

ORIGINAL ARTICLE

How do firms in Sub-Saharan Africa benefit from global value chains?

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Abstract

Sub-Saharan Africa has increased its presence in GVCs but remains the least integrated area in the world. In this paper, we go a step further in the related literature and descend to firm-level data. Thus, we identify the determinants and effects of GVC participation of manufacturing firms in the region. We use indicators of the extensive and intensive margins of participation and of backward and forward integration. We find that good infrastructure, quality of institutions and security to prevent crime are conducive to participation. In contrast, lack of access to finance, the existence of an informal sector or high trade costs discourage participation. Finally, participation in GVCs has positive effects on firm performance variables (innovation, productivity, wages and employment).

KEYWORDS

backward and forward integration, business environment, extensive and intensive margins, firm performance, global value chains, Sub-Saharan Africa

JEL CLASSIFICATION

F02, F23, L20, O12, O55

1 | INTRODUCTION

Nowadays, one cannot talk about international trade without talking about global value chains (GVCs). Their development has been remarkable. In almost all regions of the world, participation in GVCs has been increasing (De Melo & Twum, 2021; Del Prete, et al. 2017). This has also been the case for African countries, which have been particularly dynamic in recent years, with trade growth outpacing that of most economies.¹ Still, Sub-Saharan Africa is the world's least integrated region in GVCs.

¹This area has been said to be the new destination of future offshoring (Baldwin, 2016).

GVCs represent an opportunity for developing countries to enter global markets (Kowalski et al., 2015; Stamm, 2004). They can join them and save decades of investment in forming their own supply chains (Baldwin, 2013). But, what are the factors that determine firms' participation in GVCs? And, can firms benefit from this participation? Answering these questions leads to the twofold objective of this work: to identify the factors, especially those in the business environment, that influence firms' participation in GVCs and to analyse the effects of participation on some relevant measures of firm performance. In particular, this paper will focus on their impact on innovation incentives for product upgrading and production efficiency, as well as on firms' productivity, wages and employment. To achieve these goals, we use rich firm-level data from the World Bank Enterprise Survey (WBES, hereafter) for manufacturing sectors, covering the period 2005–2018 for 18 Sub-Saharan African countries.

Trade integration through GVCs is strongly related to trade in intermediates. Indeed, two very important indicators of GVC participation are based on foreign value added (FVA) in exports (or backward integration), which measures imported intermediates embodied in exports, and on domestic value added embodied in exports of intermediates that importers will use to produce exports (IVA or forward integration). These indicators have mainly been used at the country or industry level due to the difficulty of measuring trade in intermediates at the firm level (De Melo & Twum, 2021; IMF, 2016; Kowalski et al., 2015). However, aggregate measures at the country or sector-country level may suffer from a lack of sufficient variability or from aggregation bias due to their dependence on input–output tables. The work of Bems and Kikkawa (2021) focuses on the study of this bias. In particular, they find that sectoral aggregation bias leads to understating the import content of exports. It is the interaction between within-sector heterogeneity in firms' import and export intensities and firm size that explains the magnitude of the bias. Moreover, for Sub-Saharan countries, the only source of aggregate measures of GVC participation is the UNCTAD-Eora database, and there are doubts about the quality of these data for some of these countries (especially at the sector level). The lack of some input–output tables has led to missing data being filled in with estimates (Shepherd, 2016).

We therefore believe that a firm-level approach to GVC participation is particularly appealing for Sub-Saharan countries. It can help overcome problems arising from the use of more aggregated data, such as insufficient variability in regression analysis, presence of aggregation biases or the imputation of some data in some countries' input–output tables. Moreover, given that GVC participation is ultimately a firm's internationalisation strategy, there is a growing interest in studies that capture both the determinants and effects of GVC participation at this decision level.

However, the firm-level approach to GVCs is still scarce in the literature. Many firm-level databases do not have information on firm imports or, if they do, do not distinguish between imports of intermediate and final goods. The lack of information on imports prevents the calculation of one of the two relevant indicators of GVC participation, the FVA. If there is information on imports but no distinction is made between intermediate and final goods, it has to be assumed that some of them are intermediate inputs. The second indicator of GVC participation, IVA or domestic value added on exports of intermediates imported by exporting firms, requires more assumptions. Most firm-level databases, if they contain information on exports, do not usually distinguish between exports of intermediate and final goods. Therefore, it is often assumed that exporting firms export intermediate inputs that are to be incorporated by importers into their exports. These difficulties (Antràs, 2020) have led to the use of variables such as the two-way trader dummy indicator (which identifies firms that import and export, often without information on whether the goods involved are final or intermediate). Thus, the firm-level literature on GVCs has focused more on the extensive margin of participation (Del Prete, Giovannetti, & Marvasi, 2017; DAVIS & Zaki, 2020; Shepherd & Stone, 2013). Our paper differs from this literature in that we not only use the two-way trader dummy variable (and some extensions adding foreign ownership and/or international certification), but we also approximate the intensive margin of the firm's participation in

GVCs. Fortunately, our firm-level database has information on imports of intermediates and exports of goods.²

Overall, we believe that the contribution of this paper is relevant and manifold. First, it provides an in-depth analysis of GVCs in Sub-Saharan Africa from the point of view of firms, whereas previous studies use aggregate country or sector-country-level data on GVCs. Second, it jointly considers the effects of a battery of business environment variables on firms' decisions to participate in GVCs. Third, it not only explains firms' participation in GVCs but also studies its effects on various measures of firm performance (whereas previous studies focus on the determinants or the effects of GVC participation). These include innovation, productivity, wages and employment of firms. Fourth, we use indicators of the extensive and intensive margins of GVC participation, whereas previous work only considers the extensive margin when using firm-level data (Antràs, 2020). Fifth, we consider both backward (FVA) and forward (IVA) integration. Finally, in order to address both the analysis of the determinants and the effects of firms' participation in GVCs, our empirical strategy will take into account that endogeneity may arise.

Our results show that several factors in the business environment affect firms' participation in GVCs. We find that good infrastructure, strict fiscal control possibly signalling quality of institutions and security to prevent crime are conducive to participation. In contrast, difficult access to finance, the existence of an informal sector or high trade costs discourage participation. In terms of outcomes, Sub-Saharan African firms participating in GVCs enjoy superior innovation performance (both in terms of product upgrading and efficiency gains), higher productivity, pay higher wages and generate more employment. Overall, these results hold for all our extensive and intensive measures of GVC participation, including backward (FVA) and forward (IVA) integration. We find an interesting exception that points in the direction that excessive backward integration, *i.e.* excessive imported input content in exports (as measured by FVA), may negatively affect incentives for process innovation and, to a lesser extent, the productivity of manufacturing firms in Sub-Saharan Africa.

The paper is organised as follows. Section 2 presents a literature review. Section 3 introduces the data and stylised facts. Sections 4 and 5 describe the methodology used and the results obtained, respectively. Section 6 contains a series of robustness checks to strengthen the results. Finally, Section 7 concludes.

2 | LITERATURE REVIEW

Although the literature on GVCs pays overwhelming attention to country- and industry-level studies, even at this level of aggregation, it remains sparse for African countries. The reason is that the UNCTAD-Eora GVC database is the first to include estimated input–output tables for these countries. Its use led to the first works in the literature to explain the participation of African countries in GVCs. Kowalski et al. (2015) included, among other regions in the world, Eastern and Southern Africa, the Middle East and North Africa and West and Central Africa. They focused mainly on backward integration (FVA) and did not control for endogeneity. The IMF (2016) study, which focuses on backward integration and includes 185 countries from 2007 to 2011, also uses the UNCTAD-Eora GVC database, but when it comes to Sub-Saharan Africa, sample size restrictions arise. This study controls for endogeneity by including different dummy variables and lagged independent variables.

More recently, Slany (2019) and De Melo and Twum (2021) have also focused on African countries. Slany's (2019) work on regional value chains (RVCs) in 37 African countries uses country-level aggregated data from the UNCTAD-Eora GVC database for the period 2006–2012. In this paper, participation in RVCs is defined by the FVA content of regional exports, *i.e.* by regional backward integration. To explain countries' regional FVA, they include country-level business environment variables among

²Despite the greater richness of our database, some assumptions still have to be made in the calculation of our GVC-intensive margin measures, as explained in section 3 of this paper. For this reason, we also present a sensitivity analysis of the results when these assumptions are relaxed to some extent. One such assumption, which is robust to relaxation, is that the same mix of input sources (domestic/foreign) is used in domestic sales as in exports. The same proportionality assumption is required in the use of databases from which it is possible to obtain aggregate measures of FVA at country or sector-country level (such as UNCTAD-Eora).

regressors in sequential regressions, as in regressions using country-year data there may be multicollinearity problems due to lower variability at this level of aggregation and sample size limitations (a maximum of 236 observations). This study controls for endogeneity by including country dummies, a time trend and lagged independent variables. The author finds that higher trade costs may hinder the participation of these countries in RVCs. However, the quality of regulation and telecommunication infrastructure can encourage such participation. Despite the focus on regional integration and regional trade in value added among the 37 African countries, as the same author points out, variables affecting RVCs may also be relevant in explaining greater integration in GVCs.

The paper by De Melo and Twum (2021) focuses on Sub-Saharan Africa's participation in GVCs (backward and forward integration) using data at the level of four large regional economic communities: the East African Community, the Economic Community of West African States, the Southern African Development Community and the Common Market for Eastern and Southern Africa. To our knowledge, their paper is the first to analyse the evolution of GVC participation in Sub-Saharan African countries using Borin and Mancini's (2019) novel dataset on GVC participation measures. De Melo and Twum (2021) use country-year data (or sector-year-country data) on GVC participation that is based on the EORA database. Their work includes, first, a comprehensive descriptive analysis comparing African countries with all countries in the EORA database between 1995 and 2015. Second, it includes the estimation of a GVC equation. At the estimation stage, when the sample is restricted to African countries (with a maximum of 174 observations), the results obtained for the full sample of countries are not reproduced. As the authors argue, sample size may be a problem for these countries.

Despite difficulties at the firm level in measuring participation in GVCs, some studies do so. Nevertheless, this approach is still at a nascent stage, especially in the case of African countries, and more so in Sub-Saharan Africa. This affects both the analysis of the causes and effects of firms' participation in GVCs. Within this literature, we would like to highlight several works focusing on African countries. DAVIS and Zaki (2020) use firm-level data from WBES for countries of the Middle East and North Africa (MENA) and East Asia and Pacific (EAP) regions for the period 2006–2017. They propose and use various extensive margin measures of firms' participation in GVCs (depending on whether they import and export, have foreign ownership or are internationally certified). For MENA countries, the authors conclude that the business environment factors relevant to firms' participation in GVCs are mainly the stability of electricity supply, the limitation of the informal sector and the facilitation of access to finance and business procedures. Our work uses the same set of indicators to measure the extensive margin of firms' participation in GVCs. Similarly, we also explain participation with a number of variables from the firms' business environment. However, we differ in the countries analysed and in methodological issues. For example, in their regressions, they use business environment indicators at the industry-country level, whereas we use them at the firm level and instrument them to take into account possible endogeneity. The use of these regressors at the industry-country level reduces their variability and makes multicollinearity problems more likely, which justifies using them one at a time in the regressions to explain firms' participation in GVCs.

