# Global value chains and the innovativeness of firms in Africa

Ndubuisi, Gideon; Mensah, Emmanuel B.; Avenyo, Elvis K.; Sakyi, Daniel

**DOI**
10.1016/j.technovation.2025.103276

**Publication date**
2025

**Document Version**
Final published version

**Published in**
Technovation

Technovation 146 (2025) 103276

Contents lists available at ScienceDirect

Technovation

journal homepage: www.elsevier.com/locate/technovation

# Global value chains and the innovativeness of firms in Africa

Gideon Ndubuisi [a], Emmanuel B. Mensah [b,*], Elvis K. Avenyo [c], Daniel Sakyi [d]

[a] Delft University of Technology (TU Delft), the Netherlands
[b] Utrecht University, The Netherlands and South African Research Chair in Industrial Development, University of Johannesburg, South Africa
[c] South African Research Chair in Industrial Development, University of Johannesburg, South Africa
[d] Kwame Nkrumah University of Science and Technology (KNUST), Ghana

ARTICLE INFO

*JEL classification:*
codes: F14
O30
N77

*Keywords:*
Global value chain
Innovation
Spillover
SMEs
Younger firms
Africa

ABSTRACT

Firm-level innovation in developing countries is mostly incremental and depends on non-R&D activities. Integration into global production networks is one such activity that could help firms in developing countries innovate, particularly since new technologies and foreign knowledge diffuse through inter-firm linkages. Accordingly, this paper examines the relationship between Global Value Chain (GVC) participation and firm-level innovation in Africa, using data from the World Bank's Enterprise Survey (WBES). Employing different estimation strategies that enable us to address various empirical challenges, we find strong evidence suggesting that African GVC firms are highly innovative. They are not just more likely to introduce new products and processes but also more likely to jointly introduce both types of innovation as well as radical innovations. In an extended analysis, we found that integrating small and medium enterprises and younger firms into GVC enables them to overcome resource constraints, resulting in higher innovativeness. Finally, we document that the innovation gains from GVC trickle down to non-GVC firms in the same industry and region, implying that firms engaged in GVC activities generate positive spillovers to other firms in the economy. A proposed framework rationalizes our findings. The framework sheds light on the mechanisms that make firm-level innovation possible across African firms in an era where GVC is an important conduit for inter-firm learning, knowledge exchange, and technology transfer.

## 1. Introduction

Quantifying the factors that drive firm innovation and innovativeness remains an area of major interest for public policymakers in both the advanced and developing worlds. Whilst research into this question in advanced economy settings has focused predominantly on the role of research and development (R&D) (e.g., see Shefer and Frenkel, 2005), innovation in developing countries often follows an alternative route, depending more on the acquisition and absorption of foreign knowledge and technologies. Given the low volume of, and resources for, domestic R&D activities in developing countries, innovation must by necessity often take the form of imitation (Madsen et al., 2010). On this basis, several studies have analysed the impact of foreign firms or the role of exporting in the process of innovation and learning in developing countries (Haskel et al., 2007; Alvarez and López, 2008; Keller and Yeaple, 2009; Anwar and Nguyen, 2011). Whilst these studies engage extensively with the role of foreign direct investment (FDI) or final exports, the fragmented nature of modern international trade in the form of global value chains (GVC) is largely absent from the literature thus far, particularly from those papers which focus on developing economies.

In this paper, we contribute to closing this gap by offering extensive quantitative evidence on the potential role of GVC participation in driving the innovativeness of firms across multiple African countries. The formation and fragmentation of GVCs constitutes one of the most prominent aspects of the recent wave of globalization. Global production has become reorganized and now largely takes place through GVCs. This has allowed firms in developing countries to access global markets by specializing in specific tasks that form part of a value chain without building an entire domestic industry. The burden of comparative advantage, thus, has shifted from the production of entire products to the performance of specific tasks. This implies the range of products and services to the production of which developing countries can contribute has become much greater.

Rodrik (2018) argued that GVCs are vehicles for disseminating new technologies from developed to developing countries, consistent with

* Corresponding author.
*E-mail address:* e.b.mensah@uu.nl (E.B. Mensah).

https://doi.org/10.1016/j.technovation.2025.103276
Received 7 January 2024; Received in revised form 31 December 2024; Accepted 27 May 2025
Available online 13 June 2025

the earlier literature showing that goods traded across borders embody technological knowledge (e.g., Coe and Helpman, 1995). The implication is that developing country firms can join the value chains of complex products at the more routine and low-skilled stages of production, and then gradually learn about the performance of the more high-skilled stages. In a parallel argument, Pietrobelli and Rabellotti (2011) note that, for firms in developing countries, being part of GVC not only provides new markets for their products but also plays a growing and crucial role in access to knowledge and enhanced learning and innovation. Consistent with the broader literature suggesting that access to existing and new technologies leads to the creation of new products and processes (De Marchi et al., 2018), it follows that GVC participation may be considered a strong predictor of firm innovation, especially in resource-constrained and weak innovation ecosystem, such as those in Africa.

Despite the potential nexus between GVC participation and innovation, the empirical literature examining this relationship is nascent. Few existing studies provide evidence mostly for advanced and emerging countries (see Ito et al., 2023; Wang and Hu, 2020; Lema et al., 2015; Tajoli and Felice, 2018; Yang et al., 2020; Piermartini and Rubínová, 2021). We contribute to this incipient literature by providing novel firm-level evidence across African countries. To motivate our analysis, we argue that a salient feature of firm-level innovation across African countries is that it is incremental and depends largely on non-R&D activities. On average, African countries devote only 0.45 % of their GDP to R&D, far below the global average of 1.7 % (Kariuki et al., 2023). The R&D that does take place in African countries is also often concentrated in universities and public sector research institutes, with industrial R&D lagging behind (Niosi, 2010). This raises the question of how firms in such a resource-constrained and weak innovation ecosystem can innovate or, put differently, what mechanisms they can leverage to overcome their structural barriers to innovation.

Based on our earlier discussion, there are strong reasons to expect that GVC participation and integration may represent one such mechanism. Nevertheless, recent firm-level evidence shows that the level of GVC engagement in most African countries is rather low (van Biesebroeck and Mensah, 2019). This implies that raising the levels of GVC integration may provide an alternative route to innovativeness in developing countries that are severely resource-constrained. Such a finding can therefore serve as a basis for justifying (or opposing) government policies and initiatives aimed at either increasing (or decreasing) GVC participation levels of firms, both in Africa and in other resource-constrained and innovation-light developing regions. At the same time, considering the substantial gains linked to innovation—illustrated, for instance, by Naveed and Wang (2023), who demonstrate that innovation significantly enhances productivity via structural change—this route to enhanced innovation may in turn contribute to important higher-order outcomes such as structural transformation and growth.

To address our research objective, we utilize the World Bank Enterprise Survey (WBES), spanning 2006–2018 for 48 African countries.[1] Our analysis relies on two innovation types—product and process innovation—which we draw directly from the WBES. We define product innovation as a binary variable that takes the value 1 if a firm introduced a new product and 0 if otherwise. Similarly, process innovation is a binary variable that takes the value 1 if a firm introduces a new process and zero if otherwise. Since firms can jointly introduce product and process innovations, we test the robustness of the innovation indicators with two alternative empirical proxies: i) an index that takes the value of 1 if a firm simultaneously introduced a new product and process, and 0 if otherwise; and ii) an index that takes the value 2 if a firm simultaneously introduced a new product and process, 1 if it introduced either a new product or process but not both, and 0 if otherwise. We also assess the quality of innovation by using an index that takes the value zero if the firm did not introduce a new product, 1 if it introduced a new product, and two if the introduced product is new to the market. Following developments in the firm-level GVC literature (see Del Prete et al., 2017; Davis and Zaki, 2020; Reddy et al., 2021), we identify GVC participating firms as firms that simultaneously export, import (two-way traders) and have an internationally recognized quality certificate. In addition, we test the robustness of our GVC indicator against two alternative indicators, including two-way traders and two-way traders with foreign ownership.

Results from both probit and linear probability models show that GVC participation strongly predicts product and process innovation. In this case, GVC participation enhances the innovativeness of firms in African countries. Such firms are more likely to introduce new products and processes than firms in the region that do not engage in GVCs. The robustness checks which employ alternative innovation or GVC indicators support these conclusions. Nevertheless, the link we establish via these regressions may be subject to endogeneity biases arising from omitted variable bias or reverse causality. For example, while we argue that GVC participation drives innovation, it may well be that innovation drives GVC participation (see Reddy et al., 2021), resulting in simultaneity bias. Additionally, firms may self-select into GVC based on their pre-existing characteristics. This aligns with a common finding in the broader trade literature that well-performing firms engage more extensively in international trade due to the large additional fixed and variable costs associated with such trade (Melitz, 2003).[2] This would lead to omitted variable bias if the firm characteristics that increase the likelihood of GVC integration are intangible or lie outside our control set. We address these empirical challenges by employing the Instrumental Variable technique (IV), exploiting plausibly exogenous variation from two external instruments: the decision of a firm to obtain an import license and the likelihood of engaging in GVC driven by the average peer propensity to participate in GVC. Results from this estimation strategy fully corroborate the baseline probit and linear probability models, indicating a possible causal relationship between GVC participation and product and process innovation among firms in African countries.

We extend our analysis in two ways to provide further insight into the precise nature of the relationship between GVC participation and innovation in Africa. First, we consider the effect of GVC participation on the innovativeness of small and medium enterprises (SMEs) and younger firms. The motivation for this extension draws from the common finding that such firms are often the most resource-constrained (Beck et al., 2008), implying they may have the most to gain from utilizing GVC participation as an alternative route to innovation. Our findings support this argument by showing that GVC participation strongly predicts product and process innovation in SMEs and younger firms.

Second, we consider the potential for innovation gains from GVC integration to trickle down to non-GVC firms. One of the major arguments for pro-GVC policies is that GVC participation spurs economic growth and development, including via positive spillovers to the wider economy (Foster-McGregor et al., 2015). Our results support such arguments by showing evidence of positive spillovers to non-GVC participating firms. In other words, the innovation gains from GVCs affect the firms engaged in GVCs themselves and the local firms not engaged in GVCs. Our findings suggest that this spillover to non-GVC firms does not just materialize from the concentration or presence of

[1] In 2008, survey data was unavailable for all countries in our sample (see Table A1 in the appendix).

[2] Fernandes et al. (2022) argue that these costs are higher for GVC trade for two reasons: i) the number of trade links in GVC is much larger, and ii) unlike traditional trade, higher trade costs affect not only prices of exported goods but also that of imported inputs in a GVC. In this case, the bias resulting from self-selection may be more pronounced in the context of GVC.

GVC firms in an industry or region but the concentration of these firms in a spatially concentrated industry. This is consistent with the idea of spatial interdependencies of innovation (Cabrer-Borras and Serrano-Domingo, 2007). Hence, the result highlights the role of geographical proximity and similarity in production lines for non-GVC firms to reap these spillover gains.

The rest of this paper proceeds as follows. Section 2 frames the theoretical background and main hypotheses. Section 3 introduces the data sources, indicators, and empirical methodologies. Section 4 presents and discusses all results, and section 5 provides concluding remarks.

## 2. Theoretical background and hypotheses

To frame our empirical work, this section draws on the trade and innovation literatures to develop the theoretical background to our research question, in addition to our hypotheses. We draw on three strands of literature: (1) international trade and innovation, (2) competition and firms' technology search strategies, and (3) external linkages and firms' innovation strategies. We organize and collate this literature to provide a theoretical framework for how GVC participation may be expected to predict product and process innovation in developing countries.

### 2.1. Theoretical framework

A useful starting point for thinking about the relationship between GVC trade and innovation is the Schumpeterian model of innovation (Aghion and Howitt, 1992). This model was developed to explain growth, but innovation in the model, which is our focus, is driven by an intermediate firm that closely resembles GVC firms. Following recent approaches (Akcigit and Melitz, 2022; Melitz and Redding, 2021), we characterize how GVC trade affects the endogenous rate of innovation via (1) competition, (2) input channel, (3) market size, and (4) knowledge spillovers. The framework we outline below is rooted in that of Aghion and Howitt (2009).

