Chapter 1

Factors for GVC participation in sub-Saharan Africa

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Introduction

In contrast with the past, a developing country today can leap into the global value chains (GVCs) of high-tech products by specializing in a niche segment of the value chain and becoming an exporter. This is more frequent nowadays because of rapid decline in transportation and communication costs. The spread of GVCs has also affected the strategies of developing economies. On the one hand, it is no longer necessary or efficient to build an entire value chain from scratch, as assumed in the "flying geese" model of economic development (Akamatsu, 1962). Rather, a country can specialize in a niche segment of the value chain and then advance to higher value chain activities through upgrading efforts. On the other hand, the globalization of economies, spurred by trade liberalization and economic integration, has narrowed policy options for developing countries, thereby making the protection of their industries increasingly difficult.

Consequently, an alternative strategy needs to be formulated. This paper suggests a GVC-led development strategy, which consists of two phases: the participation phase and the upgrading phase. The paper focuses on the former phase, and particular attention will be paid to GVC participation in sub-Saharan African countries. The EORA multi-region input–output (MRIO) data, which originally cover 189 countries and 26 sectors for the period 1990–2015, are used to calculate the indexes of GVC participation. Then, after comparing GVC participation in sub-Saharan Africa with that of other regions, such as East Asia, Southeast Asia, and South Asia, regression analysis on the factors for GVC participation is conducted. It is expected that policy implications will be derived by considering the factors affecting GVC participation that are particularly relevant to sub-Saharan African countries.

The paper is organized as follows. Section 1 presents the literature review. Sections 2 and 3 discuss and present the factors affecting GVC participation and the method of constructing GVC participation measures, respectively. Section 4 presents the results of empirical analysis, which consist of comparisons of GVC participation rates across regions and regression analysis on the factors for GVC participation. Finally, Section 5 concludes the paper with a summary of its findings.

1. Literature review

Jones and Kierzkowski (1990) formulated an analytical framework (fragmentation theory[1]) in which lower production costs—especially lower variable costs—are realized when a labor-intensive production block is relocated to a low labor cost country. However, an increase in the number of production blocks incurs higher fixed costs (i.e., set-up costs of a new production facility) and service link costs.[2] Therefore, insofar as the set-up costs and service link costs are reduced sufficiently (so that net benefits of relocation become positive), previously vertically integrated production processes are fragmented into separate production blocks, and the activities of the firms are geographically dispersed.[3]

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[1] Global value chains (GVCs) have been studied by a variety of researchers, including not only economists, but also sociologists, economic geographers, and business strategists. These studies look at the globalized economy from different angles. Economists approach it from the perspective of production processes, i.e., fragmentation theory, whereas the others examine it from the perspective of business activities, i.e., the value chain concept. The value chain concept looks at a chain of related activities that link together to create a product or service from conception, through the different phases of production, to delivery to final consumers and after sales services, and finally to disposal or recycling (Porter, 1985). Theoretical frameworks that are relevant to the value chain concept include global commodity chains (GCCs: Gereffi, 1994); global value chains (GVCs: Gereffi, Humphrey, and Strugeon, 2005); and global production networks (GPNs: Henderson, Dicken, Hess, Coe, and Yeung, 2002). Meanwhile, fragmentation theory looks at the geographic dispersion of parts and component production within vertically integrated production processes. It can be seen that fragmentation theory looks at a specific aspect of the value chain.

[2] Production blocks are connected via service links, i.e., bundles of activities consisting of transportation, insurance, telecommunication, quality control, and management coordination to ensure that the production blocks interact in the proper manner (Arndt and Kierzkowski, 2001). Meanwhile, Yi (2003) emphasizes the importance of trade costs in production fragmentation, because of two magnifying forces: (1) goods that cross national borders multiple times incur tariffs and transportation costs multiple times; (2) tariffs are applied to gross imports, even though value added by the direct exporter may be only a fraction of this amount.

[3] More recently, Baldwin (2013,2016) has explored the mechanism of the "second unbundling," which is based on spatial economics, by referring to the history of international trade between the North and the South. After the first unbundling—in which consumption and production was geographically unbundled across borders, because of decreasing transport costs caused by the development of railroads and steamships in the 1830s—the information and communication technology (ICT) revolution, which began around the 1990s, made it possible to coordinate complex exchanges of information and communication over large distances, and the vast wage differences between the North and the South made geographically separate manufacturing sites less costly. Consequently, parts of manufacturing activities previously performed in the North were dispersed geographically, and the South obtained opportunities to participate in GVCs by specializing in labor-intensive manufacturing activities. In the second unbundling, entry barriers for industrial development are substantially lower. During the first unbundling, developing countries sought to build entire value chains by adopting an import-substitution policy, implementing first- and second-stage import substitution to protect downstream and upstream industries respectively. However, such a policy has become increasingly difficult to implement because of the shrinking policy space that has been caused by trade and investment liberalization since the mid-1980s and the proliferation of regional trade agreements since the 1990s. Thus, during the second unbundling, developing countries

It should, however, be noted that production fragmentation does not occur in all industries. According to Lall et al. (2004), the intensity of fragmentation differs depending on four factors: the technical divisibility of production processes, the factor intensity of the process, the technological complexity of each process, and the value to weight ratio of the product.[4] Considering the above factors, Lall (2003) concluded that: (1) in high-technology industries, fragmentation is strong in electronics; (2) in medium-technology industries, fragmentation is strong in automobiles, but the weight of the product and its high basic capability requirements mean that it only extends to a few proximate, relatively industrialized locations; and (3) in low-technology industries, production fragmentation is strong in clothing, footwear, sporting goods, and toys.

In sum, it is important to understand that geographical configuration varies across industries. Some industries may disperse, but others may not, depending on their nature and the conditions they face.

Several empirical studies have been conducted on production fragmentation (Yeats, 2001; Yi, 2003; Hanson, Mataloni, and Slaughter, 2003). Among them, Hummels, Ishii, and Yi (2001) focus on trade in intermediate goods that are used as inputs to produce a country's export goods, which they call vertical specialization (VS). Their method of analysis using single-country input–output data was then extended and applied to the analysis of trade in value added using international input–output data. As discussed below, the current multi-country input–output approach extends the scope of analysis and tries to incorporate the concept of global value chains, although there are some limitations on input–output data, such as lack of detailed data, especially in service sectors; sector classification based on industrial categories, not on business functions; and transactions recorded on a domestic basis, not on a national basis (Sturgeon, Nielsen, Linden, Gereffi, and Brown, 2013; Inomata, 2017).

can initially specialize in a niche segment of the value chain. Then, as they build technological capabilities, they can climb up the value chain and reach higher segments.

[4] To relocate manufacturing activities to less developed countries, production processes should be technically divisible; labor-intensive production processes should be included; production processes should not be technically too complex; and the value to weight ratio of the product should be sufficiently high (or the product should not be too heavy or bulky relative to the value of the product) (Lall et al., 2004).

2. Factors affecting GVC participation

A GVC-led development strategy consists of two phases: the participation phase and the upgrading phase, the latter of which is further divided into two stages—the formation of "operational clusters" and of "technological clusters" (Kuroiwa, 2016). This paper focuses on the former phase, because participation in GVCs is still a priority for many sub-Saharan African countries.

The mechanics of GVC participation of less developed countries is explained by production fragmentation theory (Jones and Kierzkowski, 1990). Developing countries offer advantages as well as disadvantages when involved in GVCs. On the one hand, developing countries have advantages in abundant and inexpensive labor forces. These factors attract labor-intensive activities from developed countries. On the other hand, the relocation of manufacturing activities to developing countries incurs additional costs such as set-up costs and service link costs. Moreover, some operating costs are typically higher in developing countries, because of less favorable business environments, less efficient infrastructure, and less efficient and less transparent institutions in the public sector.

As discussed below, the above-mentioned factors—such as labor costs, service link costs, and the quality of infrastructure and institutions—are expected to affect the degree of GVC participation. Among them, service link costs, particularly trade and transport costs, critically affect the GVC participation of sub-Saharan African countries, because of their geographical attributes, such as long distances from international markets, a large number of landlocked and fragmented markets, and poor transport infrastructure.

Moreover, it is not labor costs alone that determines integration in GVCs, but the combination of labor costs and productivity. Therefore, unit labor costs, which is average wages divided by average productivity, is an important determinant of GVC participation. Many sub-Saharan African countries can be shown to have higher unit labor costs relative to other countries, including China (Ceglowski et al., 2015).

