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Determinants of Participation in Manufacturing GVCs in Africa

The Role of Skills, Human Capital Endowment and Migration

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Abstract

This analysis assesses the role of skills, human capital endowment, and migration as determinants of Sub-Saharan Africa's participation in manufacturing global value chains. Due to lack of reliable data on skilled labor, skilled and unskilled labor contents in exports were generated from the Global Trade Analysis Project database. A panel of 23 countries for which data on skills and manufacturing global value chains are available for 19 subsectors was constructed. A fixed-effect gravity model was used to estimate the determinants of backward and forward global value chain participation. The estimates obtained from the sample are compared with global data covering 115 countries for benchmarking purposes. The results indicate that for economies in Sub-Saharan Africa, skilled labor seems to be the strongest determinant of participation in backward and forward global value chains. Similarly, initial human capital endowment has a strong positive impact on global value chain participation at the global level. However, countries with relatively high initial capital endowment benefit more by incorporating foreign value-added products in their manufacturing exports. Finally, countries that receive net inflows of migrants tend to engage better in backward and forward global value chains than those with net outflows of migrants. The findings suggest that policies to improve Sub-Saharan Africa's integration in manufacturing global value chains should target: shifting from unskilled to skilled labor-intensive backward and forward global value chain activities; upgrading the quality of the labor force, since unskilled workers are so far the most available and the most used in manufacturing global value chains; investing in the quality of human capital; and promoting intraregional skills mobility.

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Determinants of Participation in Manufacturing GVCs in Africa: The Role of Skills, Human Capital Endowment and Migration

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Keywords:

Global Value Chains (GVCs); Manufacturing GVCs; Forward GVCs; Backward GVCs; Skilled Labor; Unskilled Labor; Labor Content in Exports (LACEX); Human Capital Endowment; Labor Mobility; Migration; Gravity Model; Fixed effects Estimation; Sub-Saharan Africa

JEL classification: F2, F6, F22, J6, O55

I. Introduction

Global value chains (henceforth GVCs) can broadly be defined as the use of foreign goods and services in the production of exports (Jouanjean, Gourdon, and Korinek, 2017). Industrial production is increasingly fragmented across countries, with various parts of the production chains segmented across different countries. Consequently, GVCs have become an increasingly important feature of the global economy as it involves task-based cross-country trade across different stages of the production chain. In this arrangement, countries have the option to import input/intermediate goods, add value to these imports before selling them in the domestic market or for re-export. With production becoming more clustered in regional and/or global supply chains, GVCs present great opportunities for participating countries. Escaith (2014) explains that GVC participation allows countries to focus on tasks where they have a comparative advantage instead of building a complete product or value chain. Importantly, GVCs also provide new trade opportunities for developing countries to increase their participation in global trade and to diversify their exports from the export of raw materials to value added goods. However, recent data show that only a small number of developing countries are deeply involved in GVCs, especially in manufacturing GVCs. This raises the question: what factors determine countries' participation in GVCs?

So far, little is known about the determinants of countries' participation in GVCs, the effects of such engagements, and their implications for countries' development agendas (OECD, 2015). GVC participation has two components reflecting upstream and downstream linkages in the chain. Countries can participate in GVCs by either incorporating foreign inputs into their exports (backward linkages) or by supplying intermediate inputs to other countries' exports (forward linkages). The factors that determine which segments of the value chain are profitable for a particular country depend on both the characteristics of the production process as well as the relative skills and resource endowments of the country. Multinational enterprises (MNEs) explore and take advantage of differences in countries' comparative advantages and competitiveness to establish integrated networks of intra- and inter-firm production and trade. In pursuit of efficiency, these firms take into consideration several factors in deciding which country to operate in through a GVC production process. These factors include the country's natural resource endowments, comparative advantage, competitiveness, skill gaps, business environment and regulations, cost of doing business, geographic proximity, political and security/terrorist risks, etc.

In Sub-Saharan Africa (SSA), policy makers are increasingly looking towards GVCs for two main reasons. First, GVCs provide SSA countries with a unique opportunity to diversify their economies from the export of raw materials in the bottom of the value chain to high value-added activities. Second, GVCs serve as a potential source of employment creation for the continent's rapidly growing youth population. However, a good understanding of GVC characteristics (Jouanjean, Gourdon, and Korinek, 2017) and the current challenges and opportunities to strengthen domestic value chains (Farole et. al, 2018) are necessary for a country to integrate into a specific segment of a GVC. The objective of this paper is to understand these critical determinants of countries' participation in GVCs with a focus on skills, migration, and human capital endowment. Although a growing number of studies have recently tried to understand the determinants of countries' participation in GVCs, little is known about what drives the low participation rates of SSA countries in manufacturing GVCs. We provide a comparative analysis of the determinants of participation in manufacturing GVCs for Sub-Saharan Africa and the rest of the world. This is done to better understand SSA particularity in terms of GVC integration. Using panel data for 23 SSA countries for which data on skills and manufacturing GVCs are available for 19 subsectors, a fixed-effect gravity model is estimated for both backward and forward GVCs participation and results are compared with global data covering 115 countries. The results suggest that skilled labor is the strongest determinant for both backward and forward GVCs participation for SSA countries. We find human capital endowment to have a strong positive effect on GVC participation at the global level but not for SSA countries. This can be explained by the fact that SSA countries have relatively low initial human capital endowments. Finally, skill mobility, proxied by net inflow of migrants as a share of population, is an important determinant of backward and forward participation in manufacturing GVCs for SSA countries. Consequently, our findings suggest that policies to improve SSA integration in manufacturing GVCs should target: shifting from unskilled to skilled labor-intensive backward and forward GVC activities; upgrading the quality of labor force since unskilled workers are so far the most available and the most used in manufacturing GVCs; investing in the quality of human capital especially for countries that are at the bottom of the HCI ranking; and promoting intra-regional skills mobility or skilled labor migration.

The next section presents a review of literature on the effects of skills, migration, and human capital endowment on countries participation in GVCs. Section III provides a discussion on data and methodology used in this study while section IV provides a descriptive analysis of the data.

Estimation results are presented and discussed in section V while section VI concludes with some policy recommendations.

II. Literature review: Effects of skills, migration and human capital endowment on manufacturing GVC participation

Countries can participate in GVCs in two ways reflecting upstream and downstream linkages in the chain.[1] The first is backward GVC participation which is foreign value-added content on domestic exports. In this case, countries import foreign inputs or intermediates to produce final goods and services for their exports or final consumption. The second channel is forward GVC participation which is domestic value-added goods sent to other countries for further production and export through the value chain. Here, countries participate in GVCs by exporting domestically produced inputs to countries in charge of downstream production stages. This section provides a brief overview of the literature related to determinants of countries' participation in GVCs with an emphasis on the effects of skills, migration, and human capital endowments.

2.1 Effects of skills on GVC participation

An important stream of research in the GVC literature is the breaking down of trade into different production stages or tasks, and how skills affect country participation in different stages of the production process. Several studies such as Costinot et al. (2011) and Blinder and Krueger (2013) find evidence that countries with low-skilled workers to perform "routinisable" tasks are more likely to be integrated into GVCs. Grundke et al. (2017a) explain that the performance and positioning of firms, as well as the specialization and competitiveness of industries, economies and regions in GVCs are shaped by the skill composition of their workforce. Although studies in the trade literature provide significant understandings on how skills (or more broadly human capital[2]) shape comparative advantages in international trade, the literature has relatively been

[1]Timmer et al. (2012), de Backer and Miroudot (2013) and OECD (2013) discussed these two types of GVC participation in detail.

[2] For example, the Heckscher-Ohlin general equilibrium model postulates that countries (or regions) will specialize in and export products that more intensively use their relatively more abundant and cheaper factor(s) of production and import products that intensively use their relatively scarce and expensive factor(s).

silent on how such skills affect country participation in GVCs especially in manufacturing GVCs. The lack of empirical evidence on this area hampers the design of policies which aim at improving country participation in GVCs and 'social upgrading' (Grundke et al., 2017b).

Recently, researchers such as Grundke et al. (2017b) attempted to estimate the effect of skills on country participation in GVCs. However, there is no consensus on the direction of causality. This is because higher skill endowment is expected to contribute to the participation, competitiveness and positioning of countries in the global value chains (Kowalski et al., 2015). At the same time, countries are likely to gain substantial skill-benefits from higher engagement in GVCs (Del Prete et al. 2016). Del Prete et al. (2016) provide suggestive evidence that skill is one of the fundamental determinants of country participation in GVCs for North African countries, using recently released multi-regional Input-Output tables from UNCTAD-Eora. However, they pointed out that the ability to benefit and retain the benefits from GVC participation depends on country specific characteristics such as the level of human capital development.

While existing studies agree on the importance of skills in country GVC participation, they seldomly specify which skills matter for which types of GVC participation. To fill this gap in the literature, Grundke et al. (2017b) investigate the extent to which different skills and their distributions relate to global value chains in order to identify the specific skills that affect participation in GVCs. They find that cognitive skills, ICT skills, management and communication skills, and readiness to learn new skills have significant positive effects on integration into GVCs. However, this relationship is stronger for cognitive skills than for the other skill indicators. Furthermore, Grundke et al. (2017a) explore how the skill composition of a country's workforce (both types of skills and their distribution) shapes specialization in specific industries as well as their competitiveness and integration into GVCs. They find that industry competitiveness and positioning in GVCs depend on bundles of skills at the worker level, rather than on workers endowed with only one type of skills. They also find that workers' observed heterogeneity in skills' mix (i.e. their bundles of skills) and country-wide dispersion of these skills are fundamental determinants of countries' specialization in specific industries and the extent to which these industries integrate into global markets. For example, two countries characterized by similar average levels of "literacy skills" may end up specializing in completely different industries and

position themselves at different stages along GVCs depending on the "skills dispersion" underlying the observed mean levels. These show that skills are key for economies to thrive in GVCs.