Del Prete, Giovannetti and Marvasi (2017) also work with firm-level data from WBES for two MENA countries (Egypt and Morocco) in 2004 and 2007. They identify as GVC participating firms those that trade and have an internationally recognised quality certification. Their paper is focused on disentangling whether firms' GVC participation fosters productivity. For Egypt and Morocco, they obtain that GVC participation has a positive impact on firms' productivity. In the same vein, Ayadi et al. (2020) also find a positive firm-level association between Davis and Zaki's (2020) GVC indicators and productivity for a broad group of MENA countries. Regarding the labour market effects of GVC participation in developing countries, Shepherd and Stone (2013), using WBES manufacturing firm-level data from 2006 to 2010 for 108 developing and transition countries, show that there is a positive association between GVC participation (firms that import and export or have foreign ownership) and employment and the wages they pay. This may be due to scale and productivity effects resulting from participation in GVCs. On the one hand, when firms export, they should grow and employ more workers. On the other hand, in well-functioning labour markets, traders who increase productivity should pay higher wages. In

their paper, they argue that they do not establish a causal relationship, as this would require a different empirical approach, *e.g.* using instrumental variables (IVs). Finally, as regards the effects of participation in GVCs on firms' innovation, Pasquali (2021) used firm-level data from 2006 to 2015 collected by the Kenya Revenue Authority (supplemented by interviews with 17 Kenyan tanneries) to study upgrading of the Kenyan leather sector. They point out that product quality improves when exporting from the South to the North.

In conclusion, not only are studies on firms' participation in GVCs scarce for the African continent (and in particular for Sub-Saharan Africa) but also on how this participation affects innovation, job creation and wages they pay.

3 | DATA AND STYLISTED FACTS

The data used in this paper are mainly from WBES. This database provides firm-level data from surveys of a representative sample of a country's private sector. It produces internationally comparable data, with homogeneous data sections across countries.³ Our study includes 18 Sub-Saharan African countries for the years 2005 to 2018.⁴ The analysis is based on a pooled dataset, as it is not possible to use panel data with WBES. Surveys are collected every 3–4 years at best and, especially for these countries, it is very difficult to follow the same firms over time. We will work with a sample of 11,060 observations for firms in the manufacturing sectors, although this number may vary according to the different specifications used.⁵

In the following, we describe the three sets of variables used in the paper: measures of GVC participation, business environment variables to explain GVC participation and measures of firm performance (innovation, productivity, wages and employment).

3.1 | GVC variables

The main variables of interest that we will use throughout the paper are the different measures of participation in GVCs, which we can divide into two groups. In the first group, we include four measures of firms' internationalisation that capture their extensive margin of participation in GVCs (Dovis & Zaki, 2020). In the second group, we include measures of their intensive margin of participation that capture the backward and forward integration of firms into GVCs. These intensive margin measures are, respectively, FVA and IVA.

The four measures in the first group range from the simplest GVC concept to a more demanding one. The first will be called 'Two-way trader'. It implies that the firm imports inputs and exports. The second is 'Two-way trader + foreign ownership' and will be called 'GVC foreign'. It means that the firm is a two-way trader and is owned—or partly owned—by a foreign individual, firm or organisation. Note that GVCs often go hand in hand with foreign direct investment (FDI) inflows (Qiang, et al. 2021), as contractual insecurity is particularly relevant for countries with weak institutions. In these countries, foreign MNEs may prefer an organisational structure of production networks that involves intra-firm integration (taking place within firm boundaries). When FDI goes hand in hand with GVCs to guarantee contract enforcement, this points to *relational* GVCs (Antràs, 2020). The third is 'Two-way trader + International Certificate' and will be called 'GVC certificate'. In this case, the firm is a

³The data were obtained on request from the World Bank. All data can be downloaded free of charge at <http://www.enterprisesurveys.org>

⁴The countries included in our study and the years for which data are available are: Burundi (2006, 2014), Cameroon (2006, 2009, 2016), Djibouti (2013), Ethiopia (2006, 2011, 2015), Ghana (2007, 2013), Kenya (2007, 2013, 2018), Lesotho (2009, 2016), Madagascar (2005, 2009, 2013), Malawi (2005, 2009, 2014), Mali (2007, 2010, 2016), Mozambique (2007, 2018), Niger (2005, 2009, 2017), Nigeria (2007, 2010, 2014), Rwanda (2006, 2011), Senegal (2007, 2014), Tanzania (2006, 2013), Uganda (2006, 2013) and Zambia (2007, 2013).

⁵The manufacturing sectors are: 1. Food, 2. Garments, 3. Textile, 4. Machinery and Equipment, 5. Chemicals, 6. Electronics, 7. Non-metallic mineral products, 8. Wood, wood products and furniture, 9. Metal and metal products and 10. Other manufacturing.

two-way trader and it has an internationally recognised quality certification. Participation in GVCs normally requires compliance with global quality standards (Del Prete, et al. 2017). The fourth and last is the strictest. It includes all of the above; so the firm is a two-way trader, has foreign participation and holds an international certificate. It will be ‘Two-way trader + Foreign ownership + International Certificate’ and will be called ‘GVC all’. All these indicators are dummy variables that take the value 1 if the firm participates in GVCs and 0 otherwise.

The measures in the second group capture two different aspects of participation in GVCs: FVA embodied in gross exports and indirect value added (IVA). FVA refers to the value added of inputs that were imported to produce intermediate or final goods that are exported, or in other words, the content of intermediate imports embodied in exports.⁶ It is a measure of ‘Backward integration’ and also of ‘Downstream participation’.⁷ IVA (which can also be found in the literature as DVX) is the domestic value added contained in intermediate products exported to a partner economy that re-exports them to a third economy incorporated into other products. In other words, it is the domestic value added contained in inputs sent to third economies for further processing and export through value chains. It is a measure of ‘Forward integration’ and also of ‘Upstream participation’ (World Trade Organization, 2019).⁸ In this paper, we calculate FVA and IVA for each firm with the information available in WBES.

To construct FVA, the value of imported intermediate inputs has first been obtained from the percentage of foreign intermediates applied to the value of the firm’s total intermediates. Next, it has been assumed that imported intermediate inputs are allocated proportionally to the firm’s total sales.⁹ Thus, we have finally obtained the value of imported intermediate inputs that are incorporated into exports as follows:

$$\begin{aligned} \text{Value of imported intermediate inputs in firm's exports} &= \\ &= \frac{\text{Value of imported intermediate inputs} * \text{Firm's exports}}{\text{Firm's sales}}. \end{aligned}$$

FVA is then calculated as this value normalised by the firm’s exports:

$$\text{FVA} = \frac{\text{Value of imported intermediate inputs in firm's exports}}{\text{Firm's exports}}.$$

To construct IVA, we have first calculated the domestic value added as follows:

$$\text{Domestic value added} = \text{Firm's sales} - \text{Value of firm's intermediate imports}.$$

We also assume that the percentage of domestic value added exported is the same as the percentage of domestic value added in the firm’s total sales.¹⁰ With this assumption, we can calculate the domestic

⁶Note that a positive value of FVA implies a value 1 for the dummy variable ‘Two-way trader’, as this dummy variable takes value 1 when a firm that imports intermediate goods also exports (either intermediate or final goods).

⁷FVA is an indicator of the firm’s backward integration into the GVC, which also indicates that the firm is closer to the final consumer than its international input suppliers, *i.e.* it has a more downstream position in the GVC than they do.

⁸IVA is an indicator of the firm’s forward integration into the GVC, which also indicates that the firm is further away from the final consumer than its international input importers, *i.e.* it has a more upstream position in the GVC than they do. It has been argued that, using firm-level data, constructing a measure of IVA is more difficult than FVA (Antràs, 2020), so an effort will be made to make the measure as accurate as possible.

⁹This assumption implies that the proportion of foreign inputs is equally spread between exports and domestic sales. However, we will conduct a sensitivity analysis of this assumption in section 6 of the paper. This proportionality assumption will be relaxed but replaced by another assumption. We will assume that for exporters the share of foreign inputs in domestic sales is the same as the average for non-exporting firms in the same sector-country-year. With the original assumption, the average FVA is 0.022, and with its relaxation, it is higher (0.039). This is consistent with a higher share of imported inputs in exports than in domestic sales (Ahmad, 2013; Slany, 2019).

¹⁰We can relax this assumption by assuming that for exporters the proportion of Domestic Value Added in domestic sales is the same as the average for non-exporting firms in the same sector-country-year. If we relax the original proportionality assumption in this way, the average value of IVA is slightly reduced (from 0.102 to 0.096). This is consistent with a smaller share of domestic value added in exports than in domestic sales. In Section 6, we also perform a sensitivity analysis to this assumption.

value added exported, and thus, the IVA as follows (after normalising the domestic value added exported by the firm's exports):

$$\text{IVA} = \frac{\text{Domestic value added exported}}{\text{Firm's exports}}.$$

Note that with this measure we have not taken into account part of the definition of IVA. As mentioned above, IVA is the domestic value added contained in intermediates exported to a partner economy that re-exports them to a third economy incorporated in other products. However, we have not been able to fully account for the latter. This is because this information is rarely available in databases derived from enterprise surveys, including WBES. In fact, we are not aware of any enterprise survey that contains this information. Still, we can reasonably assume that, in a globalised world, firms exporting intermediate inputs are likely to be engaged in 'forward integration' (*i.e.* they have a positive IVA value). The reason is that firms that import intermediates are often also exporters (Antràs, 2020; Gal & Witheridge, 2019). Note also that IVA will not be calculated for firms in all manufacturing sectors but only for those belonging to sectors producing mainly intermediate goods.¹¹ This is because WBES does not distinguish between exports of final or intermediate goods (information that is often missing also in enterprise surveys). Therefore, since IVA refers to the domestic value added contained in exported intermediates, we borrow here an idea from studies with sectoral data, where IVA is only calculated for sectors that can be reliably assumed to produce mainly intermediate inputs (this was first suggested in Yeats, 1998).

The descriptive statistics of our data are similar to those of other African countries. Therefore, for the set of GVC indicators already in DAVIS and Zaki (2020) results are comparable. We obtain that 15% of firms are two-way traders, 5% are two-way traders with foreign ownership, 5% are two-way traders with international certificate and only 2% are two-way traders with foreign ownership and international certificate. Furthermore, for FVA it is relevant to note that there is a 2.5% content of intermediate imports embodied in exports, which is a value consistent with Amendolagine et al. (2019) using the African Investor Survey. Finally, the domestic value added contained in exported intermediate products is around 11% (IVA). As expected in resource-abundant countries (World Bank, 2020a), Sub-Saharan African firms participate more through IVA. This indicates that, on average, they are more involved in upstream participation (forward integration into GVCs). They are therefore involved in activities closer to the primary sector and further away from the final consumer than their importers. This evidence has been supported by previous research highlighting that not only is forward integration more important for these countries, but it is also the region with the highest forward integration in the world (De Melo & Twum, 2021).

In any case, although their presence has grown, the general perception emerging from the descriptives is that there are still not many Sub-Saharan African firms participating in GVCs (AfDB, OECD, UNDP, 2014). Nevertheless, participation is not evenly distributed among the different countries of study. Firms in Cameroon and Kenya are the largest participants, with an average participation rate twice that of Sub-Saharan Africa. In Cameroon, almost 31% of firms are two-way traders, the content of intermediate imports embodied in exports is 7.5% and the domestic value added contained in exported intermediate products is about 32%. In Kenya, these figures are 34.5%, 6.4% and 39%, respectively. This is not by chance, since both countries are doing an effort to consolidate their industrialisation. The Kenyan government, for example, has launched the 'National Industrialization Policy Framework for Kenya 2012–2030' with the aim of transforming Kenya into a globally competitive regional industrial hub (Correa & Todorov, 2020). In contrast, firms in Ethiopia and Nigeria hardly participate in GVCs. Their average participation is half the average for the region. In Ethiopia, 9.6% of firms are two-way traders, the content of intermediate imports embodied in exports is 1.7% and the domestic value added

¹¹The manufacturing sectors that correspond to intermediate goods according to the Standard International Trade Classification (SITC) of the United Nations (UNIDO, 2011) are as follows: 1. Textile, 2. Chemicals, 3. Electronics, 4. Non-metallic mineral products, 5. Wood, wood products and furniture and 6. Metal and metal products.

contained in exported intermediate products is 2.3%. In Nigeria, these figures are 6%, 0.6% and 6.4%, respectively.

