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Evolution of Global Value Chains Participation and Economic Growth in Africa

Ibrahim Nana[†] and Martin Paul Jr. Tabe-Ojong [‡1]

Abstract: Global value chains offer countries unique opportunities to participate in and benefit from international trade by specializing in specific production stages and tasks. The objective of this study is twofold: (i) to investigate the evolution of African countries participation in global value chains and (ii) assess the impact of global value chains participation on growth. We use the EORA Multi-Region Input-Output tables to track the evolution of African countries along global value chains, identify specialization patterns, and generate sector/task global value chains participation measures. Further, using panel data from 48 African countries over the period 1990-2016, we employ both the instrumental variable approach and the local projection method to investigate the relationship between global value chains participation and growth, and provide evidence on the sectors that drive the relationship. The findings suggest that African countries' participation in global value chains positively impacts their growth; a positive impact which is driven by trade in commodities, knowledge intensive good and regional processing. We discuss some key policy implications, including the necessity to promote skill upgrading, skill-based technological change, and various education and labor market programs.

Keywords: *Global Value Chains; Trade; Growth; Africa*
JEL Classification : F14, F15, F43, 047, O55,

1. Introduction

Global value chains (GVCs) are rapidly evolving globally with increasingly participation from developing countries. The quick expansion of GVCs occurred due to increased capital mobility under the accelerated pace of financial globalization and decreased transaction costs. It has also been favored by multinationals that conquer international markets to optimize production. This move of multinationals to the global arena through production fragmentation, offshoring, and outsourcing has paved the way for other firms to engage in GVCs, with many efforts geared at

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balancing efficiency and risks. Consequently, GVCs represent an emerging opportunity in recent years in not only connecting countries but also raising their competitiveness in world trade (WTO, 2014).

GVCs participation has been highlighted to induce structural change by transforming the nature of production (Lim and Kim, 2022). It is also associated with increasing income streams (Van den Broeck, Swinnen and Maertens, 2017) with implications for economic welfare and development (Dünhaupt and Herr, 2022; Pahl and Timmer 2020). GVCs can promote economic development through several channels. For Emerging Market and Developing Economies (EMDEs), GVCs participation is viewed as a fast track to industrialization as it allows countries to benefit from the comparative advantages of other countries both at the sectoral and production stages within the sectors (Raei and Ignatenko, 2019). Until recently, many African countries have long been excluded from the industrialization game, because of the required capital investments and technological knowledge. GVCs offer these countries unique opportunities to specialize in different stages of production, allowing them to participate in the production of complex products (Inomata and Taglioni, 2019). Recent studies have also highlighted that GVCs participation induces technological progress (Nana, 2022; Wang and Song 2021), increases firms and countries' productivity (Amiti and Konings, 2007; Pahl and Timmer, 2020), generates rising markups (Loecker et al. 2016), and leads to growth and structural transformation (Goldberg et al., 2010; Sampson, 2016). GVCs participation has also been associated with increasing employment shares and job creation effects (Banga, 2016; Farole, 2016; Lim and Kim, 2022) with significant labor market implications (Lee and Yi 2018).

So far, there exists some evidence about the growth implications of GVCs participation (Jangam and Rath, 2021; Jithin, Ashraf and Umar, 2023; Obeng, Mwinlaaru, and Ofori, 2022). Using a sample of 58 countries over the period 2005–2015, Jangam and Rath (2021) employed a system-generalized method of moments (GMM) estimator by Blundell and Bond (1998) to examine the relationship between GVCs and Gross Domestic Product (GDP). Their findings indicate that GVCs trade spurs GDP positively by 0.07 percent. The results also suggest that a 1 percent increase in Forward GVCs Participation and Backward GVCs Participation increases GDP by 0.02 percent and 0.13 percent, respectively. Recently, Jithin, Ashraf and Umar, (2023) investigated the threshold effects of GVCs participation on economic growth for 62 economies for the period 2000–2018. Using a dynamic panel threshold regression model, they find that participation in GVCs induces economic growth. They find that GVCs participation is negatively associated with economic growth in countries with lower and moderate economic growth, while GVCs participation has positive and significant impacts on economic growth in countries with higher economic growth. While most existing studies on this topic have focused either on EMDEs or on advanced economies, Obeng, Mwinlaaru, and Ofori, (2022) is one of the few studies that has examined the impact of GVCs participation on growth in Africa. They investigated the effect of GVCs participation on inclusive growth for 19 Sub-Saharan African countries over the period 1991 to 2017, using a system GMM estimator. Their results highlight that GVCs participation drives inclusive growth through job creation. Besides, none of the existing studies has undertaken a full breakdown of sectoral participation in GVCs in Africa to

confirm the positive impact observed for EMDEs and to understand the type of sectoral specialization driving the positive impact of GVCs participation on economic growth.

We build on this gap in the literature by examining the impact of GVCs participation on economic growth in Africa and taking a sectoral approach to identify the drivers of the impact. We investigate the relationship between GVCs participation and economic growth in two steps. First, through descriptive statistics, we identify and track the evolution of various countries' participation and position in GVC as well as identify patterns of specialization. Second, we investigate the relationship between GVCs participation (conditioned by the type of specialization) and position on economic growth. In doing so, we classify sectors into six broad GVC archetypes in order of ascending average product complexity: commodities, labor-intensive services, labor-intensive goods, regional processing, knowledge-intensive services, and knowledge-intensive goods, as adapted from MGI (2019). These archetypes are used as an organizing framework to analyze the drivers of the impact of GVCs participation on growth. We then use a rich panel data of 48 countries over a period of 27 years (1990-2016) and employ different empirical strategies such as an instrumental variable estimator with the specification of theory led and innovative instruments to reduce potential concerns about endogeneity and a local projections approach to examine the response of GDP per capita to an increase in the level of GVCs participation.

The findings from the descriptive analysis suggest that African countries are more specialized in commodity-based goods/tasks, while advanced economies are more specialized in knowledge intensive goods/tasks. We also show that GVCs participation is positively associated with increasing GDP per capita among African countries. Deep diving into the relationship between GVCs and GDP per capita, our findings suggest that for African countries, the positive relationship between GVCs and GDP per capita is possibly driven by trade in commodity-based and labor-intensive goods products/tasks. These findings are in line with early studies which found that despite the opportunities created for developing countries to industrialize through GVCs, several developing countries, especially some African countries remain at the bottom of the chain, mostly specializing in resource-based activities (Foster-McGregor, Kaulich and Stehrer, 2015; Owusu, 2021). We also provide suggestive evidence that Forward GVCs participation is more effective than Backward GVCs participation in driving economic growth in African countries. Our results are robust to various variable transformations and alternative specifications. Findings from the local projection show that the positive impact of GVCs participation reaches its highest level in the third year after the increase in GVCs participation. In this regard, our analysis provides an improved understanding pertaining to GVCs which may be relevant in stirring economic development in Africa. In the face of growing poverty in many developing nations, our study provides some entry and leveraging points for policy in a bid to reduce poverty, boost shared prosperity and fast-track economic development in Africa.

The rest of the paper is organized as follows. Section 2 describes the construction of the data set and the various sources where data was obtained. It also offers some description of the variables used in the estimations. Section 3 establishes some stylized facts, discussing some of the descriptive results on the evolution of African countries participation in GVCs. The empirical strategy for establishing the relationship between GVCs and growth is then presented

in section 4. The results are discussed in section 5 with the robustness checks and section 6 concludes the article and provide the key policy implications.

2. Empirical Application

2.1 Data

This study is based on a constructed panel data from 48 African countries from 1990-2016. This panel was constructed based on different datasets and databases. To construct the outcome variable of interest, we collate information from the World Development Indicators (WDI) databank. Hosted by the World Bank, WDI has relevant, high quality and globally comparable statistics about key development indicators. It has various time series indicators for different economies and country groups. The main outcome variable of the study, obtained from WDI is GDP per capita which measures the market value of all goods and services produced within a county divided by its total population. It is reported in constant US $. GDP per capita is GDP divided by mid-year population. To measure participation in GVCs and compute various participation indices, we used world Input Output (IO) tables from EORA Multi Region Input-Output (EORA-MRIOs) tables sourced from the UNCTAD-Eora GVCs database. This database provides input-output tables for different regions by country and sectors. More information on key outcome variable and GVCs participation calculations are presented with fine details below. Information on other controls used in the regression framework was obtained from different sources. Some of these variables include private and public investment from the International Monetary Fund (IMF), human capital, measured through school enrollment ratio, population, and natural resources rent from WDI, and democracy and institutions from the Center for Systemic Peace.

2.2 Measurement of GVCs participation

To compute GVCs participation indices, we used IO tables from EORA-MRIOs tables, following the export decomposition framework of Koopman, Wang and Wei, (2014). This framework allows to track the evolution of African countries integration into GVC by country/sector (Figure A3). The methodology goes from raw IO tables (see Table A13 in appendix) to sophisticated GVC measures obtained through decomposition of gross exports. One objective of this study is to delve deep in identifying GVCs participation at the sectoral level. Given that sectoral data are not available coupled with the fact that the available IO tables obtained from EORA-MRIO databases are only available for the period 1990-2016, we compute our own GVCs participation measures.

According to Koopman et al (2014), gross exports, the sum of bilateral exports can be decomposed into several elements namely domestic value-added in direct final goods exports (VAEFD), domestic value-added in intermediates exports absorbed by direct importers (VAEI1), domestic value-added in intermediates re-exported to third countries (VAEI2) (this first three elements represent value-added exports - VATRD), domestic value-added in intermediates that returns via final imports (VARHF), domestic value-added in intermediates that return via intermediates imports (VARHI), foreign value-added in final goods and

intermediates goods exports (FVA) and pure double counted values of trade in value added (two terms). See the integral demonstrations in Koopman et al (2014).

$$VATRD = V_s \sum_{r \neq s}^{G} B_{ss} Y_{sr} + V_s \sum_{r \neq s}^{G} B_{sr} Y_{rr} + V_s \sum_{r \neq s}^{G} \sum_{t \neq s,r}^{G} B_{sr} Y_{rt} \quad (1)$$

$$VARH = VARHI + VARHF = V_s \sum_{r \neq s}^{G} B_{sr} Y_{rs} + V_s \sum_{r \neq s}^{G} B_{sr} A_{rs} \ (I - A_{ss})^{-1} \ Y_{ss} \quad (2)$$

$$FVA = \sum_{t \neq s}^{G} \sum_{r \neq s}^{G} V_t B_{ts} Y_{sr} + \sum_{t \neq s}^{G} \sum_{r \neq s}^{G} V_t B_{ts} Y_{sr} \ (I - A_{rr})^{-1} Y_{rr} \quad (3)$$

$$Pure\ DC = V_s \sum_{r \neq s}^{G} B_{sr} A_{rs} \ (I - A_{ss})^{-1} \ E_s + \sum_{t \neq s}^{G} V_t B_{ts} A_{sr} \ (I - A_{rr})^{-1} \ E_s \quad (4)$$

Where *G* represents countries, $\boldsymbol{A}$, and $\boldsymbol{B}$ are *GN x GN* matrices; $\boldsymbol{V}$ and $\boldsymbol{VB}$ are *G x GN* matrices. $\boldsymbol{V_s}$ denotes a *l x N* row vector of direct value-added coefficient, $\boldsymbol{A_{sr}}$ is a *N x N* block input-output coefficient matrix, $\boldsymbol{B_{sr}}$ denotes the *N x N* block Leontief inverse matrix, which is the total requirement matrix that gives amount of gross output in producing country *s* required for a one-unit increase in final demand in destination country *r*. $\boldsymbol{X_{sr}}$ is a *N x 1* gross output vector that gives gross output produced in *s* and absorbed in *r*. $\boldsymbol{X_s} = \sum_r^G \boldsymbol{X_{sr}}$ is also a *N x 1* vector that gives country s' total gross output. $\boldsymbol{Y_{sr}}$ is a *N x 1* vector give final goods produced in *s* and consumed in *r*. $\boldsymbol{Y_s} = \sum_r^G \boldsymbol{Y_{sr}}$ is also a *N x 1* vector that gives the global use of s' final goods.