Another factor that is particularly relevant to GVC participation by sub-Saharan countries is the quality of institutions and governance. It is empirically shown that countries with better institutions such as stronger property rights and judicial quality (rule of law) participate more in GVCs. Many sub-Saharan African countries have small roles in GVCs because they have weak institutions or neighbors with weak institutions (Miranda and Wagner, 2015; Dollar, Ge, and Yu, 2016; Dollar and Kidder, 2017).

3. Construction of GVC participation measures

As discussed above, trade in value added that uses international input–output data has recently been explored as a method of analyzing international trade, where production processes have been increasingly fragmented across national borders. In particular, vertical specialization measures such as VS (i.e., foreign content in exports) and VS1 (i.e., domestic content used as an input for re-exports), which were originally developed by Hummels, Ishii, and Yi (2001), have become a point of reference for other vertical specialization measures and GVC participation measures. For example, Daudin, Rifflart, and Schweisguth (2011) presented VS1* (i.e., domestic content of imports). Johnson and Noguera (2012) defined the concept of value-added exports. Koopman, Wang, and Wei (2014) synthesized these studies by tracing the value added and double-counted elements contained in gross exports. More recently, Wang, Wei, Yu, and Zhu (2017) proposed alternative measures of GVC participation, decomposing value added and final product production in a different way and separating GVC participation into simple and complex GVC activities.

This study follows the concept of vertical specialization, which was originally proposed by Hummels, Ishii, and Yi (2001). A measure of GVC participation is then derived from the vertical specialization measures. Hummels, Ishii, and Yi (2001) suggest that vertical specialization occurs when:

A. a good is produced in two or more sequential processes;
B. two or more countries provide value added during the production of the good;
C. at least one country must use imported inputs in its stage of the production process, and some of the resulting output must be exported.

Based on the above definition, two vertical specialization measures, VS and VS1, are calculated as follows:

In the international input–output model, the accounting identity on the output side can be expressed as

$$\mathbf{X} = \mathbf{Z}\mathbf{i} + \mathbf{Y}, \qquad (1)$$

where $\mathbf{X}$ is a (GN × 1) vector of total output; G and N represent the number of countries and sectors, respectively; $\mathbf{Z}$ is a (GN × GN) intermediate transaction matrix; $\mathbf{Y}$ is a (GN × 1) vector of final demand; and $\mathbf{i}$ is a (GN × 1) column vector consisting of all ones. From Equation (1), an input coefficients matrix is given by $\mathbf{A} = \mathbf{Z}\widehat{\mathbf{X}}^{-\mathbf{1}}$, where $\widehat{\mathbf{X}}$ is a diagonal matrix of the column vector $\mathbf{X}$. Substituting this into Equation (1) gives

$$\mathbf{X} = \mathbf{AX} + \mathbf{Y}. \qquad (2)$$

Then $\mathbf{X}$ is obtained by

$$\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{Y} = \mathbf{BY}, \qquad (3)$$

where $\mathbf{I}$ and $\mathbf{B}$ are an identity matrix and the Leontief inverse matrix, respectively. By pre-multiplying the right-hand side of Equation (3) by a (GN × GN) diagonal value added coefficient matrix $\widehat{\mathbf{V}}$,[5] the induced value added is calculated as $\widehat{\mathbf{V}}\mathbf{BY}$. Then VS for country *s* is given by

$$\mathrm{VS_s} = \sum_{r \neq s}^{G} \mathbf{V_r B_{rs} E_{s*}}, \qquad (4)$$

where $\mathbf{V_r}$ is a (1 × N) row vector of value-added coefficients for country *r*; $\mathbf{B_{rs}}$ is an (N × N) block Leontief inverse matrix, which is the total requirement matrix that gives the amount of gross output in producing country *r* required for a one-unit increase in final demand in destination country *s*; and $\mathbf{E_{s*}}$ is an (N × 1) column vector of the gross exports of country *s* to the world.[6] On the other hand, VS1 is calculated as

$$\mathrm{VS1_s} = \mathbf{V_s} \sum_{r \neq s}^{G} \mathbf{B_{sr} E_{r*}}. \qquad (5)$$

In Equations (4) and (5), $\mathrm{VS_s}$ represents value added generated in countries other than country *s* through intermediate input imports from country *s* that is induced by gross exports of country *s*, while $\mathrm{VS1_s}$ represents value added generated in country *s* through intermediate input exports that is induced by other countries' gross exports. Moreover, downstream countries—which need to procure intermediate inputs from other countries—tend to have a higher VS in their exports, while upstream countries—which provide intermediate inputs to other countries—tend to have a higher VS1 (Koopman, Wang, and Wei, 2014).

Next, as a measure of GVC participation, the share of vertical trade in gross exports can be calculated as

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[5] The value-added coefficient is the ratio of value added to gross output.

[6] Gross exports can be decomposed into three elements: value-added exports (i.e., domestic content consumed in other countries), feedbacks (i.e., domestic content in intermediate exports that finally return home), and foreign content. Furthermore, these three elements can be decomposed into nine terms (see Equation (36) in Koopman, Wang, and Wei, 2014). Koopman, Wang, and Wei (2014) demonstrate how VS and VS1 are related to the terms used in the decomposition of gross exports (Equations (38) and (42)).

$$GVC_{participation} = (\mathbf{VS_s}+\mathbf{VS1_s})/\mathbf{u}\ \mathbf{E_{s*}}, \qquad (6)$$

where u is a (1 × N) row vector consisting of all ones. Note that $GVC_{participation}$ consists of two separate participation measures: $\mathbf{VS_s}/\mathbf{u}\ \mathbf{E_{s*}}$, i.e., a measure of "backward participation" and $\mathbf{VS1_s}/\mathbf{u}\ \mathbf{E_{s*}}$, i.e., a measure of "forward participation." [7]

4. Empirical results

In Section 2, we discussed potential factors affecting the degree of GVC participation based on a selective literature review, while the following section was devoted to the explanation on how to measure the degree of GVC participation. This section presents several empirical findings, beginning from (1) the nature and characteristics of GVC participation, including cross-country or regional differences, changes over time, and sectoral characteristics, and (2) factors affecting GVC participation based on econometric considerations.

4.1. GVC participation measured by VS and VS1

This subsection briefly demonstrates the nature and characteristics of GVC participation through the lens of GVC participation index (VS and VS1) as explained above. Figures 1 to 4 plot computed VS and VS1 for agriculture, textile and wearing apparel, electrical and machinery, and transport equipment sectors, respectively.[8] Four panels in each figure show selected countries in Africa, East Asia, Southeast Asia, and South Asia for comparison. Four data points in each graph indicate the years of observation, namely, 2000, 2005, 2010, and 2015, and the arrows show changes with time. VS and VS1 are measured along the horizontal and vertical axes respectively. As explained in the previous section, the larger the value of an index, the deeper the sector of the country integrates into the GVC.

Figures 1 to 4 exhibit a lot of diversity. The values of VS and VS1, their combination, and the changes across time differ significantly by sector, country, and region. For example, according to Figure 1, African countries can be found above the 45-degree line and even close to the vertical axis, indicating that low VS and high VS1 are the characteristics of the agricultural sector in Africa. The values of VS1 are also higher than

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[7] Moreover, using these measures, a position index that characterize the relative upstreamness of a country in GVCs can be calculated as:
$GVC_{position} = \ln\left(1+\frac{\mathbf{VS1_s}}{\mathbf{u}\ \mathbf{E_{s*}}}\right) - \ln\left(1+\frac{\mathbf{VS_s}}{\mathbf{u}\ \mathbf{E_{s*}}}\right)$.
From this equation, countries with a larger position index are relatively more upstream, i.e., they contribute more value added to other countries' exports than other countries contribute to theirs (Aslam, Novta, and Rodrigues-Bastos 2017).