As with countries, not all sectors have the same participation rates. The textile sector is among the top participants. In this sector, 33.5% of firms are two-way traders, the content of intermediate imports embodied in exports is 5.6% and the domestic value added contained in exported intermediate products is about 25%. The textile and garment sectors have played a key role in the industrialisation of many countries since the Industrial Revolution, and Sub-Saharan African firms have the potential to be competitive in these sectors (US International Trade Commission, 2009; World Bank, 2020a; Yülek & Yağmur, 2018). For this reason, the African Development Bank has launched “Fashionomics Africa”, which aims to stimulate the sector and help African firms capture more value within GVCs (Fashionomics Africa, 2021). Slany (2019), using sector-level data from the UNCTAD-Eora database, corroborates the importance of this sector and also highlights the relevance of the transport equipment sector when it comes to backward integration in GVCs. The same is true for our data. Therefore, our firm-level measures detect the same leading sectors as the more aggregated ones. Moreover, both sectors have been highlighted in the literature for their upgrading potential within the value chain. This is why they are on the agenda of the African Union’s Plan of Action for Accelerated Industrial Development of Africa.

3.2 | Business environment variables

Business environment factors can help or hinder firms’ participation in GVCs. Infrastructure, labour conditions, financial facilities, taxes, trade procedures or permits, the informal sector or criminality are some of the aspects that can influence this decision (see World Bank, 2020a, for a review of business environment factors that can drive participation in GVCs).

Investment in infrastructure is key to fostering a country’s growth and economic progress. It is a key element for African countries. In fact, half of the continent’s recent economic growth is due to infrastructure investment (African Development Bank Group, 2022; Moller & Wacker, 2017). In addition, good infrastructure is crucial for boosting trade (Button, 2002). Lack of basic infrastructure, such as electricity or water, affects some African countries and can become a major obstacle to their growth and participation in trade. Good communication services are also part of a country’s essential infrastructure to stay on the path to growth and internationalisation. Along these lines, there is some recent work on the role of telecommunications infrastructure (in particular, the submarine fibre-optic cable) in international connectivity (Cariolle, 2021) and trade (Imbruno, et al. 2022; Sun, 2021). Sub-Saharan countries are making efforts to improve infrastructure, which is reflected in official statistics. For example, the rising values of the Africa Infrastructure Development Index (African Development Bank Group, 2020) are evidence of their progress.

Another major obstacle faced by many developing countries, especially in Africa, is the lack of financial facilities. There seems to be a lack of medium-term financing, capital markets are rudimentary and financial intermediation is rather weak (Kounouwewa & Chao, 2011). Not only that, but regulatory environments are seen as predatory, causing firms to seek escape routes to avoid the burden of regulation. This makes access to formal finance more difficult and forces informal financing of firms. Since better access to bank financing increases the likelihood that firms will export (Abora, et al. 2014), failure to ensure this may harm their participation in GVCs. Furthermore, with regard to labour conditions and tax policy, participation in GVCs may require flexible and uncomplicated regulations and procedures that allow for fast adjustment when necessary. Similarly, trade procedures or permits may also affect trade flows of intermediate inputs, as they also affect trade costs through price increases or customs delays. To sum up, if regulation imposes an excessive burden on developing country firms, there is a risk that the informal sector will grow, making it difficult for them to integrate into GVCs.

Another severe problem on the African continent that may be interfering with its development is criminality. It can be seen as an economy-wide tax that discourages FDI (Detotto & Otranto, 2010) and thus participation in GVCs. Quality of governance and institutions can also be a problem, as all Sub-

TABLE 1 Descriptive statistics—business environment variables.

	GVC participation	
	Yes	No
Outage	0.895–0.838 (0.307–0.370)	0.856–0.843 (0.351–0.364)
Generator	0.798–0.692 (0.402–0.462)	0.512–0.482 (0.500–0.500)
Web	0.756–0.467 (0.430–0.499)	0.205–0.153 (0.404–0.360)
Skilled intensity	47.846–44.905 (25.809–26.031)	58.369–57.536 (27.625–28.196)
Average obst labour	0.012–0.007 (0.023–0.015)	0.008–0.005 (0.017–0.013)
Obst finance	0.132–0.061 (0.339–0.240)	0.256–0.218 (0.437–0.413)
Tax inspection	0.888–0.800 (0.316–0.400)	0.749–0.740 (0.434–0.438)
Obst tax	0.112–0.097 (0.316–0.297)	0.082–0.072 (0.275–0.259)
Informality	0.118–0.096 (0.323–0.296)	0.144–0.127 (0.351–0.333)
Security	0.904–0.791 (0.296–0.407)	0.643–0.621 (0.479–0.485)
Import cost	3.444–3.199 (1.673–1.683)	3.290–3.113 (1.954–1.931)
Export days	30.726–28.462 (9.640–8.768)	30.08–29.440 (11.150–10.463)

Note. Standard deviation in parenthesis. Columns called ‘Yes’ correspond to global value chain (GVC) participants, and ‘No’ to nonparticipants. We represent the range of values for all types of GVC participation.

Saharan African countries are below the 50th percentile of the World Governance Indicators. Although the situation has been improving over the years, it is still worrying (World Bank, 2020b). Low quality of governance may prevent firms from these countries from participating in GVCs.

In this paper, we will use a number of business environment variables that may influence firms’ participation in GVCs. These variables capture different aspects of the business environment, such as infrastructure, labour conditions, financing, taxation, informality, trade procedures and security. Table A1 in the Appendix contains the detailed definition of each of these variables and their sources. Most of them come from WBES, but there are two at the country level that come from the World Bank’s Doing Business. Those related to infrastructure are suffering power outages (outage), owning a generator (generator) and using website (web), whereas labour regulation as an obstacle (average obst labour) and skill intensity are those related to labour conditions. Access to finance as an obstacle (obst finance) is the measure for financing, and tax rate as an obstacle (tax obst) and the presence of tax inspection correspond to taxation. Moreover, it is taken into account whether the informal sector is an obstacle (informality) and whether firms have to pay to ensure their safety (security). Finally, import cost and export days refer to trade procedures.¹²

In Table 1, we report the mean and the standard deviation of these variables, distinguishing between GVC participants and non-participants. As the figures show, the percentage of firms that own a generator, use a website, receive tax inspections or pay for security is higher if they participate in GVCs. Nevertheless, the percentage of firms that say that financing or informality is a barrier is higher if they do not participate in GVCs. This descriptive analysis can give us an idea of the business environment factors that might be behind firms’ participation in GVCs.

3.3 | Performance variables

Once potential barriers are overcome, firm participation in GVCs can have positive effects on firm performance measures (Kowalski et al., 2015). One of the main expected benefits is improved productivity. There are several channels through which this can occur. If a firm participates in GVCs it can reduce input costs or expand the scale of production (Antràs, 2020). It can also benefit from a wider dissemination of knowledge and specialise further in its core activities or in higher value-added tasks (Crisuolo & Timmis, 2017).

¹²These are the two World Bank’s Doing Business variables.

Moreover, firms participating in GVCs may create more jobs and pay higher wages, although the literature on developing countries is inconclusive in this regard (Farole, 2016). First, formal jobs are expected to be created in the manufacturing sector and demand for low-skilled, labour-intensive jobs is also likely to increase (Shepherd, 2013). However, if participation in GVCs leads to a shift towards more skilled or capital-intensive activities, job creation could be in doubt (Banga, 2016). In addition, if the reason for developed countries' interest in African manufacturing is access to abundant low-skilled labour, a wage differential in these countries in favour of workers in globalised firms may be due to their greater ability to pay higher wages and the fact that their workers have more and better physical capital at their disposal (Bernard et al., 2018).

Another potential benefit of participation in GVCs is the increased innovation of firms. Some studies have shown that certain firms are more successful at innovating, but this is only the case if the firm participates in GVCs as a highly qualified supplier (Brancati, et al. 2017). Others suggest that it can encourage innovation and technological upgrading, especially in developing countries (Shepherd, 2015). These countries need to meet product quality, delivery time, process efficiency, environmental friendliness and labour and social standards required by GVCs, which may force them to innovate (Pietrobelli & Rabellotti, 2011). Furthermore, participation in GVCs involves not only flows of goods and materials but also of intangibles such as information, technology or managerial knowledge (Antràs, 2020; Timmer, 2017). This can also lead to greater innovation. Nevertheless, it may also be the case that firms in developing countries prefer to acquire foreign technology from advanced economies rather than innovate (Fu, et al. 2011).

In this paper, we are interested in three variables related to innovation: the R&D decision, the launch of a new product and the introduction of a new process. The first one is related to innovation inputs, whereas the last two are related to innovation outputs (they refer to quality upgrading or efficiency improvement, respectively). We are also interested in three variables related to firms' workers: the number of workers, their productivity and wages.¹³

Figures 1–6 represent the mean of the different performance measures considered, distinguishing between participants and non-participants according to different definitions of GVC participation.¹⁴ Means are always higher for GVC participants. Thus, firms participating in GVCs innovate more, pay higher wages, have higher labour productivity and have more workers. This descriptive analysis indicates some potential benefits that can be derived from participation in GVCs.

4 | METHODOLOGY

In this section, we introduce the econometric specifications and methodology for estimating the equations for firms' participation in GVCs and those for its effect on different measures of firm performance. First, we specify the GVC participation equation. For our four discrete GVC measures, we use the following probit model¹⁵:

$$Prob(GVC) = \begin{cases} 1 & \text{if } \beta_0 + \beta_1 BE + \beta_2 X + \delta_c + \delta_j + \delta_t + \varepsilon > 0 \\ 0 & \text{otherwise} \end{cases}, \quad (1)$$

where BE refers to the vector of business environment variables, X is the vector of control variables including age and firm size and δ_c, δ_j and δ_t are country, sector and year fixed effects, respectively.¹⁶

¹³Productivity can also be included among innovation variables, since it can incorporate efficiency improvements resulting from innovation.

¹⁴Table A2 in the Appendix shows the definitions of the performance measures considered. Although innovation variables (R&D decision, New product and New process) are dummy variables, employment-related variables (Labour productivity, Wages and number of Workers) are continuous variables expressed as the ratio of the firm's value over the country-sector-year average.

¹⁵The GVC variables that are discrete are as follows: 'Two-way trader', 'GVC foreign', 'GVC certificate' and 'GVC all'.

¹⁶ BE includes the business environment variables mentioned above: suffering power outages, owning a generator, using website, skills intensity, labour as an obstacle, finance as an obstacle, tax inspection, tax rate as an obstacle, informality, security, import cost and export days. Age is introduced in logarithm, and size is a dummy that takes the value 1 if the firm has more than 100 employees and 0 otherwise.