2.2 Effects of migration/diaspora in GVC participation

Studies by Saxenian (2006, 2007), Ratha (2010), and Hausmann and Neffke (2018) have demonstrated how migration and skill mobility can through technology diffusion improve the GVC participation of migrants' origin countries. The combination of increasing mobility of skilled workers with increasing fragmentation of production and improved Information and Communication Technologies have enhanced migrants and diaspora's ability to transfer technology know-how and market information to their countries of origin, and help jump-start local entrepreneurship (Saxenian, 2006). Previous studies have shown that migrants and diaspora can help their countries of origin by fostering exchange of knowledge and information, increasing trade partnerships, investing in infrastructure, housing, health care, and education projects (Ratha, 2010). Saxenian (2007) explored the emergence of high-technology clusters in Taiwan, China; China; India; and Israel and found that U.S.-educated migrants and diaspora have played vital roles in these countries by returning home with expertise and contacts that allowed them to start successful global companies. According to her, networks of foreign-born entrepreneurs and engineers transfer technology and institutional know-how from the United States to their countries of origin much faster than most multinational firms. In the case of Silicon Valley, foreign-born engineers and investors helped transfer the Silicon Valley model to Taiwan, China, and Israel. These migrants/diasporas also provided the cultural and linguistic know-how, their technical and operational skills, knowledge of new business models, their networks of contacts, as well as capital needed to operate profitably in their countries of origin. As a result, Israel and Taiwan, China, currently hold the largest venture-capital industries outside North America. In addition, skill mobility and migration can help pioneering firms to recruit their workforce in places where local workers do not have the relevant skills. Setting new activities requires a workforce that has the right skills and know-how. However, many of these skills and know-how are often acquired on-the-job making it very difficult to recruit local workers. One solution is to bring skilled workers from other localities. Hausmann and Neffke (2018) looked at the case of Germany where

pioneering plants were able to assemble their workforce in places where local labor forces offer no experienced workers. They cite examples where regions in Eastern Germany managed to re-industrialize by heavily relying on expertise from Western German migrant workers.

2.3 Role of human capital in GVC participation

Country participation in GVCs depends not only on skills (costs and quality) but also on the overall quality of human capital endowment. According to OECD (2013), higher value-added activities of GVCs are often concentrated in countries with well-developed human capital. These human-capital driven, and knowledge-based activities have become the main drivers of success in GVCs. The value added from GVCs depends on the ability of participating countries to supply sophisticated and hard-to-imitate products and services. In addition, to move from low value-added activities to high value-added activities, more knowledge-based capital is required (OECD, 2013) since advanced capabilities allow for greater upgrading possibilities (Hausmann and Hidalgo, 2011; Tacchella et al. 2012). Multinational firms look for skills that are necessary to innovate and be competitive. These skills are also affected by the changing nature of work due to technology advancement. As a result, multinational firms are increasingly looking towards workers with advanced cognitive skills (i.e. complex problem-solving skills), socio-behavioral skills (i.e. teamwork), adaptability and skill combinations such as reasoning and self-efficacy. However, building these skill sets requires strong human capital foundations. In a world governed by globalization and automation, a higher premium is put on human capabilities that cannot be fully mimicked by technology (WDR2019). Nonetheless, the labor force of many developing countries is populated by low or un-skilled workers who are mainly employed in low-productivity agriculture activities with very little access to technology. This partly explains why most of these countries are locked out of high value-added activities of the value chain. These countries are predominantly trapped in low-value added activities with little diversification and/or opportunity to upgrade to high value-added activities. Often, these countries worry they are locked out of the higher value-added activities.

III. Data and Methodology

3.1 Data

3.1.1 GVC data

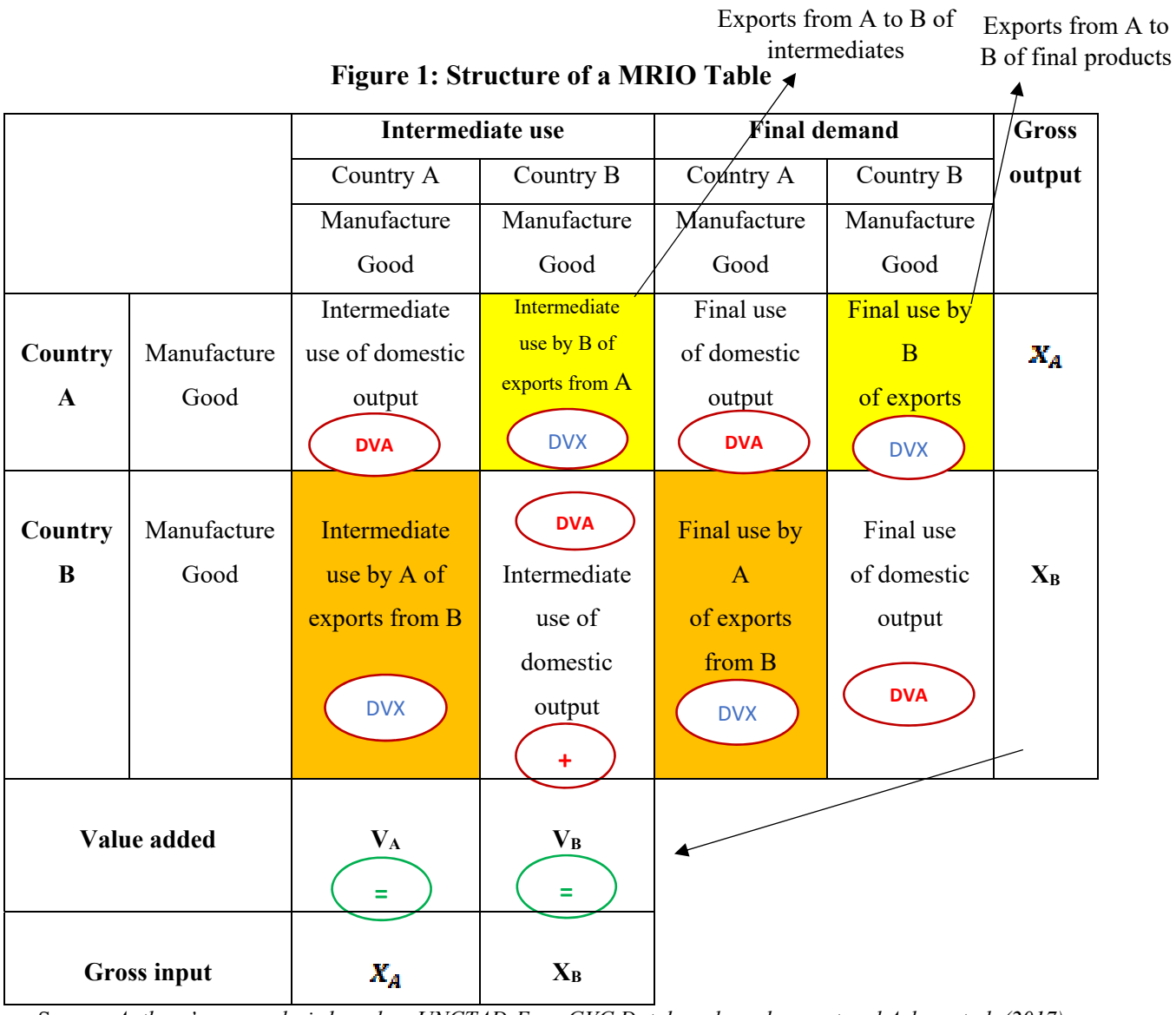
Intermediate inputs increasingly cross-national borders multiple times as production processes become more fragmented across different countries. Because of the growing importance of double-counting, traditional trade statistics have become increasingly less reliable as a measure of the value contributed by each country. Value-added trade statistics help to identify and net out the "double-counting" effect of GVCs on gross trade figures. This is done by mapping out how value addition moves between countries along the Global Value Chain before final consumption of end-products. The GVC data used in this study were obtained from the UNCTAD-Eora GVC database. This database provides value-added trade statistics for 187 countries (including 45 Sub-Saharan African countries) from 1990 to 2015 covering between 25 and 500 industries depending on the country under consideration.

To calculate both domestic and foreign value-added in trade, the Eora data set provides a global multi-region input-output (MRIO) table. A simplified MRIO table is presented in *Figure 1* to illustrate how value-added is calculated in the manufacturing industry[3] for trade between two countries. Consider a situation where country A produces a manufactured good x (say, wood products) which can be used domestically to satisfy final demand or to serve as an intermediate input in the production of another good in the same industry. Alternatively, the same good x can be exported to country B where it can be used as a final product or as an intermediate input in the production of another good in the same industry. The first row of *Figure 1* summarizes how gross output X produced in country A (X_A) can be shared between country A and country B as an intermediate input or final product. Conversely, the same good can be imported from country B and used in country A as an intermediate input or final product. This is summarized in the second row of *Figure 1*. As a result, total exports of country A to B can be obtained by adding the intermediate and final output produced in country A and used in country B (the yellow cells in *Figure 1*). For country B, total exports can be calculated by adding the intermediate and final output produced in country B and used in country A (the orange cells in *Figure 1*). Since the

[3] In the appendix, we classify a list of sectors into three different industries based on the definitions used by the World Trade Organization. Thus, the sectors included in manufacturing follow the WTO classification.

columns of *Figure 1* provide information on the share of domestic and foreign intermediate inputs needed in the production of gross output, this information can be used to measure value-added in trade, both domestic and foreign. For example, the first column shows the amounts of domestic and foreign intermediate inputs that are used in the production of gross output X in country A (X_A). Consequently, the difference between the gross output produced in each country and the sum of intermediate inputs (both domestic and foreign) used in the production process yields the value added generated in each country ($\boldsymbol{V}$).

Figure 1: Structure of a MRIO Table



Source: *Authors' own analysis based on UNCTAD-Eora GVC Database launch report and Aslam et al. (2017)*

Given these value-added trade statistics in addition to total exports, we measured the share of each country's exports that is part of a multi-stage trade process (i.e. a global value chain) using the definition from Aslam et al. (2017). Aslam et al. (2017) define country c's GVC participation in sector s at time t as:

$$GVC\ Participation_{cst} = \frac{DVX_{cst} + FVA_{cst}}{Total\ Export_{cst}} \quad (1)$$

The first component $\frac{DVX_{cst}}{Total\ Export_{cst}}$ measures the share of country c's total exports of products in sector s that are produced within the country (indirect value-added, DVX_{cst}). This is "forward participation" as it computes domestic value-added incorporated in the exports of other countries (the downstream perspective). The second component $\frac{FVA_{cst}}{Total\ Export_{cst}}$ is the share of imported (foreign) value-added that is incorporated into the exports of country c, also referred to as "backward participation" (the upstream perspective). Whereas the first component is the share of a country's exports that contributes to GDP, the second component specifies the share of a country's gross exports that is made up of inputs produced in other countries. This GVC participation rate measures the extent to which a country's exports are linked to international production networks. Consequently, the larger is the participation ratio for a given country, the greater is its involvement in GVC.

In conclusion, our GVC data capture backward and forward participation at sector level for 115 countries worldwide including 23 SSA countries (see the Appendix for the list of SSA countries included in the data). We also focus on manufacturing GVCs and classify exports into 19 subcategories as presented in a concordance table in the Appendix.