**Consumption and production**. Time is modelled as discrete such that t = 1, 2, 3, etc. The economy is endowed with a mass of workers, L, whereby each worker inelastically provides one unit of labour services.[3] Individual consumers are assumed to be risk-neutral and to maximise expected consumption. Individuals consume a final good $Y_t$. $Y_t$ is produced using labor $L$ and a continuum of intermediate goods, $m_{it}$, indexed by $i \in (0,1)$:

$$Y_t = L^{1-\alpha} \int_0^1 \omega_{it}{}^{1-\alpha} m_{it}{}^{\alpha} di \tag{1}$$

$Y_t$ is competitively produced from each intermediate good following a Cobb-Douglas production process with constant returns to scale:

$$Y_t = (\omega_{it} L)^{1-\alpha} m_{it}{}^{\alpha}$$

for $\alpha \in (0,1)$, where $\omega_{it}$ defines the quality of intermediate product $i$ at time $t$. Each $m_{it}$ is produced by an intermediate firm, which takes the form of a monopolist using final goods as the only input and a one-for-one technological process for converting final goods into intermediate goods. Assuming the final good is the numeraire, the monopolist profit is defined as:

$$\prod_{it} = p_{it} m_{it} - m_{it} \tag{2}$$

where the marginal cost of production is 1 per unit $m$, and $p_{it}$ is the relative price of the intermediate good $m_{it}$. The inverse demand that each firm faces can be derived as:

$$p_{it} = \alpha(\omega_{it} L)^{1-\alpha} m_{it}{}^{\alpha-1} \tag{3}$$

The firm optimization problem is then a profit maximization problem, given by $\prod_{it} = \alpha(\omega_{it} L)^{1-\alpha} m_{it}{}^{\alpha} - m_{it}$, whereby expression (3) is substituted into (2). By differentiating for first order conditions, it can be seen that the optimal intermediate input produced by the firm is:

$$m_{it} = \alpha^{\frac{2}{1-\alpha}} (\omega_{it} L) \tag{4}$$

Substituting (3) and (4) into (1) and (2), we derive the optimal final good and corresponding intermediate firm profit as:

$$Y_{it}^{*} = \alpha^{\frac{2\alpha}{1-\alpha}} (\omega_{it} L) \text{and} \prod\nolimits_{it}^{*} = \pi \omega_{it} L, \tag{5}$$

respectively, where $\pi$ is a term we will call the 'incentive to innovate', and is defined by $\pi = (1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}}$.

Our focus is on the innovator firm. From Equation (5) it can be seen that the profit of the innovator depends on the innovation incentive ($\pi$), the quality of the intermediate good ($\omega_{it}$), and the effective market size ($L$). We will return to these drivers when discussing the channels.

**Innovation process**. In each time period, the representative innovator firm undertakes an effort to develop a new intermediate good with enhanced quality according to:

$$\omega_{it} = \gamma \omega_{i,t-1}$$

where $\gamma > 1$. It can be seen that innovation follows a creative destruction process where new technologies are continuously replacing existing technology.

In the context of this paper, innovation efforts must be conceptualized as going beyond purely traditional R&D, as in the framework of Aghion and Howitt (1992). In our developing country context, R&D activities are limited for the reasons discussed in the introduction. Innovation efforts instead include actions such as obtaining import licenses to access higher-quality intermediate goods, securing international certifications to operate as a supplier, investing in new machinery, enhancing organizational processes, or engaging in reverse engineering, cooperation agreements with lead firms in a value chain - basically, activities which facilitate knowledge transfer and imitation. Investments in these activities inherently carry a degree of uncertainty.

The probability of successful innovation is assumed to rise with the cost of innovation efforts $E_t$ normalized by the current state of technology $\omega^{*} = \gamma \omega_{i,t-1}$ as:

$$\mu_{it} = \varnothing\left(\frac{E_{it}}{\omega_{it}^{*}}\right) \tag{6}$$

This Equation implies that if the current state of technology is high, then innovation effort $E_t$ needs to be very intensive to create new innovations. Whilst this model is originally a closed economy model, the closed economy can be conceptualized as a complete (multinational) value chain. In this case, it might be the case that downstream firms are more intensively engaged in R&D activities. A typical GVC firm in Africa, by contrast, is upstream as a supplier of primary inputs and raw materials. Therefore, $E_{it}$ may be characterized instead as effort expended on imitative activities of the type outlined above, whereby more advanced technologies require more effort to imitate. Let $E_{it}/\omega_{it}^{*}$ be denoted by $n_{it}$. Innovation outcomes are assumed to follow a Cobb-Douglas process:

$$\varnothing(n_{it}) = \varphi n_{it}^{\sigma}$$

where $\sigma \in (0,1)$ and parameter $\varphi$ is the efficiency of innovation efforts. The expected reward of innovation is given as $\varnothing(n_{it})\prod_{it}^{*}$, i.e. the volume of innovation outcomes multiplied by the profit per innovation outcome.

[3] The model assumes full employment; therefore, the mass of L workers is also the effective market size.

Therefore, substituting back in the effort to innovation environment ratio, the expected benefit is

$$\varnothing\left(\frac{E_{it}}{\omega_t^*}\right)\prod_{it}^{*} - E_{it}$$

Maximizing this expression with respect to innovation effort $E_t$, and using expression (5), $\prod_t^* = \pi\omega_t L$, yields the following innovation arbitrage condition:

$$\varnothing'(n_{it})\pi L = 1$$

From the Cobb-Douglas innovation function, it can be shown that $\varnothing'(n_{it}) = \sigma\varphi n_{it}^{\sigma-1}$, substituting this into the arbitrage condition yields:

$$\sigma\varphi n^{\sigma-1}\pi L = 1 \Rightarrow n = (\sigma\varphi\pi L)^{\frac{1}{1-\sigma}}$$

When we plug in the normalized innovation effort $n$ that the innovator chooses, we can compute the equilibrium probability of innovation as

$$\mu = \varphi n^{\sigma} = \varphi^{\frac{1}{1-\sigma}}[\sigma\pi L]^{\frac{\sigma}{1-\sigma}} \tag{7}$$

This expression shows that the probability of innovation depends on the productivity of innovation effort ($\varphi$), profit incentive ($\pi$), and market size ($L$). In the next section, we discuss how GVC participation affects these parameters and variables and, hence, the probability of product and process innovation.

#### 2.1.1. Competition channel

In the above model, profits and the rate of innovation are influenced by the innovation incentive [$\pi(\alpha)$], which is a function only of the parameter $\alpha$. If we assume that intermediate goods are produced using labor as the only input in a one-for-one technology instead of the final output, it can be shown that $p_{it} = \left[\frac{1}{1-\alpha}\right]w_{it}$. Again, the markup resulting from a successful innovation is defined by $\alpha$. More broadly, the profits from innovation are shaped by the market structure and the intensity of competition in product markets. Since international trade has the potential to alter market structures, GVC participation introduces an additional channel through which trade can impact innovation (Melitz and Redding, 2021).

Exposure to GVC trade implies that many producers worldwide can produce intermediate goods in our framework. On the one hand, increased competition in product markets due to GVC trade reduces the incentive to innovate by lowering the markup and expected profits from successful innovation (i.e., the *'discouragement effect'*). On the other hand, GVC-induced product market competition may provide strong incentives for firms to innovate to 'escape competition' (Aghion et al., 2001). Also, a decline in profitability due to product market competition can enhance managerial incentives to adopt new technologies (Aghion et al., 1999). As noted above, these new technologies mainly diffuse through GVC networks (Rodrik, 2018). Access to new technologies via GVCs may lead to the creation of new products and processes (De Marchi et al., 2018).

#### 2.1.2. Input channel

In the model, Equation (5) shows that the profit of the innovator is directly influenced by the quality of the intermediate input ($\omega_{it}$). A large body of literature has shown how access to higher quality and lower cost intermediate inputs via GVCs increases the innovation activities of GVC firms. Firms embedded in GVCs have access to higher-quality (Amiti and Konings, 2007), lower-cost (Grossman and Rossi-Hansberg, 2008), and a wider variety (Goldberg et al., 2010) of intermediate inputs. From the model above, it is straightforward to observe that access to higher-quality intermediate inputs increases the likelihood of innovation by improving the profitability of such activities. Halpern et al., (2015a) show that access to more affordable inputs enhances firms' efficiency by reducing their production costs. Finally, in a famous reinterpretation of the Krugman, (1980) model of intra-industry trade, Ethier, (1982) argues that international trade in intermediate goods increases the variety of knowledge-embodying intermediate goods available to individual firms, enhancing the productivity of these firms through positive production externalities. Through the 'love-of-variety effect', integrating into GVCs enables firms to access a wider variety of sophisticated and competitively priced inputs, leading to innovation through the wider range of technologies embodied in these intermediate goods. These arguments align with several empirical evidence that indicates that access to improved and more diverse imported intermediate inputs leads to the development of new products or the improvement of existing ones (Amiti and Konings, 2007; Goldberg et al., 2010; Bas and Strauss-Kahn, 2015; Halpern et al., 2015).

#### 2.1.3. Market size (The Schmookler effect)

The model outlined above shows that market size ($L$) directly impacts the innovation probability from the innovating firms' perspective. To the extent that GVC participation expands the market size, this represents an additional channel through which such participation can also positively impact innovation. The effect of market size on innovation is well-established in the literature. Schmookler (1966) argued that "the extent of the market governs the amount of invention." His main line of reasoning is that the bigger the actual or potential market, the higher the rate of innovation required to produce the volume and variety of output demanded by that market. This aligns with Eqn 7, where innovation increases with market size ($L$). Ethier, (1982) further argued that trade in intermediate goods increases the extent of market. Therefore, GVC participation becomes an important channel for realizing the "Schmookler effect."[4]

#### 2.1.4. International knowledge spillovers

In the model outlined above, international knowledge spillovers can be thought of as manifesting because of the effort variable $E_{it}$, which increases the probability of innovation. In this framing, the effort is expended in the form of the time and costs of pursuing imitation and technology transfer within the value chain rather than investment in R&D. Coe and Helpman (1995) emphasize international trade as the key channel for such diffusion of technological knowledge across countries. In their model, variation in innovation within domestic countries depends on both domestic R&D and foreign R&D. Foreign R&D generates advantages in two main ways: direct and indirect. Direct advantages involve acquiring knowledge about novel technologies, advanced materials, innovative production techniques, or improved organizational practices. Indirect advantages arise by importing goods and services created by trading partners, which embody the results of their R&D efforts. In the context of Africa, where domestic R&D is very low, particularly within the private sector, foreign sources of knowledge likely represent by far the dominant driver of innovation, and GVC participation is plausibly a major avenue through which this transfer takes place. A large body of empirical studies shows that international trade serves as a major conduit for international knowledge spillovers (Coe et al., 2009; Keller and Yeaple, 2009; Keller and Yeaple, 2013; Keller and Yeaple, 2013; Buera and Oberfield, 2020; Aghion et al., 2024), also via supply chain linkages (Baldwin and Lopez-Gonzalez, 2015).

[4] Kleinknecht and Verspagen (1990) re-examine the relationship between market size and innovation and provide empirical evidence for Schmookler's "demand-pull" hypothesis, highlighting the simultaneity issue. More recently, Acemoglu and Linn (2004) developed a simple open economy model to examine the impact of market size and innovation in the pharmaceutical industry. They then exploited exogenous variation driven by U. S. demographics to show a large effect of market size on pharmaceutical innovations. Aghion et al. (2024) identify a substantial impact of export demand shocks on the innovation activities of French firms, driven by changes in market size.

### 2.2. Implications for product innovation vs process innovation?

Although product and process innovation are interconnected, there are established differences in terms of their underlying drivers (Rouvinen, 2002). To distinguish how GVC integration may distinctively affect the probability of product innovation and process innovation, we refer to the competition and firms' technology search strategies literature (e.g., Morandi Stagni et al., 2021 and others) and the external linkages and firm innovation strategies literature (e.g. Freitas et al., 2011 and others). We discuss these distinct effects in light of the four channels we identified in the previous section. Fig. 1 provides a schematic diagram of these causal pathways.

To innovate and remain competitive, firms face two broad approaches: exploration or exploitation. Exploration involves the development of new technological knowledge or inventions, and exploitation involves enhancing existing knowledge or processes within the firm (Morandi Stagni et al., 2021). Firms can, of course, opt to attempt both approaches. From the strategic management perspective, firms calibrate their approach depending on the dynamics of their external environments (Posen and Levinthal, 2012; Stieglitz et al., 2016). Aspects of the external environment that may influence these decisions include the intensity of competition, the regulatory environment, the cost of inputs, and the size and composition of the market. Entering a GVC triggers a major shift in firms' external environments. Performing stages in the production of products aimed at different regions alters the intensity of competition, the regulatory environment, access to intermediate imports from upstream in the value chain alters input costs, and production for global or regional markets dramatically alters the size and composition of the market faced.