FIGURE 1

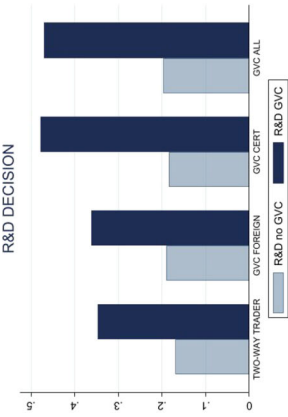


FIGURE 2

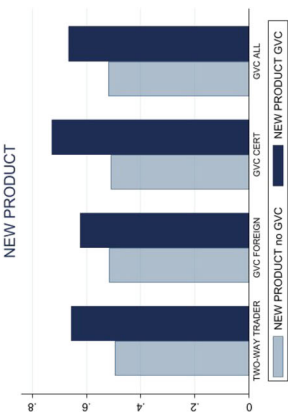


FIGURE 3

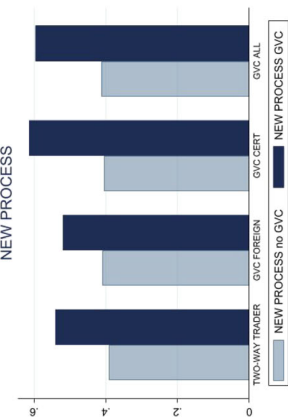


FIGURE 4

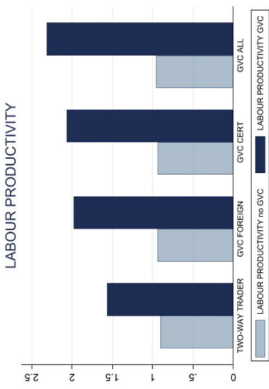


FIGURE 5

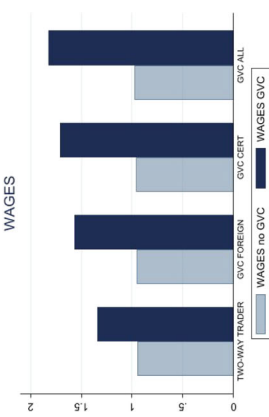
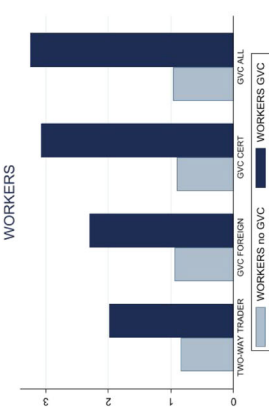


FIGURE 6



FIGURES 1–6 Means of the variables distinguishing between participants and nonparticipants in GVCs. [Color figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com)]

The two remaining GVC variables (FVA and IVA) are continuous, but with a considerable amount of zeros because many firms do not participate in GVCs. For them, we will use a Tobit model whose specification is as follows:

$$GVC = \beta_0 + \beta_1 BE + \beta_2 X + \delta_c + \delta_j + \delta_t + \varepsilon. \quad (2)$$

Due to the pooled dataset nature of WBES, we have controlled in estimation for confounding factors using firm-level characteristics such as size and age. Moreover, we have included a set of fixed effects to absorb unobserved heterogeneity at the country, sector and year level. Nevertheless, some business environment indicators measured at the firm level may be endogenous.

To address this issue, we allow firm-level decisions, such as investing in a generator, website, worker skills and firm security, to be endogenous. We also treat as potentially endogenous the regressor on whether the biggest obstacle faced by the firm is access to finance, as belonging to a GVC may alleviate firms' financial constraints.¹⁷ Our IV strategy for estimating the four discrete dependent variables of GVC participation (characterised by equation (1) above) consists of estimating the joint likelihood function of each dependent variable and the potentially endogenous regressors [limited information maximum likelihood (LIML)]. Since each regressor suspected of being endogenous has as external instrument its own mean value at the country-sector-year level (subtracting the individual firm's own response), the IV method is just identified. The endogeneity tests for the regressors generator, website, skill intensity, obstacle finance and security are classical LIML-based tests, with null hypothesis of zero correlation between the unobservables in the equation of interest (each of the four discrete GVC indicators) and the unobservables in the equations for the potentially endogenous regressors. Estimation is performed with the user-written Stata command *cmp* developed by Roodman (2011).¹⁸

Our extension to IVs of the Tobit model in equation (2), which is applied to the two remaining censored GVC variables, 'FVA' and 'IVA', follows a simple control function approach (Rivers & Vuong, 1988), as suggested by Wooldridge (2015). It proceeds in two steps. First, we obtain the generalised residuals of a probit when the potentially endogenous regressors are binary or the OLS residuals when they are continuous. Second, we add them as explanatory variables in the Tobit equation. Their statistical significance in this equation is an optimal test for rejecting the null hypothesis that potentially endogenous regressors are exogenous, and their inclusion corrects for endogeneity problems. The reason why with censored dependent variables, such as FVA and IVA, we do not estimate the joint likelihood function of the dependent variable and the potentially endogenous regressors is that numerical integration is more demanding and generates computational problems and lack of convergence.

Our next step in the paper is to analyse the effects of firms' participation in GVCs on selected performance measures. We consider six different dependent variables, three on innovation and three related to labour. The innovation variables are whether to invest in R&D, the introduction of a new product and the introduction of a new process. The labour-related variables are labour productivity, wages and the number of workers.

Due to the different nature of dependent variables, two types of models have to be estimated. For binary choice variables (such as innovation variables), we use a probit model. For labour-related variables, which are continuous, we use linear regression. Thus, for innovation variables, we specify:

$$Prob(INNOV) = \begin{cases} 1 & \text{if } \beta_0 + \beta_1 GVC + \beta_2 X + \delta_c + \delta_j + \delta_t + \varepsilon > 0 \\ 0 & \text{otherwise} \end{cases}. \quad (3)$$

¹⁷All regressors treated as potentially endogenous are WBES firm-level regressors. The others are country-level regressors from the World Bank's Doing Business (such as import cost and export days) or from the WBES but more intrinsically related to the business environment in which firms operate (such as obstacles they face related to labour regulation, presence of the informal sector in the economy and fiscal policy pressure or other factual factors such as the existence of power outages and the quality of the tax authority and the tax system).

¹⁸*cmp* estimates multi-equation mixed process models, where 'mixed process' means that different equations in the joint likelihood function can have different kinds of dependent variables (for instance, continuous like in OLS, censored like in tobit and binary like in probit). In our application of the *cmp* command for instrumenting the estimation of equation (1), all dependent variables in the joint likelihood function are binary, except for skill intensity (which is a continuous variable representing the percentage of skilled workers).

In addition, for labour-related variables:

$$EMPLOYM = \beta_0 + \beta_1 GVC + \beta_2 X + \delta_c + \delta_j + \delta_t + \varepsilon, \quad (4)$$

where the explanatory variable *GVC* refers to the different definitions of GVCs used in the paper, *X* is a vector of control variables including age and firm size and δ_c, δ_j and δ_t are country, sector and year fixed effects, respectively.

To correct for possible endogeneity of GVC measures in these regressions, we first apply an IV strategy. Second, we apply a propensity score matching method as an alternative, the results of which can be found in the robustness checks section of the paper. As for these performance equations numerical integration is not a problem because of the smaller dimension of the integrals involved, the IV strategy consists again in estimating a joint likelihood function for each dependent variable and the potentially endogenous GVC indicator (LIML). Estimation is performed with the user-written Stata command *cmp* developed by Roodman (2011), which allows mixing variables of different nature (continuous as in OLS, censored as in tobit and binary as in probit) into a single likelihood function. For each GVC indicator selected as regressor in the performance equations, we perform three instrument-related tests. The first tests the correlation between the error in the performance equation and the error in the GVC equation. This is the endogeneity test with null hypothesis of zero correlation. The second tests the joint significance of IVs in the equation that instruments a particular GVC indicator. Its null hypothesis is that instruments have no explanatory power on the GVC indicator they are instrumenting. The third tests whether, once the GVC indicator is instrumented, all instruments (excluding one) can be excluded from the performance equation (equation of interest). This test has the null hypothesis of joint exclusion of IVs in that equation. The potential IVs are those that are used to explain firms' participation in GVCs. From this set, IVs are selected in each case on the basis of the conditions required for their validity. These are to have explanatory power on the instrumented GVC indicator but no effect on the performance equation of interest (once already used as instruments).

With the alternative propensity score matching methodology, we compare a treated group (firms belonging to a GVC) with a control group (firms that do not belong to a GVC but have similar characteristics). We consider four different treatments corresponding to our dichotomous measures of GVC participation 'Two-way trader', 'GVC foreign', 'GVC certificate' and 'GVC all'. In the first step, we run four probit models based on equation (1) to obtain the different predicted probabilities (propensity scores) of belonging to a GVC. In the second step, we use Mahalanobis metric matching with propensity scores to match participants and non-participants in GVCs.¹⁹ As the performance of different matching techniques can be data specific, our selected propensity score matching technique is the one that balances all probit covariates between participants and non-participants. This indicator of matching quality is based on the difference in covariate means between the treatment and control groups, as well as on joint measures of covariate balance. Finally, the implemented propensity score matching method also keeps all treated observations on common support.

5 | EMPIRICAL RESULTS

5.1 | Business environment factors determining participation in GVCs

The estimation results of the model in (1) for the discrete GVCs dependent variables are in Table 2.1. At the bottom of this table, we provide the endogeneity tests for the potentially endogenous regressors. According to the results of these tests, there are no endogenous regressors in the 'Two-way trader' and 'GVC certificate' equations. However, *obstacle finance* and *security* are endogenous in the equations 'GVC foreign' and 'GVC all'. Moreover, in the equation 'GVC foreign' also turns out to be

¹⁹The procedure is performed in Stata, using the *psmatch2* routine developed by Leuven and Sianesi (2003).

TABLE 2.1 Estimated marginal effects—business environment factors determining participation in GVCs (IV strategy instrumenting potentially endogenous regressors with its means).

Variables	(1) Two-way trader	(2) GVC foreign	(3) GVC certificate	(4) GVC all
Outage	−0.013 (0.021)	−0.032 ^{***} (0.013)	−0.000 (0.008)	−0.022 ^{***} (0.009)
Generator	0.055 ^{***} (0.010)	0.098 ^{***} (0.023)	0.029 ^{***} (0.005)	0.010 ^{**} (0.005)
Web	0.111 ^{***} (0.012)	0.031 ^{***} (0.011)	0.069 ^{***} (0.008)	0.035 ^{***} (0.006)
Skilled intensity	−0.001 ^{**} (0.000)	−0.000 [†] (0.000)	−0.000 (0.000)	0.000 (0.000)
Average obst labour	−0.571 ^{***} (0.183)	−0.099 (0.156)	−0.212 [*] (0.124)	−0.048 (0.128)
Obst finance	−0.036 ^{***} (0.014)	−0.095 ^{***} (0.028)	−0.009 (0.006)	−0.035 ^{**} (0.017)
Tax inspection	0.021 [*] (0.012)	−0.007 (0.014)	0.016 ^{***} (0.005)	0.008 ^{**} (0.003)
Obst tax	−0.027 ^{**} (0.011)	−0.033 [*] (0.019)	−0.004 (0.010)	−0.013 (0.013)
Informality	−0.038 ^{***} (0.012)	−0.013 (0.009)	−0.015 ^{**} (0.006)	−0.010 [*] (0.005)
Security	0.044 ^{***} (0.015)	0.114 ^{***} (0.029)	0.018 ^{***} (0.004)	0.039 ^{***} (0.012)
Import cost	−0.013 ^{**} (0.006)	−0.017 ^{***} (0.006)	−0.001 (0.002)	−0.003 (0.003)
Export days	−0.016 ^{***} (0.002)	−0.006 ^{***} (0.002)	−0.000 (0.001)	−0.001 (0.001)
Size	0.133 ^{***} (0.009)	0.042 ^{***} (0.010)	0.049 ^{***} (0.005)	0.025 ^{***} (0.005)
Log age	0.010 (0.009)	−0.014 (0.009)	0.017 ^{***} (0.002)	0.006 [*] (0.003)
Constant	3.249 ^{***} (0.614)	1.300 (0.951)	−2.849 ^{***} (0.717)	2.212 ^{***} (0.520)
Observations	8,749	8,676	8,661	8,590
Endogeneity tests: Correlation between the error of each GVC equation and the errors of the equations of the potentially endogenous regressors				
Generator	−0.165 (0.242)	−0.387 ^{***} (0.081)	0.157 (0.169)	−0.042 (0.292)
Web	−0.034 (0.190)	0.039 (0.267)	−0.004 (0.165)	−0.128 (0.141)
Skilled intensity	0.437 (0.419)	0.024 (0.394)	0.443 (0.479)	−0.143 (0.556)
Obst finance	−0.070 (0.198)	0.390 [*] (0.223)	0.113 (0.149)	1.008 [*] (0.583)
Security	−0.322 (0.269)	−0.592 ^{***} (0.226)	−0.219 (0.231)	−0.353 ^{**} (0.175)
Endogenous regressor (its IV statistical significance)				
Generator _{<i>i</i>} (mean [Generator _{<i>ijt</i>}] ^{−<i>i</i>})		0.430 ^{***} (0.054)		
Obst finance _{<i>i</i>} (mean [Obst finance _{<i>ijt</i>}] ^{−<i>i</i>})		0.297 ^{***} (0.065)		0.318 ^{***} (0.066)
Security _{<i>i</i>} (mean [Security _{<i>ijt</i>}] ^{−<i>i</i>})		0.305 ^{***} (0.068)		0.289 ^{***} (0.065)

Note: Robust standard errors in parentheses clustered by country and year. All regressions control for country, sector and year dummies. For the equations instrumenting the endogenous regressors, explanatory variables are the exogenous variables in equation (1) plus the respective instrument of each endogenous regressor. The instrument of a given endogenous regressor is the mean of this regressor calculated with all firms in the same country, industry and year than firm *i*, excluding firm *i*. To increase efficiency, the estimated marginal effects for equation (1) shown in this table come from instrumenting those regressors that, according to the tests, are effectively endogenous.

