uganda	2013	685	0.84
Ukraine	2008 and 2013	1,317	1.62
Uruguay	2006, 2010 and 2017	890	1.1
Uzbekistan	2008, 2013 and 2019	1,097	1.35
Vanuatu	2009	15	0.02
Venezuela	2006 and 2010	351	0.43
Vietnam	2009 and 2015	1,483	1.83
West Bank And Gaza	2013 and 2019	287	0.35
Yemen	2010 and 2013	368	0.45
Zambia	2007 and 2013	668	0.82
Zimbabwe	2011 and 2016	665	0.82
Total		81,257	100

Source: Constructed by the author using the World Bank Enterprise Survey.

Appendix 2: Obstacles Characterising the Business Environment

Figure A1: Biggest obstacle in the Business environment, by region (% of firms)
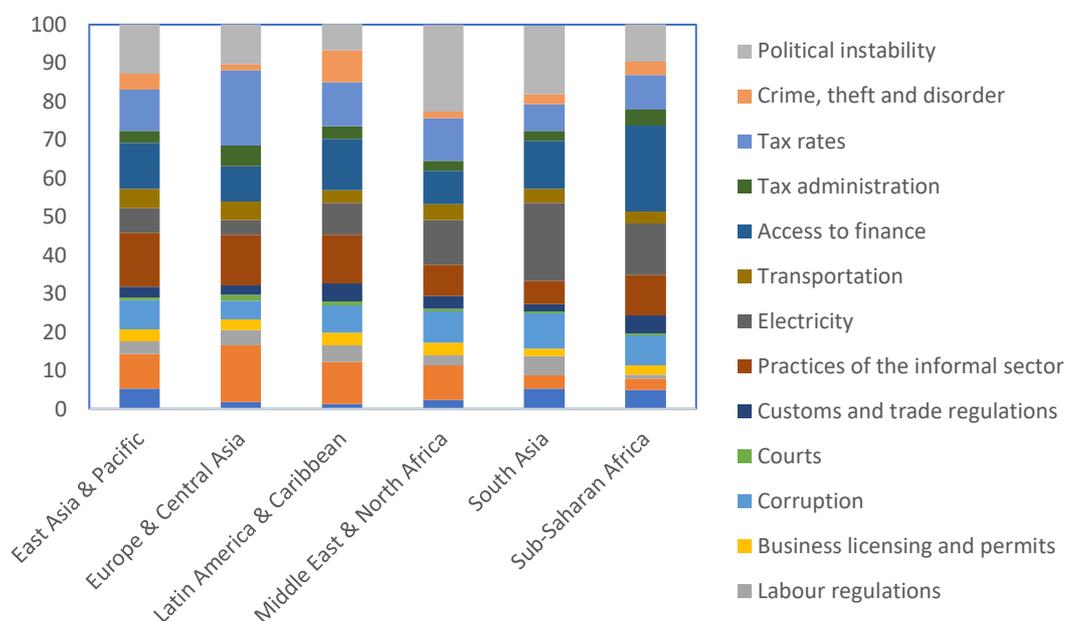
Source: Constructed by the author using firm-level data from the World Bank Enterprise Survey.

Appendix 3: Sample Summary Statistics

Table A2: Sample summary statistics.

Variable	Observations	Mean	Std. Dev.	Min	Max
Ln(Share of skilled workers)	74,545	0.256	0.18	0.000	1.000
Ln(Age)	80,735	3.202	0.542	0.693	5.858
Ln(STRI)	62,985	2.464	0.545	0.136	4.274

Source: Constructed by the authors.

Table A3: Firm size characteristics.

Firm size	Frequency	Percent
Small (<20)	32,249	39.43
Medium (20-99)	29,605	36.2
Large (100 And Over)	19,925	24.36
Total	81,779	100

Source: Constructed by the author.