Aggregated GVCs participation, is therefore the sum of domestic value-added exported used as imported inputs by other countries to produce their exports, $VS1_s$ and the foreign value-added in gross exports (FVA) as shown in Equation 5.

$$\boldsymbol{GVC\ participation_s} = VS1_s + FVA_s \quad (5)$$

With

$$VS1_s = V_s \sum_{r \neq s}^{G} B_{sr} E_{r*}$$

The terms on the right-hand side of this equation refer to the forward and backward GVCs participation in value added, that is the amount of the value-added created at home and exported to foreign markets (Forward GVCs participation) and the extent to which a domestic country uses foreign value-added to produce its exports (Backward GVCs participation). Dividing the GVCs participation by the gross exports (E_s) gives the intensity of GVCs participation and the division of the each of the right-hand sides by the gross exports give the forward and backward GVC intensity, respectively.

$$\boldsymbol{GVCs\ Intensity_s} = \frac{VS1_s + FVA_s}{E_s} \quad (6)$$

$$\textbf{\textit{Forward}}\ \textbf{GVCs Intensity}_s = \frac{VS1_s}{E_s} \quad (7)$$

$$\textbf{\textit{Backward}}\ \textbf{GVCs Intensity}_s = \frac{FVA_s}{E_s} \quad (8)$$

We also calculate GVC position, derived from different measures of GVC (GVCs participation and GVCs intensity), to investigate whether countries are mostly involved in forward or backward integration and eventually identify the well-known smile curve (Figure A5). All measures are summarized below in Table 1.

$$\textbf{GVC position1}_s = \ln\left(1 + \frac{VS1_s}{E_s}\right) - \ln\left(1 + \frac{FVA_s}{E_s}\right) \quad (9)$$

Or

$$\textbf{GVC position2}_s = \ln(VS1_s) - \ln(FVA_s) \quad (10)$$

Table 1. Different type of measurement of GVCs

Measure	Description
Backward GVCs	Involves importing foreign inputs to produce goods and services for export. It is measured as the foreign content of exports (foreign value added, or FVA).
Forward GVCs	Involves exporting goods and services that become inputs in the exports of other countries. It comprises transactions in which a country's exports are not consumed in the importing country but are instead reexported (VS1) to a third country.
Total GVCs participation	The sum of the foreign value added, and the domestic value added in an export to a third country. (FVA + VS1)
GVCs intensity	GVCs intensity is a country's total GVCs participation as a share of its total trade. GVCs intensity = (FVA + VS1)/(Exports + Imports)
GVCs position	GVCs position measures the relative position of a sector or country within the GVCs, calculated as the log-difference between the upstream (VS1) and the downstream components (FVA) of GVCs participation.

Source: Authors' organization base on Koopman, Wang and Wei, (2014).

These indices are calculated on a country and sector level. EORA-MRIOs database is made of 26 sectors that we further group into different GVCs archetypes that are mutually exclusive following Qiang and Steenbergen, (2021) (See Table 2 and Table A4).

Table 2. Different GVCs archetypes

GVC archetypes	Associated Sectors
Commodities (Com)	Agriculture; Fishing; Mining and Quarrying; Petroleum, Chemical and Non-Metallic Mineral Products
Labor-intensive goods (LIG)	Textiles and Wearing Apparel

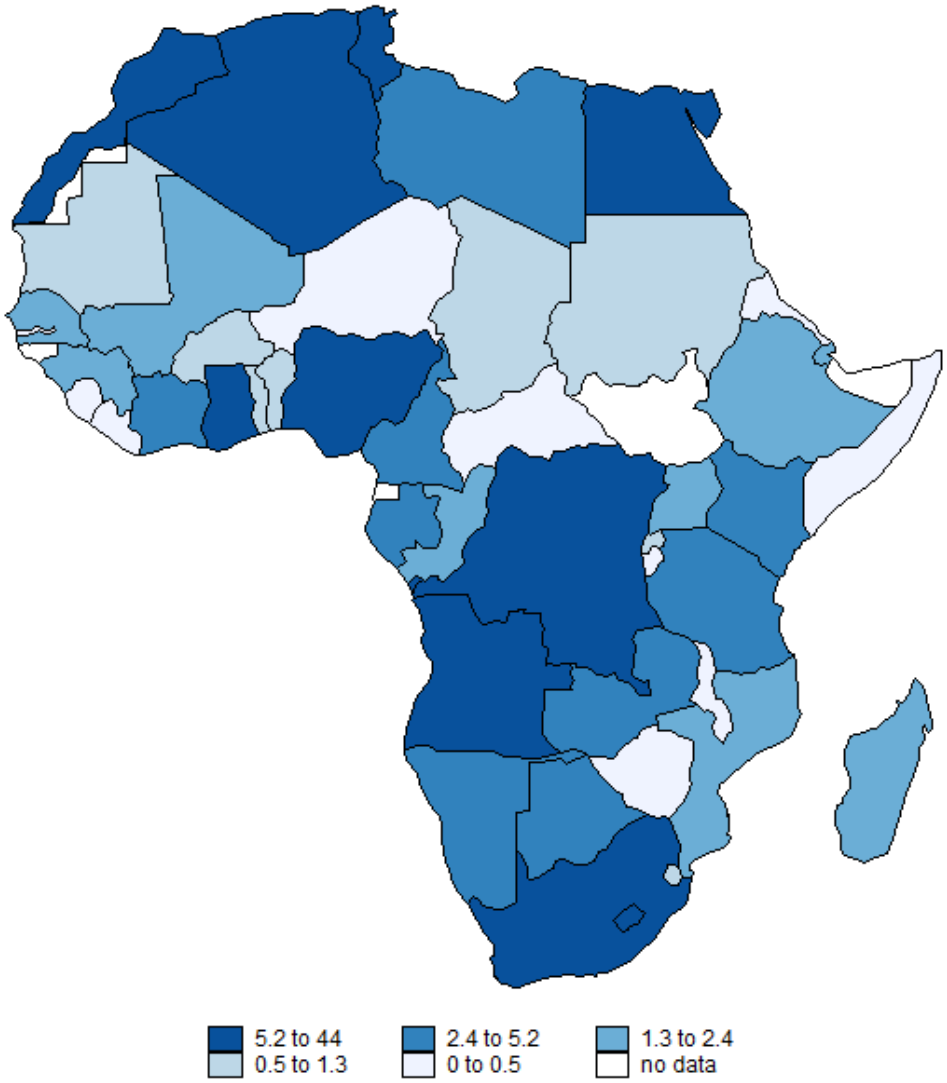
Labor-intensive services (LIS)	Construction; Maintenance and Repair; Wholesale Trade; Retail Trade; Hotels and Restaurants; Transport; Education, Health and Other Services
Regional processing (RP)	Food & Beverages; Wood and Paper; Metal Products; Other Manufacturing
Knowledge-intensive goods (KIG)	Electrical and Machinery; Transport Equipment
Knowledge-intensive services (KIS)	Post and Telecommunications; Financial Intermediation and Business Activities

3. Stylized facts on evolution of GVCs in Africa – Trend and drivers

There exists anecdotal evidence that shows that most of Africa is heavily involved in GVCs, though with significant heterogeneity across countries (Foster-McGregor, Kaulich, and Stehrer, 2015). This high involvement is accurate in terms of GVCs intensity but not valid when considering the level of GVCs participation (Figure 3-A *vs.* Figure 3-B). As shown in Figure 1, countries in the North (Algeria, Morocco, Egypt) and South (South Africa, Lesotho, Angola) of Africa are the most engaged countries in GVCs. South Africa has the highest level of GVCs participation. Other highly engaged countries are Nigeria, Democratic Republic of Congo and Ghana. Countries participate differently in GVCs along different sectoral lines. As shown in Figure A1 in the appendix, countries specialize in different sectors[2] and segments of production and broadly participate in GVCs based on their comparative advantage. To determine the position of African countries along value chains, their participation in GVCs can be compared with more advanced countries or GVC production hubs, as these are perfect benchmarks. This section first looks at the integration of African countries compared to GVC production hubs or other continents. It then presents the decomposition between forward and backward participation and finally focuses on African countries to identify the top countries that are well integrated and compare their sectoral specialization with the top GVC production hubs.

Figure 1. The level of GVCs participation in Africa (in $US Million)- 2016

[2] Sectors can be classified in several broad GVC components, focusing on their tradability (labor intensity and knowledge intensity). These components include commodities, regional processing, labor-intensive goods, knowledge-intensive goods, labor-intensive services and knowledge-intensive services (Qiang, Liu, and Steenbergen, 2021). Commodities exporters are most located in Sub-Saharan Africa and the Middle East, with few countries in Latin America and Asia. However, regional processing countries are mostly located in South America and Eastern Europe. Labor-intensive goods are produced around the world, involving countries such as Bangladesh, Pakistan, Turkey, Honduras and the Dominican Republic. Several countries from North America, Western Europe and East Asian and Pacific regions are involved in knowledge-intensive goods. African, Caribbean, and Pacific countries are involved in labor-intensive services. Knowledge intensive services, usually only next to knowledge-intensive goods are GVC segments that are located in many advanced countries such as the United States, Singapore and the United Kingdom.

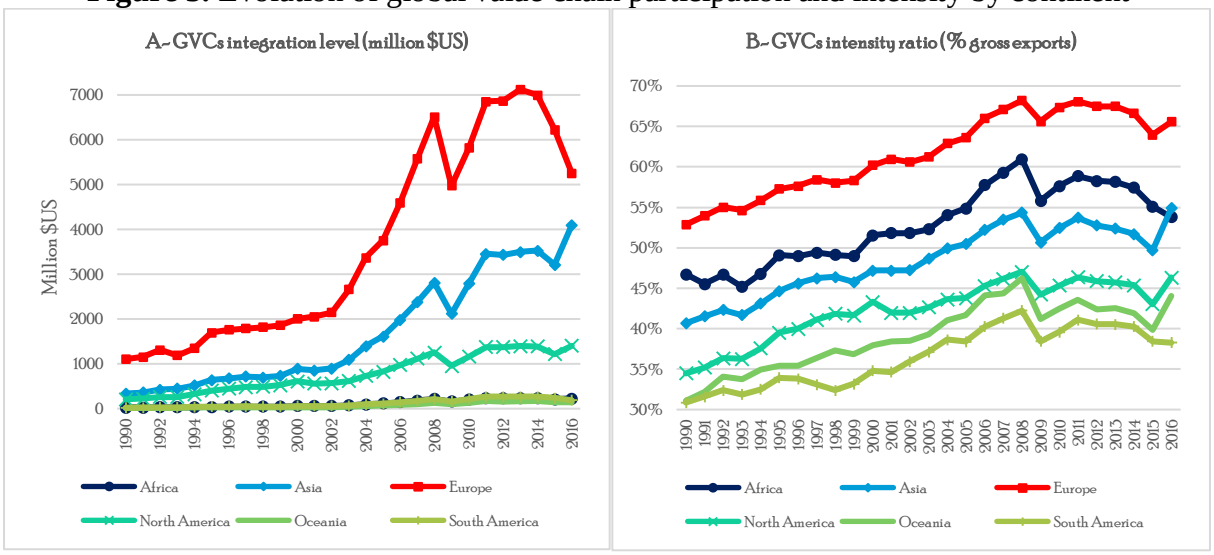


Source: Authors' calculations based on EORA-MRIO input output databases

African countries have an important share of their exports channeling through GVCs, but they capture the lowest value added from this participation.

When considering GVC intensity between 1990 and 2016, as shown in Figure 3-B, Africa is somewhat well integrated and comes after Europe and followed by Asia, North America, Oceania, and South America, respectively. However, Asia dethroned Africa in 2016 to become the second largest integrated region (In 2016 Asia GVC intensity was 55 percent *versus* 54 percent for Africa). The high integration of Africa earlier on in the 90s could be due to the high domestic value-added exports, which also demonstrates the place of Africa as a commodity supplier in the world. However, this metric on GVC intensity can be misleading since it gives the impression that GVCs participation in Africa is very high. Figure 3-A shows a different position for African countries in terms of the level of their participation in GVCs. They are among the countries that capture the lowest level of value added from their participation in GVCs, highlighting a low level of integration compared to other continents or integration into lowest value-added segments.