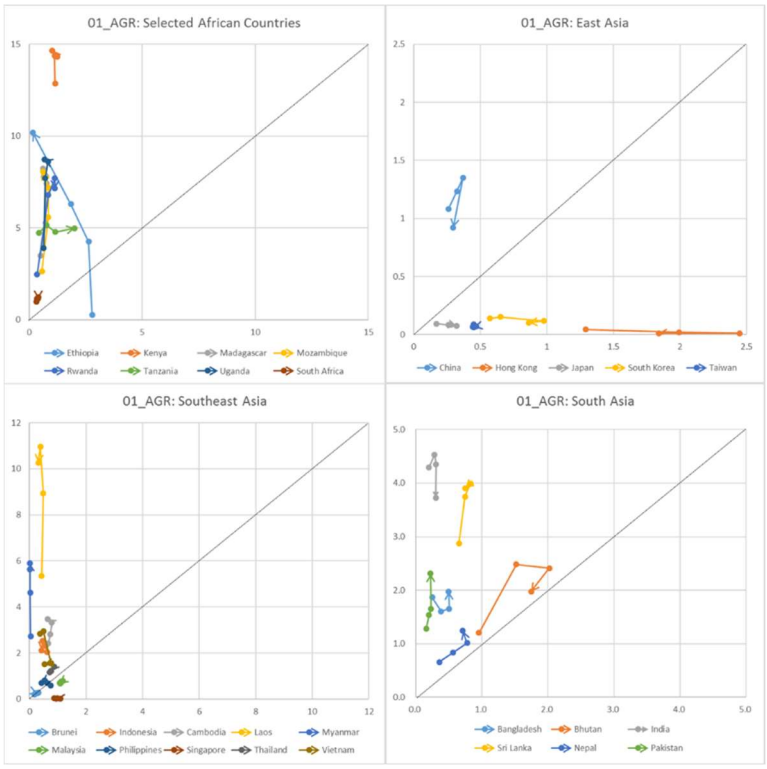
[8] These sectors are selected based on the findings of Lall (2003), as discussed in Section 1.

for other regions, and also higher than for other sectors. That is, Africa's agricultural sector tends to participate deeply into GVCs by exporting agricultural products for subsequent processing and further exporting to third countries. Similar characteristics can be found in the CLMV countries (Cambodia, Laos, Myanmar, and Vietnam) and most of the South Asian countries. In contrast, the agricultural sector in East Asian countries and Singapore is characterized by high VS and low VS1, implying backward integration, meaning that they tend to import agricultural products for processing and then export the products to other countries.[9]

In the textile and wearing apparel sector, Africa's GVC participation is still limited, as indicated by small values of VS1, in comparison with the agricultural sector. It is interesting to note that more countries are found near the 45-degree line, indicating positive correlation between VS and VS1, although the degree of GVC participation is limited, as indicated by the small values of VS and VS1. This is somewhat inconsistent with our intuition that a number of low-income Asian countries have actively participated in GVCs in this sector. For example, Bangladesh is one of the biggest producers and exporters in the apparel sector, but the values of VS have been less than one and much smaller than VS1. This may be because of the definitions of VS and VS1. If Bangladesh exports apparel products to meet the final demand in importing countries, they are not reflected in VS1. If the apparel sector of Bangladesh depends less on imported materials, it will lead to lower VS. In addition, the positive correlation between VS and VS1, as typically found in Southeast Asian countries in Figure 2, highlights the characteristics of the textile and apparel sector, in which GVC participants tend to play dual roles as importers of intermediate products for subsequent processing and exporting, and as exporters of intermediate products for further processing and exporting by importing countries. This contrasts with the agricultural sector, in which countries tend to play only one of the two roles, as illustrated in Figure 1.

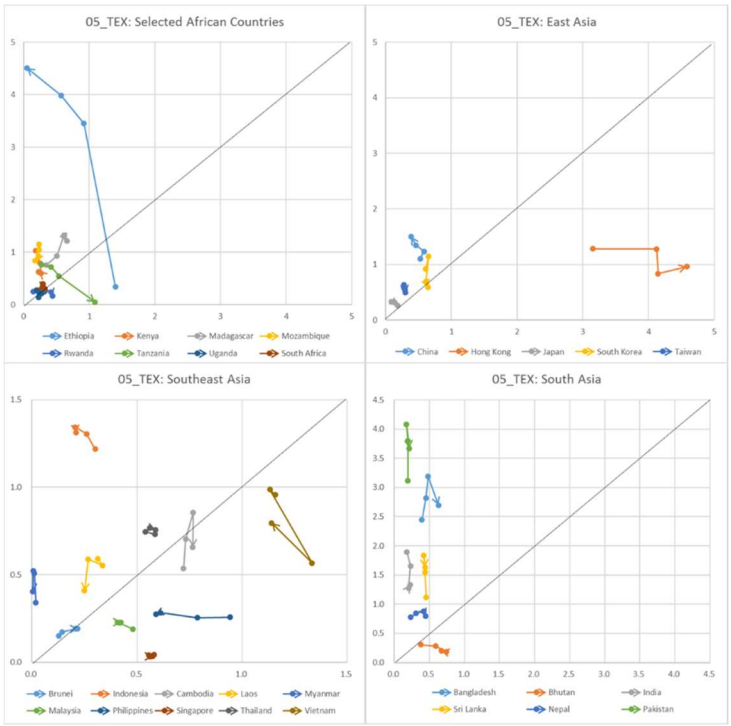
[9] A similar, or even stronger contrast can be found in the mining and quarrying sector.

Figure 1. GVC participation: Agriculture



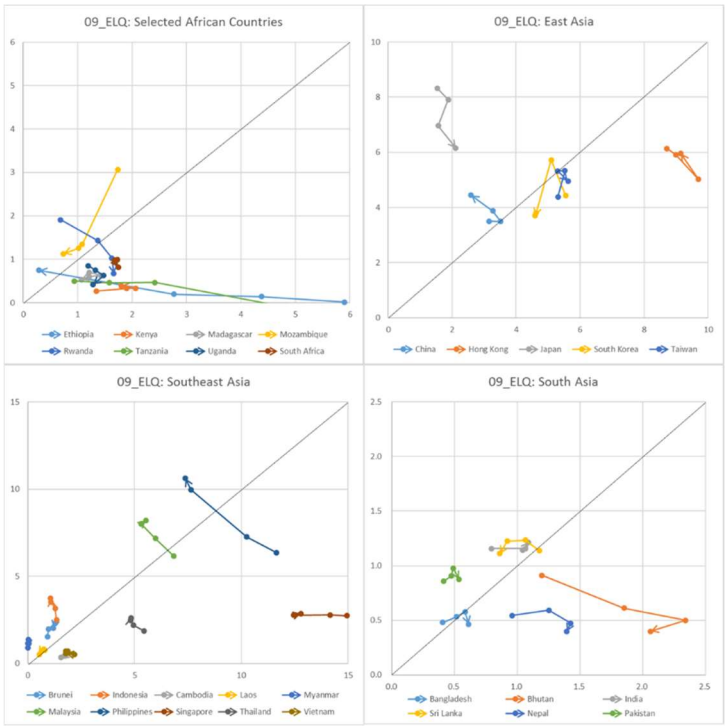
Source: Authors' calculation based on EOTA-MRIO database.

Figure 2. GVC participation: Textile and wearing apparel



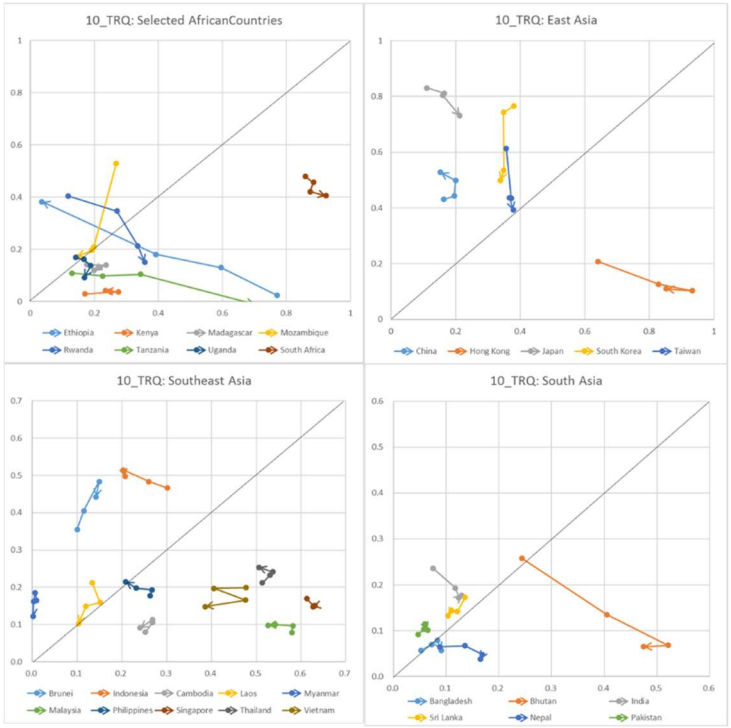
Source: Authors' calculation based on EOTA-MRIO database.

Figure 3. GVC participation: Electrical and machinery



Source: Authors' calculation based on EOTA-MRIO database.

Figure 4. GVC participation: Transport equipment



Source: Authors' calculation based on EOTA-MRIO database.