Appendix 4: First Stage Regressions and Summary Statistics

Table A4: First stage regression-Obstacles to accessing finance

	Two-way	GVC cert.	GVC for.	GVC all
Medium	0.123831***	0.061071***	0.031455***	0.015474***
	(0.004735)	(0.00294)	(0.001986)	(0.001324)
Large	0.368727	0.26237***	0.13674***	0.094459***
	(0.009515)	(0.006544)	(0.005529)	(0.004258)
ln(age)	0.016638***	0.036284***	-0.00793***	0.00459***
	(0.004269)	(0.003356)	(0.002777)	(0.002115)
ln(STRI)	0.064398***	0.01559**	0.028935***	0.01355***
	(0.012945)	(0.008141)	(0.006386)	(0.005008)
Obstacles to finance	**-0.01081***	**-0.0122***	**-0.01279***	**-0.00714***
	(0.00419)	**(0.003069)**	**(0.002376)**	**(0.001821)**
Constant	-0.32642***	-0.25244***	-0.13211***	-0.08708***
	(0.074314)	(0.039266)	(0.050232)	(0.024336)

(i)Robust standard errors in parentheses. (ii)*** $p<0.01$, ** $p<0.05$, * $p<0.1$. (iii)All regressions include country, year and region dummies. (iv)Standard errors are clustered by country, year, sector and region.

Table A5: First stage summary statistics-Obstacles to accessing finance

Adjusted variable	Partial R-sq.	Robust R-sq	R-sq	F(1,2554)	P-value
Two-way	0.2589	0.2513	0.0001	6.70313	0.0097
GVC cert.	0.215	0.2069	0.0003	15.9272	0.0001
GVC for.	0.1275	0.1187	0.0006	29.1702	0.0000
GVC all	0.103	0.094	0.0003	15.4684	0.0001

(F statistic adjusted for 2555 clusters)

Table A6: Endogeneity test-Obstacles to accessing finance

Ho: variables are exogeneous		
	F(1,2554)	P-value
Two-way	16.5668	0.0000
GVC cert.	14.721	0.0001
GVC for.	14.7779	0.0001
GVC all	14.9188	0.0001

Table A7: First stage regression-Internet speed

	Two-way	GVC cert.	GVC for.	GVC all
Medium	0.134221***	0.0813***	0.034356*	0.02033
	(0.010325)	(0.008022)	(0.004693)	(0.003747)
Large	0.36187***	0.309625***	0.163388***	0.123026***
	(0.017056)	(0.01647)	(0.011312)	(0.008965)
ln(age)	0.033782***	0.051259***	-0.01231***	0.003776***
	(0.01013)	(0.009947)	(0.007172)	(0.006043)
ln(STRI)	0.037038***	0.023148	0.010594	0.015652**
	(0.018904)	(0.014513)	(0.009744)	(0.007918)
High speed internet	**0.095611*****	**0.053795*****	**0.024125*****	**0.013156*****
	(0.012138)	**(0.009476)**	**(0.005247)**	**(0.0039)**
Constant	-0.33549***	-0.33472***	-0.01534	-0.10709***
	(0.076851)	(0.054837)	(0.048253)	(0.034328)

(i)Robust standard errors in parentheses. (ii)*** p<0.01, ** p<0.05, * p<0.1. (iii)All regressions include country, year and region dummies. (iv)Standard errors are clustered by country, year, sector and region.

Table A8: First stage summary statistics-Internet speed

Adjusted variable	Partial R-sq.	Robust R-sq	R-sq	F(1,2554)	P-value
Two-way	0.2454	0.2329	0.006	66.7291	0.0000
GVC cert.	0.2166	0.2035	0.0028	34.6818	0.0000
GVC for.	0.114	0.0993	0.001	22.7348	0.0000
GVC all	0.098	0.0831	0.0004	12.2356	0.0005

(F statistic adjusted for 611 clusters)

Table A9: Endogeneity test-Internet speed

H0: variables are exogeneous		
	F(1,610)	P-value
Two-way	18.8834	0.0000
GVC cert.	17.6973	0.0000
GVC for.	18.3811	0.0000
GVC all	19.2701	0.0000

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The Euro-Mediterranean Network for Economic Studies (EMNES) is a network of research institutions and think tanks working on socio-economics policy in the Euro-Mediterranean. EMNES is coordinated by the Euro-Mediterranean Economists Association (EMEA).

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- Digital economy;
- Healthcare policy;
- Human capital development, education, innovation, skill mismatch and migration;
- Labor markets, employment and employability;
- Finance, financial inclusion and the real economy;
- Sustainable development;
- Regional integration;
- Euro-Mediterranean economic partnership;
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