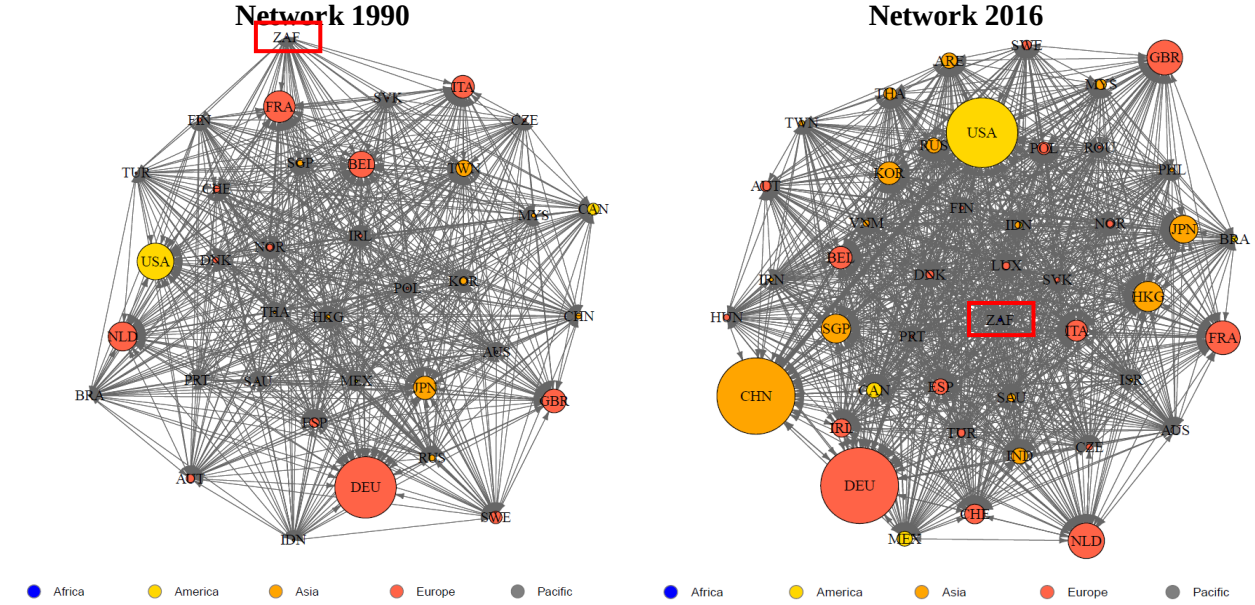
Figure 3. Evolution of global value chain participation and intensity by continent



Source: Authors' computation based on EORA-MRIO input output databases

Figure 2 presents a global simplified network analysis including all countries. While countries like China have shown a phenomenal growth in GVCs participation between 1990 and 2016, African countries cannot be seen on the nodes due to their low level of participation and the scale of the figure. South Africa is an exception here as can be captured in the red boxes. However, its participation is relatively small compared to other hub countries (in terms of the number of trade links/values) in the GVC network.

Figure 2. Global value chains and value-added exported network – world



Source: Authors' calculations based on EORA-MRIO input output tables 1990 - 2016.

Note: These two graphs are directed networks. The size of each node represents the level of gl obal value chain integration in $US and the thickness of the links represents value added expo rted. For network 2016, node sizes represent GVCs / $US 30 million and edge width based on bilateral value-added exports (Value added exports / $US 100 million). For network 1990 nod e sizes represent GVCs / $US 1 million while edge width based on bilateral value added expor ted (Value added exports / $US 100 million). Only bilateral links worth at least US$ 43 millio

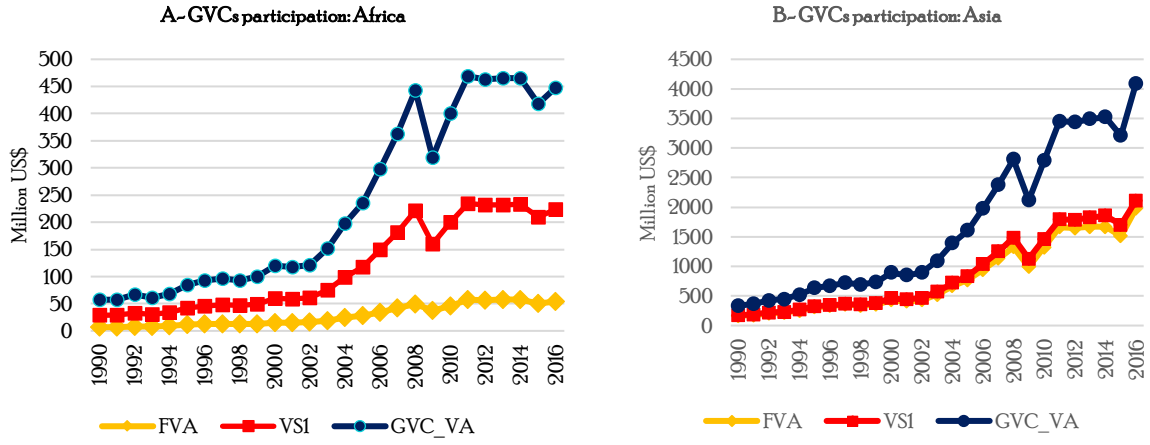
n are included in network 2016 ($US 7 million for network 1990). Nodes are colored by conti nent.

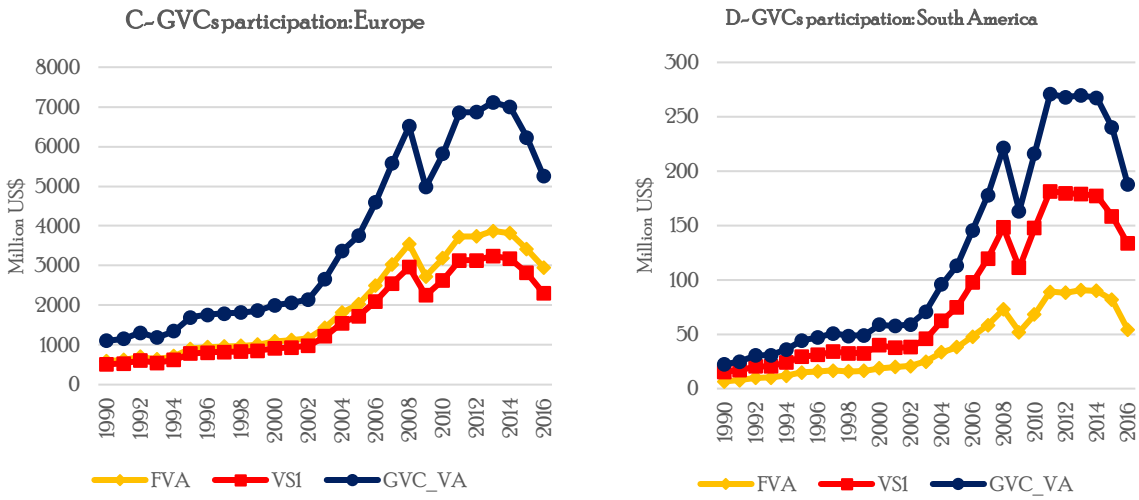
A decomposition of African countries GVCs participation highlight high forward GVCs participation, confirming commodity-based specialization.

Delving deeper through a decomposition of GVCs participation in Africa, we show that forward GVCs participation is higher than backward GVCs participation (Figure 4-A). This forward participation is a sign of high commodity exports, which does not create more value-added, and confirming the previous findings. However, this may not be the case for industrialized countries and most integrated African countries.

Forward GVCs participation is made of domestic value added that crossed borders several times. An assessment of domestic value-added exported in proportion of total, shows little differences between domestic value added exported by the world top GVCs production hubs (Figure A2) and African countries (Figure A6). While they are all mostly composed of value-added exports, we can clearly see that top GVC production hubs' domestic value added is made of a lower share of domestic content in intermediate exports that finally return home — but relatively higher than the similar figures in African countries' domestic value added. These figures show that inputs supplied by advanced economies have a relatively higher value than inputs exported by African countries. Given domestic content in intermediate exports used as inputs by other countries that finally return home represents a portion of forward GVCs participation, the difference in inputs' value explains the difference between in GVCs participation level observed between African countries and the world top GVC production hubs.

Figure 4. Decomposition of the evolution of global value chain participation



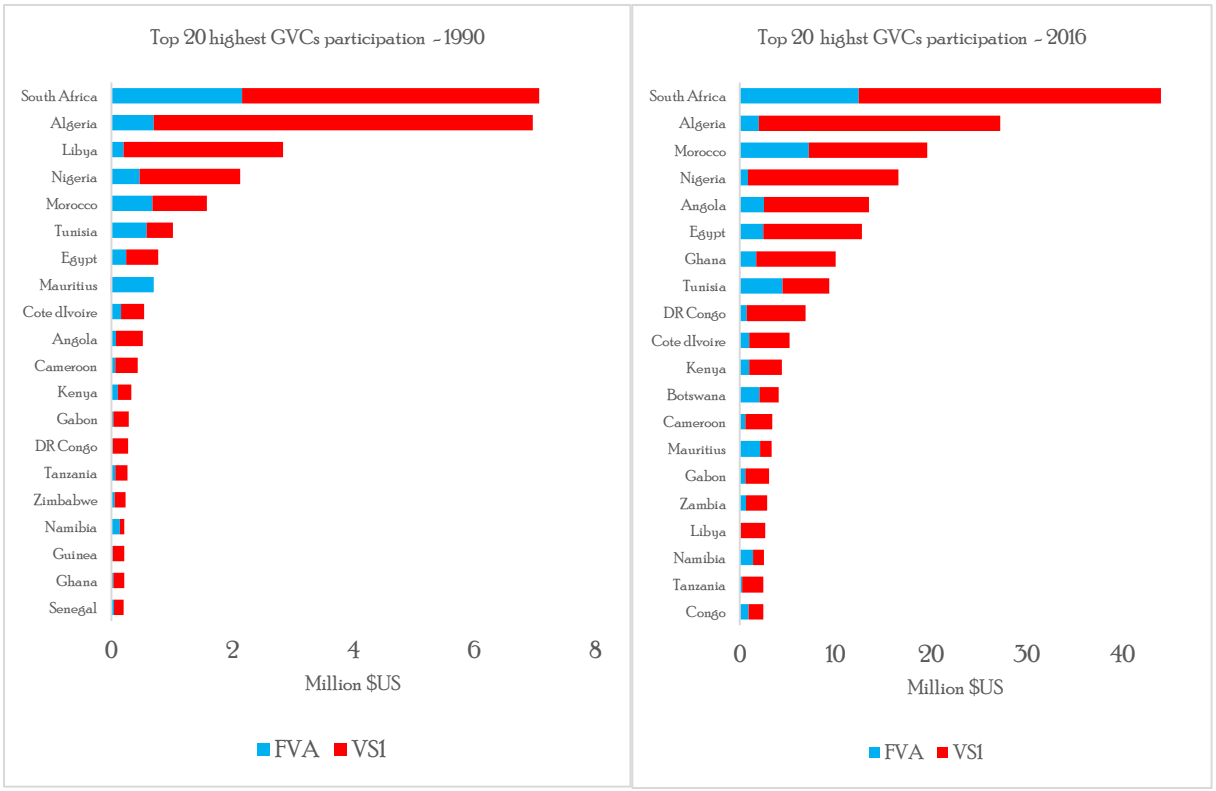


Source: Authors' computation based on EORA-MRIO input output databases
Note: FVA represents foreign value added embodied in exports; VS1 is domestic value added and GVC_VA represents GVCs participation as the sum of FVA and VS1.

Well integrated African countries: The nature of the measure of GVCs integration matters.

Like the regional rankings, the ranking of top African countries that are participating in GVCs depends on the measure considered. In 1990, Mauritius (87 percent), Lesotho (71 percent), Algeria (67 percent), DR Congo (59 percent) and Guinea (57 percent) had the highest GVC intensity. This ranking changed slightly in 2016 with Libya (86 percent), Djibouti (83 percent), Guinea (81 percent), Algeria (80 percent) and Burundi (80 percent) being the top countries with the highest GVC intensity (Figure A4 in the appendix). Given that this metric does not distinguish the value-added created by various countries, countries highly involved in commodity exports with relatively lower gross exports will tend to be ranked first compared to countries that export more. Returning to GVCs participation in value-addition, it is important to note that top African countries with the highest GVCs participation level did not change much since the 90s even though the rankings are different when using GVC intensity (Figure 5). In 1990 the top 5 African countries with the highest GVCs participation level were South Africa, Algeria, Libya, Nigeria, and Morocco. In 2016, South Africa was still topping the charts with a total GVCs participation level of $US 44 million, followed by Algeria ($US 27 million). The rest of the countries that make the top 5 included Morocco ($US 20 million), Nigeria ($US 17 million) and Angola ($US 14 million).