Figures 3 and 4 clearly show the dual-role nature of the electrical and machinery sector and the transport equipment sector, in a much more obvious way than with the textile and wearing apparel sector, in which about half of the countries are still characterized by a single role (Figure 2). This observation reminds us of Lall (2003)'s claim that the intensity of fragmentation is strong in these three sectors. In other words, the opportunities to participate in GVC are wide open in these sectors. In order to shed a clearer light on this issue, we computed correlation coefficients between VS and VS1 for each sector and year (Table 1). Sectors with consistent and significant *positive* correlation are (p1) textile and wearing apparel, (p2) metal products, (p3) electrical and machinery, (p4) transport equipment, and (p5) public administration. In contrast, sectors with consistent and significant *negative* correlation are (n1) mining, (n2) electricity, gas and water, (n3) transportation, and (n4) financial intermediation and business activities.[10,11] In addition, the correlation coefficients have changed their absolute values, and therefore their significance levels, in several sectors during the sample period. In sectors with a positive correlation, factors facilitating GVC participation through backward integration (VS) are likely to facilitate GVC participation through forward participation (VS1). Therefore, such policy measures can be more efficient. In sectors with negative correlation, however, a policy measure to facilitate GVC participation through backward integration (VS) might have a negative influence on GVC participation through forward integration (VS1). Although this is somewhat beyond the scope of the current study, we at least need to pay enough attention to these sectoral characteristics in investigating the determinants of GVC participation.

[10] We selected sectors with the same signs of correlation coefficient and significant at least at the 10% level for four years, 2000, 2005, 2010, and 2015. The correlation coefficient for the agriculture sector was consistently negative, but not significant.

[11] It can be inferred from the discussion in Section 3 that backward participation (high VS and low VS1) is strong in downstream industries, while forward participation (low VS and high VS1) is strong in upstream industries. In addition, industries with both high VS and high VS1 are likely to be midstream industries, such as metal products, that use imported inputs and export their products to other countries for further processing. Industries with both low VS and low VS1 are likely to be domestic market-oriented industries, such as public administration, that have weak international trade linkages.

Table 1. Sectoral characteristics: Correlation between VS and VS1

Sector		2000	2005	2010	2015
01_AGR	Agriculture	-0.116	-0.079	-0.057	-0.074
02_FIS	Fishing	0.251 ***	0.119	0.102	0.128 *
03_MIN	Mining and quarrying	-0.305 ***	-0.343 ***	-0.351 ***	-0.304 ***
04_FOD	Food and beverages	0.117	0.022	0.064	0.083
05_TEX	Textiles and wearing apparel	0.374 ***	0.360 ***	0.376 ***	0.376 ***
06_WOD	Wood and paper	0.161 **	0.074	0.125 *	0.206 ***
07_PET	Petroleum, chemical and non-metallic mineral products	0.061	0.026	0.072	0.170 **
08_MET	Metal products	0.301 ***	0.313 ***	0.344 ***	0.393 ***
09_ELQ	Electrical and machinery	0.440 ***	0.459 ***	0.495 ***	0.551 ***
10_TRQ	Transport equipment	0.431 ***	0.479 ***	0.531 ***	0.571 ***
11_OTM	Other manufacturing	0.013	-0.051	-0.001	0.068
12_REC	Recycling	0.186 **	0.102	0.112	0.098
13_EGW	Electricity, gas and water	-0.279 ***	-0.279 ***	-0.230 ***	-0.203 ***
14_CON	Construction	-0.290 ***	-0.161 **	-0.058	-0.026
15_MAI	Maintenance and repair	0.125 *	0.081	0.145 **	0.266 ***
16_WHT	Wholesale trade	-0.295 ***	-0.264 ***	-0.157 **	-0.093
17_RET	Retail trade	-0.004	-0.038	0.023	0.103
18_HTR	Hotels and restraurants	-0.140 *	-0.045	0.055	0.043
19_TRN	Transport	-0.221 ***	-0.229 ***	-0.134 *	-0.145 **
20_PTL	Post and telecommunications	-0.291 ***	-0.122 *	0.002	0.004
21_FIN	Financial intermediation and business activities	-0.424 ***	-0.439 ***	-0.381 ***	-0.189 ***
22_PUB	Public administration	0.143 *	0.152 **	0.331 ***	0.384 ***
23_EDU	Education, health and other services	-0.090	-0.047	0.147 **	0.170 **
24_PVH	Private households	0.138 *	0.105	0.154 **	0.269 ***
25_OTS	Others	-0.093	0.035	0.021	-0.064

Source: Authors' calculation based on EORA-MRIO database.

Note: ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively.

Table 2. Degrees of GVC participation by sector and by region

VS	World	OECD	ASEAN	SAARC	SSA
Average	0.90	1.40	0.93	0.63	0.71
01_AGR	0.88	1.03	0.54	0.86	0.88
02_FIS	0.09	0.06	0.04	0.09	0.10
03_MIN	1.74	3.16	1.76	1.19	1.19
04_FOD	0.48	0.58	0.28	0.40	0.47
05_TEX	0.61	1.00	0.48	0.41	0.51
06_WOD	0.81	1.33	0.68	0.54	0.68
07_PET	2.68	4.33	3.21	1.90	1.88
08_MET	1.63	3.22	1.61	1.00	1.01
09_ELQ	2.22	3.96	3.67	1.15	1.42
10_TRQ	0.41	0.99	0.29	0.19	0.29
11_OTM	0.17	0.22	0.15	0.13	0.15
12_REC	0.10	0.11	0.14	0.12	0.10
13_EGW	0.59	0.90	0.60	0.45	0.48
14_CON	0.25	0.32	0.16	0.18	0.21
15_MAI	0.13	0.19	0.08	0.10	0.12
16_WHT	1.13	1.75	1.54	0.80	0.82
17_RET	0.65	0.78	1.02	0.59	0.59
18_HTR	0.22	0.32	0.17	0.18	0.20
19_TRN	1.83	2.38	1.53	1.36	1.67
20_PTL	0.59	0.69	0.57	0.45	0.54
21_FIN	4.50	6.90	4.16	2.96	3.52
22_PUB	0.09	0.08	0.04	0.10	0.11
23_EDU	0.57	0.68	0.41	0.50	0.56
24_PVH	0.04	0.01	0.01	0.05	0.06
25_OTS	0.07	0.05	0.07	0.07	0.12

VS1	World	OECD	ASEAN	SAARC	SSA
Average	1.15	1.11	1.13	0.96	1.29
01_AGR	2.51	1.01	2.62	3.15	5.37
02_FIS	0.20	0.06	0.08	0.26	0.27
03_MIN	4.04	2.25	6.00	0.97	3.63
04_FOD	0.56	0.59	0.38	0.43	0.59
05_TEX	0.56	0.74	0.51	1.41	0.42
06_WOD	0.76	1.43	1.02	0.52	0.73
07_PET	2.00	3.16	2.05	2.48	1.17
08_MET	1.55	2.66	0.70	1.10	0.85
09_ELQ	1.47	2.81	3.25	0.66	0.69
10_TRQ	0.33	0.82	0.21	0.10	0.22
11_OTM	0.17	0.14	0.16	0.24	0.20
12_REC	0.05	0.05	0.06	0.06	0.07
13_EGW	0.97	0.62	0.91	0.94	1.05
14_CON	0.54	0.28	0.39	0.46	0.81
15_MAI	0.26	0.26	0.09	0.26	0.39
16_WHT	1.67	1.40	1.64	1.76	2.13
17_RET	0.70	0.42	1.05	0.66	0.77
18_HTR	0.54	0.34	0.32	0.51	0.87
19_TRN	2.41	2.00	1.47	2.10	3.25
20_PTL	1.02	0.64	0.64	1.11	1.56
21_FIN	5.28	5.46	4.08	3.92	5.71
22_PUB	0.20	0.06	0.06	0.18	0.34
23_EDU	0.59	0.50	0.38	0.52	0.76
24_PVH	0.11	0.01	0.02	0.15	0.23
25_OTS	0.12	0.04	0.04	0.15	0.16

Source: Authors' calculation based on EORA-MRIO database.
Note: Each cell is colored in red when the value is above the world average and in blue when it is below the world average. The denser the color, the further away it is from the world average. SAARC stands for South Asian Association for Regional Cooperation and SSA stands for Sub-Saharan Africa.