In the context of Africa, increased competition resulting from GVC participation is likely to favour an exploitation approach and drive process innovation. Morandi Stagni et al. (2021) argue that exploration is not only a riskier and more costly approach than exploitation but also takes longer to yield profitable product innovations. Increased import penetration typically drives intense competition, leading to reduced profit margins, lower prices, and heightened demands for efficiency. Concurrently, African firms usually integrate into value chains at the upstream, lower value-added stages of production, implying that their optimal strategy is to attempt to upscale this production as rapidly as possible. Often this is what is demanded by lead firms in the value chain (Sturgeon et al., 2008). The incentive is to innovate as quickly as possible to survive in the value chain, and process innovation commonly offers a more rapid pathway to this. Furthermore, exploration involves riskier R&D and high absorptive capacity, which is less prevalent among African firms. Firms that primarily follow an imitation strategy tend to favour acquiring horizontal technological knowledge from competitors (Baldwin and Yan, 2014). Therefore, we argue that GVC-induced competition is more likely to drive process innovation than product innovation in the context of African firms.

Process innovations derive from technology embedded in capital inputs, while product innovations rely on technology in disembodied forms (Rouvinen, 2002). Furthermore, process innovation requires investment in machinery and equipment and knowledge of how to use them, both of which are facilitated by the partnerships inherent in GVCs (Freitas et al., 2011; Saliola and Zanfei, 2009). It has been shown historically, for example, that the diffusion of numerical machinery to replace conventional machinery across firms leads to widespread process innovation (Romeo, 1977). Such transfers of existing machines and knowledge to African firms from lead firms in the value chain is a more plausible form of knowledge spillover than the provision of resources for speculative R&D.

Proponents of life-cycle theories argue that product innovation helps firms minimize market uncertainty (Utterback and Abernathy, 1975; Klepper, 1996). As product innovations gradually reveal the nature and specificity of demand, this reduction in uncertainty facilitates the refinement of production processes and the advancement of process innovations (Cabagnols and Le Bas, 2002). From this perspective, product innovation is expected to have a positive correlation with market uncertainty, while process innovation is expected to have a negative correlation.

Nevertheless, despite the likely stronger influence on process innovation, there are still reasons to suppose that GVC participation may also stimulate some product innovation in African firms. A major constraint on product innovation is the additional uncertainty over the degree of demand for new or upgraded products, and access to larger markets as a result of GVC participation surely reduces such uncertainty (Cabagnols and Le Bas, 2002). Another contributor to product innovation is customer-user interaction (von Hippel, 1988), and this also will be stimulated by GVC participation when upstream African firms form very direct relationships with the downstream firms that purchase their inputs. Whilst we argued above that the voluntary aspect of knowledge sharing within the value chain is more likely to focus on process innovation given the incentives of the lead firms, knowledge sharing also has a large involuntary component. Lead firms may not intentionally share their R&D capabilities or new product innovations with partner firms, but close collaboration can lead to observation and eventually to

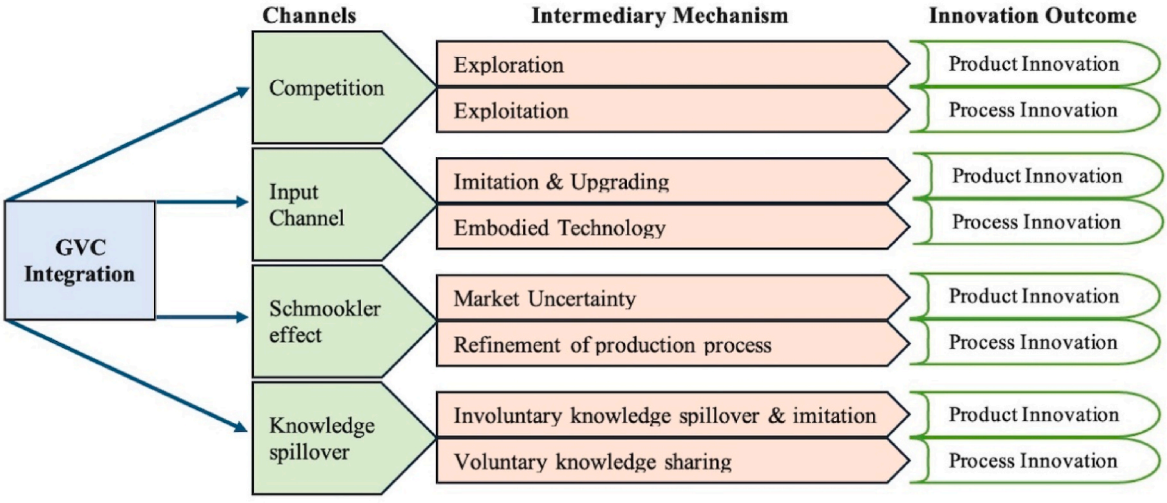


**Fig. 1.** GVC integration and innovation strategy. *Notes: we highlight the channels for both innovation outcomes but the texts below indicate which outcome is more likely for each channel in the context of Africa.*

imitation, and when African firms join value chains that also contain particularly innovative lead firms, a change in the innovation ethos of the African firm may happen almost symbiotically.

This argument can further be advanced by the demand-based innovation framework of Adner and Levinthal (2001). In a diverse demand environment, early technological innovations are driven by the need to satisfy market needs. Depending on the initial capabilities and costs of the technological innovations, firms may prioritize product innovations to improve functionality and align with user needs or process innovations to lower costs and match consumers' willingness to pay. At later stages of development, once the technology exceeds market expectations, product innovations are motivated by competitive firms seeking to maximise profits despite dealing with "technologically satisfied" consumers (Adner and Levinthal, 2001). We note that the latter description may characterize advanced technology products like Apple. In the context of African supply chain firms, this may be less relevant.

Finally, disembodied technology spillover via GVC is known to have induced both product and process innovation. Knowledge transfer can occur both involuntarily and voluntarily. Involuntary transfer happens through human capital mobility and the imitation of global buyers' technological and managerial practices. Voluntary transfer, on the other hand, involves multinationals sharing critical knowledge assets to enhance the efficiency of local suppliers or to gain access to local competencies on a reciprocal basis. These voluntary transfers support process innovations. Vertical linkages in MNE's international production often facilitate knowledge sharing, productivity spillovers, and hence, production innovation (Saliola and Zanfei, 2009). The bottom line is that international knowledge spillover channels spur both product and process innovations. This argument aligns with the empirical evidence of Rouvinen (2002), which shows that international spillovers have a symmetric effect on both product and process innovation.

On the basis of the above discussion, we draw three testable hypotheses for the impact of GVC participation on innovation for African firms.

**H1**. GVC participation will lead to more process innovation among African firms;

**H2**. GVC participation will lead to more product innovation among African firms;

Finally, if we interpret all these in the innovation framework of Cohen and Klepper (1996) where innovation strategy is expressed by a certain increase of the price-cost margin. For process innovations, a firm's price-cost margin increases due to reduced production costs. In contrast, for product innovations, the margin expands as customers are willing to pay a premium for novel features, allowing the firm to earn monopoly rents until these features are replicated by competitors. The goal of every firm is to maximise profit therefore it is likely that the GVC firms will likely adopt both innovation strategies to maximise profit. Also, it should be noted that the factors or actors that drive innovation can be complementary (Freitas et al., 2011) and as noted by Hullova et al. (2016) under certain circumstance, there are unique complementarities between product and process innovation. Therefore.

**H3**. GVC participation will jointly stimulate both product and process innovation.

## 3. Methodology

### 3.1. Data

The main source of data for our analysis of the effects of GVC integration on innovation at the firm level is the World Bank Enterprise Survey (WBES). The WBES is collected and compiled by the World Bank via face-to-face interviews with firm managers or owners and contains information on a variety of firm characteristics. The number of firms interviewed varies by country, depending on the size of the population. The survey is conducted in 144 countries and covers both the manufacturing and services sectors. The survey is designed to provide nationally representative firm-level data via stratification by firm size, location, and sector. In line with our focus on Africa as a representative developing region, we restrict the sample to firms in African countries. 48 African countries are included in the sample, implying wide coverage of the continent; the sample period is 2006–2018, except for 2008, in which no data was collected. The survey is not a repeated cross-section, although some firms may be sampled twice or more; each new survey wave selects firms randomly and does not deliberately track the same firms. While the WBES began in 2006, some countries entered later, and not every country is included in every wave. Appendix Table A1 illustrates data availability in each period on a country-specific basis.

The key variables for our analysis are indicators of firm GVC participation and innovation. In line with our research hypotheses, we use two different types of innovation variables: product and process innovation. Product innovation is a binary variable that takes the value 1 if a firm introduces a new product in a sample year and 0 if otherwise. Process innovation is a binary variable that takes the value 1 if a firm introduces a new process and 0 if otherwise.[5] These variables represent our main innovation indicators. However, in the extended analysis, we will use three additional innovation variables: i) a variable that takes the value of 1 if a firm simultaneously introduces product and process innovation and 0 if otherwise. We call this *"Innovation mode 1";* ii) a variable that takes the value 2 if a firm simultaneously introduces product and process innovation, 1 if a firm introduces either product or process innovation but not both, and 0 if otherwise. We call this "*Innovation mode 2"*; and iii) a variable that takes the value 0 if the firm did not introduce a new product, 1 if it did introduce a new product, and two if the introduced product is new to the market. We call this *"Novelty of Innovation"*. To compute this variable, we combine information from the product innovation and another WBES question: "*Were any of the new or improved products or services also new for the establishment's main market?"*

We define GVC participating firms as two-way traders with internationally recognized quality certificates.[6] We consider this as the most consistent with the recent literature for two reasons. First, the restriction to only two-way traders enables us to capture the sequential and back-and-forth aspect of global linkages and underscores the characteristic of GVCs where firms use imported intermediate to produce goods that are then exported (Baldwin and Yan, 2014). Second, GVC-related trade entails higher relationship-specific investments, such as developing and adapting products and production to buyers' specific needs in the same value chain (Antràs and Chor, 2013). Hence, global buyers tend to cherry-pick the most capable suppliers to avoid production line delays and quality debasements caused by problems in the supply base. In this case, meeting the quality requirement of global buyers, which can be proved through requisite certification, becomes integral to participating in GVC. This argument is particularly salient to GVC participating firms in African countries that predominantly specialize in upstream activities where they serve as input suppliers to global lead firms (Ndubuisi and Owusu, 2022). Nevertheless, we test the robustness of our preferred GVC

[5] The precise formulation of the WBES survey questions, which yield our innovation indicators, are as follows: i) "During the last three years, has this establishment introduced new or improved products or services?"; and ii) "During the last three years, has this establishment introduced any new or improved process?"

[6] We compute this variable based on three questions from the WBES: i) "*What percentage of this establishment's purchases of material inputs or supplies were of foreign origin?"*; ii) *"What percentage of this establishment's sales were direct exports?"*; and iii) *"Does this establishment have an internationally recognized quality certification?"*. For questions (i) and (ii), we first converted them into dummy variables that take the value 1 when a firm has a positive trade share above zero. The variable then takes on the value zero when this condition is fulfilled.

indicator to alternative definitions, including two-way traders and two-way traders with foreign ownership.[7]

Finally, in a first attempt to reduce omitted variable bias as well as to increase the precision of our estimates, we include a set of control variables on the basis of the literature on the determinants of innovation (see Goedhuys, 2007; Fritsch and Görg, 2015). We control for line of credit, age, firm size, and training. Table 1 summarizes all the variables used in our analysis and includes descriptions and definitions of these controls.