Figure 5 Top 20 countries with the highest GVCs participation level in Africa 1990-2016

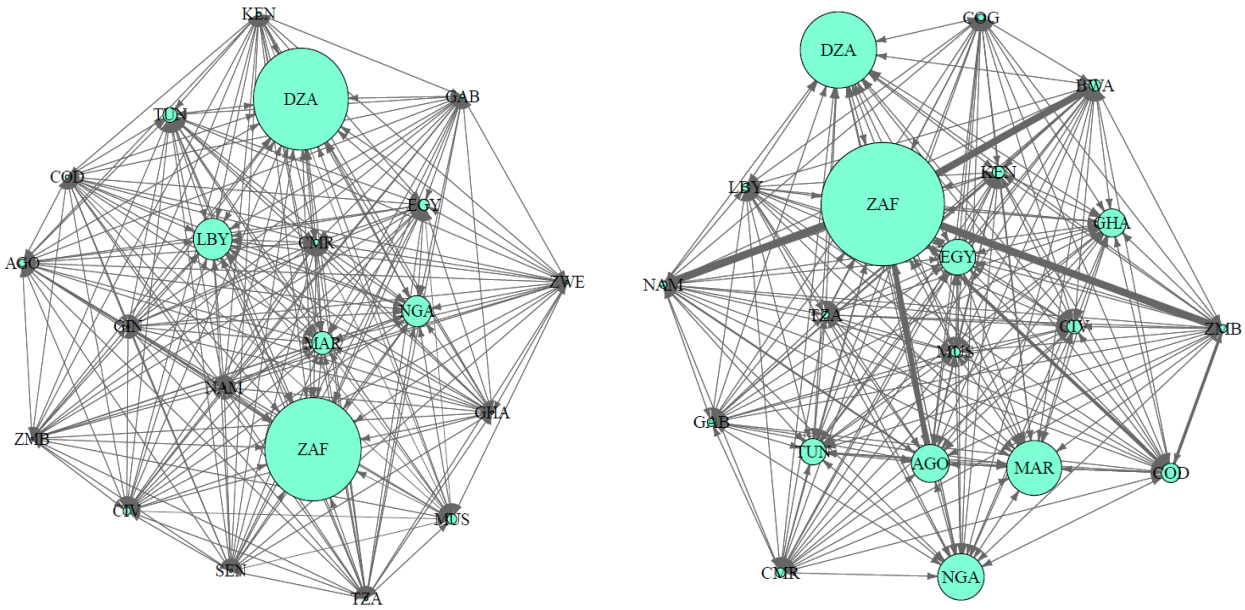


Source: Authors' computation based on EORA-MRIO input output databases

The dominant place of South Africa and Algeria in the African continent are evidenced by the network analysis presented in Figure 6. Focusing now on this intra-African network analysis we can clearly identify the biggest GVC actors in the continent and their trade in value added links. The 2016 network shows that in terms of value-added exports, the two biggest GVC production hubs are not actively exchanging (the thickness of the links represents value added exported). In terms of intra African trade, the biggest GVC actor, South Africa is exchanging much more with countries in Southern Africa like Zimbabwe, Botswana, Angola, and Namibia, which just represents their geographic neighbors.

Figure 6. Global value chains and value-added exported network – Africa

Network 1990 **Network 2016**



Source: Authors' calculations based on EORA-MRIO input output tables 1990 – 2016.
Notes: These two graphs are directed networks. The size of each node represents the level of global value chain integration in $US and the thickness of the links represents value added exported. For network 2016, node sizes represent GVCs / $US 100.000 and edge width based on bilateral value added exported (Value added exports / $US 500.000). For network 1990 node sizes represent GVCs / $US 500.000 while edge width based on bilateral value added exported (Value added exports / $US 500.000). Only bilateral links worth at least US$ 2 million are included in network 2016 analysis ($US 291160 for network 1990).

Sectoral Specialization: African countries behave differently from GVC production hubs.

Decomposing total GVCs participation into sectoral participation, we highlight that the world's top GVC production hubs are mostly involved in knowledge-intensive goods/tasks and services exports, while African most integrated countries' participation in GVC is mostly driven by commodity and less sophisticated products exports, except for a few countries (Table A1, Table A2 and Figure A1 in the supplementary material). The top sectors driving GVCs in South Africa are "mining and quarrying" (24 percent of total GVCs participation); "metal products" (16 percent); "petroleum, chemical and mineral products" (11percent); financial intermediation and business (10 percent) and electrical and machinery (7 percent). However, the rest of African countries with low GVCs participation (other than the top 5 well-integrated countries) do not have knowledge-intensive goods and services among their top 5 sectors driving GVCs as shown in Tables A1 and A2 in the supplementary material.

4. Methodology and empirical model

To establish the relationship between GVCs participation and position (forward vs. backward) on growth, we use panel data covering 48 countries over the period 27 years (1990-2016). Our empirical model is based on Mankiw, Romer and Weil, (1992) theoretical specification of the augmented Solow model. The empirical model is specified as:

$$\ln\left[{GDP}/{capita}\right]_{i,t} = \delta + \eta_i + \varphi_t + \alpha_1 \ln(GVCs\ participation)_{i,t} + \beta_1 \ln(Inv)_{i,t} + \beta_2 \ln(GovCons)_{i,t} + \beta_3 \ln(HK)_{i,t} + \theta Pop_{i,t} + \gamma \ln(NatRes)_{i,t} + \partial Polity4_{it} + \varepsilon_{i,t} \quad (11)$$

Where η_i and φ_t represents country-specific and time-specific effects respectively. $\ln(Inv)_{i,t}$ represents the logarithm of investment (measured by private investment- gross fixed capital formation); $\ln(GovCons)_{i,t}$ represents government consumption; $\ln(HK)_{i,t}$ is the logarithm of human capital (measured by average year of schooling), $\ln(Pop)_{i,t}$ represents the logarithm of active population (aged between 15 and 64) ; $\ln(NatRes)_{i,t}$ is the logarithm of natural resources rents; $Polity4_{i,t}$ represents political stability and $\varepsilon_{i,t}$ represents the stochastic error term.

We include a battery of controls to improve the precision of the model. The set of control variables include private investments that have been argued to be a key determinant of growth (Balasubramanyam, Salisu and Sapsford, 1996; Rasmidatta, 2011; Stiglitz and Yusuf, 2001). It is measured as gross fixed capital formation obtained from the IMF capital database. Government expenditures obtained from the World Bank WDI databases are also used as a proxy of public investment. It includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditures on national defense and security but excludes government military expenditures that are part of a government's capital formation. The data are in constant 2015 prices and expressed in U.S. dollars. Human capital, a fundamental determinant of economic growth, is included as another control variable. We proxy for human capital using the secondary school enrollment ratio[3]. The gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown.

Additionally, we include variables like population, and natural resources rent which also come from the World Bank WDI databases. Total natural resources rent is the sum of oil rent, natural gas rent, coal rent (hard and soft), mineral rent, and forest rent. Finally, we controlled for institutional quality which has been highlighted as crucial in the process of economic growth (e.g., Dawson, 1998; Góes, 2016). We use the Polity2 indicator from the polity4 database[4] to get country level information on the level of democracy. The Polity2 variable is a revised and combined version of the Polity score indicators, which captures the authority spectrum of the political regime on a scale from -10 (hereditary monarchy) to 10 (consolidated democracy). The summary statistics of all these variables are presented in the supplementary material.

4.1. Estimation techniques and identification strategy

We estimate Equations (11) using the fixed effect and instrumental variables estimators. The advantage of using the fixed effect estimator over the random effect model lies in its flexibility to control for time invariant unobserved heterogeneity without assuming strict exogeneity

[3] The gross enrollment ratio in secondary school measures the flow of human capital. This measure can be misleading for some developing countries because they may have a low enrollment ratio for a given year, giving the impression of a lack of sufficient human capital, while they have an important stock.

[4] The Polity dataset covers all major, independent states in the global system over the period 1800-2018 (i.e., states with a total population of 500,000 or more in the most recent year; currently 167 countries).

between the controls and unobserved heterogeneity. For this reason, the fixed effect estimator has been used as the work horse in estimating panel linear models. Our choice of the fixed effects estimator is further supported by the Hausman test.

After controlling for time invariant unobserved heterogeneity, we may still have endogeneity concerns arising from reverse causality and measurement error. While participation in GVCs has the potential to increase GDP per capita, through better trading opportunities, GDP per capita could also enhance participation in GVCs. This implies that beyond time invariant unobservables, there may be some time variant factors affecting this relationship. To control for this and any other residual endogeneity, we rely on instrumental variable estimators. Getting valid instruments is not trivial as they must be relevant and exogenous. This is even more the case in the trade led growth literature, where getting instruments exogenous to trade has been a challenge. Following Nana, Motelle, and Starnes, (2023) we make use of innovative instruments. We use four instruments namely the mean GDP of "top 5 export partners", the mean GDP of "top 5 import partner's GDP", the mean "distance to the top 5 GVC production hubs", and the country's "air transport freight capacity". These instruments satisfy both relevance and exogeneity conditions.

For the mean GDP of top 5 trade (exports and imports) partners, we argue that they are clearly relevant for GVCs participation and exogeneous to domestic growth. Mean GDP of Top 5 Trade partners is by construction external to domestic growth. The only way through which partners' income can impact domestic GDP is through trade[5], and GVCs trade constitutes an important share of global trade. An increase in trade partners' economic wealth may increase their demand for domestic products or their capacity to supply. The greater the increase in trade partners' GDP, the more countries trade with each other (demand and supply effects). The exclusivity of the instrument may be violated through capital flows from trade partners or remittances. However, the choice of top trade partners makes the trade dimension larger than the investment or the migration dimension.[6]

For the mean distance to the top 5 GVC production hubs, the gravity model provide evidence that bilateral distance is a significant determinant of international trade (see Frankel and Romer 1999). Countries tend to exchange more with their neighbors. On the contrary, countries that are separated from each other with a natural obstacle (landmasses or oceans) will tend to trade less or differently. Therefore, we considered the mean distance to the top 5 GVC production hubs as an instrument, which allows us to have a distance measure in a simple specification (not a gravity model). The closer a country is to a global production hub, the more it trades. Inspired by gravity models and their efficiency in predicting international trade, mean distance to top GVC production hubs constitutes an innovative and relevant instrument that has only been used in Nana, Motelle, and Starnes, (2023) so far. Despite this, some authors such as Fernandes, Kee and Winkler, (2022) listed distance to top GVC production hubs as an important

[5] We do not expect the trade of African partners to affect the GDP of the top five exporters, importers, and production hubs. However, this will be correlated with the trade intensity of the African countries.

[6] It would pose a problem if top five trade partners were similar to top five sources of foreign investment (or source of remittances). In that case, increase in partners GDP would increase not only trade between bilateral pairs, but also investment from one country to another, violating the requirement for a strong instrument.

determinant of GVCs participation. This study relies on the same concept and adapts it for use as an instrument.

Finally, regarding our last instrument, the country's air transport freight capacity, we argue that shipment technology has evolved. In addition to road and sea transportation, air transport capacity has been on the increase over the years. Due to technological progress, air freight capacity has increased, allowing faster and safe trade of some products including efficient shipment of perishable products. This variable is a good determinant of trade but may only affect growth through trade. It helps to isolate the trade impact of air transport improvement. This concept of air distance was used by Feyrer (2019) in a gravity model to predict exogenous trade. One can argue that air transfer freight capacity can impact growth through tourism for example, but this argument can be relevant in some cases and does not prevent the variable from being a relevant instrument. While, in general, air transport technology progress has also benefited both tourism and migration, affecting GDP and GDP per capita, the instrument measures air freight capacity only, which is dedicated to international trade and product shipments instead of human movements. Therefore, the instrument impacts GDP only because of its impact on trade.

Based on the above justifications, and following Nana, Motelle, and Starnes, (2023), these instruments[7] can significantly explain GVCs participation and they can only impact GDP per capita through trade. Besides, it is important to mention that getting valid instruments in a non-experimental setting is not trivial but given that we also control for time invariant unobserved heterogeneity, our instruments may be valid, making our estimates not overly biased if at all. In addition, the Sargan-Hansen test for overidentification accepts the null hypothesis that overidentifying restrictions are valid (see Tables A10 and A11 in the supplementary material). Furthermore, while not a test for instrument validity, the "weak identification test" rejects the null hypothesis of weak instruments, suggesting a relevance of our instrument (see Tables A12 in the supplementary material).