Table 2 compares the degrees of GVC participation by sector and by region. First of all, the values of VS and VS1 vary significantly across sectors. The world average VS ranges from 0.04 (24_PVH: Private households) to 4.50 (21_FIN: Financial intermediation and business activities), and VS1 ranges from 0.05 (12_REC: Recycling) to 5.28 (21_FIN). Even among the sectors with high relevance to trade in goods, VS ranges from 0.09 (02_FIS: Fishing) to 2.68 (07_PET: Petroleum, chemical and non-metallic mineral products), and VS1 ranges from 0.17 (11_OTH: Other manufacturing) to 4.04 (03_MIN: Mining and quarrying). Second, the regional difference is also clear: 21 out of 25 sectors of OECD countries have higher VS than the world average, and VS values for most sectors in South Asia and Sub-Saharan Africa are lower than the world average. ASEAN countries are somewhere in between, but closer to the latter. OECD countries tend to import more for further processing and subsequent exporting. Although some of the manufacturing sectors in Sub-Saharan Africa have higher VS than the regional average (0.71), the degree of GVC participation is still lower than the world average (e.g., 1.63 for the metal sector). The characteristics of GVC participation through backward

integration is similar in Sub-Saharan Africa and South Asia. ASEAN countries have higher VS than the world average in two manufacturing sectors, namely petroleum products and electrical and machinery.

In terms of forward integration, more than half of the sectors in Sub-Saharan Africa exhibit higher VS1 than the world average, led by the agriculture sector. VS1 for fishing and food product sectors are also higher than the world average. Although VS1 is high (3.63) in the mining sector, the degree of GVC participation is still lower than the world average. Most manufacturing sectors in Sub-Saharan Africa have lower VS1 than the regional average (1.29) as well as the world average (except 1.55 for the metal sector), implying weak competitiveness of supplier industries in Sub-Saharan Africa. This contrasts with ASEAN and SAARC countries, where several manufacturing sectors have higher VS1 than the world average, in addition to the regional average. Although OECD countries have lower VS1 in most sectors than the world average, manufacturing sectors are exceptional with significantly higher VS1, as well as VS, than the world average, in addition to the regional average. In short, OECD countries participate in GVC in many manufacturing sectors through both forward and backward integration.

4.2. Hypotheses and data

As presented in the previous subsection, the degree of GVC participation differs significantly by country, sector, year, and the modes of participation (VS or VS1), implying that factors affecting GVC participation could also vary across country, sector, year, and the modes of participation. However, most of the potential explanatory variables are available only at an aggregated national level, instead of sector level, and for a limited number of years. In the following, we transform our discussion in Section 2 to testable hypotheses, accompanied by necessary explanations on data issues.

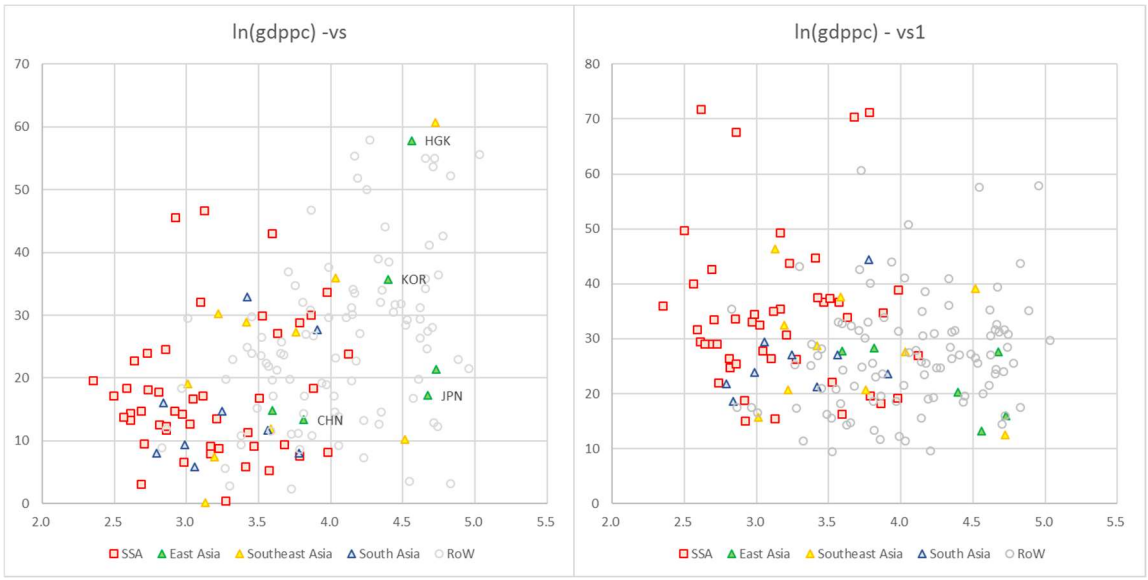
Kowalski et al. (2015) claimed the following elements to be the most important factors affecting GVC participation: market size, level of development, industrial structure, location, tariffs at home and at export markets, engagement in regional trading agreements (RTAs), inward FDI openness, logistic performance, quality of infrastructure and institutions, and intellectual property protection.

The larger the size of the domestic market, the lower the backward integration of a country (lower VS), implying that such a country is more likely to purchase intermediate inputs from the domestic market. In addition, such a country is likely to export more of these intermediate inputs to other countries for subsequent processing. Therefore, the larger the size of the domestic market, the higher the forward integration (higher VS1). Although a natural proxy for market size would be nominal GDP, we will use population in this study in order to reduce the possible endogeneity with real GDP per capita, which is another key variable of interest to represent the level of economic development.

According to Kowalski et al. (2015), the higher the per capita income, the higher is the aggregate forward and backward engagement, implying higher VS and VS1, because "(d)eveloped countries tend to source more from abroad and sell a higher share of their gross exports as intermediate products" (p.7). This is indeed an issue where we are trying to make an additional contribution. Based on the development experience of Asian countries, which is often figuratively described as the "flying geese model of economic development," we propose a hypothesis that the relationship between the degree of GVC participation and the level of economic development is non-linear, and that the non-linear relationship differs by modes of GVC participation (VS or VS1). The rationale behind this hypothesis is as follows. In the beginning, developing countries take part in GVC by exporting primary goods, such as agricultural products and natural resources. At this stage, such a country positions itself upstream in the value chain with strong forward participation (high VS1) and weak backward participation (low VS). The second stage is characterized by the start of industrialization. At this stage, industrialization requires imported inputs such as raw materials and parts and components, as well as machineries, because the domestic market cannot supply them. The country moves downstream along the value chain with weaker forward participation (lower VS1) and stronger backward participation (higher VS). The third stage is characterized by increasing competitiveness of the country's manufacturing industries, accompanied by progress in import substitution, i.e., domestic production of intermediate products (parts and components), and the subsequent exportation of the domestically produced intermediate products. The country moves upstream with stronger forward participation (higher VS1) and weaker backward participation (lower VS). In summary, VS starts at a low level at the first stage, increases at the second stage, and finally decreases in the third stage. In contrast, VS1 starts with a high value at the first stage, decreases at the second stage, and finally increases at the third stage. Based on this hypothesis, it can be inferred, for example, that Cambodia and Laos are still in the first stage, Thailand and Vietnam are largely in the second stage, and Japan, Korea, and some sectors of China are in the third stage. In order to confirm the validity of this hypothesis, we use the squared term of GDP per capita, as well as the original term, as one of the key explanatory variables.

Figure 5 plots the logarithm of real GDP per capita against VS and VS1. In Figures 5 to 9, red squares, green triangles, yellow triangles, and blue triangles denote Sub-Saharan Africa, East Asia, Southeast Asia, and South Asia, respectively. Other countries are shown by grey circles. It is clear that Sub-Saharan African countries lag behind in terms of real GDP per capita and the degree of backward integration (VS), in comparison with East Asia and some of the Southeast Asian countries. However, the degree of GVC participation through forward integration (VS1) looks rather higher in Sub-Saharan African countries than in their Asian counterparts.

Figure 5. GDP per capita and GVC participation (2015)



Source: VS and VS1 are computed based on the EORA-MRIO database, and GDP per capita is drawn from IMF's *World Economic Outlook Database*, October 2018.
Note: The horizontal axis measures real GDP per capita (ln (gdppc)) and the vertical axis measures VS and VS1. The same applies to Figures 6 to 9.