Abbreviation: GVC, global value chain.

*** $p < 0.01$,

** $p < 0.05$,

* $p < 0.1$.

[†]slightly above 0.1.

endogenous generator.^{20,21} Also, at the bottom of Table 2.1, we show the IV statistical significance for each endogenous regressor. This is the estimated marginal effect and the statistical significance of the corresponding instrument in each endogenous regressor equation (where explanatory variables are the

²⁰The estimated marginal effects for equation (1) in Table 2.1 come from instrumenting those regressors that, according to the tests, are indeed endogenous. In this way, we increase efficiency.

²¹Endogeneity problems seem to arise when the definition of GVC participation includes foreign capital.

TABLE 2.2 Estimated marginal effects—business environment factors determining participation in GVCs (IV strategy instrumenting potentially endogenous regressors with its means).

Variables	(1) FVA	(2) IVA
Outage	0.006 (0.069)	−0.099 (0.118)
Generator	0.157*** (0.033)	0.233*** (0.066)
Web	0.239*** (0.051)	0.381*** (0.115)
Skilled intensity	−0.002** (0.001)	−0.002* (0.001)
Average obst labour	−1.241** (0.530)	1.568 (3.103)
Obst finance	−0.102* (0.054)	−0.200** (0.102)
Tax inspection	0.093** (0.040)	0.118† (0.076)
Obst tax	−0.100** (0.044)	−0.099 (0.095)
Informality	−0.107** (0.050)	−0.205* (0.105)
Security	0.155*** (0.047)	0.123† (0.078)
Import cost	−0.043*** (0.015)	−0.131** (0.065)
Export days	−0.038*** (0.007)	−0.086*** (0.016)
Size	0.374*** (0.058)	0.562*** (0.107)
Log age	0.053** (0.023)	0.093† (0.060)
Constant	1.139** (0.342)	3.607*** (0.944)
Observations	8,561	3,573
Endogeneity tests: Correlation between the error of each GVC equation and the errors of the equations of the potentially endogenous regressors		
Generator	−0.052 (0.142)	0.143 (0.298)
Web	0.244 (0.179)	0.575 (0.565)
Skilled intensity	0.008 (0.007)	0.020 (0.014)
Obst finance	−0.047 (0.132)	0.343 (0.301)
Security	−0.008 (0.160)	0.392 (0.328)

Note: Robust standard errors in parentheses clustered by country and year. All regressions control for country, sector and year dummies. For the equations instrumenting the endogenous regressors, explanatory variables are the exogenous variables in equation (1) plus the respective instrument of each endogenous regressor. The instrument of a given endogenous regressor is the mean of this regressor calculated with all firms in the same country, industry and year than firm i , excluding firm i . To increase efficiency, the estimated marginal effects for equation (2) shown in this table come from instrumenting those regressors that, according to the tests, are effectively endogenous.

Abbreviations: FVA, foreign value added; GVC, global value chain; IVA, indirect value added.

*** $p < 0.01$,

** $p < 0.05$,

* $p < 0.1$.

†slightly above 0.1.

exogenous regressors in equation (1) plus the instrument). Finally, the estimation results of the model in (2) for the continuous GVC indicators FVA and IVA can be found in Table 2.2. The endogeneity tests at the end of Table 2.2 indicate that there are no endogeneity problems for these cases.

As results show, several business environment variables have a significant impact on GVC participation (extensive margin) and GVC deepening (intensive margin). To begin with, infrastructure variables have a rather homogeneous qualitative effect on the different measures of GVCs. Although suffering a power outage is only statistically significant for the dichotomous indicators GVC foreign and GVC all, in the other cases, it still shows a generally negative sign, which is to be expected. Furthermore, having a generator or a website always has a positive and significant effect. Our results show the importance of a good infrastructure that includes both basic elements (such as electricity) and communication (Baghdadi & Guedidi, 2021, show that internet adoption boosts African countries' participation in GVCs).

Moreover, when labour regulation as an obstacle is statistically significant, it has a negative impact on GVC measures (see Two-way trader, GVC certificate and the tobit equation 'FVA'). On the other hand,

skill intensity has a significant negative effect in most cases. This implies that having a higher skill intensity reduces the probability of participating in GVCs or, in terms of the results of the tobit equations, that it decreases FVA and IVA. This may be because firms are outsourcing labour-intensive stages of production to areas with low labour costs, such as Sub-Saharan Africa. These stages often require unskilled labour (Bottini, Ernst, & Luebker, 2007). This is consistent with 'skilled-labour abundant countries benefit from importing low-skill-labour intensive goods from low-skill labour abundant economies' (Antràs, 2020). In other words, as Sub-Saharan African countries are unskilled labour abundant, they can specialise in stages of production that are unskilled labour intensive (Heckscher–Ohlin theory).

Similarly, access to finance as an obstacle significantly reduces participation and deepening in GVCs. This finding is similar to other work on Africa, which finds that access to finance is a major barrier (Fowowe, 2017). Tax rates as an obstacle are only statistically significant in the case of the indicators Two-way trader, GVC foreign and the tobit equation 'FVA', although in all other cases, they still maintain their expected negative sign. In contrast, the existence of tax inspections increases the probability of GVC participation and deepening. Increased tax inspection may be a sign of institutional quality and procedural rigour, so it should not be surprising that it helps firms to participate in GVCs. The opposite can be expected from the practices of competitors in the informal sector, which are an obstacle to firms' operations (Bacchetta, Ekkehard, & Bustamante, 2009). We find that they significantly harm participation and deepening in GVCs. According to the World Bank report (2019), a major challenge for emerging economies is the existence of persistent informality in employment. The report highlights that in Sub-Saharan Africa around 75% of employment between 2006 and 2016 was informal.

In addition, having a security system in place always has a significant and positive impact. Crime is a major obstacle in Africa, preventing firms from doing business properly, generating large losses and becoming a serious constraint to new investments and business performance (Bah & Fang, 2015; United Nations: Office of Drugs and Crime, 2005).

Finally, the results of the two country-level variables in the regressions indicate that higher import costs or time to export work against firms' participation and deepening in GVCs. In other words, trade procedures are essential to smooth and facilitate the functioning of chains (OECD and WTO, 2015). These results are consistent with those found in Slany (2019) for RVCs in a study using aggregate country-level data for 37 African countries from the UNCTAD-Eora database. The author finds that higher trade costs can hinder countries' participation in RVCs. In addition, she notes that variables affecting RVCs can also affect integration into GVCs.

5.2 | The impact of participation in GVCs on performance measures

Table 3 presents the results of estimating the models in (3) and (4) by the IVs method. Starting with the endogeneity tests, the bottom half of Table 3 shows the instrument-related tests for each GVC indicator selected as a regressor in the firm performance equations. First, we reject the exogeneity of the GVC indicators. Second, we reject that instruments have no explanatory power over the GVC indicator they are instrumenting. Finally, we do not reject the null hypothesis of the joint exclusion of IVs in the firm performance equations. This means that they affect performance variables only through their effects on GVC indicators. These results reveal that there was an endogeneity problem in the performance equations and that our instruments are valid.²²

The results in Table 3 show that Sub-Saharan countries can reap benefits from participation in GVCs, as participating firms innovate more, are more productive, pay higher wages and turn out to be larger. Among the innovation-related variables, the largest marginal effects are found for product innovation, which may indicate the need for product upgrading. Moreover, in most cases, the GVC all

²²For more details on the statistical significance of each individual instrument when instrumenting a GVC indicator in a specific performance equation of interest (R&D, product innovation, process innovation, labour productivity, wages per worker or number of workers), see Tables S1–S6 of the supplementary material in the additional file.

TABLE 3 Estimated marginal effects—the impact of participation in GVCs on performance measures (IV strategy instrumenting potentially endogenous GVC indicators).

	(1) R&D decision	(2) New product	(3) New process
Two-way trade ^{a,aaa,aaa}	0.153 ^{***} (0.041)	0.278 ^{***} (0.034)	0.208 ^{***} (0.038)
GVC foreign ^{b,bbb,bbb}	0.222 ^{***} (0.073)	0.316 ^{***} (0.078)	0.202 ^{***} (0.067)
GVC certificate ^{c,ccc,ccc}	0.291 ^{***} (0.085)	0.380 ^{***} (0.047)	0.259 ^{***} (0.095)
GVC all ^{d,ddd,ddd}	0.240 ^{***} (0.091)	0.357 ^{***} (0.071)	0.325 ^{***} (0.118)
FVA ^{e,eee,eee}	0.0001 ^{***} (0.00003)	0.0001 ^{***} (0.00003)	−0.133 ^{***} (0.035)
IVA ^{f,fff,fff}	0.100 ^{***} (0.017)	0.264 ^{***} (0.070)	0.135 ^{***} (0.033)
Observations	2,519–5,610	3,169–7,218	3,055–7,191
^a Correlation-dependent variable and GVC indicator errors	−0.119 [*] (0.072)	−0.345 ^{***} (0.068)	−0.196 ^{***} (0.055)
^{aa} Chi2 test and <i>p</i> -value of joint non-significance of IVs in the equation instrumenting the GVC indicator	433.81 0.0000	364.25 0.0000	426.77 0.0000
^{aaa} Chi2 test and <i>p</i> -value of joint exclusion of IVs in the dependent variable equation	2.24 0.5244	1.83 0.8721	3.65 0.4555
^b Correlation-dependent variable and GVC indicator errors	−0.243 ^{***} (0.090)	−0.473 ^{***} (0.174)	−0.249 ^{***} (0.107)
^{bb} Chi2 test and <i>p</i> -value of joint non-significance of IVs in the equation instrumenting the GVC indicator	198.17 0.0000	234.95 0.0000	176.70 0.0000
^{bbb} Chi2 test and <i>p</i> -value of joint exclusion of IVs in the dependent variable equation	1.59 0.2066	0.49 0.4855	3.09 0.2130
^c Correlation-dependent variable and GVC indicator errors	−0.215 [*] (0.121)	−0.527 ^{***} (0.119)	−0.204 [‡] (0.128)
^{cc} Chi2 test and <i>p</i> -value of joint non-significance of IVs in the equation instrumenting the GVC indicator	131.94 0.0000	154.46 0.0000	136.40 0.0000
^{ccc} Chi2 test and <i>p</i> -value of joint exclusion of IVs in the dependent variable equation	1.62 0.2024	0.00 0.9658	0.43 0.5143
^d Correlation-dependent variable and GVC indicator errors	−0.204 [*] (0.120)	−0.601 ^{***} (0.183)	−0.378 [*] (0.204)
^{dd} Chi2 test and <i>p</i> -value of joint non-significance of IVs in the equation instrumenting the GVC indicator	80.57 0.0000	104.62 0.0000	79.76 0.0000
^{ddd} Chi2 test and <i>p</i> -value of joint exclusion of IVs in the dependent variable equation	3.48 0.1759	1.31 0.2520	0.41 0.8154
^e Correlation-dependent variable and GVC indicator errors	0.210 ^{***} (0.033)	0.170 ^{***} (0.021)	0.250 ^{***} (0.037)
^{ee} Chi2 test and <i>p</i> -value of joint non-significance of IVs in the equation instrumenting the GVC indicator	8.02 0.0181	7.36 0.0252	11.11 0.0254
^{eee} Chi2 test and <i>p</i> -value of joint exclusion of IVs in the dependent variable equation	0.73 0.3917	0.11 0.7412	0.54 0.9095
^f Correlation-dependent variable and GVC indicator errors	0.196 (0.164)	−0.246 ^{***} (0.084)	−0.012 (0.109)
^{ff} Chi2 test and <i>p</i> -value of joint non-significance of IVs in the equation instrumenting the GVC indicator	9.40 0.0091	36.90 0.0000	20.24 0.0000
^{fff} Chi2 test and <i>p</i> -value of joint exclusion of IVs in the dependent variable equation	0.98 0.3228	1.24 0.5368	1.60 0.2055