4.2 Local projections approach

To estimate the relationship between GVCs and growth, we follow Jordà (2005, 2017) local projections technique. The local projections approach is an alternative to Vector Autoregressive (VAR) models, but admittedly has several advantages. Some of these advantages are; (1) they can be estimated with simple least squares, (2) they provide appropriate inferences that do not require asymptotic delta-method approximations nor of complex numerical techniques for their calculation, (3) they are robust to misspecification in the Data Generating Process (Jordà 2005; Kpodar, Le Goff and Singh, 2019) and (4) they easily accommodate experimentation with highly nonlinear specifications that are often impractical or infeasible in a multivariate context. The model is presented as follows for each future period k,

[7] Despite this, one could argue against some of the instruments our innovative instruments. For instance, the GDP of top 5 trade partners may be correlated with GDP per capita through other routes such as investments, remittances and air transport capacity that can be correlated with improvement in tourism. However, we have argued and made significant effort to reduce biased that may be in the way of the IV. That said, finding strong and perfect instruments is not trivial especially in non-experimental studies.

$$\Delta_k Y_{i,t-1} = \propto_{i,k} + \delta_{t,k} + \theta_k \Delta\, GVCs_{i,t-1} + \sum_{j=1}^{l} \gamma_{j,k}\, \Delta Y_{i,t-j} + \sum_{j=0}^{l} \beta_{j,k} X_{i,t-j} + \varepsilon_{i,t,k} \qquad (12)$$

Where $\Delta_k Y_{i,t-1} = y_{i,t+k} - y_{i,t-1}$ and corresponds to change in GDP per capita difference from the base year $t-1$ up to year $t+k$ with k= 0,1, …,8; $\propto_{i,k}$ and $\delta_{t,k}$ are the country and time fixed effects; $\gamma_{j,k}$ captures the persistence of the logarithm of GDP per capita and $\beta_{j,k}$ capture the effect of a change in control variables. The Impulse Response Function is obtained by plotting the estimated coefficient θ_k for $k = 1, \dots, 8$.

5. Estimation results and discussion

5.1 Global value chains and growth

Table 3 shows the relationship between GVCs, and growth measured as GDP per capita. We estimate different specifications using both the fixed effects estimator and the instrumental variable (IV) estimator. In the first specification, we run a simple fixed effect model. Throughout all the specifications, we find evidence that GVCs participation increases GDP per capita. The results are robust to the different specifications as we find similar effect sizes. The finding suggest that the fixed effects underestimate the impact of GVCs participation. Using the IV estimation, we show that a 10-percentage point increase in GVCs participation level increases GDP per capita by 4.5 percentage points. While we find similar insights for forward GVCs, we find little or no evidence from the data about any relationship between backward GVCs and GDP per capita. Excluding all controls, we find a positive and statistically significant relationship between backward GVCs and GDP per capita as we show in the supplementary material (Table A9). However, this significance vanishes when we control for the endogeneity of GVCs. This result is probably due to the specialization of many African countries in commodity exports, which increases their forward GVCs participation level. Our findings on the positive relationship between GVCs and growth corroborate earlier findings on the productivity and growth impacts of GVCs (Amiti and Konings 2007; Pahl and Timmer 2020) with significant potentials for stirring development (Dünhaupt and Herr 2022).

Table 3. Estimates of the relationship between GVCs participation and GDP per capita

	OLS – OLS Fixed – Effect				**FE-IV**			
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log GVCs	0.0445***				0.458**			
	(0.0169)				(0.218)			
Log VS1		0.0574***		0.0678***		0.408**		0.398*
		(0.0159)		(0.0168)		(0.188)		(0.205)
Log FVA			-0.0101	-0.0251*			0.201	0.141
			(0.0127)	(0.0133)			(0.155)	(0.201)
Capital	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Labor	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Institutions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	626	625	626	625	397	396	397	396
R-squared	0.765	0.764	0.762	0.766	0.469	0.567	0.277	0.646
Id	41	41	41	41	34	34	34	34

Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Log GVCs is the logarithm of GVCs participation in terms of value-added (VS1 + FVA); Log VS1 is the logarithm of forward GVCs integration in terms of value-added; Log FVA is the logarithm of backward GVCs integration in terms of value-added. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Full results with all controls are presented in the supplementary material in **table A5**.

5.2 Insights from Sectoral GVCs

Using sectoral GVCs data, we further investigate which sectors of GVCs drive growth in GDP per capita. We aggregate the 26 sectors from the input-output country/sectoral data into six different GVCs archetypes (Table 1, Table A4 in the supplementary material), following the World Bank adaptation of MGI (2019). Estimating the relationship between the disaggregated GVCs participation and GDP per capita, we find that commodities, knowledge intensive services, labor intensive goods, and regional processing GVCs participation are positively associated with GDP per capita. Here we report higher coefficients for commodities and labor-intensive goods. A 10-percentage point increase in GVCs participation in commodities increases GDP per capita by 4.7 percentage point. These findings are in line with stylized fact highlighting a specialization of African countries in commodity-based trade and the positive impact observed for forward GVCs participation. The second driver of African countries growth is GVCs participation in labor intensive goods. The findings suggest that a 10-percentage point increase in GVCs participation in labor intensive goods increase GDP per capita by 4 percentage point (Table 4, column 1 to 6). This finding makes sense as African countries are still specialized in labor intensive goods trade. However, this may change as technology change provide alternatives to capture more value added with reduced labor force. This makes us to surmise that the positive relationship between GVCs participation and GDP per capita for African countries is driven by commodities, knowledge intensive good and regional processing trade. Knowledge intensive services also impact growth. These findings highlight that the current specialization of African countries drive growth but more important, they also show that switching from commodity trade to more knowledge intensive goods and services trade can help African countries capture more value-added in their participation into GVCs. This is especially true given that knowledge intensive goods and services trade make the top 5 sectors of top GVC production hubs' sectors.

Table 4. Estimates of sectoral GVCs participation and GDP per capita

	Instrumental Variable					
VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Log GVCs Com	0.466**					
	(0.196)					
Log GVCs KIG		0.218				
		(0.148)				
Log GVCs KIS			0.281**			
			(0.120)			
Log GVCs LIG				0.412**		
				(0.185)		
Log GVCs LIS					0.105	

					(0.245)	
Log GVCs RP						0.297**
						(0.119)
Capital	Yes	Yes	Yes	Yes	Yes	Yes
Labor	Yes	Yes	Yes	Yes	Yes	Yes
Institutions	Yes	Yes	Yes	Yes	Yes	Yes
Observations	397	397	397	397	397	397
Id	34	34	34	34	34	34
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes

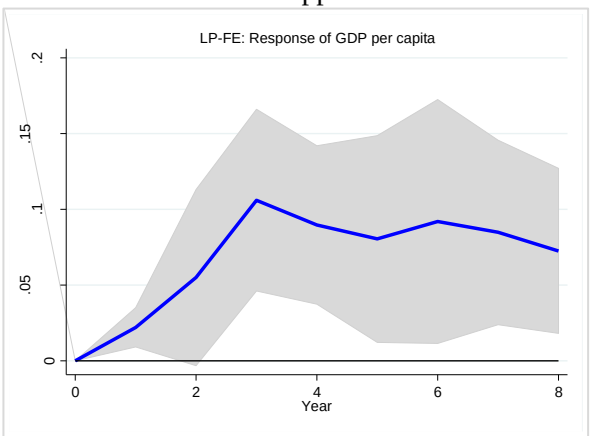
Note: Log GVCs Com is the logarithm of GVCs in commodities; Log GVCs KIG is the logarithm of GVCs in Knowledge-intensive goods; Log GVCs KIS is the logarithm of GVCs in Knowledge-intensive services; Log GVCs LIG is the logarithm of GVCs in Labor-intensive goods; Log GVCs LIS is the logarithm of GVCs in Labor-intensive services; Log GVCs RP is the logarithm of GVCs in Regional processing. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Full results with all controls are presented in the supplementary material in **table A7**.

5.3 Estimates of the local projections

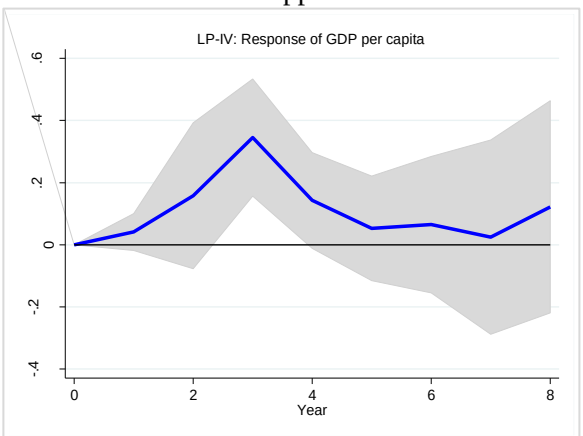
To investigate the response of GDP per capita to a change in GVCs participation, we rely on local projections to estimate Impulse Response Function (IRF). Local projection estimates consider both country and time fixed effects and can also rely on instruments presented above. The results of the local projections confirm previous findings and provide additional insights on GDP per capita. According to the findings, GVCs participation increases GDP per capita. The positive association starts immediately after the increase (year 1) and is significant as shown in figure 7. The impact stays positive and increases until year 3. It then begins to decrease in year 3 but stays positive and significant until year 8 (Figure 7A). When using the IV approach in our local projection method, the results show a positive association of GVCs participation on GDP per capita that is only significant at year 3 (Figure 7B). Our fixed-effects estimation confirms the existence of a positive and significant relationship starting from year 1 until year 8 (Figure 7A).

Figure 7. GVCs participation, GDP per capita

A- OLS approach



B- IV approach



Source: Results of the local projection estimations

Note: LP-FE represents the combination between local project and panel fixed -effects, which means that the equation has been estimated using the fixed effect approach. LP-IV refers to local projections with the equation estimated using the IV Method.

6. Conclusion

This paper fills a gap in the literature regarding the relationship between GVCs participation and growth for African countries. Using a constructed panel of 48 countries over 27 years from 1990 to 2016, this paper begins by presenting stylized facts on GVCs in Africa, with details at the sectoral level to identify the drivers of higher value-added captured through GVCs trade. After establishing this and generating GVCs participation measures, we use different empirical strategies like the panel fixed effects estimator, instrumental variable estimators, and local projection methods to link GVCs to growth.

We find three key results. First, the participation of African countries in GVCs is increasing but significant heterogeneity remains. While we do not explore what may be constraining participation in GVCs, it may be important for future research efforts to identify these factors as they may inform policy action. Second and related to the first, we establish a positive relationship between forward GVCs and economic growth but find little or no evidence for backward GVCs. Finally, we show that the positive relationship between GVCs and GDP per capita in Africa is explained by trading in commodities and labor-intensive goods.

In terms of policy implications, our findings clearly highlight the importance of promoting GVCs as they have the potential to stimulate economic growth which may enable some leapfrogging of African nations. In this case, investments in knowledges intensive goods and services should take central stage. Although trade in commodities and labor-intensive goods have a positive impact on growth, a shift from trade in commodities to trade in more knowledge-intensive goods and services can help African countries capture more value from their participation in GVCs. Therefore, African countries should promote policies to attract more technology, improve human capital levels, and create the necessary facilities to make the transition from commodity-based trade to more sophisticated and knowledge-intensive product trade.

To end, we mention some limitations of our study that could be taken up in future research agendas. In the first place, we guide the understanding of our analysis from an association point of view. We have controlled for many confounding factors including the three ruffians of endogeneity: unobserved heterogeneity, reverse causality, and measurement error. However, our employed strategies may not be perfect, especially given that we do not have experimental data. We thus refrain from implying any causality about the analysis. Notwithstanding, the insights from the analysis should be very much in order and suggestive of the impacts of GVCs on growth.