As already discussed in Section 2, location matters. GVC activity tends to be organized around large manufacturing hubs—the larger the distance to the main manufacturing hubs in Europe, North America and Asia, the lower the backward engagement, suggesting that there is a premium to locating close to large "headquarter" economies. Indeed, one of the key observations from the development experiences of Asian countries is that these nations grew simultaneously, or one after another, as if there were chain reactions (Akamatsu, 1962). It is true that open trade policies in the United States offered tremendous opportunities for Asian countries to export, and the resulting export-oriented industrialization was key to the successful economic development of Asian countries. However, it is also important to note that Asian countries were offering markets among themselves, as well as servicing the huge markets in advanced countries from a distance. Although the size of each market was smaller than those in the United States or European countries, they locate in proximity. Against this backdrop, we computed a measure of market proximity ($mkrprox_{ct}$) of country c at year t as:

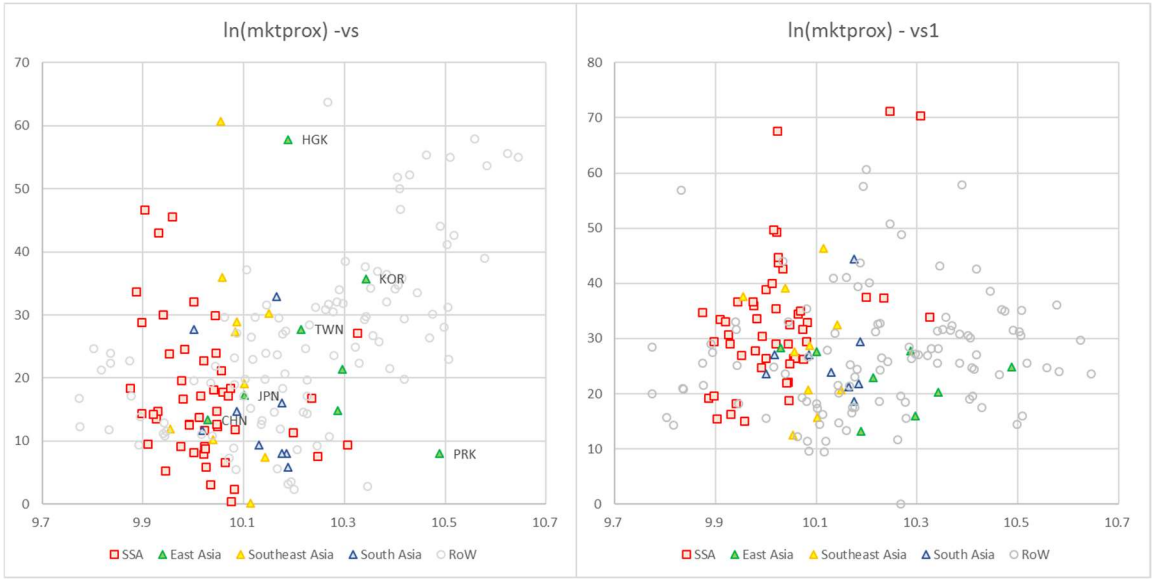
$$mktprox_{ct} = \sum_{a=1,\neq c}^{189} \left(\frac{ngdpd_{at}}{dist_{ca}}\right) \qquad \ldots\ldots (8)$$

where $ngdpd_{at}$ is nominal GDP (in US dollars) in country a at year t, and $dist_{ca}$ is the distance between capital cities of country c and country a.[12] The rationale for this

[12] Nominal GDP is taken from the IMF's *World Economic Outlook Database*, October 2018, and the distances between capital cities are based on the GeoDist Database maintained by CEPII.

indicator is very simple and is similar to the basis of the gravity models. A higher value indicates more market opportunity in the neighborhood, and is expected to encourage GVC participation in terms of both VS and VS1.

Figure 6. Market proximity and GVC participation (2015)



Source: VS and VS1 are computed based on the EORA-MRIO database, and the proximity to markets is computed based on the IMF's *World Economic Outlook Database*, October 2018; and the GeoDist database developed by Mayer (2011) and maintained by CEPII.

Figure 6 shows the relationship of the index of market proximity with VS and VS1. It is clear that Sub-Saharan African countries are in a disadvantageous position in terms of proximity to markets in comparison with their Asian counterparts, where countries offer growing domestic markets to each other. It appears that VS is positively associated with proximity to markets, but the relationship with VS1 is not clear.

Tariffs are natural and important determinants of GVC participation. We use import tariffs and tariffs faced when a country exports differently. The import tariff of country *c*, in sector *i*, in year *t* (im_tariff_{cit}) is defined as:

$$im\_tariff_{cit} = [average\ tariff\ rate]_{ct} * ims_{cit}, \qquad \ldots\ldots (9)$$

where "average tariff rate" is taken from the World Bank's World Development Indicators (WDI) database, and ims_{cit} is the import share of intermediate inputs of industry *i* of country *c* in year *t*. Here, a higher value indicates the industry has a higher tariff barrier and is therefore expected to discourage GVC participation (lower VS) in the given industry.

Similarly, the export tariff of country c, in sector i, in year t (ex_tariff_{cit}) is defined as:

$$ex\_tariff_{cit} = \sum_{d=1}^{189}[average\ tariff\ rate]_{dt} * exs_{cit}^{d} \quad \ldots\ldots (10)$$

where exs_{cit}^{d} is the share of export to country d out of the value added in industry i of country c in year t. A higher tariff in export destination is expected to negatively affect forward participation (VS1).[13]

Figure 7 plots the average import tariffs against VS and VS1. A negative correlation is observed between the tariff and VS, but the relationship with VS1 is not clear. This might be because the tariff that is expected to affect VS1 is the tariff in the export destination, instead of import tariffs in the home country. This point will be investigated further in the next subsection.

Figure 7. Import tariffs and GVC participation (2015)

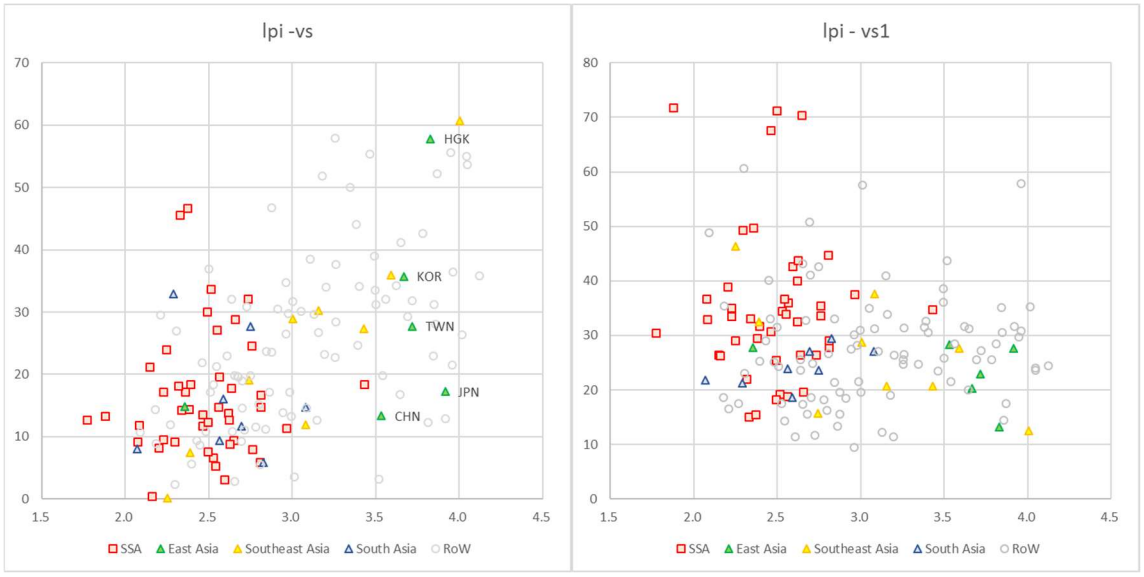
Source: VS and VS1 are computed based on the EORA-MRIO database, and import tariffs are based on average tariff rates in the World Development Indicators (WDI) developed and maintained by the World Bank, which are available at https://datacatalog.worldbank.org/dataset/world-development-indicators.

[13] We introduced this specification based on a suggestion by Prof. Lawrence Edwards at the University of Cape Town during a seminar on 11 February 2019.

Figure 8. Governance and GVC participation (2015)

Source: VS and VS1 are computed based on the EORA-MRIO database, and the governance level is measured by Worldwide Governance Indicators (WGI) developed and maintained by the World Bank, which are available at http://info.worldbank.org/governance/wgi/index.aspx#home.

Figure 9. Logistic performance (2014) and GVC participation (2015)



Source: VS and VS1 are computed based on the EORA-MRIO database, and the logistic performance is measured by Logistic Performance Index (LPI) developed and maintained by the World Bank, which is available at https://lpi.worldbank.org/.
Note: Due to data availability, LPI in the figure is for 2014.