### 3.2. Empirical specification

Our benchmark model for estimating the relationship between GVC participation and innovation can be represented mathematically as follows:

$$Pr\left(y_{k,i,j,t}=1\right)=\Phi\left(\alpha+\delta GVC_{k,i,j,t}+Z'+\varepsilon_{k,i,j,t}\right) \quad (8)$$

Where the subscripts $k$, $i$, $j$, and $t$ denote firm, industry, country, and survey year. $y$ is a binary variable that takes the value 1 when firm $k$ implemented an innovation in survey year $t$, which is either a product or process innovation depending on the specification. $\alpha$ is the intercept and $Z'$ is a vector of control variables which also includes industry, country, and survey year dummies. $\varepsilon_{kijt}$ is the error term. $GVC_{kijt}$ is an indicator variable that takes a value of 1 if a firm participates in GVCs and 0 if otherwise, according to the definition outlined above. $\delta$ is, therefore, the coefficient of interest. A positive estimate for $\delta$ would suggest innovation increases with GVC participation in line with the hypotheses developed in section 2.

Two econometric features of Equation (1) warrant further discussion. First, we have a binary dependent variable. For this reason, we utilize the probit class of estimators. Second, as discussed in the previous sections, this specification may not alleviate all forms of endogeneity bias. Whilst the control variables combined with the industry, country, and year dummies may be expected to reduce the magnitude of such biases, some bias may remain. Therefore, we supplement the analysis with an instrumental variable (IV) approach. The IV technique helps us to address potential reverse causality, as innovating firms may have a higher propensity to engage in GVC. Moreover, it also reduces omitted variable bias. We utilize two external instruments: i) import license—a dummy variable that takes the value of 1 if a firm has an import license and 0 if otherwise; and ii) average peer propensity - the average propensity to participate in GVC reported by other firms operating in the same industry, region, and country in the same year.

Our arguments for the validity of these instruments are as follows. The motivation to use import license as an instrument for GVC participation is drawn from our earlier arguments regarding the sequential nature of GVC activities. Obtaining an import license is a prerequisite to engaging in GVCs but not a necessary innovation prerequisite. The motivation to use average peer propensity is that the propensity of other firms in the same industry, region, and country to engage in GVCs reflects many factors that affect a firm's decision to engage in GVCs. Hence, they should strongly correlate with the firm's decision to participate in GVC. Instrument relevance is established empirically, and the relevant test statistics are presented alongside the results.

[7] Whilst there is not one standard classification in the literature, most major GVC participation studies employ either of these qualifications. For example, Rigo (2021) identified GVC participating firms as two-way traders—i.e., firms that jointly export and import, while Del Prete et al. (2017) and Reddy et al. (2021) identified them as internationally trading firms (i.e., firms that are either only importing, exporting or are two-way traders) and have international quality certification. Dovis and Zaki (2020) identified international trading firms with foreign ownership as GVC participating firms. Baldwin and Yan (2014) defined GVC participating firms as firms that simultaneously import intermediate inputs and export intermediate or final goods. Most recent studies have employed a combination of these qualifications to identify GVC participating firms (see Gopalan et al., 2022; Reddy et al., 2024), which is our approach.

## 4. Results and discussion

### 4.1. Baseline results

Table 2 presents the baseline regression results on the innovation effect of firm GVC participation, defined as two-way traders with internationally recognized quality certification. The coefficients presented in the table are the point estimates for the marginal effects of being a GVC participant on firm innovation derived from the probit estimation. Columns (1) and (2) show the regression results for process innovation, while columns (3) and (4) show the results for product innovation. Columns (1) and (3) show the regression results without the country dummies, while Columns (2) and (4) show the regression results when we include them alongside the survey year and industry dummies. Across all specifications, the estimated coefficient for GVC participation is positive and statistically significant at the one-percent significance level. This implies that GVC-participating firms are more likely to introduce new products and processes than non-GVC-participating firms. The economic interpretation of the marginal effect estimates is that integrating into GVC increases the firm probability of introducing new products and processes by 5–6 percent, depending on the precise specification.

The findings support hypothesis 1 and 2 developed in section 2. The findings are also consistent with extant literature suggesting a positive effect of GVC on innovation (Tajoli and Felice, 2018; Piermartini and Rubínová, 2021; Yang et al., 2020). The results contribute to this literature by providing the first firm-level evidence on Africa and, more generally, in developing countries. Firms in these economies often face structural challenges, including limited access to advanced technologies, weak innovation systems, and insufficient R&D capabilities that often limit innovation. As argued in the introduction and supported by our result, GVC participation serves as a potential pathway to overcome these barriers. Consistent with the theoretical background presented in section 2, the factors explaining this innovation enhancement effect of GVC include competition, knowledge spillover, market size, and input effect, respectively.

### 4.2. Baseline result: robustness checks

We test the sensitivity of our baseline results to a variety of robustness checks. First, our empirical model excluded R&D because this could be considered a proxy for our outcome variable - innovation - and would, therefore, represent a bad control (Cinelli et al., 2024). Hence, we have excluded it to guard against model misspecification. Nevertheless, R&D is certainly also a determinant of innovation, and the extent to which it overlaps with innovation output is unclear. For this reason, we repeat the estimates of Table 2 but with an R&D indicator included in the control set. These results are reported in Table A2 in the Appendix. The coefficient of R&D control is positive and statistically significant. However, the coefficient of GVC participation remains positive and statistically significant.

Second, the fixed-effect probit model in the baseline analysis may retain some bias due to an incidental parameter problem common when the maximum likelihood estimator is used to estimate nonlinear panel data models with fixed effects. For this reason, we re-estimate the baseline model using an OLS linear probability model (LPM). These results are reported in Table A3 in the appendix and are largely consistent with the baseline results, suggesting that GVC participating firms are more innovative than non-GVC firms.

Third, as discussed above, the GVC indicator may retain some endogeneity bias. We address this concern by implementing an IV approach, employing two external instruments: import license and

**Table 1**
Definition and summary statistics.

| Variable | Description and Measurement | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|---|
| Process Innovation | Dummy variable that equals 1 if the firm introduced a new process over the last three years; and 0 if otherwise. | 19,937 | 0.437 | 0.496 | 0 | 1 |
| Product Innovation | Dummy variable that equals 1 if the firm introduced a new or significantly improved good or service over the last three years and 0 if otherwise. | 19,937 | 0.404 | 0.491 | 0 | 1 |
| Novelty of Innovation | Dummy variable that equals 0 if the firm did not introduce a new product; 1 if it did introduce a new product; and 2 if the introduced product is new to the market. | 19,937 | 0.679 | 0.876 | 0 | 2 |
| Innovation mode 1 | Dummy variable that equals 1 if the firm simultaneously introduced new product and process; and 0 if otherwise. | 19,937 | 0.310 | 0.463 | 0 | 1 |
| Innovation mode 2 | Dummy variable that equals 2 if the firm jointly introduced a new product and process; 1 if it introduced either a new product or process but not both; and 0 if otherwise. | 19,937 | 0.841 | 0.868 | 0 | 2 |
| GVC1 | Dummy variable equals 1 if the firm is a two-way trader with internationally recognized certificate; and 0 if otherwise. | 19,937 | 0.081 | 0.273 | 0 | 1 |
| GVC2 | Dummy variable that equals 1 if the firm is a two-way trade; and 0 if otherwise. | 19,516 | 0.078 | 0.268 | 0 | 1 |
| GVC3 | Dummy variable that equals 1 if the firm is a two-way trader and has a foreign ownership at least 10 %; and 0 if otherwise. | 19,639 | 0.027 | 0.161 | 0 | 1 |
| Indirect GVC1 | Dummy variable that equals 1 if the firm is an indirect exporter and sources material inputs from abroad; and 0 if otherwise | 19,926 | 0.048 | 0.213 | 0 | 1 |
| Indirect GVC2 | Dummy variable that equals 1 if the firm sources material inputs from abroad and is "strictly" an indirect exporter; and 0 if otherwise. | 19,931 | 0.026 | 0.160 | 0 | 1 |
| Direct GVC | Dummy variable that equals 1 if the firm sources material inputs from abroad and is strictly a direct exporter; and 0 if otherwise. | 19,582 | 0.058 | 0.234 | 0 | 1 |
| Log Age | A continuous variable is defined as the total number of years a firm has been in operation, constructed as the natural logarithm of the total number of years plus 1. | 19,468 | 2.540 | 0.882 | 0 | 7.578 |
| Log Age squared | Dummy variable that takes the value of 1 if medium and large enterprise; and 0 if otherwise | 19,468 | 7.231 | 4.289 | 0 | 57.421 |
| Size | Dummy variable that takes the value of 1 if medium and large enterprise; and 0 if otherwise | 19,937 | 0.850 | 0.357 | 0 | 1 |
| Credit Line | A dummy variable that equals 1 if a firm has a line of credit or loan from a financial institution and 0 if otherwise. | 19,206 | 0.201 | 0.401 | 0 | 1 |
| Training | Dummy variable that takes the value 1 if the firm has a formal training program for permanent, full-time employees in the last fiscal year. | 19,937 | 0.253 | 0.435 | 0 | 1 |
| Import license | Dummy variable that takes the value of 1 if a firm has an import license and 0 if otherwise. | 19,937 | 0.118 | 0.322 | 0 | 1 |
| Average peer GVC1 propensity | Predicted propensity to participate in GVC1 reported by other firms operating in the same industry, region, and country in the same year. | 15,781 | 3.232 | 4.976 | 0 | 0.513 |

**Table 2**
GVC integration and innovation: Baseline Results.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | **Process Innovation** | | **Product Innovation** | |
| GVC1 | 0.0479*** | 0.0530*** | 0.0529*** | 0.0621*** |
| | (0.0137) | (0.0133) | (0.0138) | (0.0136) |
| Log Age | 0.0781*** | 0.0271* | 0.0586*** | 0.0388** |
| | (0.0144) | (0.0146) | (0.0150) | (0.0153) |
| Log Age squared | −0.0136*** | −0.0043 | −0.0104*** | −0.0061* |
| | (0.0030) | (0.0030) | (0.0031) | (0.0031) |
| Size | −0.0192* | −0.0488*** | −0.0322*** | −0.0578*** |
| | (0.0103) | (0.0099) | (0.0106) | (0.0104) |
| Credit Line | 0.0879*** | 0.0816*** | 0.0766*** | 0.0849*** |
| | (0.0084) | (0.0084) | (0.0087) | (0.0087) |
| Training | 0.2102*** | 0.1741*** | 0.2021*** | 0.1768*** |
| | (0.0073) | (0.0073) | (0.0076) | (0.0076) |
| # Observations | 18,441 | 18,441 | 18,497 | 18,497 |
| Survey Year Dummies | YES | YES | YES | YES |
| Industry Dummies | YES | YES | YES | YES |
| Country Dummies | NO | YES | NO | YES |

**Note.**
a. This table reports the marginal effects from a probit model.
b. Robust Standard errors in parentheses.
c. ***p < 0.01, **p < 0.05, *p < 0.1.
d. GVC1 is defined as two-way traders with internationally recognized quality certificate.

average peer propensity, as explained in section 3. Table 3 presents the results from this IV-probit estimation. Panel A reports the second-stage regression result, while Panel B reports the first-stage regression result, which can be used to establish instrument relevance. The first stage results show that the instruments are sufficiently strong. From Panel A, the effect of GVC participation on process and product innovation remains positive and statistically significant when the GVC variable is instrumented. The results are consistent with those from the baseline estimation. Because there is still no standardized statistical test for testing the validity of external instruments when the structural model is nonlinear, we defer to a conventional 2SLS IV technique to test the appropriateness of our two external instruments. The results of this exercise are reported in Table A4 in the appendix. The structure of the table is the same as that of Table 3. Again, the estimated coefficient of GVC integration shows that it significantly increases firms' product and process innovativeness. The F-statistic exceeds the standard rules-of-thumb of 10 for instrument relevance. This holds irrespective of whether we consider the external instruments indepednently, as in Columns (1), (2) (4) and (5), or jointly as in Columns (3) and (6). The Hansen J-statistic from tests of overidentifying restrictions is statistically insignificant, as reported in the lower part of the panel, which provides strong supporting evidence in favour of the exclusion restriction holding in this context. The IV and the baseline probit results tell a consistent story that GVC participating firms are more likely to introduce new products and processes than non-GVC participating firms.