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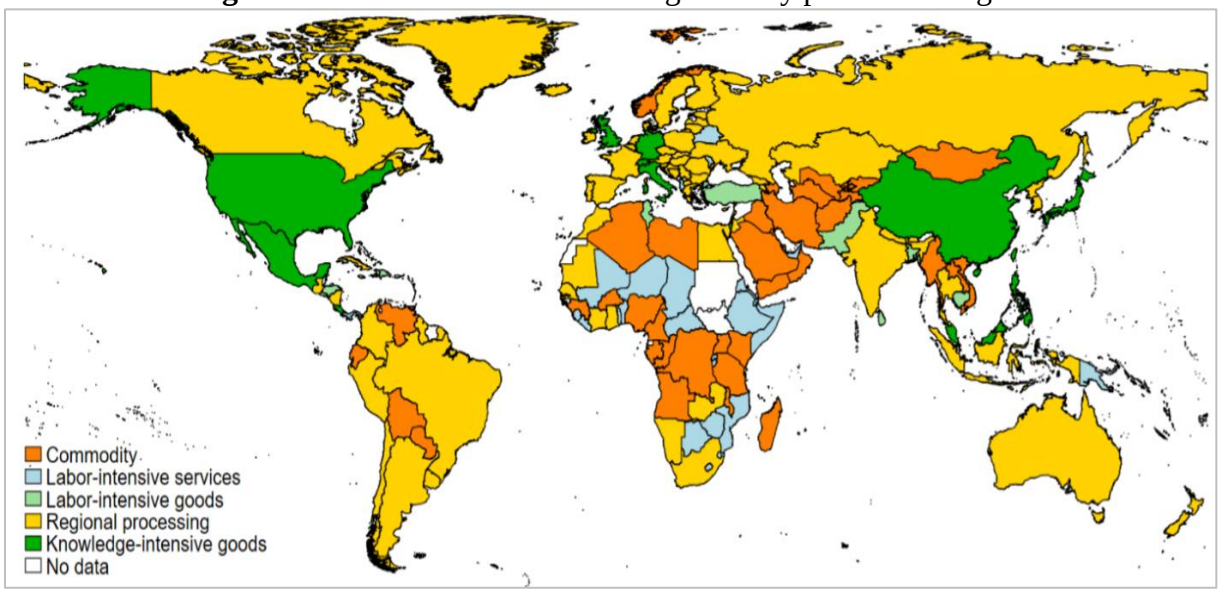
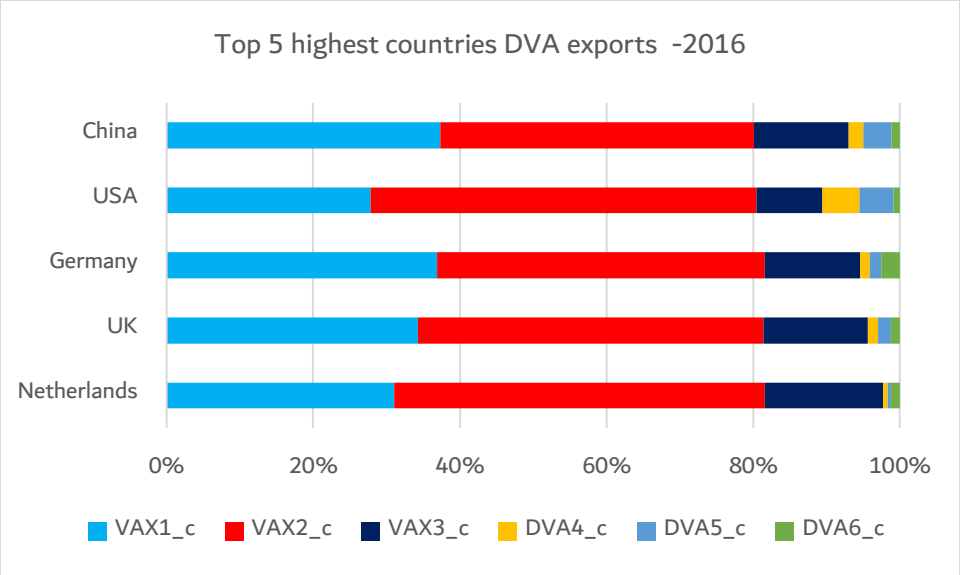
Supplementary material

Figure A1. Global value chains integration by production segment



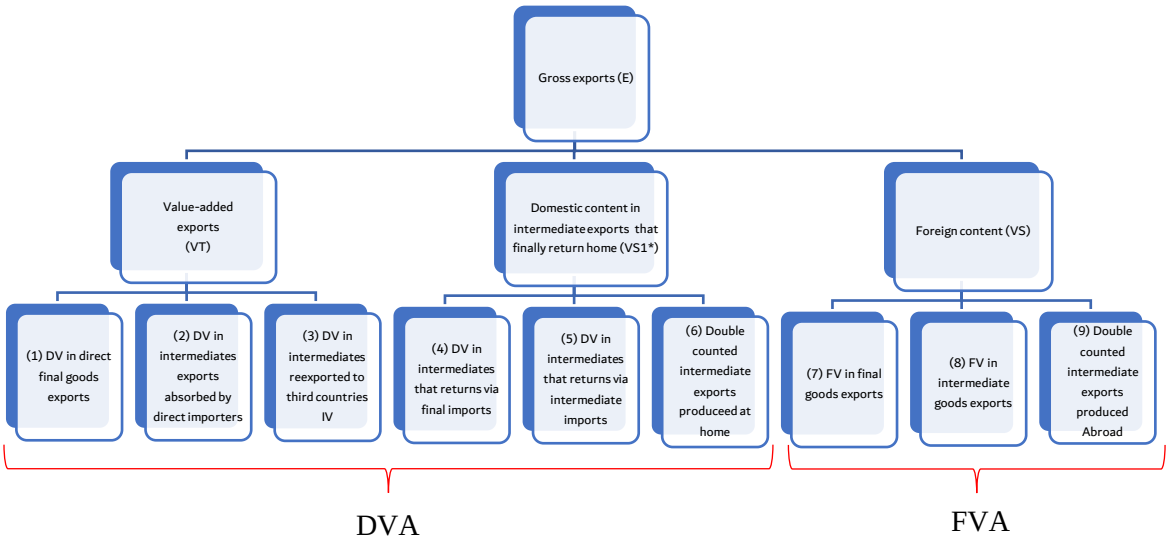
Source: The World Bank Group - Qiang, C. Z., Liu, Y., & Steenbergen, V. (2021).

Figure A2. Top 5 Domestic Value-Added Exports in the World 1990-2016



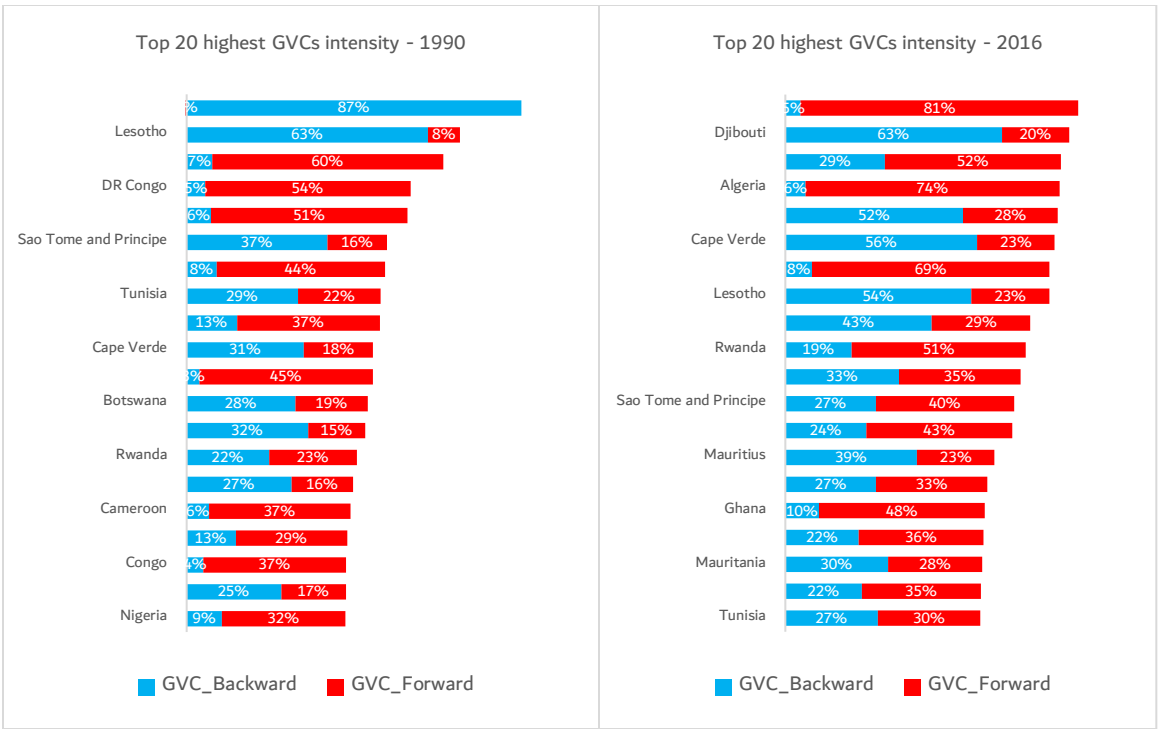
Source: Authors' calculation base on EORA MRIO input output databases
Note: VAX1_c, VAX2_c and VAX3_c are value-added exports. They represent domestic value added (DV) in direct final goods exports, DV in intermediates exports absorbed by direct importers, and DV in intermediates reexported to third countries. DVA4_c and DVA5_c includes the source country's value-added in both its final and intermediate goods imports, which are first exported but eventually returned and consumed at home and DVA6_c is a double counted intermediate exports produced at home

Figure A3. Decomposition of Gross Exports



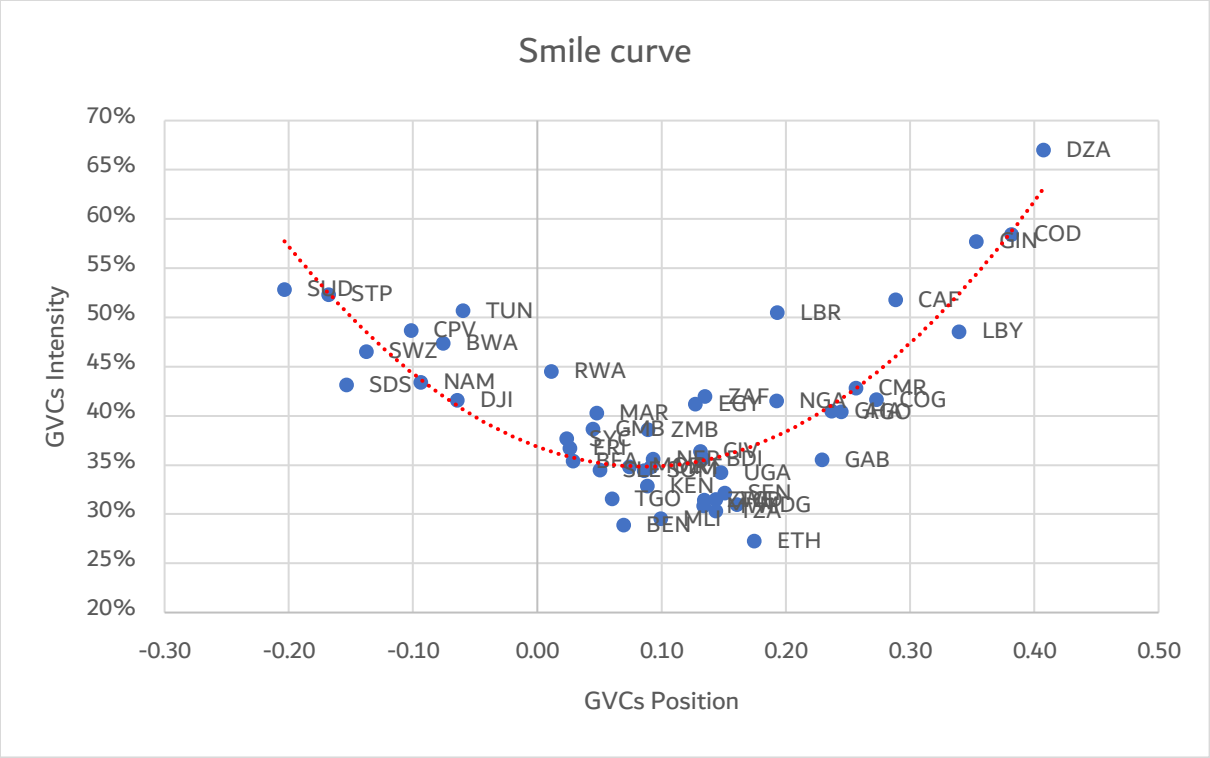
Source : Koopman et al (2014).