3.1.2 Skill data

Human capital is potentially an important determinant of country participation in global markets. However, data on human capital are often very difficult to obtain especially for SSA countries. This study derived skills data using information from the Global Trade Analysis Project (GTAP) input-output tables. We also used the recently published Human Capital Index developed by the WBG (2018) as an indicator of human capital endowment. This index measures the knowledge,

skills, and health a country's population accumulates over their life-cycles. In addition, we explore how skill-mobility (proxied by a country's net migration-to-population ratio) impacts on country GVC participation. The following subsections discuss each of these three skill indicators and how they are constructed.

a. Skilled and unskilled labor content in exports

Skilled labor data are very difficult to obtain especially for African countries. Even data on the education level of workers, as a proxy for skill-level, are not available for most SSA countries. We therefore generate skilled and unskilled labor content in exports (LACEX) using data from GTAP's Input-Output (IO) tables and a methodology developed by Cali et al. (2016). Based on the International Labor Organization's (ILO) classification, skilled labor comprises professional workers who consist of managers and administrators (including far managers), professionals, and para-professionals. Unskilled workers (production workers) category consists of tradespersons, clerks, salespersons, personal service workers, plant and machine operators and drivers, laborers and related workers, and farm workers (Liu et al. 1998; Vo and Tyers 1996; Dimaranan and Narayanan, 2009 and 2014). Since there is no complete global data set with disaggregate employment by worker type, the GTAP team initially used labor force surveys and national censuses of 15 different economies where data are available to develop a statistical model to explain labor payment shares in the sample regions. In a second stage, they use the results to predict labor payment shares in 37 aggregated sectors for unobserved regions. The authors subsequently mapped individual country data to GTAP concordance to address inconsistencies in occupational classifications used by different governments. The GTAP approach in splitting total labor payment into payment to skilled and unskilled labor has been used in several GTAP IO database version (GTAP 1-7) which are used in this analysis. Liu et al. (1998) provide a detailed description of the methodology used in GTAP to disaggregate labor payments by skills level.

The IO tables in the GTAP data set allow one to exploit a form of social-accounting matrix (SAM) where incomes are shown in the rows of the SAM while expenditures are shown in the columns (Hertel, 2013 and McDougall, 2001 cited in Cali et al. 2016). The structure of the data is based on a general equilibrium principle – every income has a corresponding expenditure. The advantage of using this framework is that it provides a comprehensive record of the interrelationships of an economy, including intermediate and final demand linkages (Cali et al. 2016). This database

allows us to obtain skilled and unskilled labor contents in total output and exports. The first step in estimating the labor content of output and exports is to derive the intermediate multiplier matrixes. These matrixes will then be multiplied with total output and exports to obtain our measures of labor value added. The relationship between intermediate inputs and final demand can be summarized as follows:

$$Y = Z - AZ \tag{2}$$

where Y and Z denote vectors of final demand and gross output, respectively. A represents the intermediate coefficient matrix which can be calculated from the IO tables. We therefore calculate the Leontief inverse matrix (also known as the multiplier matrix) M as:

$$Z = (I - A)^{-1}Y = MY \tag{3}$$

Here, the multiplier matrix M measures the inputs contained in a unit of final output. Since we are only interested in (skilled and unskilled) labor contents, the second step is to extract the contribution of labor in total gross output from the value added of other factors of production. This is done by calculating a diagonal matrix $\hat{B}$ that measures the labor value added share of total gross output. The diagonal matrix $\hat{B}$ therefore has diagonal elements equal to the share of workers' compensation in output Z, which can also be divided between skilled and unskilled labor.

The final step is to use our M and $\hat{B}$ matrixes to extract the inputs of labor value added in total output and export. Using the product of these two matrixes as a multiplier for final outputs and export, we obtain the total labor value added of outputs G and exports H, respectively. This is mathematically presented below

$$G = \hat{B}M\hat{Y}$$
$$H = \hat{B}M\hat{X}$$

where $\hat{Y}$ and $\hat{X}$ are diagonal matrixes whose non-zero diagonal elements are the vector of final demand and national export. This can also be done by sector relating to a unit of final output and export of each sector. We considered a total of 57 sectors in the economy (57 rows and 57 columns) for both skilled and unskilled labor. The H matrix contains the total labor value added in exports and has 57 sectors, for both skilled and unskilled labor. We harmonized the number of sectors in both the GTAP data and the GVC data in order to have the same sectors in both data sets. This

leads to 19 different sectors, but only 10 sectors are manufacturing sectors. Moreover, the skills data generated from the GTAP IO tables cover only 3 years: 2004, 2007, and 2011. These data are matched with our GVC data according to these 3 years and for corresponding manufacturing sectors. A panel of three years of data is generated accordingly and used in the analysis. Our underlying assumption is that, we expect skilled labor content in exports to have a positive and significant impact on countries' participation in GVCs while unskilled labor is expected to have less impact on GVC participation for a given country.

b. Human capital index

The Human Capital Index (HCI), developed by the WBG, measures the human capital of the next generation. It captures the amount of human capital a child born today could expect to attain by age of 18, in view of prevailing risks associated with poor health and poor education in the country where she/he lives (WBG, 2018). The index has three components: survival, expected years of learning-adjusted school and health. The survival component is measured using the mortality rate of child under 5 years. This component reflects the fact that children born today need to survive before they can benefit from human capital accumulation through formal education. For expected years of learning-adjusted school, this component measures how much children learn in school based on countries' relative performance on international student achievement tests. Finally, the health component combines adult survival rate and the rate of stunting for children under 5 years old to measure a country's overall health environment. In this study, the HCI, which runs from zero to one, is used as a proxy to measure a country's initial human capital endowment. A score of 1 means that a child born today in a country can expect to achieve both full education potential (i.e. 14 years of high-quality school by age of 18) and full health (i.e. no stunting and 100% adult survival). A score of 0.80 for instance means that the future productivity of a child born today is 20% below what could have been achieved with complete education and full health. We assume the HCI does not change much in the short and medium term since the benefits of investing in people can take a long time to materialize (WBG, 2018). Since we consider HCI as a measure of initial human capital endowment, we expect countries with high HCI endowment to perform better in GVC participation. Therefore, we expect a positive and significant relationship between HCI and countries' participation in GVC.

c. Economic migrants

Data on skill mobility between countries and regions are difficult to obtain for SSA, as in other parts of the world. However, this can be proxied using data on international economic migrants although such data do not dissociate skilled from unskilled economic migrants. An economic migrant can be defined as a person who leaves his or her place of origin to seek better livelihood in another place (for a short or long term). In other words, economic migrants search for better job opportunities in places where they can earn better income compared to their place of origin. These migrants include both skilled and unskilled workers who move from one place to another purely for economic reasons. Since data on international economic migrants are available for most countries in the world, we use net migration-to-population ratio as a proxy for labor mobility. This is defined as:

$$Net\_Migration_{ct} = \frac{(Immigration - Emigration)_{ct}}{Total\ Population_{ct}}$$

A positive ratio for a given country means that more people (i.e. workers) are coming than leaving the country for work. In addition, a positive ratio means that more people join the domestic workforce since economic migrants add to the workforce of host countries. It is however important to note that economic migrants are different from refugees or asylum seekers and their worker statuses depend on host countries' laws and openness to foreign workers. In this regard, economic migrants can work either legally or illegally in formal or informal sectors of host countries. Consequently, their skills can be incorporated in GVC activities. Thus, we expect the net migration ratio to have a positive and significant impact on countries' participation in GVCs.

3.2 Methodology: Model specifications and estimation technique

We use a gravity model to estimate the effects of skills and migration on the participation of African countries in GVCs. Since the pioneering work by Tinbergen (1962), gravity models have become an important tool used in explaining trade flows. For example, McCallum (1995) used gravity-type equations to understand the impact of borders on trade patterns and to show the importance of gravity models as a framework to estimate the effect of trade integration policies.

Head and Mayer (2014) explain that the micro-foundation of gravity equations in trade contributed to the extensive use of these models for a range of other bilateral flows and interactions.

We proceed by specifying our gravity-type relationships between (backward and forward) GVC participation, skills, migration and other control variables such as average distance to global GVC hubs. These gravity-type relationships will then be estimated using fixed-effect estimation techniques to understand the determinants of manufacturing GVC participation in Sub-Saharan Africa. Following Kowalski et al. (2015), we define the backward and forward GVC participation equations for country c in sector s at time t as:

$$Backward\ Participation_{cst} = f(X_{cst};\ X_{ct}; \varepsilon_{cst}) \quad (4)$$

$$Forward\ Participation_{cst} = f(X_{cst};\ X_{ct}; \varepsilon_{cst}) \quad (5)$$

Here, we decompose our explanatory variables into two. The first set of variables in matrix X are country-sector specific factors. These factors are skilled and unskilled-labor content in exports all at sector level by country. The second set of variables are country specific factors such as average distance to global GVC hubs, GDP per capita, natural resource endowment, population, net migration as a share of total population, human capital index, fragile and conflict situation (FCS), and net remittances as a share of GDP. Although we are interested in estimating the role of skills and migration in GVC participation in Africa, we include two important controls to increase the robustness of our estimates. The first is natural resource endowment. In the African context, natural resource endowment is an important determinant of a country's comparative advantage in trade and can potentially stimulate or crowd-out country participation in manufacturing GVCs. We obtain data on natural resource endowment from World Bank's WDI and use it to classify SSA countries into three groups base on their natural resource endowment.[4] The second important control variable is location/remoteness given the "gravity nature" of global trade. According to

[4] Using the classification in Allard et al. (2016), SSA countries are first divided into 18 countries that are natural resource-rich and 22 countries that are not. The natural resource-rich countries are subsequently divided into oil exporting and non-oil exporting resource-rich countries. See below:

- **Oil exporters**: Angola, Cameroon, Chad, the Republic of Congo, Equatorial Guinea, and Nigeria.
- **Non-oil exporting resource - rich countries**: Botswana, Burkina Faso, Central African Republic, the Democratic Republic of Congo, Ghana, Guinea, Mali, Namibia, Niger, Sierra Leone, South Africa, Zambia, Zimbabwe.
- **All other countries Sub-Saharan Africa** – Benin, Burundi, Comoros, Cabo Verde, Côte d'Ivoire, Gambia, Guinea-Bissau, Ethiopia, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, São Tomé and Príncipe, Senegal, the Seychelles, Eswatini, Tanzania, Togo, Uganda.

gravity models, trade volumes are negatively related with the distance between trading partners (Anderson, 1979; Evenett and Keller, 2002; Anderson and van Wincoop, 2003). Interestingly, GVC activities are highly clustered around three major manufacturing hubs worldwide: Germany, China and the United States (Baldwin and Lopez-Gonzalez, 2013). Kowalski et al. (2015) provide evidence that the farther a country is from these hubs, the lower its GVCs engagement. In contrast to Kowalski et al. (2015) who used the shortest distance from a given country to the three major manufacturing hubs, this study uses the average distance between a given SSA country and the three major hubs above. This is because African countries are increasingly diversifying their trading partners toward emerging countries such as China, Brazil, and the Russian Federation. This is demonstrated by the increasing trade volumes between SSA and China over the past two decades even though China is relatively remote from SSA. Because of the strong presence of China in Africa, using the closest manufacturing hub (which de facto is Germany) will exclude China, potentially making our results biased. We therefore use average distance between SSA countries and the three major hubs. Finally, as widely used in gravity models, we also include GDP per capita as a proxy of countries' economic mass.