Fourth, we test the sensitivity to alternative classifications of GVC participation by re-estimating Equation (1) using the alternative GVC indicators discussed in section 3. These results are presented in Table 4. Columns (1) and (2) show the results using the two-way traders' classification, while Columns (3) and (4) show the results using the two-way traders with foreign ownership classification. Across all the columns, the estimated coefficients of the varying GVC indicators remain positive and statistically significant at conventional levels. We also find that controlling for R&D (see Columns (2), (3), (5), and (6) of Table A2 in the appendix) or re-estimating the model using LPM (see Columns (2), (3), (5) and (6) of Table A3 in the appendix) does not change the direction of our results. Overall, these results show that our choice of GVC indicator does not drive our results. The finding that two-way traders with foreign ownership structure drive innovation is consistent with the empirical literature. Dovis and Zaki (2020) argue that foreign ownership and

**Table 3**
GVC integration and innovation: Addressing endogeneity.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | **Panel A:** Second Stage IV-Probit | | | | | |
| | **Process Innovation** | | | **Product Innovation** | | |
| GVC1 | 1.2115*** | 1.0081*** | 1.1388*** | 1.245*** | 0.8185*** | 1.0176*** |
| | (0.2065) | (0.3369) | (0.1818) | (0.2069) | (0.3305) | (0.1730) |
| Log Age | 0.0457*** | 0.0365** | 0.0393** | 0.0573*** | 0.0447** | 0.0485*** |
| | (0.01759) | (0.0191) | (0.0187) | (0.0179) | (0.0189) | (0.018) |
| Log Age squared | −0.0084** | −0.0070* | −0.0076** | −0.0103*** | −0.079** | −0.0888** |
| | (0.0037) | (0.0040) | (0.0039) | (0.0038) | (0.0039) | (0.0039) |
| Size | 0.1740*** | 0.1434*** | 0.1684*** | 0.1689*** | 0.0929* | 0.1318*** |
| | (0.0695) | (0.0680) | (0.0384) | (0.0420) | (0.0661) | (0.0366) |
| Credit Line | 0.0334** | 0.0375 | 0.0319** | 0.0353** | 0.0480** | 0.0393** |
| | (0.0138) | (0.0184) | (0.03847) | (0.0142) | (0.0.0181) | (0.0.136) |
| Training | 0.1299*** | 0.1308*** | 0.1259*** | 0.1307*** | 0.1440*** | 0.1362*** |
| | (0.0123) | (0.0184) | (0.0124) | (0.0126) | (0.0162) | (0.0,012) |
| | **Panel B:** First Stage IV-Probit | | | | | |
| Dependent Variable⇒ | **GVC Participation** | | | | | |
| Import license | 0.0692*** | | 0.0730*** | 0.0702*** | | 0.0745*** |
| | (0.0077) | | (0.0081) | (0.0077) | | (0.0082) |
| Average peer GVC1 propensity | | 0.0035*** | 0.0031*** | | 0.00352*** | 0.0030*** |
| | | (0.0007) | (0.0006) | | (0.000702) | (0.0006) |
| Controls | YES | YES | YES | YES | YES | YES |
| # Observations | 18,441 | 15,510 | 15,510 | 18,497 | 15,563 | 15,563 |
| Survey Year Dummies | YES | YES | YES | YES | YES | YES |
| Industry Dummies | YES | YES | YES | YES | YES | YES |
| Country Dummies | YES | YES | YES | YES | YES | YES |

**Note.**
a. This table reports the results from estimating an IV-probit model. Panel A reports marginal effects.
b. Robust Standard errors in parentheses.
c. ***p < 0.01, **p < 0.05, *p < 0.1.
d. GVC1 is defined as two-way traders with internationally recognized quality certificate.

**Table 4**
GVC integration and innovativeness: Alternative GVC indicator.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | **Process Innovation** | **Product Innovation** | **Process Innovation** | **Product Innovation** |
| GVC2 | 0.0578*** | 0.0684*** | | |
| | (0.0130) | (0.0134) | | |
| GVC3 | | | 0.0686*** | 0.0685*** |
| | | | (0.0199) | (0.0211) |
| Log Age | 0.0272* | 0.0389** | 0.0294** | 0.0425*** |
| | (0.0144) | (0.0152) | (0.0146) | (0.0154) |
| Log Age squared | −0.0042 | −0.0060* | −0.0046 | −0.0069** |
| | (0.0030) | (0.0031) | (0.0030) | (0.0032) |
| Size | −0.0456*** | −0.0549*** | −0.0499*** | −0.0631*** |
| | (0.0098) | (0.0103) | (0.0098) | (0.0102) |
| Credit Line | 0.0801*** | 0.0835*** | 0.0800*** | 0.0858*** |
| | (0.0083) | (0.0087) | (0.0084) | (0.0087) |
| Training | 0.1756*** | 0.1767*** | 0.1729*** | 0.1758*** |
| | (0.0072) | (0.0075) | (0.0073) | (0.0076) |
| # Observations | 18,742 | 18,798 | 18,489 | 18,545 |
| Survey Year Dummies | YES | YES | YES | YES |
| Industry Dummies | YES | YES | YES | YES |
| Country Dummies | YES | YES | YES | YES |

**Note.**
a. This table reports the marginal effects from a probit model.
b. Robust Standard errors in parentheses.
c. ***p < 0.01, **p < 0.05, *p < 0.1.
d. GVC2 is defined as two-way traders, while GVC3 is defined as two-way traders with foreign ownership structure.

quality certification can be substitutes and complements. In our case, the analysis suggests foreign ownership and quality certification are substitutes since firms that are two-way traders and have both measures of integration are not likely to innovate more than firms that have either foreign ownership or quality certification.

### *4.3. Extended analysis*

#### *4.3.1. GVC integration and the mode of firm innovativeness*

Our main analysis considered product and process innovation separately. However, some firms may do both simultaneously because undertaking both yields greater higher-order benefits. This view aligns with evidence from Avenyo et al. (2019), which showed that the job

"compensating effect" of innovation is more pronounced for firms that jointly undertake product and process innovation than for firms that only undertake one. In a study covering firms in Brazil, Goedhuys and Veugelers, (2012) also found that combining product and process innovations significantly improves firm growth. This, nonetheless, jointly undertaking product and process innovation is costly. For emerging economies, where resource constraints and institutional weaknesses are binding, the high costs of innovation persist and often impede firms from engaging in innovation.

As previously noted, participating in GVC provides firms in resource-constrained and institutionally weak environments with opportunities to overcome structural barriers to innovation. For this reason, we expand our analysis in this section by considering whether GVC participating firms are more likely to introduce both types of innovation than non-GVC participating firms jointly. We address this question by employing two innovation variables, including *"Innovation mode 1"* and *"Innovation mode 2"*. The former is a variable that takes the value 1 if a firm simultaneously introduces a new product and process and 0 otherwise. *"Innovation mode 2"*, on the other hand, is a variable that takes the value 2 if a firm simultaneously introduced a new product and process, 1 if it introduced only a new product or process, and 0 otherwise.

Column 1 of Table 5 presents the results using *"Innovation Mode 1"* as the outcome variable. Since the outcome variable here is still binary, we estimate the model using the probit estimation technique and report the marginal effects computed from the estimation in the column. The coefficient of GVC integration is positive and statistically significant at 1 percent, suggesting that GVC-participating firms are more likely to jointly introduce new products and processes than non-GVC-participating firms. The marginal effect estimates suggest that integrating into GVC increases the firm's probability of jointly introducing new products and processes by 5 percent. Column 2 reports the results using *"Innovation mode 2"* as the outcome variable. Since the outcome variable is ordered, we use the Oprobit model. These results show that GVC integration increases the firm's probability of introducing new products and processes jointly. Panel A of Table A5 in the appendix reports the marginal effect. The result further shows that while GVC integration significantly increases the probability of introducing either product or process innovation, the impact intensity is higher for jointly introducing both types, confirming hypothesis 3 in Section 2. Hence, GVC integration is not only a precursor to firm innovativeness in a resource-constrained environment but also a precursor to the mode and diversity of firm innovativeness.

**Table 5**
GVC integration and the mode and novelty of innovativeness.

| | (1) | (2) | (3) |
|---|---|---|---|
| | **Innovation mode 1** | **Innovation mode 2** | **Novelty of Innovation** |
| GVC1 | 0.0463*** | 0.1847*** | 0.1896*** |
| | (0.0125) | (0.0375) | (0.0390) |
| Log Age | 0.0258* | 0.1068** | 0.1211*** |
| | (0.0141) | (0.0430) | (0.0450) |
| Log Age squared | −0.0038 | −0.0169* | −0.0198** |
| | (0.0029) | (0.0088) | (0.0092) |
| Size | −0.0470*** | −0.1789*** | −0.1710*** |
| | (0.0095) | (0.0287) | (0.0299) |
| Credit Line | 0.0706*** | 0.2764*** | 0.2523*** |
| | (0.0079) | (0.0242) | (0.0250) |
| Training | 0.1673*** | 0.5854*** | 0.5241*** |
| | (0.0067) | (0.0220) | (0.0223) |
| /cut1 | | −0.9641*** | −0.5106** |
| | | (0.2110) | (0.2316) |
| /cut2 | | −0.2478 | −0.1014 |
| | | (0.2109) | (0.2316) |
| # Observations | 18,441 | 18,497 | 18,497 |
| Survey Year Dummies | YES | YES | YES |
| Industry Dummies | YES | YES | YES |
| Country Dummies | YES | YES | YES |

**Note**.
a. Estimation in column 1 is achieved using probit model, while estimation in Columns (2) and (3) are achieved using the Oprobit.
b. Column (1) reports the marginal effects, while the corresponding marginal effects for Columns (2) and (3) are reported in Table A5 in the appendix.
c. Robust Standard errors in parentheses.
d. ***p < 0.01, **p < 0.05, *p < 0.1.
e. GVC1 is defined as two-way traders with internationally recognized quality certificate.

#### 4.3.2. GVC integration and innovation novelty

Our analysis thus far has not considered the novelty or quality of innovations. However, levels of innovation novelty matter for higher-order firm outcomes (Barbosa et al., 2014; Guisado-González et al., 2016). The literature discusses two levels of innovation novelty: incremental and radical innovation.[8] Incremental innovation consists of a minor improvement in technology or product. Such improvement can either be the firm's own product or products developed by others. Conversely, radical innovation refers to entirely new products introduced into the market by a firm. These are mostly breakthrough technologies; hence, they are often disruptive, cater to novel consumer needs, and confer a temporary monopoly position to the innovator.

It has been established that the benefit derived from an innovation outcome is interlaced with its levels of novelty, as higher levels of novelty are expected to impact firm growth and generate positive externalities, such as enabling firms to capture larger domestic and foreign market shares (Barbosa et al., 2014). However, realizing radical innovation is more challenging because of higher technological uncertainties, resource demands, and market resistance. Integrating into GVCs can help firms alleviate these constraints by offering them access to cutting-edge technologies, knowledge, and markets via their linkages with advanced economy firms in the value chain. Hence, we extend our analysis in this section by examining the effect of GVC integration on innovation novelty. We rely on the *"Novelty of innovation"* variable as the outcome variable for this exercise. As noted in the data section, the variable is an ordered variable that takes the value 0 if the firm did not introduce a new product, 1 if it did introduce a new product, and two if the introduced product is new to the market.[9]

Column 3 of Table 5 presents the results of this exercise. Since the outcome variable is ordered, we again use the Oprobit model. The coefficient of GVC integration is positive and statistically significant, indicating that integrating into GVCs increases the probability of a firm introducing highly innovative products. Panel B of Table A5 in the appendix reports the marginal effect. The results show that while GVC integration reduces the probability of 'no product innovation' (see Table A5 panel B column 1), GVC firms are also more likely to introduce products that are new both to the firm and to the market. Interestingly, the marginal effect for products new to the market exceeds the marginal effect for products new to the firm. Integrating into GVC particularly increases the firm probability of introducing products new to the firm by 0.9 percent and new to the market by 5 percent. This new evidence leads to the further conclusion that GVC integration is not only a precursor to firm innovativeness and its mode but also to the degree of innovation novelty. Given that our sample covers firms in a resource-constrained environment, we argue that this novelty gains likely results from such firms being knitted tightly with the lead firm through vertical integration. In this case, they become knowledge-generating hubs and are more likely to generate innovations that are novel in and outside their local

[8] Whereas incremental innovation is mostly operationalized as an innovation that is new to the firm, radical innovation is mostly operationalized as an innovation new to the market and beyond.

[9] As has become conventional in the literature, we assume that internal novelty—i.e., new to the firm—captures incremental innovation, while external novelty-i.e., new to the market-captures radical innovation.

milieu.