Figure A4. Top 20 GVCs intensity index in Africa 1990-2016



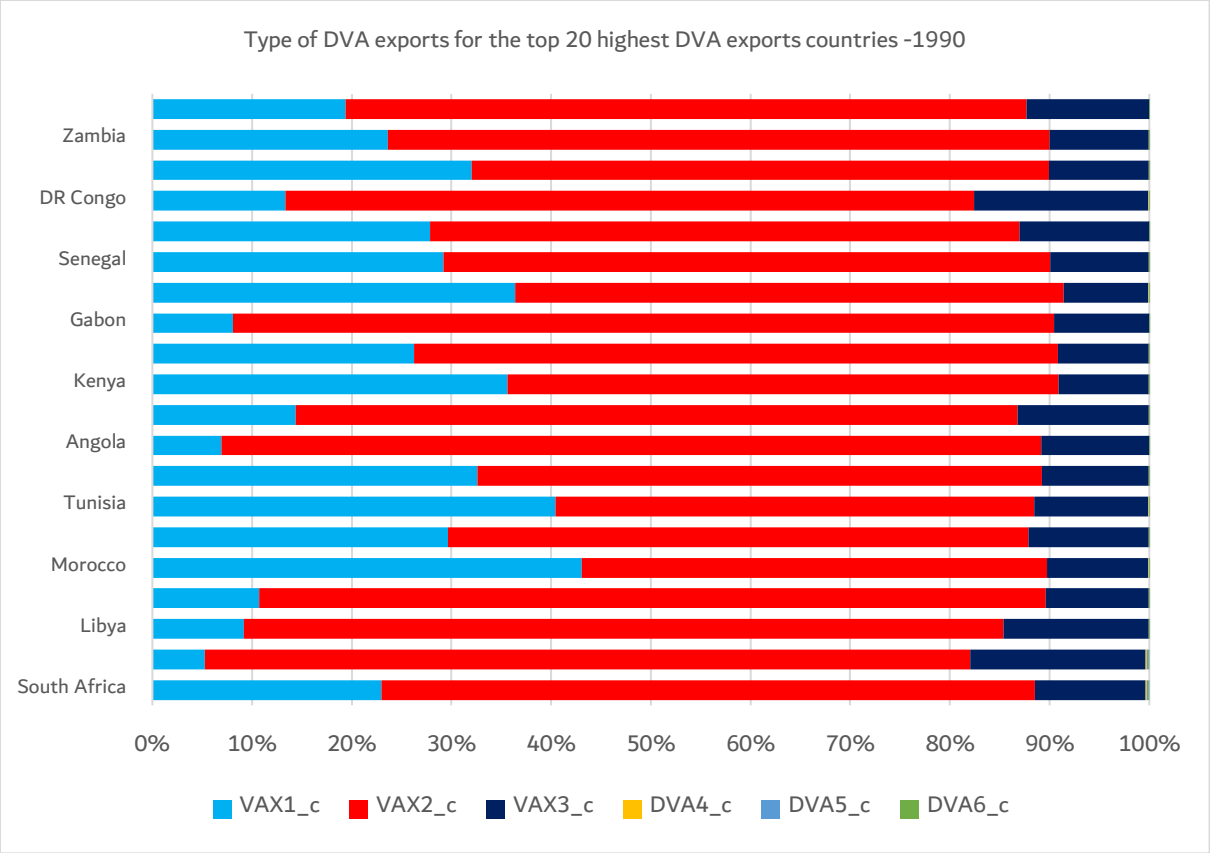
Source: Authors' calculation base on EORA MRIO input output databases

Figure A5. Scatter plot representing GVCs position and GVCs intensity – 2016



Source: Authors' calculation based on EORA MRIO database

Figure A6. Top 20 Domestic Value-Added Exports in Africa 1990-2016



Source: Authors' calculation based on EORA MRIO input-output databases

Note: VAX1_c, VAX2_c and VAX3_c are value-added exports. They represent domestic value added (DV) in direct final goods exports, DV in intermediates exports absorbed by direct importers, and DV in intermediates reexported to third countries. DVA4_c and DVA5_c includes the source country's value-added in both its final and intermediate goods imports, which are first exported but eventually returned and consumed at home and DVA6_c is a double counted intermediate exports produced at home

Table A1. Ranking of top 5 GVCs sectors for highest integrated countries in 2016

	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5
China	Electrical and Machinery US$ 269437974.2	Petroleum, Chemical and Mineral Products US$ 135286312.2	Metal Products US$ 94149142.87	Textiles and Wearing Apparel US$ 86683267.54	Financial Intermediation and Business US$ 81554630.16
Germany	Re-export & Re-import US$ 249376261.9	Electrical and Machinery US$ 162470481.2	Petroleum, Chemical and Mineral Products US$ 132719307.4	Transport Equipment US$ 97190353.19	Financial Intermediation and Business US$ 93233619.51
UK	Electrical and Machinery US$ 88058203.07	Financial Intermediation and Business US$ 78115915.02	Petroleum, Chemical and Mineral Products US$ 59390452.09	Re-export & Re-import US$ 48584879.41	Metal Products US$ 29525754.08
Netherlands	Re-export & Re-import US$ 208634877.4	Petroleum, Chemical and Mineral Products US$ 58511872.96	Financial Intermediation and Business US$ 43167120.57	Electrical and Machinery US$ 36587347.25	Food & Beverages US$ 22510476.34
USA	Financial Intermediation and Business US$ 237136512.2	Petroleum, Chemical and Mineral Products US$ 150228024.1	Electrical and Machinery US$ 149235500.9	Wholesale Trade US$ 106092333.9	Transport Equipment US$ 49580807.6

Source: Authors' calculation based on EORA MRIO database
Note: Sectors represents top 5 sectors driving GVCs. Value between parenthesis represents the level of GVCs participation for the sector. Countries are the top 5 countries with the highest GVCs participation level. Countries are listed in alphabetical order.

Table A2. Ranking of top 5 GVCs sectors for highest integrated African countries in 2016

	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5
Angola	Mining and Quarrying US$ 7483000.561	Electricity, Gas and Water US$ 1344339.192	Financial Intermediation and Business US$ 1006596.101	Transport US$ 707805.833	Construction US$ 608339.4914
Algeria	Mining and Quarrying US$ 20931336.68	Electricity, Gas and Water US$ 1714682.604	Petroleum, Chemical and Mineral Products US$ 1071680.286	Transport US$ 953367.6801	Financial Intermediation and Business US$ 656358.3328
Morocco	Electrical and Machinery US$ 4999861.275	Agriculture US$ 2932306.174	Petroleum, Chemical and Mineral Products US$ 1609343.183	Financial Intermediation and Business US$ 1481702.478	Textiles and Wearing Apparel US$ 1449752.792
Nigeria	Mining and Quarrying US$ 9067315.08	Agriculture US$ 3555698.806	Transport US$ 887981.7759	Financial Intermediation and Business US$ 885613.6977	Petroleum, Chemical and Mineral Products US$ 500850.3353
South Africa	Mining and Quarrying US$ 10553053.71	Metal Products US$ 6927070.219	Petroleum, Chemical and Mineral Products US$ 4704344.516	Financial Intermediation and Business US$ 4438264.387	Electrical and Machinery US$ 2890384.862

Source: Authors' calculation based on EORA MRIO database
Note: Sectors represents top 5 sectors driving GVCs. Value between parenthesis represents the level of GVCs participation for the sector. Countries are the top 5 African countries with the highest GVCs participation level. Countries are listed in alphabetical order.

Table A3. Ranking of top 5 GVCs sectors for highest integrated African countries in 1990

Algeria	Mining and Quarrying US$ 3181728.294	Financial Intermediation and Business US$ 992604.1456	Transport US$ 693455.1454	Petroleum, Chemical and Mineral Products US$ 665622.9907	Electricity, Gas and Water US$ 348448.8397
Libya	Financial Intermediation and Business US$ 804377.3184	Mining and Quarrying US$ 624967.1125	Petroleum, Chemical and Mineral Products US$ 281865.3667	Transport US$ 228666.3092	Wholesale Trade US$ 172707.6457
Morocco	Textiles and Wearing Apparel US$ 208886.8599	Financial Intermediation and Business US$ 206718.1206	Food & Beverages US$ 197704.9136	Petroleum, Chemical and Mineral Products US$ 169022.1642	Electrical and Machinery US$ 146036.9311
Nigeria	Mining and Quarrying US$ 993633.4748	Financial Intermediation and Business US$ 281931.976	Petroleum, Chemical and Mineral Products US$ 179094.7067	Transport US$ 158838.4686	Wholesale Trade US$ 89596.73442

South Africa	Mining and Quarrying US$ 1514988.026	Metal Products US$ 1179425.846	Financial Intermediation and Business US$ 863473.9521	Petroleum, Chemical and Mineral Products US$ 731422.2378	Transport US$ 609846.0661
	Sector 1	**Sector 2**	**Sector 3**	**Sector 4**	**Sector 5**

Source: Authors' calculation based on EORA MRIO database

Note: Sectors represents top 5 sectors driving GVCs. Value between parenthesis represents the level of GVCs participation for the sector. Countries are the top 5 African countries with the highest GVCs participation level. Countries are listed in alphabetical order.

Table A4. Correspondence between sectors and GVCs archetypes

Sectors	**GVC archetypes**
Agriculture	Commodities
Fishing	Commodities
Mining and Quarrying	Commodities
Food & Beverages	Regional processing
Textiles and Wearing Apparel	Labor-intensive goods
Wood and Paper	Regional processing
Petroleum, Chemical and Non-Metallic Mineral Products	Commodities
Metal Products	Regional processing
Electrical and Machinery	Knowledge-intensive goods
Transport Equipment	Knowledge-intensive goods
Other Manufacturing	Regional processing
Recycling	Others

Electricity, Gas and Water	Others
Construction	Labor-intensive services
Maintenance and Repair	Labor-intensive services
Wholesale Trade	Labor-intensive services
Retail Trade	Labor-intensive services
Hotels and Restaurants	Labor-intensive services
Transport	Labor-intensive services
Post and Telecommunications	Knowledge-intensive services
Financial Intermediation and Business Activities	Knowledge-intensive services
Public Administration	Others
Education, Health and Other Services	Labor-intensive services
Private Households	Others
Others	Others
Re-export & Re-import	Others

Source: Qiang, Liu, and Steenbergen (2021), United Nations Comtrade; United Nations Conference on Trade and Development–Eora Global Value Chain database; World Bank calculations.

Table A5. Estimates of GVCs participation and GDP per capita

	OLS - Fixed – Effect				FE-IV			
VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)
Log GVCs	0.0445***				0.458**			
	(0.0169)				(0.218)			
Log VS1		0.0574***		0.0678***		0.408**		0.398*
		(0.0159)		(0.0168)		(0.188)		(0.205)
Log FVA			-0.0101	-0.0251*			0.201	0.141
			(0.0127)	(0.0133)			(0.155)	(0.201)
Log Inv	0.0466***	0.0476***	0.0506***	0.0496***	0.0191	0.0183	0.0310***	0.0161
	(0.00755)	(0.00742)	(0.00758)	(0.00748)	(0.0137)	(0.0141)	(0.0105)	(0.0157)
Log Gov Cons	0.120***	0.113***	0.120***	0.108***	0.0893***	0.0458	0.164***	0.0694
	(0.0132)	(0.0133)	(0.0134)	(0.0136)	(0.0298)	(0.0461)	(0.0294)	(0.0603)
Log School E	0.132***	0.138***	0.122***	0.140***	0.269***	0.261***	0.175***	0.286***
	(0.0212)	(0.0214)	(0.0211)	(0.0214)	(0.0726)	(0.0691)	(0.0436)	(0.0828)
Log Pop 15-65	-1.022***	-1.000***	-1.005***	-1.002***	-1.433***	-1.097***	-1.319***	-1.223***
	(0.0770)	(0.0776)	(0.0773)	(0.0775)	(0.221)	(0.153)	(0.226)	(0.244)
Log Nat Rent	-0.0126	-0.0120	-0.00809	-0.0106	-0.0492***	-0.0509***	-0.0367**	-0.0563***
	(0.00861)	(0.00858)	(0.00865)	(0.00859)	(0.0173)	(0.0184)	(0.0144)	(0.0214)
Polity	0.000536	0.000405	0.000894	0.000439	0.00126	0.000791	0.00373	0.000351
	(0.00165)	(0.00166)	(0.00166)	(0.00165)	(0.00295)	(0.00318)	(0.00229)	(0.00352)
Constant	18.95***	18.64***	19.37***	18.92***	20.82***	17.44***	21.22***	17.34***
	(1.219)	(1.227)	(1.228)	(1.233)	(2.150)	(2.570)	(1.968)	(2.802)

Observations	626	625	626	625	397	396	397	396
R-squared	0.765	0.764	0.762	0.766				
Number of id	41	41	41	41	34	34	34	34
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Log GVCs is the logarithm of GVCs participation in terms of value-added (VS1 + FVA); Log VS1 is the logarithm of forward GVCs integration in terms of value-added; Log FVA is the logarithm of backward GVCs integration in terms of value-added; Log Inv is the logarithm of private investment; Log Gov Cons represents the logarithm of government consumption; Log pop represents the logarithm of population aged between 15 and 64; Log School E is the logarithm of secondary school enrollment ratio; Log Nat Rent is the logarithm of natural resource rent in percentage of GDP; and Polity represents the level of political stability (the regime). The instruments used for the IV method are the mean GDP of top 5 trade partners', the mean distance to the top GVC production hubs and air freight capacity. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A6. Impact of GVCs participation and GVCs position on GDP per capita