The GVC participation equation defined in equation (1) is the sum of backward and forward participations. Consequently, we can write GVC participation as a function of X

$$GVC\ Participation_{cst} = f(X_{cst};\ X_{ct}; \varepsilon_{cst}) \qquad (6)$$

where ε_{cst} is an error term. Based on the discussions above, a fixed-effect estimation technique is used to estimate equations (4) to (6) accounting for sector, year, and country group fixed effects. The fixed-effects estimation technique is widely use because it yields consistent estimates without strong structural assumptions (Head and Mayer, 2013). Equations (4) to (6) are therefore estimated focusing on the effects of skills, migration, human capital endowment on GVC participation. As discussed previously, skilled labor data are derived from the GTAP IO tables and skill mobility is proxied by net migration-to-population ratio to analyze the impact of foreign labor contribution on GVC activities. For comparative purpose, we independently estimate equations (4) to (6) for SSA countries and for the rest of the world. This is done to assess if the effects of skills and migration on GVC participation in SSA are any different from what is observed in other parts of the world. To the best of our knowledge, this study is the first to assess the impacts of skills, migration, human capital endowment on the integration of SSA countries in backward and forward GVCs.

IV. Descriptive Analysis

Table 1 presents some descriptive statistics using data on 23 SSA countries (Table A1 presents a list of these countries) that have data on both manufacturing GVC and skilled/unskilled labor contents of exports. First, let's look at the GVC participation index. The larger the ratio, the greater the intensity of a country's involvement in GVCs. *Table 1* shows that on average the intensity of involvement for SSA countries in manufacturing GVCs is approximately 44 percent. This means that less than half of total manufacturing exports in SSA are GVCs related exports. Since GVC participation has only two components reflecting upstream and downstream linkages in the chain, *Table 1* provides suggestive evidence that the intensity of involvement for SSA countries is greater in backward (24%) than in forward (20%) manufacturing GVCs. This signifies that SSA countries incorporate more foreign inputs in their manufacturing exports (backward linkages) than they supply intermediate manufacturing inputs to the exports of other countries (forward linkages).

Table 1: Summary Statistics – African Countries

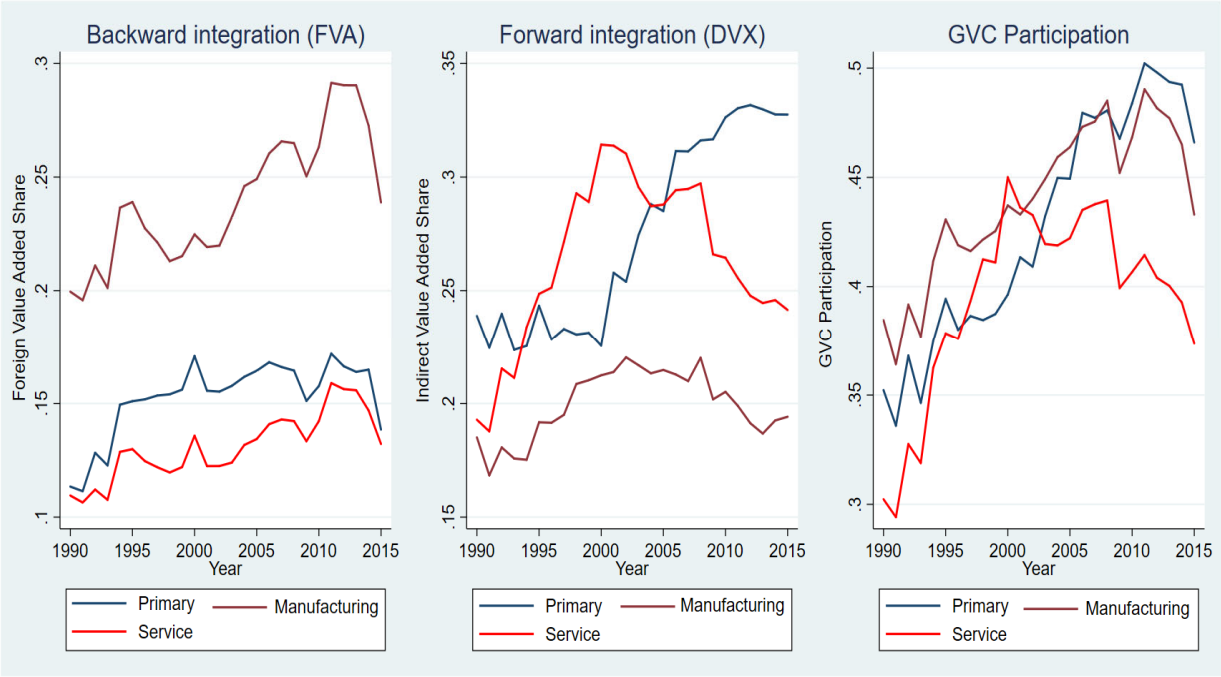
Variable	***Obs***	***Mean***	***Std. Dev.***	***Min***	***Max***
DVX	508	7,593,820	5,179,819	1,887,196	17,500,000
DVA	508	34,800,000	20,500,000	11,700,000	73, 500,000
FVA	508	8,972,219	5,984,821	1,936,014	19, 900,000
DVX_share	508	0.1995	0.0150	0.1683	0.2203
FVA_share	508	0.2400	0.0284	0.1958	0.2914
GVC Participation	508	0.4395	0.0348	0.3642	0.4903
GDP per capita	508	1865.609	2320.022	214.0448	8313.271
LACEX_usk	508	0.0245	0.0410	6.85e-08	0.4224
LACEX_sk	508	0.0046	0.0080	2.95e-09	0.0851
VA_usk	508	0.1082	0.0889	6.97e-08	0.5867
VA_sk	508	0.0200	0.0178	3.00e-09	0.1179
HCI	508	0.4129	0.0606	0.3415	0.6258
Migrant Stock	508	453441.3	459822.8	15543	2095185
Migrants as a share of total population	508	2.6103	2.0745	0.1371	11.0895
Remittances-to-GDP ratio	472	0.0074	0.0076	0.0001	0.0306
Average Distance from the 3 major hubs	508	10050.35	1144.898	8390.698	11801.62

Note: *LACEX_usk and LACEX_sk stand for labor content of export for unskilled and skilled workers respectively while VA_usk and VA_sk denote the shares of value added by unskilled and skilled workers respectively.*

According to *Table 1*, we observe that the average human capital index for SSA countries is 0.41 which means that the productivity of a newborn as a future worker is on average 59% below what could be achieved with complete education and full health. The global average is 0.66 which means

that the SSA region lags behind the global average in terms of human capital endowment. The sample average of net migration as a share of total population is roughly 2.6% while net remittances as a share of GDP is less than 1%, on average, for SSA countries. For the skill variables, *Table 1* shows that on average skilled labor content in exports is lower than the unskilled labor content. This suggests that although skilled labor is more valued in exports than unskilled labor, the participation of SSA countries in manufacturing GVCs is concentrated in low-skilled manufacturing products.

Figure 2: Trend in GVC participation (at sector level) for SSA countries

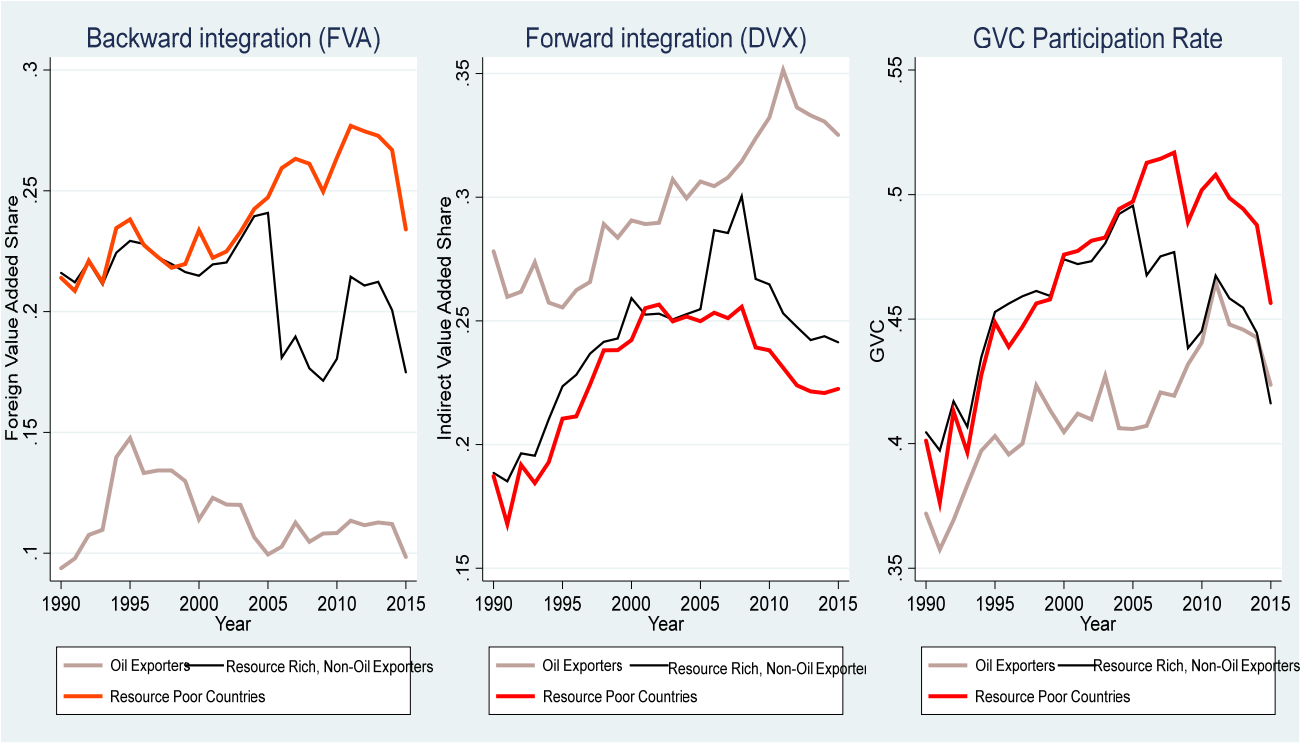


Source: *Authors' using UNTAD-MERO data*

To compare manufacturing GVC with other sectors, *Figure 2* presents GVC participation rates for the primary, service and manufacturing sectors. It shows that SSA economies are more integrated into backward manufacturing GVC compared to the agriculture and service sectors. However, backward participation has been declining for all these three sectors since 2011. On the other hand, forward participation in manufacturing GVC is the lowest compared to the primary and service sectors. This suggests that SSA countries supply less intermediate manufacturing inputs to the exports of other countries than they supply service and primary inputs in the exports of other countries. Moreover, forward participation in manufacturing GVC exhibits a declining trend since 2000 while forward participation in agriculture and service GVCs started declining in 2008 during