#### 4.3.3. GVC integration and innovativeness: implications for small-sized and younger firms

SMEs and younger firms are central to many economies, particularly in developing countries, as they tend to have large shares of job creation and the highest sales and employment growth rates (Ayyagari et al., 2014). However, these firms often face the challenge of small-scale production and sales that are reinforced by their resource constraints, such as limited access to finance, raw materials, and frontier technologies (Schmitz, 1982; Hewitt-Dundas, 2006; Ndubuisi and Owusu, 2023). These constraints have significant negative consequences on the innovativeness of SMEs and younger firms as they hinder a firm's capacity to fully exploit its internal and external economies of scale. Through GVC participation, however, these firms can overcome these resource constraints and, ultimately, boost their innovativeness. This route may appear even more attractive in a resource-constrained environment, which characterizes many SMEs and younger firms.

Against this backdrop, we extend our analysis to consider the effect of GVC participation exclusively on SMEs and younger firms. We identify SMEs as firms with a total employment level of less than 100, while we use the sample median age to classify firms as younger firms. The median firm age is 16 years. Hence, firms that are 16 years of age or less are considered younger firms. Table 6 reports the marginal effects of a probit regression on the effect of GVC participation on SMEs and younger firms. Panel A of Table 6 shows the results for SMEs, while Panel B shows the results for younger firms. Beginning with the former, the estimated coefficient of GVC is positive and statistically significant at the 1 percent significance level for both process and product innovation. The results, therefore, support the conjecture that integration into GVC enables SMEs to overcome their liability of smallness, which tends to impact their innovativeness negatively. The marginal effect estimates suggest that integrating into GVC increases the SME's probability of introducing new products and processes by 6 percent. In Panel B, we also observe that the GVC indicator enters the regression with a positive and statistically significant coefficient. The result, thus, also confirms that integrating into GVC enables younger firms to overcome their liability of newness, which tends to impact their innovativeness negatively.

#### 4.3.4. Eliciting the implication of indirect GVC integration on firm innovativeness

Thus far, our analysis has focused on direct GVC integration, arguing that it fosters innovation through arrays of channels. However, firms can also indirectly integrate into GVCs, where firms supply intermediate goods to exporters rather than export directly. In principle, indirect GVC integration could offer participating firms an avenue to extract some benefit from GVCs without directly facing the costs and complexities of international trade. To shed some light on this, we complement our main analysis by examining how indirect GVC integration affects firm innovativeness. Following Colovic et al. (2022), we constructed indirect GVC participation as a binary variable. The variable equals 1 if the firm is an indirect exporter and sources material inputs from abroad and 0 otherwise. We call this *"Indirect GVC1"*. As in their study, we do not consider international quality certification when constructing this variable since indirect exporting firms do not generally need international quality certification. Firms could adopt a multi-chain strategy wherein they integrate into multiple value chains, directly integrating into some and indirectly integrating into others. The definition of *"Indirect GVC1"* captures some of these firms. To identify firms that are only indirectly integrated into GVC, we construct a second variable that takes the value 1 if the firm sources material inputs from abroad and is "strictly" an indirect exporter, and 0 otherwise. We call this *"Indirect GVC2"*. For completeness, we construct a third variable that takes the value 1 if the firm sources material inputs from abroad and is strictly a direct exporter, and 0 otherwise. We call this *"Direct GVC1"*.

The results of this exercise are reported in Table 7, whereby all estimates are produced using the probit estimator. Columns (1) and (4) report the results for *"Indirect GVC1"*. The variable enters the regression with a positive and statistically significant coefficient for both product and process innovation. Compared to the coefficients of Indirect GVC2 reported in Columns (2) and (5), the coefficient of the latter is only statistically significant for process innovation. Even so, the marginal effect of Indirect GVC1 for both process and product innovation trump those of Indirect GVC2. The results, thus, suggest that the innovation benefits of being only indirectly integrated into GVC are limited. Conversely, the estimated coefficient of Direct GVC1 turns out to be positive and statistically significant for both process and product innovation. In an unreported result, we found that this result holds if we also adjust the definition of "Direct GVC1" by accounting for "international quality certification".

**Table 6**
GVC integration, firm characteristics, and innovation.

| | Panel A: SMEs | | Panel B: Younger Firms | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| VARIABLES | **Process Innovation** | **Product Innovation** | **Process Innovation** | **Product Innovation** |
| GVC1 | 0.0632*** | 0.0642*** | 0.0792*** | 0.0826*** |
| | (0.0184) | (0.0183) | (0.0226) | (0.0229) |
| Log Age | 0.0278* | 0.0242 | 0.1150*** | 0.0705** |
| | (0.0166) | (0.0158) | (0.0309) | (0.0292) |
| Log Age squared | −0.0038 | −0.0038 | −0.0322*** | −0.0180** |
| | (0.0035) | (0.0034) | (0.0094) | (0.0089) |
| Size | | | −0.0745*** | −0.0475*** |
| | | | (0.0174) | (0.0168) |
| Credit Line | 0.0902*** | 0.0815*** | 0.0993*** | 0.0905*** |
| | (0.0099) | (0.0096) | (0.0128) | (0.0125) |
| Training | 0.1786*** | 0.1839*** | 0.1918*** | 0.1966*** |
| | (0.0085) | (0.0082) | (0.0109) | (0.0107) |
| # Observations | 15,721 | 15,682 | 9762 | 9696 |
| Survey Year Dummies | YES | YES | YES | YES |
| Industry Dummies | YES | YES | YES | YES |
| Country Dummies | YES | YES | YES | YES |

**Note**.
a. This table reports the marginal effects from a probit model.
b. Robust Standard errors in parentheses.
c. ***p < 0.01, **p < 0.05, *p < 0.1.
d. GVC1 is defined as two-way traders with internationally recognized quality certificate.

**Table 7**
Indirect GVC integration and innovativeness.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | **Process Innovation** | | | **Product Innovation** | | |
| Indirect GVC1 | 0.0694*** | | | 0.0334** | | |
| | (0.0154) | | | (0.0160) | | |
| Indirect GVC2 | | 0.0459** | | | 0.0206 | |
| | | (0.0200) | | | (0.0210) | |
| Direct GVC1 | | | 0.0299** | | | 0.0654*** |
| | | | (0.0152) | | | (0.0155) |
| Log Age | 0.0267* | 0.0259* | 0.0268* | 0.0374** | 0.0373** | 0.0379** |
| | (0.0144) | (0.0144) | (0.0145) | (0.0152) | (0.0152) | (0.0152) |
| Log Age squared | −0.0043 | −0.0041 | −0.0043 | −0.0058* | −0.0058* | −0.0059* |
| | (0.0030) | (0.0030) | (0.0030) | (0.0031) | (0.0031) | (0.0031) |
| Size | −0.0543*** | −0.0569*** | −0.0547*** | −0.0697*** | −0.0704*** | −0.0616*** |
| | (0.0096) | (0.0095) | (0.0099) | (0.0100) | (0.0100) | (0.0103) |
| Credit Line | 0.0818*** | 0.0826*** | 0.0824*** | 0.0846*** | 0.0848*** | 0.0850*** |
| | (0.0083) | (0.0083) | (0.0084) | (0.0086) | (0.0086) | (0.0087) |
| Training | 0.1759*** | 0.1770*** | 0.1758*** | 0.1782*** | 0.1795*** | 0.1767*** |
| | (0.0072) | (0.0072) | (0.0073) | (0.0075) | (0.0074) | (0.0075) |
| # Observations | 18,761 | 18,824 | 18,571 | 18,966 | 19,029 | 18,769 |
| Survey Year Dummies | YES | YES | YES | YES | YES | YES |
| Industry Dummies | YES | YES | YES | YES | YES | YES |
| Country Dummies | YES | YES | YES | YES | YES | YES |

Note.
a. This table reports the marginal effects from a probit model.
b. Robust Standard errors in parentheses.
c. ***p < 0.01, **p < 0.05, *p < 0.1.
d. "Indirect GVC1" is defined as firms that source input from abroad and engage in indirect export. "Indirect GVC2" is defined as firms that source input from abroad and strictly engage in indirect export. "Direct GVC1" is defined as firms that source input from abroad and strictly engage in direct export.

#### 4.3.5. *GVC integration, spillover, and the innovativeness of non-GVC firms*

The theoretical premise of our analysis thus far is that through integration into GVCs, firms not only access cheaper and more sophisticated intermediate inputs that relieve resource constraints but also are exposed to best global practices and acquire knowledge and technology either through knowledge spillovers or outright technology transfer from global lead firms and by learning from and interacting with other value chain actors (Pietrobelli and Rabellotti, 2011; Rigo, 2021; Ndubuisi and Owusu, 2021). Foster-McGregor et al. (2015) note that such gains from GVC are expected to positively affect both the firms engaged in GVC and local firms not engaged in GVC, potentially leading to spin-off firms and industries. This is an example of innovation spillovers outside of the value chain. To explore this possibility, we extend our analysis to consider the potential for the innovation gains from GVC integration to trickle down to non-GVC peer firms. In the spirit of the broader spillover literature (Javorcik, 2004; Alvarez and López, 2008; Anwar and Nguyen, 2011), we construct three additional GVC indicators as follows:

$$Horizontal\_industry\_GVC_{ktj} = \frac{GVC^{n}_{kitj}}{Firm^{n}_{kitj}} \tag{9a}$$

$$Horizontal\_industry\_region\_GVC_{krtj} = \frac{GVC^{n}_{kirtj}}{Firm^{n}_{kirtj}} \tag{9b}$$

$$Regional\_concentrated\_GVC_{krtj} = \frac{GVC^{n}_{krtj}}{Firm^{n}_{krtj}} \tag{9c}$$

Where $r$ denotes proximate spatial area, which can be either region or city depending on the classification used in the WBES, $GVC^{n}$ is the total number of GVC firms, while $Firm^{n}$ is the total number of firms, and all other subscripts are as previously defined. Equation (9a) captures the share of GVC firms present in the same industry, while Equation (9b) captures the share of GVC firms present by industry and region. Accordingly, the first equation captures the GVC spillover arising from the same industry, while the second equation captures the effect of the regional agglomeration of seemingly related GVC firms. Equation (9c) measures spillover from the concentration of GVC firms in a region without the industry dimension.

We introduce these variables one-by-one into the main baseline specification, Equation (1), and present the probit regression results in Table 8. The table reports the marginal effects. Panel A shows the results of process innovation, while Panel B shows the results of product innovation. Columns (1), (4), and (7) show results when, in addition to the GVC spillover variables, we control for the firm-specific GVC integration variable. Columns (2), (5), and (8) show results when we drop the firm-specific GVC integration variable. Columns (3), (6), and (9) show the results when we drop the firm-specific GVC integration variable and run the analysis based on a restricted sample of non-GVC firms.

Beginning with columns (1)–(3), which focus on $Horizontal\_industry\_GVC_{ktj}$, the estimated coefficient on the GVC spillover variable is positive and statistically significant for both product and process innovation. This result holds when we use the full sample (Columns 1 and 2) and the sample restricted to non-GVC firms (Column 3), underscoring potential industry spillover to non-GVC firms in an industry that GVC firms densely populate. Similar evidence and conclusions emerge in Columns (4)–(6), which show the product and process innovation effects of $Horizontal\_industry\_region\_GVC_{krtj}$. This result also underscores the importance of geographical proximity in driving the magnitude of spillovers. The results reported in Columns (1)–(6) underscore plausible spillovers from GVC firms to non-GVC firms in the same industry and region. In columns (7)–(9), the estimated coefficient of $Regional\_concentrated\_GVC_{krtj}$ shows no evidence of spillover to the process-innovation of non-GVC firms (Columns (7)–(9) of Panel A). When we consider product innovation, however, we find some evidence, albeit weak (Columns (7)–(9) of Panel B). Notably, the spillover variable is not statistically significant in Column (7), which also controls for firm-specific GVC integration indicators. While the spillover coefficient gains statistical significance at 10 percent in Column (8), where we dropped the firm-specific GVC indicator, it becomes statistically insignificant in Column (9), where we restricted the sample to non-GVC firms.