TABLE 3 (Continued)

	(4) Labour productivity	(5) Wages	(6) Workers
Two-way trader ^{a,aa,aaa}	0.197 (0.367)	4.134 ^{***} (1.053)	2.556 ^{***} (0.233)
GVC foreign ^{b,bbb,bbb}	0.606 [†] (0.381)	0.543 ^{***} (0.202)	3.276 ^{***} (0.265)
GVC certificate ^{c,ccc,ccc}	5.047 ^{***} (1.310)	4.334 ^{***} (0.980)	0.930 ^{***} (0.210)
GVC all ^{d,ddd,ddd}	5.623 ^{***} (1.111)	4.829 ^{***} (0.854)	3.442 ^{***} (0.309)
FVA ^{e,eee,eee}	−0.0002 ^{***} (0.00003)	0.0003 ^{***} (0.0001)	0.002 ^{***} (0.00001)
IVA ^{f,fff,fff}	0.942 ^{***} (0.406)	0.103 (0.196)	2.839 ^{***} (0.379)
Observations	4,255–10,378	4,102–10,047	4,568–11,060
^a Correlation-dependent variable and GVC indicator errors	0.063 ^{***} (0.016)	−1.134 ^{***} (0.358)	−0.463 ^{***} (0.116)
^{aa} Chi2 test and <i>p</i> -value of joint non-significance of IVs in the equation instrumenting the GVC indicator	19.99 0.0000	22.54 0.0010	105.63 0.0000
^{aaa} Chi2 test and <i>p</i> -value of joint exclusion of IVs in the dependent variable equation	0.00 0.9687	5.15 0.3976	1.98 0.3721
^b Correlation-dependent variable and GVC indicator errors	0.044 ^{***} (0.013)	0.007 (0.022)	−0.589 ^{***} (0.119)
^{bb} Chi2 test and <i>p</i> -value of joint non-significance of IVs in the equation instrumenting the GVC indicator	115.44 0.0000	331.27 0.0000	113.59 0.0000
^{bbb} Chi2 test and <i>p</i> -value of joint exclusion of IVs in the dependent variable equation	1.21 0.5466	0.74 0.9467	1.78 0.1823
^c Correlation-dependent variable and GVC indicator errors	−0.929 ^{***} (0.290)	−1.073 ^{***} (0.276)	−0.008 (0.008)
^{cc} Chi2 test and <i>p</i> -value of joint non-significance of IVs in the equation instrumenting the GVC indicator	17.08 0.0002	29.19 0.0000	137.38 0.0000
^{ccc} Chi2 test and <i>p</i> -value of joint exclusion of IVs in the dependent variable equation	1.00 0.3161	3.48 0.4807	2.70 0.2591
^d Correlation-dependent variable and GVC indicator errors	−1.050 ^{***} (0.257)	−1.394 ^{***} (0.218)	−0.318 ^{***} (0.105)
^{dd} Chi2 test and <i>p</i> -value of joint non-significance of IVs in the equation instrumenting the GVC indicator	21.57 0.0000	74.51 0.0000	72.64 0.0000
^{ddd} Chi2 test and <i>p</i> -value of joint exclusion of IVs in the dependent variable equation	1.91 0.1673	5.66 0.3412	0.01 0.9288
^e Correlation-dependent variable and GVC indicator errors	0.067 ^{***} (0.018)	0.054 ^{***} (0.021)	0.072 ^{***} (0.011)
^{ee} Chi2 test and <i>p</i> -value of joint non-significance of IVs in the equation instrumenting the GVC indicator	38.23 0.0000	12.19 0.0068	37.35 0.0000

TABLE 3 (Continued)

	(4) Labour productivity	(5) Wages	(6) Workers
^{cce} Chi ² test and <i>p</i> -value of joint exclusion of IVs in the dependent variable equation	2.17 0.8249	0.67 0.7144	0.31 0.8551
^f Correlation-dependent variable and GVC indicator errors	0.003 (0.018)	0.063 ^{***} (0.013)	−0.511 ^{***} (0.110)
^{ff} Chi ² test and <i>p</i> -value of joint non-significance of IVs in the equation instrumenting the GVC indicator	21.68 0.0000	51.79 0.0000	8.02 0.0182
^{fff} Chi ² test and <i>p</i> -value of joint exclusion of IVs in the dependent variable equation	0.76 0.3839	1.21 0.8756	0.24 0.6208

Note: Robust standard errors in parentheses clustered by country and year. All regressions control for country, sector and year dummies as well as for firm size and age. For the equations instrumenting the potentially endogenous global value chain (GVC) indicator, explanatory variables are the control variables in equations (3) and (4), sector, country and year dummies and the corresponding external instruments. The pool of potential external instruments comes from the business environment variables in equations (1) and (2). Among this pool, IVs were selected in each case on the basis of the required conditions for IV validity: 1) have explanatory power over the instrumented GVC indicator and 2) not having a direct effect as a regressor in the outcome (performance) equation of interest.

^{cce} $p < 0.01$,
^f $p < 0.05$,
^{ff} $p > 0.1$,
^{fff} slightly above 0.1.

participation indicator (the strictest, requiring the firm to be a two-way trader with foreign capital participation and an international certificate) has the greatest effect. However, the effect of GVC certificate is slightly higher on the R&D decision and product innovation.

There are only a few exceptions to these general results. One is that two-way trader, if not combined with foreign participation or international certification, does not have a statistically significant effect on productivity. Similarly, IVA has no significant effect on wages. As for FVA, what is relevant for process innovation and labour productivity is participation in GVCs through backward (downstream) integration and not the intensity. Its intensification at some point weakens the incentives for efficiency through process innovation. This is also likely to have a negative effect on labour productivity.²³ This possibly indicates the existence of a threshold beyond which an increase in FVA in firms' exports discourages process innovation and negatively affects productivity.

6 | ROBUSTNESS CHECKS

We perform three robustness checks of our results in the paper. Two for the first objective of the paper, *i.e.* the determinants of firms' participation in GVCs, and one for the second, *i.e.* the effects of participation on firms' performance variables. First, Table A3 in the Appendix shows the results of Table 2.2 when the intensive margin measures of GVC participation 'FVA' and 'IVA' relax the original proportionality assumptions. FVA was calculated assuming that the proportion of foreign inputs is the same in exports as in domestic sales, whereas it is now calculated assuming that for exporters the share of foreign inputs in domestic sales is the same as the average of non-exporting firms in the same sector-country-year. Moreover, IVA was calculated assuming that the proportion of domestic value added is the same in exports as in domestic sales, whereas it is now calculated assuming that for exporters the share of domestic value added in domestic sales is the same as the average of non-exporting firms in the same sector-country-year. The results for the new dependent variables, FVA and IVA, broadly mimic those in Table 2.2. This confirms that our original proportionality assumptions, also present in aggregate measures at the country or sector-country level in international databases such as UNCTAD-Eora, do not lead to misleading results, as anticipated by Ahmad (2013).

Second, we repeat our analysis of the determinants of GVC participation by replacing firm-level regressors from WBES with similar country-level regressors from the World Bank's Doing Business. Table A4 in the Appendix shows the results of these regressions. As these regressions also include country and year dummies, it is not surprising that regressors with little within-country time variation, such as access to electricity (as an indicator of the level of infrastructure), level of tertiary education (as an indicator of skills) or government effectiveness (as an indicator of the quality of institutions), are not significant.²⁴ In contrast, when others are significant, they have the expected signs. This is the case of a country's better position in the ICT Development Index (IDI), which is a proxy for infrastructure that positively affects GVC participation, or lower access to bank financing, higher crime rates (proxy for security) and a lower position in the Logistics Performance Index (proxy for trade procedures), all of which have a negative sign.²⁵

²³Recall that the two-way trader dummy variable in Table 3 takes the value 1 when the FVA variable is positive and 0 when the FVA variable is 0. Therefore, the two-way trader dummy can be interpreted as the dichotomised version of FVA. This two-way trader dummy variable can appear in combination with foreign capital participation or international certification. Although these dummy versions of FVA tend to positively affect process innovation and productivity, their corresponding intensive margin measure has a negative and significant coefficient.

²⁴Electricity access is measured as the percentage of population with access to electricity. The level of tertiary education is calculated as the gross percentage of school enrolment on tertiary education. Government effectiveness is measured as the country's position in the government effectiveness ranking from the World Bank's Worldwide Governance Indicators. Government effectiveness reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. It ranges from 0 (lowest) to 100 (highest) rank.

²⁵The IDI variable measures a country's position in the IDI ranking showing advances in information and communication technology, where higher values mean a better position in the ranking. Access to bank financing measures the percentage of firms not using banks to finance working capital. Crime rates are measured as losses due to theft and vandalism expressed as a percentage of annual sales of affected firms. The Logistics Performance Index measures performance along the country's entire logistics supply chain, with higher values indicating worse performance.

Finally, Table A5 in the Appendix shows the results of using the propensity score matching method instead of the IVs approach to assess the effects of GVC participation on firm performance measures. The results of the balancing tests can be found in Tables S7–S11 of the supplementary material in the additional file.²⁶ There it is confirmed that, after matching, the covariates have statistically the same mean in the two groups and that, therefore, the matching procedure has been able to balance the treated and untreated groups, creating a homogeneous group with common characteristics. In addition, Figure S1 in the supplementary material shows the density plots of the GVC propensity scores before and after matching for the treated and untreated groups. The similarity between the groups after matching further confirms matching quality.

The results in Table A5 are qualitatively consistent with those in Table 3 above, as most of the GVC participation indicators have positive and significant effects on firms' innovation and employment measures. However, there are quantitative differences. Thus, the effects of GVC participation with propensity score matching methods are generally smaller, except for labour productivity with indicators other than GVC certificate and GVC all. The reason may be that in observational studies the two methods for testing a hypothesised causal relationship, design-based methods such as propensity score matching and instrument-based methods such as IVs, target different populations, which is relevant for the interpretation of results. Thus, IV analysis focuses on the local average treatment effect (LATE), which is the treatment effect for those whose treatment status is affected (changed) by the instruments. In our case, it is the effect on our performance measures for those firms whose GVC participation is affected by the instruments. In contrast, propensity score matching provides the average treatment effect among the treated (ATT), *i.e.* the difference between the average performance measures observed for GVC participants and those they would have experienced had they not participated. The target population is the treated firms. This makes the estimates resulting from IVs analysis not directly comparable to the results obtained with propensity score matching methods. For this reason, the best path to causal inference is to recognise the complementarity of the two approaches.

7 | CONCLUSIONS

This paper analyses GVCs in Sub-Saharan Africa using firm-level data from WBES. It answers two questions. First, what business environment factors determine firms' participation in GVCs? Second, what are the effects of participation on different measures of firm performance? Regarding the first question, we find that good infrastructure, quality of institutions and security to prevent crime favour participation. In contrast, difficult access to finance, the existence of an informal sector or high trade costs discourage participation. Related to this, although there are several multi-country and regional aid for trade projects in Africa aimed at alleviating barriers to trade and infrastructure (OECD, WTO, 2015), new complementary policies targeting the remaining barriers would be needed.