the global financial crisis. In terms of overall GVC participation rate, the chart indicates that, on average, GVC participation has improved in SSA although participation is more dominant in primary industries than in manufacturing. From *Figure 3*, we report that resource rich oil-exporting SSA countries have the lowest participation rates in backward GVCs, followed by non-oil resource-rich exporters. Overall, resource-poor SSA countries perform better in backward manufacturing than their resource rich counterparts. Although the participation of SSA countries in backward GVC has been declining, these countries have registered tremendous improvements in their forward GVC integration over the past two decades. Unlike backward GVCs, resource rich oil-exporting countries are the dominant forces in forward GVCs while resource-poor countries have the lowest participation rates in forward manufacturing GVC. Focusing on overall GVC participation, *Figure 3* shows that resource-poor SSA countries have the highest GVC participation rates than resource-rich countries who are least integrated in GVCs since the 1990s. This is a very interesting result as it is closely related with the popular Dutch-Disease effect of resource endowment.

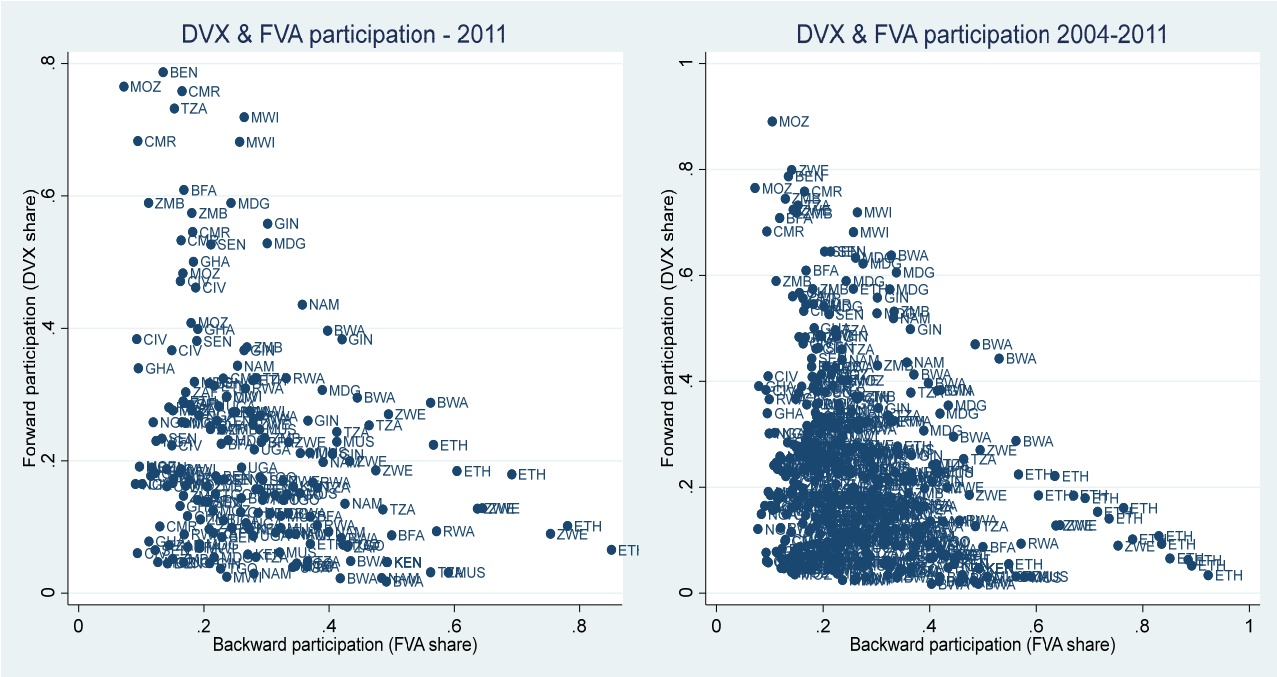
Figure 3: Trend in GVC participation for resource-rich and resource-poor SSA countries



Source: *Authors' using UNTAD-MERO data*

Furthermore, Figure 4 exhibits a negative relationship between forward and backward GVC participation for all manufacturing sectors in 2011. In addition, this relationship holds for all the years combined as shown in the panel on the right. This means that countries with high forward integration tend to have lower backward integration and vice-versa, with a negative correlation of (-0.262) as shown in the correlation matrix presented in Table A2. This negative correlation coefficient is consistent with the finding of Kowalski et al. (2015) who also found a negative correlation between backward and forward integration in GVC by sector.

Figure 4: Cross-country correlation between forward and backward GVC participation Index



Source: *Authors' using UNTAD-MERO data*

We also look at how GVC participation is related with countries' level of economic development, measured by their GDP per capita. *Figure 5* shows that at the global level, backward and forward GVC participation improve with GDP per capita but seemingly at a decreasing rate. This is because of the concavity of the chart in *Figure 5*. In this figure, poor countries populate the bottom of the chart while rich countries are at the top of the distribution for both forward and backward GVC participations. This is not necessarily true in SSA, see *Figure 6,* with the exception of South Africa. Nigeria, SSA's biggest economy, has a lower GVC participation in manufacturing compared to smaller economies like Mauritius, Zimbabwe and Kenya. Nonetheless, SSA's poorest countries

grouped at the bottom of the chart in *Figure 6*. Interestingly, both *Figures 5* and *6* show that forward integration rates are generally lower than backward integration for most countries.

Figure 5: World GVC participation and GDP per capita

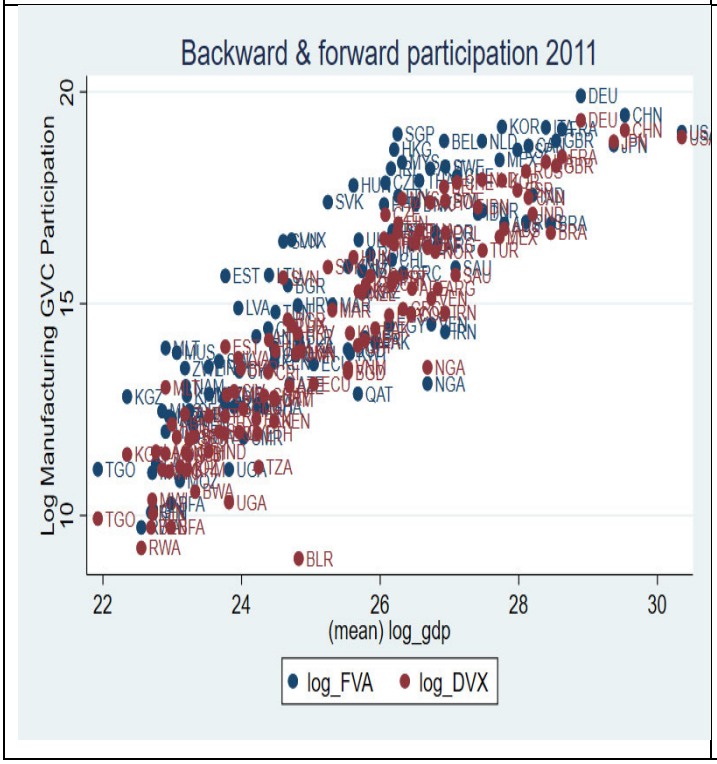
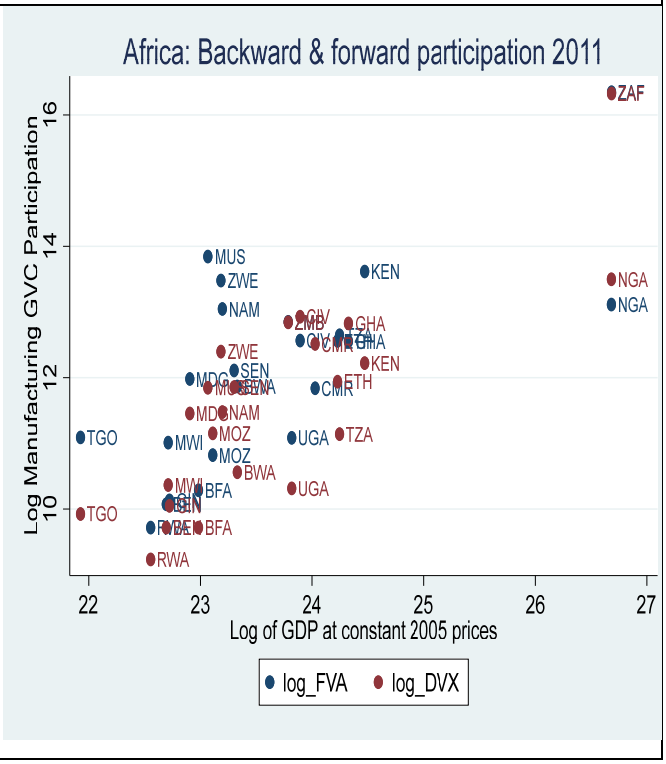


Figure 6: SSA GVC participation and GDP per capita



Source: *Authors' using UNTAD-MERO data*

In addition, *Figures 7* and *8* present the relationships between forward and backward GVC integration with skilled and unskilled labor contents in exports. In both figures, the relationships between forward and backward integration with skilled/unskilled labor in exports are not very clear although there seem to be non-linear negative relationships between forward GVC integration and skilled/unskilled labor. For clarity, *Table 2* presents the correlation matrix between our explanatory and dependent variables with their level of significance (at least 10% or better) for SSA countries. Most correlation coefficients are statistically significant with FVA, but not very significant for DVX. Importantly, *Table 2* sheds light on the relationships between GVC integration and skilled/unskilled labor in exports. This table shows a positive relationship between (backward) GVC participation, and skilled and unskilled labor contents in exports although these correlations are very small. The table also shows that GDP per capita is negatively correlated with backward GVC participation as well as with overall GVC participation.