Overall, the results presented in Table 8 support the argument that gains from GVC participation positively affect both the firms engaged in GVCs and the local firms not engaged in GVCs. This spillover to non-GVC firms materializes from the presence of GVC firms in a spatially

**Table 8**
Horizontal GVC spillover and the innovativeness of non-GVC firms.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | **Panel A:** Process Innovation | | | | |
| GVC1 | 0.0559*** | | | 0.0533*** | | | 0.0760*** | | |
| | (0.0134) | | | (0.0140) | | | (0.0130) | | |
| *Horizontal_industry_GVC$_{ktj}$* | 0.2106*** | 0.2620*** | 0.3077*** | | | | | | |
| | (0.0414) | (0.0393) | (0.0464) | | | | | | |
| *Horizontal_industry_region_GVC$_{krtj}$* | | | | 0.1270*** | 0.1804*** | 0.1895*** | | | |
| | | | | (0.0320) | (0.0291) | (0.0372) | | | |
| *Regional_concentrated_GVC$_{krtj}$* | | | | | | | −0.0114 | 0.0575 | 0.0058 |
| | | | | | | | (0.0692) | (0.0677) | (0.0764) |
| #Observation | 18,497 | 18,798 | 17,027 | 18,497 | 18,798 | 17,027 | 18,497 | 18,798 | 17,027 |
| Survey Year Dummies | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Country Dummies | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| | | | | | **Panel B:** Product Innovation | | | | |
| GVC1 | 0.0668*** | | | 0.0627*** | | | 0.0811*** | | |
| | (0.0139) | | | (0.0145) | | | (0.0135) | | |
| *Horizontal_industry_region_GVC$_{krtj}$* | | | | 0.119*** | 0.1781*** | 0.1756*** | | | |
| | | | | (0.0331) | (0.0301) | (0.0385) | | | |
| *Horizontal_industry_GVC$_{ktj}$* | 0.182*** | 0.2327*** | 0.2450*** | | | | | | |
| | (0.0428) | (0.0407) | (0.0476) | | | | | | |
| *Regional_concentrated_GVC$_{krtj}$* | | | | | | | 0.0709 | 0.1560** | 0.1129 |
| | | | | | | | (0.0709) | (0.0697) | (0.0778) |
| # Observations | 18,497 | 18,798 | 17,027 | 18,497 | 18,798 | 17,027 | 18,497 | 18,798 | 17,027 |
| Survey Year Dummies | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Country Dummies | YES | YES | YES | YES | YES | YES | YES | YES | YES |

Note.
a. This table reports the marginal effects from a probit model.
b. Robust Standard errors in parentheses.
c. ***p < 0.01, **p < 0.05, *p < 0.1.
d. All columns contain unreported control variables as in Table 2.

concentrated industry. It appears that the spillovers we document operate through changing market forces that are underpinned by competition, demonstration effect, and inter-firm collaboration that has been highlighted in the knowledge and technology literature on technology spillover (see Javorcik, 2004; Farole and Winkler, 2014). Along these lines, our result is consistent with the broader economic development literature that argues as well as documents evidence of horizontal spillovers from exporters and (foreign) multinationals to local firms or domestic non-exporting firms (Haskel et al., 2007; Alvarez and López, 2008; Keller and Yeaple, 2009; Anwar and Nguyen, 2011). We contribute to this literature by providing evidence for the case of GVC firms.

## 5. Discussion: Policy and managerial implications

The results of our analysis indicate that i) GVC integration enhances the innovativeness of firms of all sizes and ages and ii) innovation gains from GVC participation spillover to non-GVC firms in the same industry and region. These findings have multiple policy and managerial implications. Understanding these implications is essential for policymakers and managers when crafting strategies to maximise the benefits of GVC participation while fostering broader innovation ecosystems. We briefly review these implications in this section.

### 5.1. Policy implications

*Promote GVC integration to stimulate innovation:* Given that GVC participation appears to boost firm innovation, policymakers should prioritize strategies that facilitate their domestic firms' wider integration. This should come alongside efforts to reduce any friction that impede GVC firms from gaining optimally from international partner firms. In terms of tangible policy priorities, this implies investment of time and resources in four key areas: i) simplifying regulatory frameworks and procedures. Among others, this will include trade-related policies and broader industrial-related policies that affect entry costs into GVCs and the general competitiveness of firms in local and international markets; ii) logistics infrastructure, including physical and digital infrastructure, as they strengthen connectivity to global lead firms and global suppliers in the value chain; iii) building GVC-specific skills and human capital. The national government must identify niches or specialized roles within GVCs where they can build capabilities; and iv) export promotion programs to enhance firm visibility and competitiveness in global markets, thereby facilitating GVC integration.

*Empower small and young firms:* Small and young firms tend to be more resource-constrained, resulting from their liability of smallness and newness. While this can adversely affect their innovativeness, our findings underscore the capacity of these firms to leverage GVC integration for innovation, thereby overcoming their resource constraints. GVC participation as an alternative route to build innovative capability may be particularly salient for such firms. Policymakers can support this integration via targeted programs to address structural barriers these firms face, such as limited access to finance and technological capabilities, and disproportionate regulatory burdens. For example, providing targeted financial assistance, including grants, low-interest loans, and subsidies, can enable these firms to upgrade their capabilities. Complementary initiatives, such as training programs on export readiness, quality certification, and intellectual property management, can further prepare small and young firms for global integration.

*Leverage spillover effect to broaden economy-wide innovation:* Successful innovation is key to sustainable economic growth and development. Hence, the documented spillover effects to non-GVC firms underscore the broader potential economic benefits of GVC participation. Therefore, policymakers should promote national policies that foster knowledge diffusion and collaboration between GVC and non-GVC firms. Initiatives like industrial clusters, technology parks, and business incubators can foster interaction and knowledge sharing. Additionally, incentives for joint ventures, partnerships, and collaborative research programs can further bridge the innovation gap between GVC and non-GVC firms, helping them adopt innovative practices and technologies.

### 5.2. Managerial implications

*Leverage GVCs to drive firm innovation:* Our findings support the widely held view in the literature that participating in GVCs provides firms access to advanced knowledge and technologies, which are precursors to innovativeness. Therefore, managers should view GVC integration not just as a pathway for market expansion but as an opportunity to enhance the firm's innovation capabilities, especially in the case of younger and small-sized firms that are predominantly resource-constrained. These firms should i) identify niches or specialized roles within GVCs where their unique capabilities align with global demand and ii) develop joint ventures or partnerships with upstream and downstream firms in the value chain to acquire insights and expertise in product development and process optimization. Maximizing the innovation benefits from GVC integration also requires managers to allocate resources to ensure effective knowledge transfer and invest in training programs to equip employees with the requisite skills to assimilate and implement these innovations.

*Amplify and cultivate spillover benefits:* The spillover effects of GVC on non-GVC firms present a unique opportunity for managers to enhance their regional or national innovation ecosystems. To amplify these effects, managers can: i) strengthen relationships with local suppliers and subcontractors by sharing expertise and providing technical support, thereby uplifting the broader industrial base; ii) partner with non-GVC firms, universities, and research institutions to co-develop technologies and share insights gained through GVC activities; and iii) facilitate workshops and training sessions to disseminate insights and foster industry-wide collaboration. By fostering a culture of knowledge exchange, managers can position their firms as leaders within their sectors and enhance their reputation among stakeholders. On the other hand, managers of resource-constraint firms can consider co-locating to areas with a high density of GVC-integrated firms or linking up with GVC-integrated firms to gain from knowledge spillovers easily.

## 6. Conclusion

Integration into global value chains (GVC) is increasingly recognized as an important avenue for developing countries to acquire new technologies and foreign knowledge and, through these, to drive innovation. This paper investigates this relationship quantitatively using firm-level data across several African countries. Through an array of alternative estimation strategies, all of which tell a consistent story whilst alleviating different concerns over endogeneity bias or misspecification, we provide robust evidence that GVC firms are more innovative than non-GVC firms and that GVC participation itself is likely driving at least part of these innovation gains. Such consistent findings over such a wide array of models and techniques represent a solid body of evidence in support of our central hypothesis that GVC participation stimulated innovation in Africa. Additional results show that integrating small-sized and younger firms into GVC enables them to overcome their resource constraints, resulting in a higher degree of innovativeness among these firms. Finally, we also show that innovation gains from GVC participation trickle down to non-GVC firms in the same industry and region, implying that GVC firms generate positive innovation spillovers to other firms in the local economy.

Taken together, our findings emphasize the strategic importance of global integration for firms of all sizes and ages. In particular, the findings underscore the critical role of GVC participation in fostering innovation and generating spillover benefits across the economy. An alternative way of looking at our results is that low levels of GVC participation may explain the current lack of innovative firms in many African and other developing countries. To take advantage of the relationship established by our results, managers of developing country firms may wish to further prioritize GVC participation as a core component of their innovation strategies. Particularly for SMEs and younger firms facing resource constraints, GVC participation may represent a cheaper and easier route to innovation. At the national level, policymakers can support these processes by adopting a multi-pronged approach to support and facilitate GVC integration. By doing so, local firms can achieve competitive advantages and contribute to the broader development of their industries and economies while raising the rate of innovation in the overall macro economy. We also see the importance of regional organizations and policies supporting this, especially in providing related global public goods, the absence of which continues to undermine Africa's opportunities in the international market. The African Continental Free Trade Agreement (AfCFTA) may be one such framework through which the advancement of broad-based active trade-and-industrial-related policies to drive innovation activities of African firms can be realized.

Our results also open avenues for future research. For example, which channel and intermediary mechanism discussed in section 2 is quantitatively more important in the context of Africa? Due to lack of harmonized and consistent data, we are unable to test these mechanisms in this paper. Testing these channels and mechanisms would advance our understanding of the causal pathways through which GVC integration affects innovation in Africa.

## CRediT authorship contribution statement

**Gideon Ndubuisi:** Writing – review & editing, Writing – original draft, Software, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Emmanuel B. Mensah:** Writing – review & editing, Writing – original draft, Supervision, Software, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Elvis K. Avenyo:** Writing – review & editing, Writing – original draft, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Daniel Sakyi:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization.

## Acknowledgements

We thank the editor and two anonymous referees for helpful suggestions. We would like to thank Jaime de Melo, Calumn Hamilton, Abebe Shimeles, Dominique Njikeu, Marcelo Olarrega, and the African Economic Research Consortium (AERC) workshop participants for their valuable comments and suggestions. Financial support from AERC is gratefully acknowledged [Grant number RC21555 (2021)].

## Appendix

**Table A1**
Time dimension for which surveys are available

| Countries | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Angola | X | | | | X | | | | | | | | |
| Benin | | | | X | | | | | | | X | | |
| Botswana | X | | | | X | | | | | | | | |
| Burkina Faso | | | | X | | | | | | | | | |
| Burundi | X | | | | | | | | X | | | | |
| Cameroon | | | | X | | | | | | | X | | |
| Cape Verde | | | | X | | | | | | | | | |
| Central African Republic | | | | | | X | | | | | | | |
| Chad | | | | X | | | | | | | | | X |
| Congo | | | | X | | | | | | | | | |
| Côte d'Ivoire | | | | X | | | | | | | X | | |
| DRC | X | | | | X | | | X | | | | | |
| Djibouti | | | | | | | | X | | | | | |
| Egypt | | | | | | | | X | | | X | | |
| Eritrea | | | | X | | | | | | | | | |
| Ethiopia | | | | | | X | | | | X | | | |
| Gabon | | | | X | | | | | | | | | |
| Gambia | X | | | | | | | | | | | | |
| Ghana | | X | | | | | | X | | | | | |
| Guinea | X | | | | | | | | | | X | | |
| Guinea Bissau | X | | | | | | | | | | | | |
| Kenya | | X | | | | | | X | | | | | |
| Lesotho | | | | X | | | | | | | X | | |
| Liberia | | | | X | | | | | | | | X | |
| Madagascar | | | | X | | | | X | | | | | |
| Malawi | | | | X | | | | | X | | | | |
| Mali | | X | | | X | | | | | | X | | |
| Mauritania | X | | | | | | | | X | | | | |
| Mauritius | | | | X | | | | | | | | | |
| Morocco | | | | | | | | X | | | | | |
| Mozambique | | X | | | | | | | | | | | |
| Namibia | X | | | | | | | | X | | | | |
| Niger | | | | X | | | | | | | | X | |
| Nigeria | | X | | | | | | | X | | | | |
| Rwanda | X | | | | | X | | | | | | | |
| Senegal | | X | | | | | | | X | | | | |
| Sierra Leone | | | | X | | | | | | | | X | |
| South Africa | | X | | | | | | | | | | | |
| South Sudan | | | | | | | | | X | | | | |
| Sudan | | | | | | | | | X | | | | |
| Swaziland | X | | | | | | | | | | X | | |
| Tanzania | X | | | | | | | X | | | | | |
| Togo | | | | X | | | | | | | X | | |
| Tunisia | | | | | | | | X | | | | | |
| Uganda | X | | | | | | | X | | | | | |
| Zambia | | X | | | | | | | X | | | | |
| Zimbabwe | | | | | | X | | | | | X | | |