A result to reflect on is that obtained for workers' skill intensity, with a negative effect on the likelihood of participating in GVCs. So far, Sub-Saharan countries have the comparative advantage of being endowed with abundant low-cost unskilled labour, which has been attractive for labour-intensive manufacturing activities. However, as Rodrik (2018) highlights, GVCs are increasingly intensive in new technologies, which may pose a threat to these countries. The lack of skills required to handle these technologies may diminish their comparative advantage, as several authors highlight the importance of skilled labour (Hollweg, 2019) or even automation (Stapleton, 2019) in GVCs. Policy makers should pay attention to this risk.

Regarding the second question, we find that Sub-Saharan African firms participating in GVCs enjoy superior innovation performance (both in terms of product upgrading and efficiency gains), higher productivity, pay higher wages and generate more employment. This suggests that their participation can

²⁶Table S11 reports the test on overall significance of covariates in the probit models for propensity score matching after the matching.

help them to grow, develop and play an active role in the international arena. However, they still have a long way to go.

An interesting exception to these general results seems to suggest that excessive backward integration, *i.e.* excessive imported input content in exports (as measured by FVA), may negatively affect incentives for process innovation and productivity of manufacturing firms in Sub-Saharan Africa. More research is needed to understand why this may occur, but perhaps an excess of foreign content in exports implies excessive technological substitution that discourages process innovation and negatively affects productivity. Importing intermediates, which may incorporate technology, may at some point substitute for internal knowledge, negatively affect absorptive capacity and hinder firms' incentives for process innovation. The fact that there is a negative effect on productivity may reinforce the idea of a deterioration of firms' absorptive capacity for imported technology beyond a threshold.

Finally, although this study provides relevant insights at the firm level, we acknowledge the limitation of the pooled dataset nature of WBES. As the issue of endogeneity may arise with this type of data, in this paper, we implement IVs strategies consisting of estimating the joint likelihood function of each dependent variable and the potentially endogenous regressors (LIML) or implementing a control function approach (Rivers & Vuong, 1988), as suggested by Wooldridge (2015). In addition, we also test the robustness of our results on the effects of GVC participation by alternatively using a propensity score methodology. In any case, it is a challenge for future research in this area to have rich firm-level panel surveys covering Sub-Saharan countries in a comparable manner.

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CONFLICT OF INTEREST STATEMENT

The authors report there are no competing interests to declare.

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REFERENCES

- Ahora, J.Y., Agbloyor, E.K. & Kuipo, R. (2014) Bank finance and export activities of small and medium enterprises. *Review of Development Finance*, 4(2), 97–103. Available from: <https://doi.org/10.1016/j.rdf.2014.05.004>
- AFDB, OECD, UNDP. (2014) *African economic outlook 2014: global value chains and Africa's industrialisation*. Paris: OECD Publishing.
- AFRICAN DEVELOPMENT BANK GROUP. (2020). Africa Infrastructure Development Index (AIDI) 2020. Retrieved from: <https://www.afdb.org/en/documents/economic-brief-africa-infrastructure-development-index-aidi-2020-july-2020>
- AFRICAN DEVELOPMENT BANK GROUP. (2022). Infrastructure development. Retrieved from: <https://www.afdb.org/en/knowledge/publications/tracking-africa's-progress-in-figures/infrastructure-development>
- Ahmad, N. (2013) Estimating trade in value-added: why and how? In: Elms, D.K. & Low, P. (Eds.) *Global value chains in a changing world (chapter 3)*. Geneva, Switzerland: World Trade Organization (WTO), pp. 85–108.
- Amendolagine, V., Presbitero, A.F., Rabellotti, R. & Sanfilippo, M. (2019) Local sourcing in developing countries: the role of foreign direct investments and global value chains. *World Development*, 113, 73–88. Available from: <https://doi.org/10.1016/j.worlddev.2018.08.010>
- Antràs, P. (2020) Conceptual aspects of global value chains. *The World Bank Economic Review*, 34(3), 551–574. Available from: <https://doi.org/10.1093/wber/lhaa006>
- Ayadi, R., Giovannetti, G., Marvasi, E., & Zaki, C. (2020). Global value chains and firms' productivity of MENA countries: does connectivity matter? EMNES Working Paper 28.
- Bacchetta, M., Ekkehard, D. & Bustamante, J.P. (2009) *Globalization and informal jobs in developing countries: a joint study of the International Labour Office and the Secretariat of the World Trade Organization*. Geneva, Switzerland: International Labour Organization and World Trade Organization.

- Baghdadi, L. & Guedidi, I. (2021) Global value chains in the age of internet: what opportunities for Africa? In: *Adapting to the digital trade era: challenges and opportunities*. Geneva: WTO Publications, pp. 54–69.
- Bah, E.-H. & Fang, L. (2015) Impact of the business environment on output and productivity in Africa. *Journal of Development Economics*, 114, 159–171. Available from: <https://doi.org/10.1016/j.jdeveco.2015.01.001>
- Baldwin, R. (2013) Global supply chains: why they emerged, why they matter, and where they are going. In: Elms, D.K. & Low, P. (Eds.) *Global value chains in a changing world (chapter 1)*. Geneva, Switzerland: World Trade Organization (WTO), pp. 13–59.
- Baldwin, R. (2016) *The great convergence: information technology and the new globalization*. Cambridge, Massachusetts: The Belknap Press of Harvard University Press.
- Banga, K. (2016) Impact of global value chains on employment in India. *Journal of Economic Integration*, 31(3), 631–673. Available from: <https://doi.org/10.11130/jei.2016.31.3.631>
- Bems, R. & Kikkawa, A.K. (2021) Measuring trade in value added with firm-level data. *Journal of International Economics*, 129, 103434. Available from: <https://doi.org/10.1016/j.jinteco.2021.103434>
- Bernard, A.B., Jensen, J.B., Redding, S.J. & Schott, P.K. (2018) Global Firms. *Journal of Economic Literature*, 56(2), 565–619. Available from: <https://doi.org/10.1257/jel.20160792>
- Borin, A. & Mancini, M. (2019) *Measuring what matters in global value chains and value-added trade*, World Bank Policy Research Working Paper No. 8804. Washington, DC: World Bank, p. 66.
- Bottini, N., Ernst, C. & Luebker, M. (2007) *Offshoring and the labour market: what are the issues?* Geneva: Economic and Labour Market Paper. International Labour Organisation.
- Brancati, E., Brancati, R. & Maresca, A. (2017) Global value chains, innovation and performance: firm-level evidence from the Great Recession. *Journal of Economic Geography*, 17(5), 1039–1073. Available from: <https://doi.org/10.1093/jeg/lbx003>
- Button, K. (2002) *Effective infrastructure policies to foster integrated economic development*. Addis Ababa: Third African Development Forum.
- Cariolle, J. (2021) International connectivity and the digital divide in Sub-Saharan Africa. *Information Economics and Policy*, 55, 100901. Available from: <https://doi.org/10.1016/j.infoecopol.2020.100901>
- Correa, N. & Todorov, V. (2020) *African industrial competitiveness report: an overview of the manufacturing industry in the region*. UNIDO.
- Crisuolo, C. & Timmis, J. (2017) The relationship between global value chains and productivity. *International Productivity Monitor*, 32, 61–83.
- De Melo, J. & Twum, A. (2021) Prospects and challenges for supply chain trade under the Africa continental free trade area. *Journal of African Trade*, 8(2), 49–61.
- Del Prete, D., Giovannetti, G. & Marvasi, E. (2017) Global value chains participation and productivity gains for North African firms. *Review of World Economics*, 153(4), 675–701. Available from: <https://doi.org/10.1007/s10290-017-0292-2>
- Detotto, C. & Otranto, E. (2010) Does crime affect economic growth? *Kyklos*, 63(3), 330–345. Available from: <https://doi.org/10.1111/j.1467-6435.2010.00477.x>
- Dovis, M. & Zaki, C. (2020) Global value chains and local business environment: which factors really matter in developing countries? *Review of Industrial Organization*, 57(2), 481–513. Available from: <https://doi.org/10.1007/s11151-020-09768-w>
- Farole, T. (2016) *Do global value chains create jobs?* vol. 291. IZA World of Labor. Available from: <https://doi.org/10.15185/izawol.291>
- FASHIONOMICS AFRICA. (2021). Fashionomics Africa. Retrieved from <https://fashionomicsafrica.org/about-us>
- Fowowe, B. (2017) Access to finance and firm performance: evidence from African countries. *Review of Development Finance*, 7(1), 6–17. Available from: <https://doi.org/10.1016/j.rdf.2017.01.006>
- Fu, X., Pietrobello, C. & Soete, L. (2011) The role of foreign technology and indigenous innovation in the emerging economies: technological change and catching-up. *World Development*, 39(7), 1204–1211. Available from: <https://doi.org/10.1016/j.worlddev.2010.05.009>
- Gal, P. & Witheridge, W. (2019) *Productivity and innovation at the industry level: what role for integration in global value chains?* Paris: OECD Productivity Working Papers, No. 19, OECD Publishing.
- Hollweg, C.H. (2019) Global value chains and employment in developing countries. In: *Technological innovation, supply chain trade, and workers in a globalized world*. Geneva: World Trade Organization, pp. 63–81.
- Imbruno, M., Cariolle, J., & De Melo, J. (2022). Digital connectivity and firm participation in foreign markets: an exporter-based bilateral analysis. CEPR Press Discussion Paper No. 17318.
- IMF. (2016) *Trade integration and global value chains in Sub-Saharan Africa—in pursuit of the missing link. Technical report*. Washington, D.C.: International Monetary Fund (IMF).
- Kounouwewa, J. & Chao, D. (2011) Evidence on how African enterprises choose informal credit. *The International Journal of Applied Economics and Finance*, 5(1), 46–61. Available from: <https://doi.org/10.3923/ijaf.2011.46.61>
- Kowalski, P., Gonzalez, J.L., Ragoussis, A. & Ugarte, C. (2015) *Participation of developing countries in global value chains: implications for trade and trade-related policies*, OECD trade policy papers, no. 179. Paris: OECD Publishing.
- Leuven, E. & Sianesi, B. (2003). PSMATCH2: Stata module to perform full Mahalanobis and propensity score matching, common support graphing, and covariate imbalance testing. <http://ideas.repec.org/c/boc/bocode/s432001.html>
- Moller, L.C. & Wacker, K.M. (2017) Explaining Ethiopia's growth acceleration—the role of infrastructure and macroeconomic policy. *World Development*, 96, 198–215. Available from: <https://doi.org/10.1016/j.worlddev.2017.03.007>