Figure 7: Forward Integration and (un)skilled labor content in exports at sectoral level

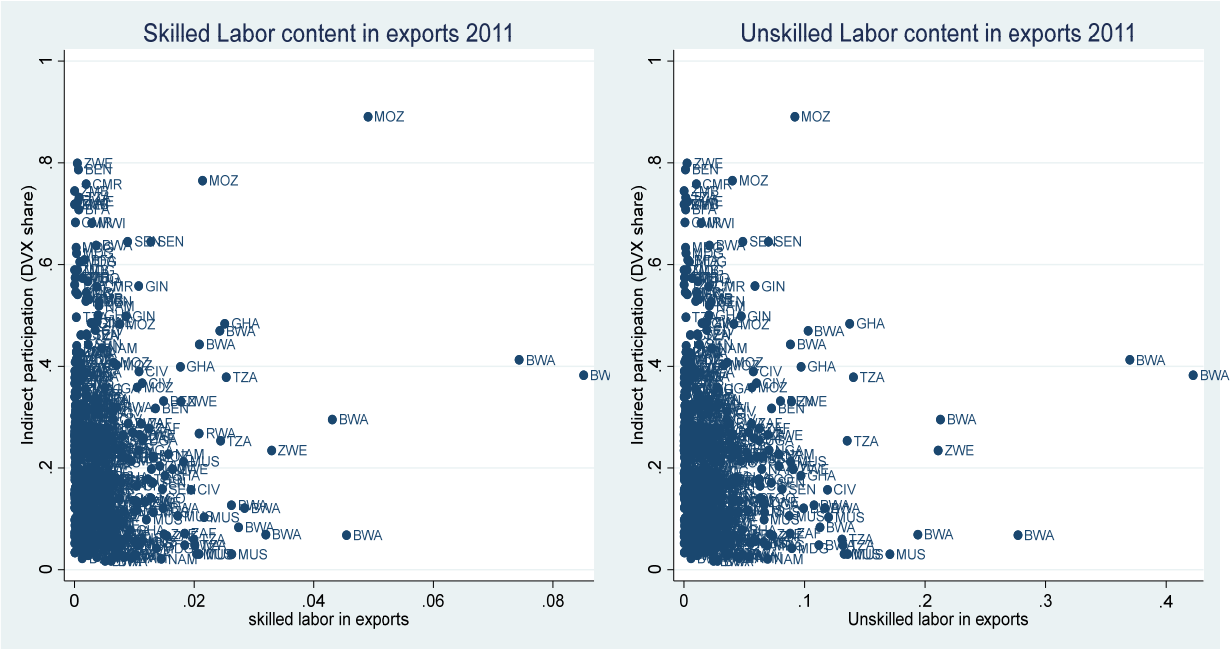
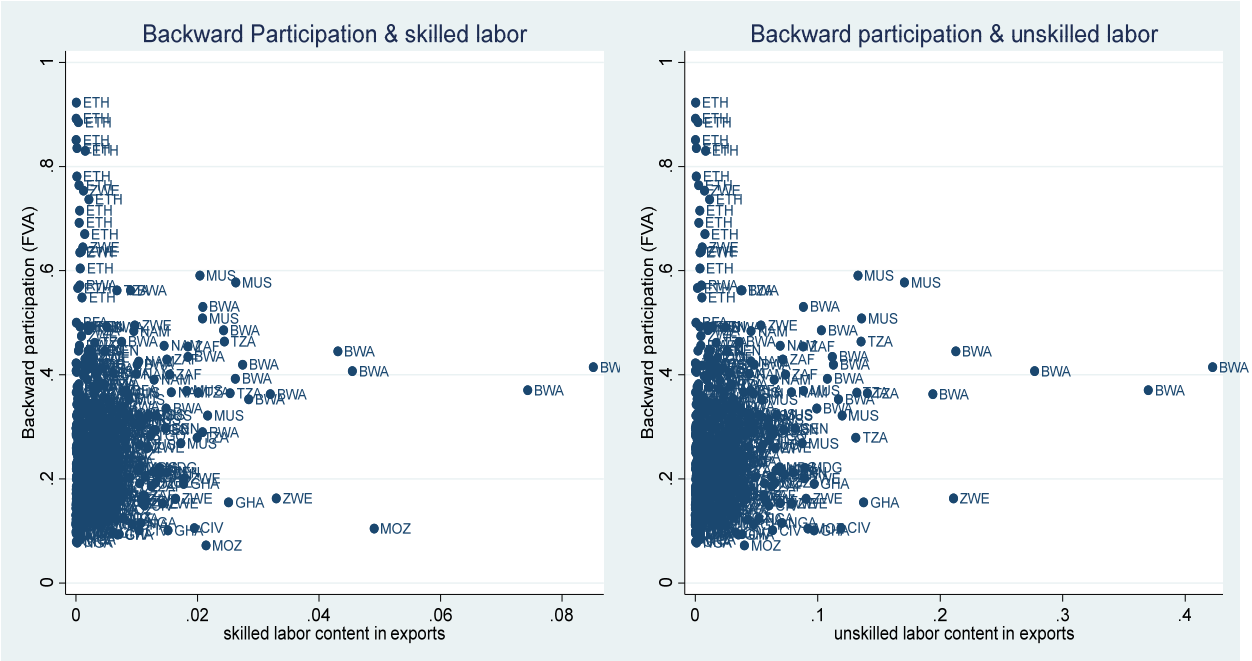


Figure 8: Backward Integration and (un) skilled labor content in exports at sectoral level



Source: Authors' using UNTAD-MERO data

For the human capital index, this is positively correlated with FVA but negatively correlated with DVX. Moreover, there is a significant negative relation between oil exporting and (backward) GVC participation but a positive correlation between oil exporting and forward GVC integration.

Table 2: Pairwise Correlation Matrix for Sub-Saharan Africa

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) FVA_share	1.00														
(2) DVX_share	-0.26*	1.00													
(3) GVC_participation	0.52*	0.69*	1.00												
(4) LACEX_sk	0.12*	0.02	0.11*	1.00											
(5) LACEX_usk	0.13*	-0.05	0.05	0.97*	1.00										
(6) log_GDP	-0.11*	-0.05	-0.13*	-0.04	-0.04	1.00									
(7) log_distance	0.08*	-0.04	0.02	0.24*	0.23*	0.08*	1.00								
(8) log_population	-0.11*	0.05	-0.03	-0.31*	-0.31*	0.58*	-0.33*	1.00							
(9) HCI	0.21*	-0.18*	0.00	0.17*	0.21*	-0.08*	0.32*	-0.55*	1.00						
(10) Remit/GDP	0.09*	-0.05	0.02	-0.09*	-0.09*	-0.12*	-0.29*	0.06	0.01	1.00					
(11) migration_share	0.01	-0.08*	-0.07	0.11*	0.08*	0.44*	0.19*	0.24*	-0.19*	-0.25*	1.00				
(12) FCS	-0.03	0.03	0.002	0.01	0.02	-0.21*	-0.12*	-0.08*	-0.07	0.29*	-0.40*	1.00			
(13) non_oil_rich	0.001	0.02	0.02	0.15*	0.14*	0.20*	0.29*	-0.22*	-0.002	-0.11*	-0.01	0.13*	1.00		
(14) oil_rich	-0.22*	0.10*	-0.08*	-0.09*	-0.09*	0.35*	-0.24*	0.24*	-0.14*	0.03	0.06	-0.08*	-0.17*	1.00	
(15) overall_LPI	-0.08	-0.08	-0.13*	-0.03	-0.02	0.59*	0.10*	0.32*	0.05	0.07	0.38*	0.01	0.06	0.05	1.00

*shows significance at the 10% level at least. Note: *LACEX_usk and LACEX_sk denote labor content of export for unskilled and skilled workers respectively. HCI is human capital index, FCS is a dummy for countries' fragility and conflict situation, and* non_oil_rich and oil_rich *are dummy variables for oil rich and non-oil rich countries. Finally, LPI represents countries' Logistics Performance Index.*

V. Estimation results and discussion

Due to the small size of the SSA sample (508 observations compared to 2,278 for the global sample), different specifications (see results from Table 3-5) were run separately to assess the effects of skills and migration on GVC participation. These specifications were estimated while considering identification problems that might affect our estimated impacts. Moreover, we report robust standard errors to obtain unbiased standard errors under heteroscedasticity. *Table 3* presents the fixed effects panel estimation results for our baseline model with key explanatory variables that are expected to drive GVC participation. Estimated results on backward and forward GVC participation are also presented side by side with the GVC participation estimates. For comparison purpose, we also estimate our model for the rest of the world using a sample of 115 countries. This is done to assess how SSA countries performs compared to the rest of the world. For this analysis, our variables of interest are skilled and unskilled labor content in exports, the human capital index, and net migration as share of the population.

The results presented in Table 3 show that skilled labor content in exports has the greatest positive impact on both backward and forward GVC participation, and these effects are stronger for SSA countries compared to the rest of the world. According to our estimates, a 1% increase in skilled labor content in exports could globally increase forward participation by less than 3% but increases forward integration in manufacturing GVC by more than 20% in SSA. Similarly, a 1% increase in skilled labor content of exports could increase global backward GVC participation by more than 5% and increases SSA's backward GVC participation by 24%. This suggests that increasing the skill component of SSA's exports will tremendously help these countries in incorporating foreign inputs into their exports. This is because with higher skills, SSA countries can import more sophisticated products from foreign countries and incorporate these products into their production processes to produce and export high value-added products. At the same time, higher skill will help SSA countries in supplying high value-added inputs into the exports of more advanced countries. Importantly, higher-skills provides new trading opportunities to further increase the participation of SSA countries in GVC and to diversify their exports away from the export of raw materials to value added goods. From these empirical results, we can say that skilled labor is the most important determinant of backward and forward GVC participation in SSA even stronger in comparison with the rest of the world. On the contrary, for all the specifications we ran (*Table 3-*

4) we find that unskilled labor in exports has a negative but statistically insignificant effect on backward and forward integration at the global level. However, in SSA, these negative effects are statistically significant for both forward and backward GVC participation. Thus, when a country is well endowed with skilled labor which could help produce sophisticated goods, this significantly affects the quality of its production and therefore its backward and forward integration. But for a country that is endowed with a high percentage of unskilled labor, its productive capabilities are limited especially for sophisticated production. This restricts the country's ability to participate in forward and backward GVC.