4.3. Model and methodological issues

Our panel dataset consists of a maximum of 4,725 (= 189 countries × 25 sectors) observations for each year. As we use the data for four years, namely, 2000, 2005, 2010, and 2015, the total number of observations has a maximum of 18,900. However, most of the explanatory variables are at an aggregated national level, instead of sector levels, and the availability of data differ significantly by database and countries. Therefore, our panel dataset is inevitably unbalanced, and the available number of observations differs significantly by specification.

We divide explanatory variables into two broad groups: basic factors and policy factors. Basic factors are those expected to influence the degree of GVC participation, but beyond the scope of policy intervention at least in the short term, and include real GDP per capita (*gdppc*), and its squared term (*gdppc2*), population (*pop*), and the proximity to markets (*mktprox*). Policy factors are those expected to influence the degree of GVC participation and fall under the control of policy measures, and include tariffs (*im_tariff* for VS and *ex_tariff* for VS1), governance (*wgi*), logistic performance (*lpilag*), and unit labor costs (wage). Although the nominal wage is fundamentally determined in the labor market and is beyond the control of government policy, except for the case of setting a minimum wage, we regard this variable as a policy factor to consider the possibility of government policy to influence labor productivity. This is another important aspect of unit labor costs as discussed in Section 2, through the development of industrial infrastructure and capacity-building activities, such as the *Kaizen* project in Ethiopia and so on.

In estimation, after controlling for basic factors, we will investigate whether policy factors are significant or not. As explanatory variables are not sufficient to capture sectoral variations, we use dummy variables for each sector to control for sector-specific fixed effects. In order to control endogeneity, we use lagged variables as instruments except for *wgi* and *lpi*, where the data availability is limited. As the WGI is not available for 1999, we use the index for 1998 as the instrument in estimation. LPI is available only for limited years: 2007, 2010, 2012, 2014, 2016, and 2018. Therefore, we use the latest available lag as the explanatory variable. That is, LPI for 2007 is used in estimating VS and VS1 in 2010, and LPI for 2014 is used in estimating VS and VS1 in 2015.

Table 3 shows the correlation matrix of potential explanatory variables in this study. It is not surprising that the per capita GDP (*ln_gdppc*), governance (*wgi*), and the logistic performance (*lpilag*) are highly correlated, with coefficients greater than 0.8, which may cause unstable estimation due to multicollinearity. The correlations of these variables and the market proximity (*ln_mktprox*) are also relatively high.

Table 3. Correlation among explanatory variables

obs=6,368	*ln_ gdppc*	*ln_ pop*	*ln_ mktprox*	*im_ tariff*	*ex_ tariff*	*wgi*	*lpilag*	*wage*
ln_gdppc	1.000							
ln_pop	-0.141	1.000						
ln_mktprox	0.523	-0.172	1.000					
im_tariff	-0.364	-0.046	-0.175	1.000				
ex_tariff	-0.017	0.014	-0.039	-0.012	1.000			
wgi	0.845	-0.215	0.475	-0.289	-0.016	1.000		
lag_lpi	0.815	0.139	0.478	-0.284	-0.032	0.811	1.000	
wage	0.222	-0.123	0.195	-0.100	-0.038	0.263	0.215	1.000

Source: Authors.

4.4. Estimation results

Table 4 presents estimation results, offering several important implications.

First of all, the determinants of VS and VS1 are similar, but in many cases the signs of coefficients are opposite. Therefore, using PAR (=VS+VS1) as the dependent variable may lead to insignificant or sometimes wrong results. As most of coefficients have different signs between VS and VS1, one might suspects a negative correlation between VS and VS1. This is not always the case, however. In addition to the discussion based on Table 1 above, the correlation coefficients between VS and VS1 for all countries and sectors, i.e., 4,725 observations each year, are all significantly positive: 0.377 in 2000, 0.331 in 2005, 0.333 in 2010, and 0.337 in 2015.

The squared term of GDP per capita (*ln_GDPPC2*) is always positively associated with VS1, implying a U-shape relationship. In addition, *ln_GDPPC2* is almost always negatively associated with VS, in 30 out of 32 specifications, implying an inverted-U-shape relationship. Therefore our hypothesis on the non-linear relationship between the level of economic development and GVC participation is largely confirmed.

Population (*ln_pop*) is always negatively associated with VS and positively associated with VS1, at the 1% level of significance, in strong support of our hypothesis that larger economies tend to purchase intermediate inputs from domestic markets (lower VS) and supply intermediate products to external markets (higher VS1).

Market proximity (*ln_mktprox*) is a robust, positive determinant of GVC participation, with a 1% level of significance for most of the specifications, with higher influence on VS (backward integration) than on VS1 (forward integration). The difference in the coefficients might reflect the fact that forward integration in the form of exporting primary products is more prone to the factor endowment. For example, how far from

markets an oilfield is situated, it can still export petroleum, as long as it is highly valued relative to transport costs. In contrast, in the case of backward integration, which is more prevalent in the manufacturing sector, a country far from other industrialized countries has a disadvantage in access to manufactured intermediate inputs.

Tariff variables, both *im_tariff* in VS estimation and *ex_tariff* in VS1 estimation, did not produce the expected results. According to Table 3, import tariff (*im_tariff*) is positively associated with VS at the 1% significance level. It is difficult to find a reasonable explanation as to why a higher import tariff facilitates GVC participation through backward integration. The coefficients for export tariff (*ex_tariff*) are negative in many specifications, but not significant in explaining VS1. Further investigation on this issue is necessary, including the introduction of more precise measures of tariffs or other measures of regional integration.

The estimation results for governance (*wgi*) and logistic performance (*lpilag*) are similar, in the sense that both are significantly positively associated with VS, but negatively associated with VS1. This is probably due to moderate multicollinearity, including the tendency of *wgi* and/or *lpilag* to raise the absolute value of the coefficient of *ln_GDPPC*. However, it seems that the impacts on estimation results are not very serious. The difference in the coefficients on VS and VS1 might indicate that governance and logistic performance are important factors in facilitating Asian-style manufacturing-led economic development, but the same does not apply to forward participation through exporting primary products.

Unit labor cost (*wage*) is a significantly negative determinant for VS1, indicating that GVC participation by exporting intermediate inputs is negatively affected by "higher nominal wage" and/or "lower labor productivity." In contrast, the results on VS are not robust. As discussed above, although governments' control over nominal wages could be limited, policy measures to enhance labor productivity, such as education, capacity building, vocational training, and related infrastructure development can help the country to maintain relatively lower unit labor costs, and thereby facilitate GVC participation through forward integration.

Table 4. Estimation results

Dependent variable:	(1) vs	(2) vs1	(3) vs	(4) vs1	(5) vs	(6) vs1	(7) vs	(8) vs1
ln_gdppc	**-0.084**	**-0.338** ***	**0.381** ***	**-0.343** ***	**0.332** ***	**-0.668** ***	**0.416** ***	**-0.810** ***
	0.058	0.120	0.072	0.120	0.059	0.130	0.090	0.226
ln_gdppc2	**0.009** ***	**0.018** **	**-0.016** ***	**0.018** **	**-0.027** ***	**0.047** ***	**-0.032** ***	**0.054** ***
	0.003	0.007	0.004	0.007	0.004	0.009	0.006	0.015
ln_pop	**-0.066** ***	**0.034** ***	**-0.053** ***	**0.034** ***	**-0.042** ***	**0.015** **	**-0.152** ***	**0.091** ***
	0.004	0.007	0.005	0.007	0.004	0.007	0.008	0.017
ln_mktprox	**0.346** ***	**0.117** ***	**0.415** ***	**0.102** ***	**0.373** ***	**0.096** ***	**0.415** ***	**0.141** ***
	0.017	0.023	0.020	0.025	0.017	0.023	0.034	0.048
tariff #			**0.056** ***	**-0.018**				
			0.007	0.012				
wgi					**0.418** ***	**-0.332** ***		
					0.016	0.046		
lpilag							**0.669** ***	**-0.498** ***
							0.043	0.108
wage (ulc)								
_cons	**-6.900** ***	**1.157**	**-10.668** ***	**1.614** **	**-8.399** ***	**2.345** ***	**-11.478** ***	**3.372** **
	0.447	0.773	0.596	0.818	0.446	0.790	0.864	1.645
Fixed Effect (Country):	No	No	No	No	No	No	No	No
Fixed Effect (Sector):	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effect (Year):	No	No	No	No	No	No	No	No
Number of observation:	16,400	16,400	11,325	16,392	16,400	16,400	7,200	7,200
R-squared:	0.570	0.356	0.610	0.356	0.587	0.361	0.597	0.333