	OLS Fixed-Effect			FE-IV		
VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Log GVCs	0.0445***		0.0494***	0.458**		0.470*
	(0.0169)		(0.0167)	(0.218)		(0.244)
GVCs position		0.0393***			0.122	
		(0.0120)			(0.105)	
GVCs position * Log GVCs			0.00340***			0.00284
			(0.000939)			(0.00889)
Log Inv	0.0466***	0.0518***	0.0478***	0.0191	0.0321***	0.0179
	(0.00755)	(0.00745)	(0.00746)	(0.0137)	(0.00945)	(0.0141)
Log Gov Cons	0.120***	0.110***	0.107***	0.0893***	0.0896**	0.0739
	(0.0132)	(0.0136)	(0.0136)	(0.0298)	(0.0420)	(0.0508)
Log School E	0.132***	0.130***	0.144***	0.269***	0.143***	0.269***
	(0.0212)	(0.0211)	(0.0213)	(0.0726)	(0.0275)	(0.0736)
Log Pop 15-65	-1.022***	-0.993***	-1.027***	-1.433***	-0.947***	-1.298***
	(0.0770)	(0.0777)	(0.0776)	(0.221)	(0.141)	(0.210)
Log Nat Rent	-0.0126	-0.00717	-0.0107	-0.0492***	-0.0274**	-0.0465***
	(0.00861)	(0.00851)	(0.00853)	(0.0173)	(0.0109)	(0.0170)
Polity	0.000536	0.000859	0.000622	0.00126	0.00426**	0.00169
	(0.00165)	(0.00165)	(0.00164)	(0.00295)	(0.00205)	(0.00291)
Constant	18.95***	19.24***	19.19***	20.82***	19.36***	18.93***
	(1.219)	(1.231)	(1.239)	(2.150)	(1.841)	(2.365)
Observations	626	625	625	397	396	396
R-squared	0.765	0.763	0.768			
Number of id	41	41	41	34	34	34

Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: Log GVCs is the logarithm of GVCs participation in terms of value-added (VS1 + FVA); GVCs position is GVCs position measures as the log difference between forward (log VS1) and forward (log FVA) GVCs participation; Log Inv is the logarithm of private investment; Log Gov Cons represents the logarithm of government consumption; Log pop represents the logarithm of population aged between 15 and 64; Log School E is the logarithm of secondary school enrollment ratio; Log Nat Rent is the logarithm of natural resource rent in percentage of GDP; and Polity represents the level of political stability (the regime). The instruments used for the IV method are the mean GDP of top 5 trade partners', the mean distance to the top GVC production hubs and air freight capacity. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A7. Estimates of sectoral GVCs participation and GDP per capita

	Instrumental Variable					
VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Log GVCs Com	0.466**					
	(0.196)					
Log GVCs KIG		0.218				
		(0.148)				
Log GVCs KIS			0.281**			
			(0.120)			
Log GVCs LIG				0.412**		
				(0.185)		
Log GVCs LIS					0.105	
					(0.245)	
Log GVCs RP						0.297**
						(0.119)
Log Inv	0.00328	0.0359***	0.0294***	0.0235	0.0306**	0.0314***
	(0.0179)	(0.0106)	(0.0107)	(0.0154)	(0.0131)	(0.0110)
Log Gov Cons	0.0564	0.153***	0.0991***	0.177***	0.131***	0.118***
	(0.0393)	(0.0228)	(0.0240)	(0.0324)	(0.0177)	(0.0206)
Log School E	0.269***	0.211***	0.228***	0.215***	0.147***	0.202***
	(0.0661)	(0.0612)	(0.0496)	(0.0533)	(0.0456)	(0.0400)
Log Pop 15-65	-1.574***	-1.070***	-1.010***	-1.293***	-1.127***	-1.078***
	(0.257)	(0.130)	(0.131)	(0.203)	(0.163)	(0.133)
Log Nat Rent	-0.0478***	-0.0518**	-0.0469***	-0.0692***	-0.0324*	-0.0347***
	(0.0168)	(0.0214)	(0.0151)	(0.0257)	(0.0181)	(0.0131)
Polity	0.00242	-0.000246	0.00180	-0.00273	0.00422*	0.00277
	(0.00273)	(0.00411)	(0.00254)	(0.00456)	(0.00239)	(0.00243)
Observations	397	397	397	397	397	397
Id	34	34	34	34	34	34
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: Log GVCs Com is the logarithm of GVCs in commodities; Log GVCs KIG is the logarithm of GVCs in Knowledge-intensive goods; Log GVCs KIS is the logarithm of GVCs in Knowledge-intensive services; Log GVCs LIG is the logarithm of GVCs in Labor-intensive goods; Log GVCs LIS is the logarithm of GVCs in Labor-intensive services; Log GVCs RP is the logarithm of GVCs in Regional processing; Log Inv is the logarithm of private investment; Log Gov Cons represents the logarithm of government consumption; Log pop represents the logarithm of population aged between 15 and 64; Log School E is the logarithm of secondary school enrollment ratio; Log Nat Rent is the logarithm of natural resource rent in percentage of GDP; and Polity represents the level of political stability (the regime). The instruments used for the IV method are the mean GDP of top 5 trade partners', the mean distance to the top GVC production hubs and air freight capacity. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A8. Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Key outcomes					
GDP per capita ($US)	1,204	2,137	2,598	164	13,606
Growth Inequality	1,204	-0.6	1	-2.5	1.9
Absolute Gini	1,293	236	244	24	1,216
Gini sd	1,293	66	69	7	328
GVCs participation in value added ($US million)					
GVCs participation	1,293	2.4	7	0.0016	70
VS1	1,293	1.8	6	0.0009	47
FVA	1,293	0.6	2	0.0007	23
GVCs ratio in % of gross exports					
GVCs ratio	1,293	0.5	0.11	0.25	0.89
Forward GVCs ratio	1,293	0.33	0.12	0.06	0.81
Backward GVCs ratio	1,293	0.16	0.11	0.02	0.65
Control variables					
Inv ($US million)	1,258	7,154	14,832	0	99,442
Gov Cons ($US million)	936	5,145	11.640	52	85,840
School E	802	41	26	5	116
Pop1564 (million)	1,288	9.5	13.8	0.04	98.8
Rents (% GDP)	1,243	12	12	0	69
Polity2	1,235	0.62	5.5	-10	10

Table A9. Impact of GVCs on GDP per capita (without control variables)

	OLS - Fixed – Effect				FE-IV			
VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)
Log GVCs	0.164***				1.439**			
	(0.0162)				(0.702)			
Log VS1		0.174***		0.174***		0.633***		0.645**
		(0.0146)		(0.0155)		(0.201)		(0.316)
Log FVA			0.0500***	0.00413			0.421	0.648
			(0.0129)	(0.0130)			(0.397)	(0.652)
Constant	5.023***	5.007***	6.439***	4.955***	-10.50	-0.347	2.493	-7.557
	(0.193)	(0.167)	(0.138)	(0.184)	(8.588)	(2.369)	(4.345)	(8.364)
Observations	1,242	1,241	1,241	1,240	792	791	791	790
R-squared	0.518	0.532	0.482	0.533				
Number of id	48	48	48	48	44	44	44	44
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Log GVCs is the logarithm of GVCs participation in terms of value-added (VS1 + FVA); Log VS1 is the logarithm of forward GVCs integration in terms of value-added; Log FVA is the logarithm of backward GVCs integration in terms of value-added. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A10. Results of the overidentification test - the dependent variable is GDP per capita

	H0 : overidentifying restrictions are valid							
	Without Time FE				With Time FE			
Endogenous variable	GVCs	Forward	Backward	Both	GVCs	Forward	Backward	Both
Sargan-Hansen	5.268	2.936	9.114	0.339	5.526	4.722	11.518	3.452
Chi-sq	(3)	(3)	(3)	(2)	(3)	(3)	(3)	(2)
P-value	0.1532	0.4016	0.0278	0.8441	0.1371	0.1933	0.0092	0.1780

Source: Results of the Sargan-Hansen overidentification test

Table A11. Results of the overidentification test - the dependent variable is inequality

	H0 : overidentifying restrictions are valid							
	Without Time FE				With Time FE			
Endogenous variable	GVCs	Forward	Backward	Both	GVCs	Forward	Backward	Both
Sargan-Hansen	9.517	5.576	16.464	0.367	2.564	1.419	18.471	1.359
Chi-sq	(3)	(3)	(3)	(2)	(3)	(3)	(3)	(2)
P-value	0.0231	0.1342	0.0009	0.8323	0.4639	0.7010	0.0004	0.5069

Source: Results of the Sargan-Hansen overidentification test

Table A12. Results of the weak identification test

A	Weak identification test (H0: Instrument are weak)							
	Dependent variable is GDP per capita				Dependent variable is income inequality			
Endogenous variable	GVCs	Forward	Backward	Both	GVCs	Forward	Backward	Both
Cragg-Donald Wald F statistic	30.81	29.88	27.52	1.95	30.78	29.88	27.36	1.98
B	Stock-Yogo weak ID test critical values							
	Max IV relative bias				Max IV size			
P-value	5%	10%	20%	30%	5%	10%	20%	30%
Corresponding Statistics (1 endogenous variable)	16.85	10.27	6.71	5.34	24.58	13.96	10.26	8.31
Corresponding Statistics (2 endogenous variable)	11.04	7.56	5.57	4.73	16.87	9.93	7.54	6.28

Source: Results of the Weak identification test.

Note: These results are obtained without including additional control variables. Table A12_A shows the results of the weak identification test namely the F-test. However, Table A12_B provide critical values for the interpretation of the results.

Table A13. Example of Eora MRIO Input-Output Table structure

Year: 20XX		T matrix												Final Demand (FD) Matrix				
		Country 1				Country 2				Country 3				Country 1	Country 2	Country 3		
		Sector 1	Sector 2	Sector 3	Sector 4	Sector 1	Sector 2	Sector 3	Sector 4	Sector 1	Sector 2	Sector 3	Sector 4	Households	Households	Households	Gross output	Gross Exports
Country 1	Sector 1	346	156	95	594	819	154	832	397	409	562	241	554	394	902	446	**6,901**	**5,316**
	Sector 2	354	443	7	908	42	92	561	839	470	770	83	368	514	694	512	**6,657**	**4,431**
	Sector 3	291	795	243	825	753	2	340	232	251	605	526	610	384	753	909	**7,518**	**4,980**
	Sector 4	637	259	289	813	500	716	947	645	856	221	898	41	91	653	301	**7,868**	**5,778**
Country 2	Sector 1	547	466	910	276	518	149	779	553	197	285	305	828	630	565	857	**7,864**	**5,300**
	Sector 2	752	936	822	638	611	496	98	924	608	689	872	972	847	209	37	**9,511**	**7,173**
	Sector 3	295	444	7	828	929	535	367	257	890	429	641	26	165	419	886	**7,117**	**4,610**
	Sector 4	113	518	791	459	79	748	254	218	586	673	424	157	800	355	501	**6,677**	**5,022**
Country 3	Sector 1	46	457	552	572	632	680	730	607	796	186	15	958	338	320	194	**7,082**	**4,934**
	Sector 2	962	96	544	96	675	113	711	337	787	571	241	211	479	14	608	**6,445**	**4,027**
	Sector 3	531	190	686	191	374	615	788	738	351	32	565	622	269	814	559	**7,326**	**5,197**
	Sector 4	857	776	897	18	915	482	308	458	253	145	982	270	700	822	729	**8,612**	**6,233**
																	89,578	
	VA matrix																	
Country 1	Value Added	1,172	1,120	1,676	1,648	-	-	-	-	-	-	-	-					
Country 2	Value Added	-	-	-	-	1,019	4,730	401	471	-	-	-	-					
Country 3	Value Added	-	-	-	-	-	-	-	-	626	1,278	1,532	2,995					
	Total input	**6,901**	**6,657**	**7,518**	**7,868**	**7,864**	**9,511**	**7,117**	**6,677**	**7,082**	**6,445**	**7,326**	**8,612**	**89,578**				

Source: EORA-MRIO - https://worldmrio.com/eora26/