Table 3: Fixed effects panel estimation results – Baseline specification

VARIABLES	(1) DVX LCX Global	(2) DVX LCX SSA	(3) FVA LCX Global	(4) FVA LCX SSA	(5) GVC Participation LCX Global	(6) GVC Participation LCX SSA
log_distance	-1.516***	2.879***	-2.293***	4.757***	-0.189***	0.0893
	(0.163)	(0.633)	(0.170)	(0.696)	(0.0186)	(0.0890)
log_GDP	1.034***	1.074***	0.949***	0.896***	-0.0228***	-0.0269***
	(0.0189)	(0.0678)	(0.0217)	(0.0681)	(0.00260)	(0.00932)
LACEX_sk	2.923*	20.16***	5.318***	24.24*	0.489	6.746**
	(1.548)	(7.143)	(1.934)	(13.41)	(0.392)	(2.959)
LACEX_usk	-0.754	-4.428***	-0.791	-4.548*	-0.0975	-1.309**
	(0.458)	(1.591)	(0.494)	(2.516)	(0.101)	(0.560)
Constant	-2.517	-43.51***	5.958***	-57.39***	2.872***	0.303
	(1.675)	(5.713)	(1.756)	(6.450)	(0.195)	(0.825)
Observations	2,727	508	2,727	508	2,727	508
Number of panelid	982	205	982	205	982	205
Sector FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

We also ran the regression using the GVC participation ratio as defined in *equation (6)*, and all specification results (Table 3-5) are statistically insignificant for both skilled and unskilled labor in the global sample. However, in SSA, the positive impacts of skilled labor on overall GVC participation are large and significant while unskilled labor also exhibits significant negative effects (see Table 3-5). These results again confirm that skilled labor is a very important determinant for the integration of SSA countries in manufacturing GVCs, and its impact is larger in SSA countries than in other parts of the world given the region's low human capital endowment.

To account for initial human capital endowment, fragility and resource endowments, we include these indicators in our regressions in *Tables 4* and *5*. The effects of skilled labor on backward GVC

participation become statistically significant but remain insignificant for forward and overall GVC participation at the global level. At the global level, initial human capital endowment seems to be the strongest determinant for both backward and forward manufacturing GVCs participation compared to other determinants. This suggests that at the global level, countries with strong initial human capital endowment do better in integrating their production processes into manufacturing GVCs than countries with low initial human capital endowment. For SSA, the HCI estimates are insignificant in the forward participation, but strongly positive in the backward integration. This is a very interesting result as it indicates that SSA countries with relatively high initial capital endowments are more likely to benefit from the opportunities provided by GVCs in terms of incorporating foreign value-added products in their manufacturing exports (the upstream participation).

Table 4: Fixed effects estimation results – resource endowments and fragility indicators

VARIABLES	(16) DVX LCX Global	(17) DVX LCX SSA	(18) FVA LCX Global	(19) FVA LCX SSA	(20) GVC Participation LCX Global	(21) GVC Participation LCX SSA
log_distance	-0.791***	3.013***	-0.590***	3.963***	-0.0999***	0.201*
	(0.162)	(0.658)	(0.184)	(0.659)	(0.0215)	(0.103)
log_GDP	0.876***	0.998***	0.723***	0.816***	-0.0461***	-0.0665***
	(0.0365)	(0.110)	(0.0482)	(0.109)	(0.00690)	(0.0156)
LACEX_sk	1.781	18.93***	3.507*	25.18***	0.330	6.848***
	(1.507)	(6.746)	(1.853)	(8.377)	(0.358)	(2.447)
LACEX_usk	-0.532	-4.013***	-0.537	-4.563**	-0.0811	-1.260**
	(0.456)	(1.537)	(0.497)	(1.816)	(0.109)	(0.519)
log_population	0.0849**	0.127	0.0776	0.265**	0.0202***	0.0461**
	(0.0405)	(0.122)	(0.0518)	(0.113)	(0.00715)	(0.0196)
HCI	4.706***	2.703	7.658***	7.997***	0.504***	0.271
	(0.491)	(1.663)	(0.613)	(1.797)	(0.0832)	(0.210)
FCS	0.0239	0.529***	-0.0192	0.449**	0.0210	-0.0138
	(0.0426)	(0.177)	(0.0456)	(0.180)	(0.0154)	(0.0202)
non_oil_rich	0.523***	0.324*	0.574***	0.334*	0.0735***	0.0516**
	(0.162)	(0.167)	(0.190)	(0.180)	(0.0204)	(0.0253)
oil_rich	0.300	0.432	-0.535*	-0.387	0.100**	0.0939*
	(0.235)	(0.338)	(0.315)	(0.375)	(0.0406)	(0.0485)
Constant	-9.325***	-46.40***	-9.608***	-56.04***	2.005***	-0.691
	(1.555)	(6.103)	(1.824)	(6.244)	(0.217)	(0.914)
Observations	2,626	508	2,626	508	2,626	508
Number of panelid	947	205	947	205	947	205
Sector FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Moreover, a marginal improvement in the HCI could increase backward GVC integration by 6 to 8 percent (see Table 4-5) comparing to the statistically insignificant 2 percent increase in forward participation. Tables 5 and 6 present the impact of migration on manufacturing GVC participation by respectively introducing net migration as a share of population and net remittances as a share of GDP. Net migration exhibits a positive and statistically significant effect on both backward and forward integration. Nonetheless, the benefits of migration on backward and forward GVC integration is greater for SSA countries compared to the rest of the world.

Table 5: Estimation results – net migration

VARIABLES	(28) DVX LCX Global	(29) DVX LCX SSA	(30) FVA LCX Global	(31) FVA LCX SSA	(32) gvc_participation LCX Global	(33) gvc_participation LCX SSA
log_distance	-0.800***	2.667***	-0.599***	3.369***	-0.103***	0.0998
	(0.162)	(0.640)	(0.184)	(0.645)	(0.0214)	(0.104)
log_GDP	0.934***	1.083***	0.777***	0.988***	-0.0299***	-0.0355***
	(0.0219)	(0.0698)	(0.0269)	(0.0742)	(0.00293)	(0.00893)
LACEX_sk	1.958	17.30***	3.745**	23.15***	0.282	6.188**
	(1.508)	(6.511)	(1.846)	(8.795)	(0.362)	(2.602)
LACEX_usk	-0.571	-3.854**	-0.582	-4.430**	-0.0785	-1.213**
	(0.453)	(1.499)	(0.499)	(1.815)	(0.111)	(0.532)
HCI	4.040***	1.903	7.037***	6.129***	0.332***	-0.0511
	(0.374)	(1.394)	(0.431)	(1.714)	(0.0562)	(0.153)
FCS	0.0285	0.537***	-0.0151	0.461**	0.0235	-0.00811
	(0.0427)	(0.185)	(0.0458)	(0.185)	(0.0155)	(0.0200)
non_oil_rich	0.457***	0.245*	0.514***	0.160	0.0578***	0.0206
	(0.157)	(0.144)	(0.181)	(0.150)	(0.0195)	(0.0225)
oil_rich	0.255	0.331	-0.577*	-0.575	0.0866**	0.0596
	(0.235)	(0.327)	(0.313)	(0.366)	(0.0403)	(0.0486)
net_migration_share	0.224***	5.245**	0.276**	5.257*	0.0195	0.930
	(0.0715)	(2.391)	(0.128)	(3.102)	(0.0277)	(0.741)
Constant	-8.909***	-42.71***	-9.220***	-49.34***	2.062***	0.424
	(1.553)	(5.748)	(1.814)	(6.032)	(0.215)	(0.911)
Observations	2,626	508	2,626	508	2,626	508
Number of panelid	947	205	947	205	947	205
Sector FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As shown in *Table 5*, a 1% increase in net migration flow as a percentage of recipient country's population could individually increase backward and forward GVC integration of the receiving

SSA country by roughly 5% but only increases backward and forward GVC participation by less than 1%, on average, for any non-SSA country. In other words, SSA countries that tend to receive net inflows of migrants seem to better engage in backward and forward GVCs than those with net outflows of migrants. To this point, migration is a strong and important determinant of manufacturing GVCs integration in SSA. Assuming that these migrants are both skilled and unskilled workers, we can infer that it is the skilled foreign workers that would contribute the most in increasing the participation of SSA countries in manufacturing GVCs. These foreign workers complement the local labor force especially in countries where there are skilled-labor shortages. In sum, migration seems to be good for integration into manufacturing GVCs for SSA countries.

In *Table 6*, we also look at the role of net remittance inflows as a share of GDP on GVC participation, but the results are not very impressive. At the global level, a 1% increase in global remittances as a share of global GDP translates to a 0.4% increase in forward GVC participation and a 1.9% increase in backward GVC integration. In SSA, an increase in remittances as a share of GDP does not translate into a significant effect on manufacturing GVC participation with both estimates not statistically significant at 95% confidence level. This suggests that remittance inflows from migrants abroad do not affect GVC participation for SSA countries, however net inflows of immigrants have a strong positive impact on GVC participation. In other words, emigration does not directly contribute to improve origin countries' engagement in GVCs. Finally, we now discuss the impact of some of our control variables (such as fragility, resource endowments and average distance from the three major manufacturing hubs) on GVC participation before concluding this study. In *Tables 4* to *6*, we respectively included a dummy fragility indicator in our regressions to account for countries' fragility at a given year. In most of these regressions, our estimates are positive and statistically significant for only SSA countries. This is because Côte d'Ivoire, one of the fragile SSA countries, is a major GVC participant and a major driver of growth in West Africa. This, consequently, drives the fragility index to have a significant positive effect on both backward and forward participation in SSA while having statistically insignificant effects on backward and forward integration in the global sample. Moreover, our results in *Tables 4-6* indicate that SSA countries that are rich in non-oil resources tend to be more engaged in manufacturing GVCs than resource-poor SSA countries.