Dependent variable:	(9) vs	(10) vs1	(11) vs	(12) vs1	(13) vs	(14) vs1	(15) vs	(16) vs1
ln_gdppc	**-0.078**	**-0.404** ***	**0.851** ***	**-0.671** ***	**0.584** ***	**-0.817** ***	**0.399** ***	**-0.408** ***
	0.059	0.125	0.076	0.130	0.108	0.226	0.074	0.125
ln_gdppc2	**0.009** **	**0.022** ***	**-0.058** ***	**0.047** ***	**-0.041** ***	**0.055** ***	**-0.018** ***	**0.023** ***
	0.004	0.008	0.005	0.009	0.007	0.015	0.004	0.008
ln_pop	**-0.066** ***	**0.029** ***	**-0.032** ***	**0.015** **	**-0.146** ***	**0.091** ***	**-0.052** ***	**0.029** ***
	0.004	0.007	0.005	0.007	0.011	0.017	0.005	0.007
ln_mktprox	**0.345** ***	**0.128** ***	**0.431** ***	**0.085** ***	**0.427** ***	**0.140** ***	**0.411** ***	**0.114** ***
	0.017	0.023	0.020	0.025	0.038	0.047	0.020	0.025
tariff #			**0.056** ***	**-0.013**	**0.064** ***	**-0.008**	**0.056** ***	**-0.016**
			0.006	0.012	0.011	0.036	0.007	0.012
wgi			**0.509** ***	**-0.330** ***				
			0.021	0.046				
lpilag #					**0.672** ***	**-0.499** ***		
					0.059	0.109		
wage (ulc)	**0.049**	**-0.493** ***					**0.164** ***	**-0.488** ***
	0.043	0.107					0.054	0.107
_cons	**-6.910** ***	**1.240**	**-11.975** ***	**2.666** ***	**-12.560** ***	**3.465** **	**-10.674** ***	**1.650** **
	0.449	0.776	0.588	0.835	0.987	1.624	0.595	0.819
Fixed Effect (Country):	No	No	No	No	No	No	No	No
Fixed Effect (Sector):	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effect (Year):	No	No	No	No	No	No	No	No
Number of observation:	16,388	16,388	11,325	16,392	5,575	7,179	11,313	16,380
R-squared:	0.570	0.357	0.627	0.361	0.609	0.333	0.610	0.357

Dependent variable:	(17) vs	(18) vs1	(19) vs	(20) vs1	(21) vs	(22) vs1	(23) vs	(24) vs1
ln_gdppc	**0.629** ***	**-0.973** ***	**0.321** ***	**-0.691** ***	**0.421** ***	**-0.842** ***	**0.959** ***	**-0.979** ***
	0.092	0.244	0.060	0.133	0.091	0.230	0.115	0.243
ln_gdppc2	**-0.050** ***	**0.068** ***	**-0.027** ***	**0.048** ***	**-0.032** ***	**0.056** ***	**-0.070** ***	**0.068** ***
	0.006	0.017	0.004	0.009	0.006	0.015	0.007	0.017
ln_pop	**-0.104** ***	**0.054** ***	**-0.043** ***	**0.013** *	**-0.150** ***	**0.078** ***	**-0.089** ***	**0.054** ***
	0.009	0.017	0.004	0.007	0.009	0.017	0.011	0.017
ln_mktprox	**0.449** ***	**0.115** **	**0.377** ***	**0.105** ***	**0.413** ***	**0.159** ***	**0.467** ***	**0.115** **
	0.034	0.049	0.017	0.023	0.034	0.047	0.038	0.048
tariff #							**0.079** ***	**0.000**
							0.011	0.036
wgi	**0.371** ***	**-0.283** ***	**0.429** ***	**-0.309** ***			**0.447** ***	**-0.283** ***
	0.025	0.080	0.016	0.044			0.034	0.080
lpilag #	**0.390** ***	**-0.285** ***			**0.663** ***	**-0.458** ***	**0.383** ***	**-0.285** ***
	0.046	0.090			0.044	0.103	0.061	0.089
wage (ulc)			**-0.166** ***	**-0.339** ***	**0.095**	**-0.623** ***		
			0.044	0.094	0.063	0.178		
_cons	**-12.062** ***	**3.816** **	**-8.412** ***	**2.321** ***	**-11.445** ***	**3.122** *	**-13.871** ***	**3.850** **
	0.858	1.680	0.446	0.787	0.861	1.615	0.991	1.658
Fixed Effect (Country):	No	No	No	No	No	No	No	No
Fixed Effect (Sector):	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effect (Year):	No	No	No	No	No	No	No	No
Number of observation:	7,200	7,200	16,388	16,388	7,194	7,194	5,575	7,179
R-squared:	0.607	0.335	0.587	0.361	0.597	0.335	0.620	0.335

Dependent variable:	(25) vs	(26) vs1	(27) vs	(28) vs1	(29) vs	(30) vs1	(31) vs	(32) vs1
ln_gdppc	**0.848** ***	**-0.694** ***	**0.590** ***	**-0.849** ***	**0.629** ***	**-0.984** ***	**0.959** ***	**-0.989** ***
	0.077	0.133	0.109	0.230	0.092	0.245	0.115	0.245
ln_gdppc2	**-0.058** ***	**0.048** ***	**-0.041** ***	**0.057** ***	**-0.050** ***	**0.068** ***	**-0.070** ***	**0.069** ***
	0.005	0.009	0.007	0.015	0.006	0.017	0.007	0.017
ln_pop	**-0.032** ***	**0.013** *	**-0.144** ***	**0.078** ***	**-0.105** ***	**0.047** ***	**-0.089** ***	**0.047** ***
	0.005	0.007	0.011	0.017	0.009	0.018	0.011	0.018
ln_mktprox	**0.433** ***	**0.095** **	**0.423** ***	**0.159** ***	**0.450** ***	**0.134** ***	**0.468** ***	**0.134** ***
	0.020	0.025	0.038	0.046	0.034	0.048	0.038	0.047
tariff #	**0.056** ***	**-0.012**	**0.066** ***	**-0.004**			**0.079** ***	**0.002**
	0.006	0.012	0.011	0.036			0.011	0.036
wgi	**0.513** ***	**-0.308** ***			**0.372** ***	**-0.253** ***	**0.448** ***	**-0.254** ***
	0.022	0.044			0.026	0.077	0.034	0.077
lpilag #			**0.664** ***	**-0.458** ***	**0.391** ***	**-0.272** ***	**0.383** ***	**-0.272** ***
			0.061	0.103	0.046	0.089	0.061	0.088
wage (ulc)	**-0.065**	**-0.336** ***	**0.121**	**-0.623** ***	**-0.025**	**-0.541** ***	**-0.009**	**-0.542** ***
	0.053	0.094	0.081	0.178	0.060	0.164	0.080	0.164
_cons	**-11.988** ***	**2.620** ***	**-12.506** ***	**3.183** **	**-12.078** ***	**3.553** ***	**-13.880** ***	**3.564** **
	0.587	0.830	0.980	1.589	0.856	1.646	0.985	1.619
Fixed Effect (Country):	No	No	No	No	No	No	No	No
Fixed Effect (Sector):	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effect (Year):	No	No	No	No	No	No	No	No
Number of observation:	11,313	16,380	5,569	7,191	7,194	7,194	5,569	7,191
R-squared:	0.627	0.361	0.609	0.335	0.607	0.337	0.620	0.337

Source: Authors' estimation.

Notes: Figures in second rows are robust standard errors, and ***, **, and * indicate significance levels of 1%, 5%, and 10% respectively.

5. Policy implications and concluding remarks

This study has investigated factors facilitating the participation into GVCs, with the objective of drawing policy implication for Sub-Saharan African countries. GVC participation indexes computed based on the EORA-MRIO database reveal that the degree of GVC participation differ significantly by region, country, sector, time, and the modes of integration (forward or backward).

Based on our econometric analyses, we can draw the following implications to facilitate the GVC participation of Sub-Saharan African countries. First, governance does matter in order to facilitate GVC participation through backward integration. Second, the same applies to the logistic performance. Higher LPI is found to be a facilitating factor. Third, as higher unit labor costs can have negative impacts on GVC participation through backward integration, it is important to enhance labor productivity through various policy measures, including education, capacity-building activities, vocational training, and related infrastructure development.

We also find an inverted-U-shape relationship between VS and the level of economic development, and a U-shape relationship between VS1 and the level of economic development, as hypothesized based on the development experiences of Asian countries. This implies that the Asian-style development model, known as the flying geese, may be applicable to other parts of the world, including Sub-Saharan Africa.

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