- OECD, WTO. (2015) Chapter 6. Connecting to value chains: The role of trade costs and trade facilitation. In: *Aid for trade at a glance 2015: reducing trade costs for inclusive, sustainable growth*. Paris: OECD Publishing, pp. 165–184.
- Pasquali, G.P. (2021) When value chains go south: upgrading in the Kenyan leather sector. *Journal of World Business*, 56(2), 101161. Available from: <https://doi.org/10.1016/j.jwb.2020.101161>
- Pietrobelli, C. & Rabellotti, R. (2011) Global value chains meet innovation systems. Are there learning opportunities for developing countries? *World Development*, 39(7), 1261–1269. Available from: <https://doi.org/10.1016/j.worlddev.2010.05.013>
- Qiang, C.Z., Liu, Y. & Steenberg, V. (2021) *An investment perspective on global value chains*. Washington, DC: World Bank.
- Rivers, D. & Vuong, Q.H. (1988) Limited information estimators and exogeneity tests for simultaneous probit models. *Journal of Econometrics*, 39(3), 347–366. Available from: [https://doi.org/10.1016/0304-4076\(88\)90063-2](https://doi.org/10.1016/0304-4076(88)90063-2)
- Rodrik, D. (2018) *New technologies, global value chains, and the developing economies*, Pathways for Prosperity Commission Background Paper Series; no. 1. Oxford, United Kingdom.
- Roodman, D. (2011) Fitting fully observed recursive mixed-process models with cmp. *The Stata Journal*, 11(2), 159–206. Available from: <https://doi.org/10.1177/1536867X1101100202>
- Shepherd, B. (2013) *Global value chains and developing country employment: A literature review*. OECD trade policy papers, no. 156. Paris: OECD Publishing.
- Shepherd, B. (2015). Global value chains, technology transfers and innovation. Asia-Pacific Trade and Investment Report, 147–161.
- Shepherd, B. (2016) Infrastructure, trade facilitation, and network connectivity in Sub-Saharan Africa. *Journal of African Trade*, 3(1–2), 1–22.
- Shepherd, B. & Stone, S. (2013) *Global production networks and employment: a developing country perspective*. OECD trade policy papers, no. 154. Paris: OECD Publishing.
- Slany, A. (2019) The role of trade policies in building regional value chains—some preliminary evidence from Africa. *South African Journal of Economics*, 87(3), 326–353. Available from: <https://doi.org/10.1111/saje.12214>
- Stamm, A. (2004). Value Chains for Development Policy. Challenges for Trade Policy and the Promotion of Economic Development. Deutsche Gesellschaft für Technische Zusammenarbeit.
- Stapleton, K. (2019) *Automation, global value chains and development: what do we know so far?* Pathways for Prosperity Commission Background Paper Series; no. 26. Oxford, United Kingdom.
- Sun, M. (2021) The internet and SME participation in exports. *Information Economics and Policy*, 57, 100940. Available from: <https://doi.org/10.1016/j.infoecopol.2021.100940>
- Timmer, M. (2017) Productivity measurement in global value chains. *International Productivity Monitor*, 33, 182–193.
- UNIDO. (2011) *Mapping global value chains: intermediate goods trade and structural change in the world economy*. Vienna: Development Policy and Strategic Research Branch.
- UNITED NATIONS: OFFICE OF DRUGS AND CRIME. (2005). Crime and development in Africa.
- US INTERNATIONAL TRADE COMMISSION. (2009). Sub-Saharan African textile and apparel inputs: potential for competitive production, Investigation No. 332-502, Publication 4078. Washington.
- Wooldridge, J.M. (2015) Control function methods in applied econometrics. *Journal of Human Resources*, 50(2), 420–445. Available from: <https://doi.org/10.3368/jhr.50.2.420>
- WORLD BANK. (2019) *World Development Report 2019: The changing nature of work*. Washington, DC: World Bank 10.1596/978-1-4648-1328-3.
- WORLD BANK. (2020a) *World Development Report 2020: Trading for development in the age of global value chains*. Washington, DC: World Bank 10.1596/978-1-4648-1457-0.
- WORLD BANK. (2020b). Worldwide Governance Indicators. Retrieved from: <https://info.worldbank.org/governance/wgi/>
- WORLD TRADE ORGANIZATION. (2019). WTO “Trade in Value-Added and Global Value Chains” profiles. Explanatory notes.
- Yeats, A. J. (1998). Just how big is global production sharing? Available at SSRN 597193.
- Yülek, M.A. & Yağmur, M.H. (2018) Textile and clothing sector, and the industrialization of Sub-Saharan Africa. In: Efobi, U. & Asongu, S. (Eds.) *Financing sustainable development in Africa*. Cham: Palgrave Macmillan. Available from: https://doi.org/10.1007/978-3-319-78843-2_16

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX

TABLE A1 Definitions—business environment variables (most at firm level).

Variable	Source	Definition
Outage (infrastructure)	WBES	Dummy equal to 1 if the establishment experienced power outages over the last fiscal year and 0 otherwise
Generator (infrastructure)	WBES	Dummy equal to 1 if the establishment owned or shared a generator last fiscal year and 0 otherwise
Web (infrastructure)	WBES	Dummy equal to 1 if the establishment has its own website at the present time and 0 otherwise
Skilled intensity (labour)	WBES	Ratio of skilled workers/total number of workers (multiplied by 100)
Average obst labour (labour)	WBES	Labour regulation as the biggest obstacle faced by establishments in the same country-sector-year. Measured by subtracting the individual firm's own response to the country-sector-year average
Obst finance (finance)	WBES	Dummy equal to 1 if the biggest obstacle faced by the establishment is access to finance and 0 otherwise
Tax inspection (taxation)	WBES	Dummy equal to 1 if the establishment was visited or inspected by tax officials or required to meet with them over the last year and 0 otherwise
Obst tax (taxation)	WBES	Dummy equal to 1 if the biggest obstacle faced by the establishment are tax rates and 0 otherwise
Informality	WBES	Dummy equal to 1 if practices of competitors in the informal sector are a very severe obstacle to the current operations of the establishment and 0 otherwise.
Security	WBES	Dummy equal to 1 if the establishment paid for security last fiscal year, for example equipment, personnel, or professional security services including internet security and 0 otherwise.
Import cost (trade procedures)	DB	Trading across Borders—Cost to import (US\$ per container deflated). Multiplied by 1,000.
Export days (trade procedures)	DB	Trading across Borders—Time to export (days)

Note: WBES corresponds to World Bank Enterprise Survey and DB to World Bank's Doing Business (firm-level and country-year data, respectively).

TABLE A2 Definitions—Performance variables: related to innovation and employment (at firm level).

Variable	Source	Definition
R&D decision	WBES	Dummy equal to 1 if the establishment spent on research and development activities, either in-house or contracted with other companies (excluding market research surveys) during the last fiscal year and 0 otherwise
New product	WBES	Dummy equal to 1 if the establishment introduced new or improved products or services during the last 3 years and 0 otherwise
New process	WBES	Dummy equal to 1 if the establishment introduced any new or improved process during the last 3 years and 0 otherwise
Labour productivity	WBES	Ratio of labour productivity/country-sector-year average of labour productivity. Labour productivity calculated as sales/workers
Wages	WBES	Ratio of wages/country-sector-year average of wages. Wages calculated as labour cost/workers
Workers	WBES	Ratio of number of workers/country-sector-year average of workers

Note: WBES corresponds to World Bank Enterprise Survey.

TABLE A3 Estimated marginal effects—business environment factors determining participation in GVCs (relaxing the proportionality assumptions in the calculation of dependent variables *new* FVA and *new* IVA).

Variables	(1) FVA	(2) IVA
Outage	0.028 (0.082)	−0.110 (0.149)
Generator	0.221 ^{***} (0.056)	0.213 ^{***} (0.075)
Web	0.356 ^{***} (0.063)	0.451 ^{***} (0.156)
Skilled intensity	−0.003 ^{***} (0.001)	−0.002 (0.002)
Average obst labour	−3.446 ^{***} (1.276)	1.973 (3.739)
Obst finance	−0.101 [†] (0.069)	−0.234 ^{**} (0.104)
Tax inspection	0.089 [†] (0.058)	0.193 [*] (0.098)
Obst tax	−0.084 [†] (0.055)	−0.209 [*] (0.108)
Informality	−0.165 ^{***} (0.059)	−0.280 ^{**} (0.115)
Security	0.207 ^{***} (0.068)	0.033 (0.091)
Import cost	−0.023 (0.017)	−0.234 ^{**} (0.114)
Export days	−0.062 ^{***} (0.005)	−0.107 ^{***} (0.024)
Size	0.583 ^{***} (0.064)	0.583 ^{***} (0.099)
Log age	0.078 ^{**} (0.038)	0.069 (0.070)
Constant	1.628 ^{***} (0.380)	4.925 ^{***} (1.513)
Observations	8,561	3,573

Note: Robust standard errors in parentheses clustered by country and year. All regressions control for country, sector and year dummies as well as for firm size and age. Foreign value added (FVA) in exports was calculated assuming that the proportion of inputs of foreign origin is spread equally to exports and to domestic sales, whereas *new* FVA has been calculated assuming instead that for exporters the proportion of foreign inputs in domestic sales is the same as the average one for non-exporting firms in the same sector-country-year. Indirect value added (IVA) was calculated assuming that the proportion of domestic value added is spread equally to exports and to domestic sales, whereas *new* IVA has been calculated assuming instead that for exporters the proportion of domestic value added in domestic sales is the same as the average one for non-exporting firms in the same sector-country-year. The same estimation procedure has been used as for the main text results in Table 2.2.

*** $p < 0.01$,

** $p < 0.05$,

* $p < 0.1$.

† slightly above 0.1.

TABLE A4 Estimated marginal effects—business environment factors determining participation in GVCs (results with country-level regressors).

	(1) Two-way trader	(2) GVC foreign	(3) GVC certificate	(4) GVC all
Electricity access	−0.001 (0.003)	0.002 (0.002)	−0.001 (0.002)	−0.001 (0.001)
IDI	0.005 ^{***} (0.001)	0.003 ^{***} (0.001)	−0.001 (0.001)	−0.000 (0.001)
Tertiary education	−0.002 (0.016)	−0.014 (0.011)	0.006 (0.012)	0.002 (0.005)
Bank use	0.006 (0.004)	0.002 (0.003)	0.002 (0.003)	−0.002 [†] (0.001)
Crime	−0.032 ^{**} (0.014)	−0.001 (0.009)	−0.003 (0.011)	0.000 (0.005)
Government effectiveness	−0.001 (0.002)	0.000 (0.001)	−0.000 (0.001)	−0.001 (0.001)
LPI	−0.044 (0.092)	−0.162 ^{**} (0.064)	−0.020 (0.073)	−0.035 [*] (0.021)
Size	0.199 ^{***} (0.009)	0.090 ^{***} (0.006)	0.091 ^{***} (0.006)	0.044 ^{***} (0.004)
Log age	0.034 ^{***} (0.006)	0.003 (0.004)	0.029 ^{***} (0.004)	0.009 ^{***} (0.003)
Constant	0.987 (3.176)	−4.290 (4.660)	−6.158 (5.033)	−1.390 (4.030)
Observations	7,332	7,260	7,142	6,960

Note: Robust standard errors in parentheses. All regressions control for country, sector and year dummies.

Abbreviations: GVC, global value chain; IDI, ICT Development Index; LPI, Logistics Performance Index.

^{***} $p < 0.01$,

^{**} $p < 0.05$,

^{*} $p < 0.1$.

[†]slightly above 0.1.

TABLE A5 Estimated marginal effects (ATT)—the impact of participation in GVCs on performance measures (propensity score matching method).

	(1) R&D decision	(2) New product	(3) New process
Two-way trader	0.101 ^{***} (0.021)	0.044 ^{***} (0.022)	0.063 ^{***} (0.028)
GVC foreign	0.034 (0.044)	−0.035 (0.032)	−0.020 (0.034)
GVC certificate	0.109 ^{***} (0.039)	0.064 [†] (0.043)	0.114 ^{***} (0.045)
GVC all	0.139 ^{***} (0.068)	−0.071 (0.055)	0.058 (0.060)
Observations	4,455–4,656	5,133–5,316	5,132–5,288

TABLE A5 (Continued)

	(4) Labour productivity	(5) Wages	(6) Workers
Two-way trader	0.787 ^{***} (0.149)	0.322 ^{***} (0.084)	0.405 ^{***} (0.144)
GVC foreign	1.015 ^{***} (0.229)	0.685 ^{***} (0.170)	0.256 (0.250)
GVC certificate	0.936 ^{***} (0.217)	0.496 ^{***} (0.164)	1.180 ^{***} (0.229)
GVC all	1.121 ^{***} (0.352)	0.795 ^{***} (0.224)	0.983 ^{***} (0.481)
Observations	7,981–8,173	7,741–7,921	8,534–8,749

Note: Bootstrap standard errors.
Abbreviations: ATT, average treatment effect on the treated; GVC, global value chain.
*** $p < 0.01$,
** $p < 0.05$,
* $p < 0.1$,
† slightly above 0.1.