Table 6: Estimation results – net remittances

VARIABLES	(22) DVX LCX Global	(23) DVX LCX SSA	(24) FVA LCX Global	(25) FVA LCX SSA	(26) gvc_participation LX Global	(27) gvc_participation LCX SSA
log_distance	-0.817***	2.723***	-0.638***	3.409***	-0.113***	0.155
	(0.169)	(0.645)	(0.192)	(0.660)	(0.0218)	(0.110)
log_GDP	0.926***	1.156***	0.743***	0.830***	-0.0422***	-0.0718***
	(0.0365)	(0.107)	(0.0519)	(0.109)	(0.00797)	(0.0169)
LACEX_sk	2.318	19.12***	3.144**	22.09***	-0.0152	4.856**
	(1.545)	(6.957)	(1.470)	(6.958)	(0.335)	(2.116)
LACEX_usk	-0.769	-4.491***	-0.380	-3.059**	0.0814	-0.512
	(0.477)	(1.609)	(0.414)	(1.463)	(0.0972)	(0.429)
log_population	0.0554	-0.0543	0.0543	0.326***	0.0172**	0.0662***
	(0.0431)	(0.124)	(0.0595)	(0.111)	(0.00816)	(0.0213)
HCI	4.212***	0.893	7.444***	9.201***	0.425***	0.549**
	(0.513)	(1.712)	(0.669)	(1.848)	(0.0919)	(0.239)
net_remittances/GDP	0.436**	1.485*	1.854***	0.303	0.00830	-0.169
	(0.172)	(0.808)	(0.280)	(0.944)	(0.0562)	(0.167)
FCS	0.00943	0.385**	-0.0314	0.430**	0.0257*	0.0103
	(0.0403)	(0.150)	(0.0477)	(0.181)	(0.0153)	(0.0168)
non_oil_rich	0.481***	0.107	0.759***	0.563***	0.0996***	0.0969***
	(0.169)	(0.173)	(0.199)	(0.190)	(0.0224)	(0.0302)
oil_rich	0.216	0.219	-0.547*	-0.450	0.0905**	0.101**
	(0.242)	(0.353)	(0.318)	(0.379)	(0.0412)	(0.0509)
Constant	-9.541***	-43.60***	-9.167***	-52.72***	2.126***	-0.614
	(1.622)	(5.881)	(1.901)	(6.218)	(0.220)	(0.973)
Observations	2,353	472	2,353	472	2,353	472
Number of panelid	875	195	875	195	875	195
Sector FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses

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

For oil-rich countries, the effects are not statistically significant, which implies that oil-resource endowment does not necessarily help countries to engage more in manufacturing GVCs. This can partly be explained by the fact that oil-rich SSA countries are more engaged in mining/extractive GVCs than in manufacturing GVCs. In other words, natural resource endowments (both oil and non-oil resources) contribute marginally, at best, in comparison with human capital (skills and initial endowment) towards improving the engagement of SSA countries in backward and forward manufacturing GVCs. Lastly, average distance from the three major manufacturing hubs (Germany, the United States, and China) has a significant negative effect on both backward and

forward integration, albeit higher on forward participation in the global sample. On the contrary, distance to major manufacturing hubs has a strong positive effect on both backward and forward integration in SSA. This means that hubs that are relatively farther away from SSA tend to trade more in manufacturing GVCs than those that are closer to the region. This is not very surprising for two main reasons. First, is China's increasing presence in the African continent despite not being the closest major manufacturing hub. Apart from China being one of the continent's major trading partners for the past decade, SSA countries are increasingly diversifying their export partners toward the BRIC and other emerging economies which are far from the closest manufacturing hubs (i.e. Germany). Second, the strong positive effect of distance on backward and forward GVC participation in SSA can be explained by South Africa's presence in the SSA sample. This is because South Africa has the highest rate of integration in global value chains despite being the farthest country from the three major manufacturing hubs.

VI. Concluding remarks and policy recommendations

This study assesses the role of human capital and natural resource endowment in SSA participation in manufacturing GVCs. We looked at the effects for both backward (FVA) and forward (DVX) participations as well as the overall GVC participation ratio. Fixed effects panel regressions with robust standard errors are estimated for 23 SSA countries and results are compared with a global sample of 115 countries, covering 19 manufacturing subsectors. Because of the lack of skilled/unskilled labor data for most SSA countries, we generated skilled/unskilled labor content in export using the labor content of exports (LACEX) methodology developed by Cali et al. (2016). We mapped the skilled data set defined for 57 sectors from the input-output GTAP table with the GVCs data derived from UNCTAD-Eora GVC Database which has 25 sectors. We focus on the impacts of skilled/unskilled labor contribution, migration and initial human capital endowment on forward and backward GVC participations. To our knowledge, this study is the first in the literature to assess the role of skilled and unskilled labor, net inflows of skilled/unskilled migrant workers, and the human capital index in GVCs integration. Importantly, this is the first study that focuses on SSA countries where skills related data are often very difficult to collect.

Our results show that skilled labor is the most important determinant of backward and forward GVC participation in SSA. However, unskilled labor, which is the most available labor form in SSA economies, has adverse effects on both backward and forward GVC integration. This suggests that SSA countries need to improve their skilled labor content in exports to better engage in manufacturing GVCs. Public policies that upgrade unskilled to skilled labor should be encouraged in SSA countries. Investing in professional and skills developments that are required to support direct and indirect GVC related activities is needed for SSA countries to maximize the gains from GVC participation. In addition, our findings show that net migration as a share of population has a strong positive effect on backward and forward GVC participation. To this point, migration is an important determinant of integration in manufacturing GVCs for SSA countries. This is because skilled foreign workers contribute in increasing the participation of SSA countries in manufacturing GVCs especially in countries where there are skilled-labor shortages. Therefore, regional agreements that encourage and support intra-regional skilled mobility can be a great vehicle to upgrade countries' integration in backward and forward global and regional value chains.

Moreover, our results suggest that countries with greater human capital endowment (high HCI) tend to engage more in manufacturing GVCs than those with low initial endowments. Since SSA countries lag behind the rest of world in initial human capital endowment, our results show that the impact of HCI on GVC participation is minimal in SSA compared to the rest of the world. This signals the need for policies to be directed towards improving the human capital index of SSA countries. Investing in children today is a great opportunity to boost long-term skilled endowment which has proven to register the highest impact on both backward and forward GVC participation in SSA. Finally, it is important to note that our analyses focus on manufacturing GVCs integration, but the methodology employed can also be extended to the primary and service sectors. Another limitation of this study is the small size of the SSA sample due to limited available skills related data. But future research on the role of skills in GVCs integration could explore other ways of collecting more longitudinal skilled/unskilled labor data for developing countries in general and explore how SSA would perform in comparison with other developing regions, especially those that are performing better.

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Appendix

Table A1: List of SSA countries in the sample

Country	Country Code
Benin	BEN
Botswana	BWA
Burkina Faso	BFA
Cameroon	CMR
Côte d'Ivoire	CIV
Ethiopia	ETH
Ghana	GHA
Guinea	GIN
Kenya	KEN
Madagascar	MDG
Malawi	MWI
Mauritius	MUS
Mozambique	MOZ
Namibia	NAM
Nigeria	NGA
Rwanda	RWA
Senegal	SEN
South Africa	ZAF
Tanzania	TZA
Togo	TGO
Uganda	UGA
Zambia	ZMB
Zimbabwe	ZWE

TableA2: Classification of sampled SSA countries by National Resource endowment

	Freq.	**Percent**	**Cum.**
Oil-exporters	28	5.51	5.51
Non-oil exporting resource-rich countries	174	34.25	39.76
Non-resource- rich countries	306	60.24	100.00
Total	508	100.00	

Table A3: Classification of sampled SSA countries by fragility

	Freq.	Percent	Cum.
Fragile states	75	14.76	14.76
Non-fragile states	433	85.24	00.00
Total	508	100.00	

Table A4: Concordance Matrix to Merge by Sectors

	Sector	GVC	GTAP	Industry
1	Agriculture	Agriculture	pdr wht gro v_f osd c_b pfb ocr ctl oap rmk wol frs	**Primary Products**
2	Fishing	Fishing	fsh	
3	Mining and Quarrying	Mining and Quarrying	coa oil gas omn	
4	Food & Beverages	Food & Beverages	cmt omt vol mil pcr sgr ofd b_t	**Manufacturing Industry**
5	Textiles and Wearing Apparel	Textiles and Wearing Apparel	tex wap lea	
6	Wood and Paper	Wood and Paper	lum ppp	
7	Petroleum, Chemical and Non-Metallic	Petroleum, Chemical and Non-Metallic	p_c crp nmm	
8	Metal Products	Metal Products	i_s nfm fmp	
9	Electrical and Machinery	Electrical and Machinery	mvh ele	
10	Other Machinery	Others	ome	
11	Electricity, Gas and Water	Electricity, Gas and Water	ely gdt wtr	
12	Other Manufacturing	Other Manufacturing Maintenance and Repair Recycling	omf	
13	Transport Equipment	Transport Equipment	otn	
14	Construction	Construction	cns	**Service Industry**
15	Trade	Wholesale Trade Retail Trade	trd	
16	Hotels and Restaurants	Hotels and Restaurants	ros	
17	Transport	Transport	otp wtp atp	
18	Post and Telecommunications	Post and Telecommunications	cmn	
19	Financial Intermediation and Business ..	Financial Intermediation and Business ..	ofi isr obs	
20	Other Services	Public Administration Education, Health and Other Services Private Households	osg dwe	

Table A5: Summary Statistics – Global sample of 115 countries (2004, 2007, 2011)

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
DVX	2,278	1945008	6028184	20.1189	7.25e+07
DVA	2,278	8948453	2.77e+07	31.65835	4.25e+08
FVA	2,278	3875701	1.08e+07	17.17576	1.43e+08
DMX_share	2,278	0.1924	0.1609	0.0006	0.9449
FVA_share	2,278	0.2950	0.1580	0.0059	0.9981
DVA_share	2,278	0.7050	0.1580	0.0019	0.9941
GVC Participation	2,278	0.4873	0.1865	0.0456	0.9993
GDP per capita	2,246	20051.23	21573.33	525.0823	111968.4
LACEX_usk	2,278	0.0378	0.0397	6.13e-08	0.3923
LACEX_sk	2,278	0.0099	0.0126	6.62e-23	0.1206
VA_usk	2,278	0.1266	0.0736	1.11e-07	0.5607
VA_sk	2,278	0.0311	0.0246	1.50e-22	0.2777
hci	2,150	0.6619	0.1131	0.3887	0.8844
Migrant Stock	2,246	1868920	4544230	11475	4.42e+07
Migrants as a share of total population	2,246	9.4424	13.4208	0.0400	87.8402
Remittance sent to GDP ratio	2,043	0.0110	0.0254	0.00001	0.2148
Remittance received to GDP ratio	2,162	0.0283	0.0468	0.00004	0.3364
Average Distance from the 3 major hubs	2,246	7544.847	2260.345	5191.282	13742.21