**Table A2**
GVC integration and innovation: Controlling for R&D

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | **Process Innovation** | | | **Product Innovation** | | |
| GVC1 | 0.0280** | | | 0.0405*** | | |
| | (0.0132) | | | (0.0135) | | |
| GVC2 | | 0.0317** | | | 0.0461*** | |
| | | (0.0129) | | | (0.0133) | |
| GVC3 | | | 0.0528*** | | | 0.0544*** |
| | | | (0.0202) | | | (0.0211) |
| R&D | 0.2613*** | 0.2596*** | 0.2616*** | 0.2384*** | 0.2372*** | 0.2385*** |
| | (0.0085) | (0.0084) | (0.0084) | (0.0087) | (0.0086) | (0.0087) |
| Log Age | 0.0257* | 0.0265* | 0.0285** | 0.0380** | 0.0389*** | 0.0423*** |
| | (0.0140) | (0.0139) | (0.0141) | (0.0149) | (0.0148) | (0.0150) |
| Log Age squared | −0.0043 | −0.0044 | −0.0048* | −0.0063** | −0.0063** | −0.0071** |
| | (0.0029) | (0.0029) | (0.0029) | (0.0031) | (0.0030) | (0.0031) |
| Size | −0.0282*** | −0.0249** | −0.0255*** | −0.0373*** | −0.0344*** | −0.0397*** |
| | (0.0099) | (0.0098) | (0.0097) | (0.0103) | (0.0102) | (0.0102) |

(*continued on next page*)

**Table A2** (*continued*)

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Credit Line | 0.0626*** | 0.0613*** | 0.0602*** | 0.0661*** | 0.0650*** | 0.0662*** |
| | (0.0083) | (0.0083) | (0.0083) | (0.0087) | (0.0086) | (0.0086) |
| Training | 0.1282*** | 0.1299*** | 0.1262*** | 0.1338*** | 0.1340*** | 0.1324*** |
| | (0.0074) | (0.0073) | (0.0074) | (0.0077) | (0.0076) | (0.0077) |
| # Observations | 18,441 | 18,742 | 18,489 | 18,497 | 18,798 | 18,545 |
| Survey Year Dummies | YES | YES | YES | YES | YES | YES |
| Industry Dummies | YES | YES | YES | YES | YES | YES |
| Country Dummies | YES | YES | YES | YES | YES | YES |

**Note**.
a. This table reports the marginal effects from a probit model.
b. Robust Standard errors in parentheses.
c. ***p < 0.01, **p < 0.05, *p < 0.1.
d. GVC1 is defined as two-way traders with internationally recognized quality certificate, GVC2 is defined as two-way traders, while GVC3 is defined as two-way traders with foreign ownership structure.

**Table A3**
GVC integration and innovation: LPM

| | (1) | (2) | (3) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|
| | **Process Innovation** | | | **Product Innovation** | | |
| GVC1 | 0.0399*** | | | 0.0537*** | | |
| | (0.0125) | | | (0.0137) | | |
| GVC2 | | 0.0449*** | | | 0.0604*** | |
| | | (0.0122) | | | (0.0134) | |
| GVC3 | | | 0.0610*** | | | 0.0674*** |
| | | | (0.0192) | | | (0.0217) |
| Log Age | 0.0292** | 0.0291** | 0.0313** | 0.0398*** | 0.0400*** | 0.0435*** |
| | (0.0147) | (0.0146) | (0.0148) | (0.0151) | (0.0150) | (0.0152) |
| Log Age squared | −0.0049 | −0.0048 | −0.0052* | −0.0064** | −0.0062** | −0.0071** |
| | (0.0030) | (0.0030) | (0.0030) | (0.0031) | (0.0031) | (0.0031) |
| Size | −0.0465*** | −0.0434*** | −0.0463*** | −0.0525*** | −0.0496*** | −0.0566*** |
| | (0.0095) | (0.0094) | (0.0093) | (0.0103) | (0.0102) | (0.0101) |
| Credit Line | 0.0838*** | 0.0823*** | 0.0815*** | 0.0887*** | 0.0872*** | 0.0891*** |
| | (0.0086) | (0.0085) | (0.0086) | (0.0092) | (0.0091) | (0.0091) |
| Training | 0.1800*** | 0.1814*** | 0.1782*** | 0.1888*** | 0.1885*** | 0.1873*** |
| | (0.0077) | (0.0077) | (0.0077) | (0.0084) | (0.0083) | (0.0084) |
| # Observations | 18,497 | 18,798 | 18,545 | 18,497 | 18,798 | 18,545 |
| R-Squared | 0.2722 | 0.2734 | 0.2728 | 0.1754 | 0.1745 | 0.1741 |
| Survey Year Dummies | YES | YES | YES | YES | YES | YES |
| Industry Dummies | YES | YES | YES | YES | YES | YES |
| Country Dummies | YES | YES | YES | YES | YES | YES |

**Note**.
a. This table reports the marginal effects from the LPM model.
b. Robust Standard errors in parentheses.
c. ***p < 0.01, **p < 0.05, *p < 0.1.
d. GVC1 is defined as two-way traders with internationally recognized quality certificate, GVC2 is defined as two-way traders, while GVC3 is defined as two-way traders with foreign ownership structure.

**Table A4**
GVC integration and innovation: IV Estimation

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | **Panel A:** Second Stage IV-2SLS | | | | | |
| | Process Innovation | | | Product Innovation | | |
| GVC1 | 1.1924*** | 0.9178*** | 1.0938*** | 1.283*** | 0.871** | 1.0434*** |
| | (0.2063) | (0.3305) | (0.1790) | (0.217) | (0.352) | (0.1637) |
| Log Age | 0.0474*** | 0.0369* | 0.0405** | 0.0591*** | 0.0468** | 0.0503*** |
| | (0.0176) | (0.0189) | (0.0188) | (0.0179) | (0.0192) | (0.0194) |
| Log Age squared | −0.0090** | −0.0073* | −0.0081** | −0.0107*** | −0.00843** | −0.0093** |
| | (0.0037) | (0.0040) | (0.0039) | (0.00379) | (0.00406) | (0.0040) |
| Size | 0.1748*** | 0.1284* | 0.1630*** | 0.184*** | 0.110 | 0.1435*** |
| | (0.0416) | (0.0663) | (0.0377) | (0.0439) | (0.0705) | (0.0345) |
| Credit Line | 0.0353** | 0.0432** | 0.0353** | 0.0370** | 0.0488** | 0.0411*** |
| | (0.0141) | (0.0182) | (0.0140) | (0.0149) | (0.0193) | (0.0132) |
| Training | 0.1351*** | 0.1403*** | 0.1333*** | 0.141*** | 0.155*** | 0.1478*** |
| | (0.0126) | (0.0164) | (0.0126) | (0.0135) | (0.0175) | (0.0119) |
| | **Panel B:** First Stage IV-2SLS | | | | | |
| | **GVC Participation** | | | | | |
| Import license | 0.0692*** | | 0.0730*** | 0.0702*** | | 0.0745*** |
| | (0.0077) | | (0.0081) | (0.0077) | | (0.0082) |

(*continued on next page*)

**Table A4** (*continued*)

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Average peer GVC1 propensity | | 0.0035*** | 0.0031*** | | 0.00352*** | 0.0030*** |
| | | (0.0007) | (0.0006) | | (0.000702) | (0.0006) |
| Controls | YES | YES | YES | YES | YES | YES |
| # Observations | 18,497 | 15,563 | 15,563 | 18,497 | 15,563 | 15,563 |
| Survey Year Dummies | YES | YES | YES | YES | YES | YES |
| Industry Dummies | YES | YES | YES | YES | YES | YES |
| Country Dummies | YES | YES | YES | YES | YES | YES |
| First Stage F-test | 135 | 33.4 | 75.7 | 135 | 33.4 | 75.7 |
| Hansen J-Statistic (*p-val* ue) | | | 0.6 | | | 0.6 |

**Note**.
a. This table reports the results from estimating an IV-LPM model.
b. Robust Standard errors in parentheses.
c. ***p < 0.01, **p < 0.05, *p < 0.1.
d. GVC1 is defined as two-way traders with internationally recognized quality certificate.

**Table A5**
Innovation Modes and Novelty: Marginal Effects

| | Panel A: Mode of Innovation | | |
|---|---|---|---|
| | New Product or Process Innovation = No | New Product or Process Innovation = Yes | New Product & Process innovation = Yes |
| GVC1 | −0.0582*** | 0.0060*** | 0.0522*** |
| | (0.0118) | (0.0012) | (0.0106) |
| Log Age | −0.0337** | 0.0035** | 0.0302** |
| | (0.0135) | (0.0014) | (0.0121) |
| Log Age squared | 0.0053* | −0.0005* | −0.0048* |
| | (0.0028) | (0.0003) | (0.0025) |
| Size | 0.0564*** | −0.0058*** | −0.0506*** |
| | (0.0090) | (0.0010) | (0.0081) |
| Credit Line | −0.0871*** | 0.0090*** | 0.0782*** |
| | (0.0076) | (0.0009) | (0.0068) |
| Training | −0.1845*** | 0.0190*** | 0.1656*** |
| | (0.0067) | (0.0012) | (0.0060) |
| **Panel B:** Novelty of Innovation | | | |
| | Product Innovation = No | Product Innovation (New to the firm) = Yes | Product Innovation (New to the market) = Yes |
| GVC1 | −0.0629*** | 0.0087*** | 0.0542*** |
| | (0.0129) | (0.0018) | (0.0112) |
| Log Age | −0.0402*** | 0.0055*** | 0.0346*** |
| | (0.0149) | (0.0021) | (0.0129) |
| Log Age squared | 0.0066** | −0.0009** | −0.0057** |
| | (0.0031) | (0.0004) | (0.0026) |
| Size | 0.0567*** | −0.0078*** | −0.0489*** |
| | (0.0099) | (0.0014) | (0.0085) |
| Credit Line | −0.0837*** | 0.0115*** | 0.0721*** |
| | (0.0082) | (0.0012) | (0.0071) |
| Training | −0.1738*** | 0.0239*** | 0.1498*** |
| | (0.0071) | (0.0012) | (0.0062) |

## Data availability

Data will be made available on request.

## References


Acemoglu, D., Linn, J., 2004. Market size in innovation: theory and evidence from the pharmaceutical industry. Q. J. Econ. 119 (3), 1049–1090.

Adner, R., Levinthal, D., 2001. Demand heterogeneity and technology evolution: implications for product and process innovation. Manag. Sci. 47 (5), 611–628.

Aghion, P., Howitt, P., 1992. A model of growth through creative destruction. Econometrica 60 (2), 323–351. https://doi.org/10.2307/2951599.

Aghion, P., Howitt, P., 2009. The Economics of Growth. MIT Press.

Aghion, P., Dewatripont, M., Rey, P., 1999. Competition, financial discipline and growth. Rev. Econ. Stud. 66 (4), 825–852.

Aghion, P., Harris, C., Howitt, P., Vickers, J., 2001. Competition, imitation and growth with step-by-step innovation. Rev. Econ. Stud. 68 (3), 467–492.

Aghion, P., Bergeaud, A., Lequien, M., Melitz, M.J., 2024. The heterogeneous impact of market size on innovation: evidence from French firm-level exports. Rev. Econ. Stat. 106 (3), 608–626.

Akcigit, U., Melitz, M., 2022. International trade and innovation. In: Handbook of International Economics (Vol. 5, Pp. 377-404). Elsevier.

Alvarez, R., López, R.A., 2008. Is exporting a source of productivity spillovers? Rev. World Econ. 144, 723–749.

Amiti, M., Konings, J., 2007. Trade liberalization, intermediate inputs, and productivity: evidence from Indonesia. Am. Econ. Rev. 97 (5), 1611–1638.

Antràs, P., Chor, D., 2013. Organizing the global value chain. Econometrica 81 (6), 2127–2204.

Anwar, S., Nguyen, L.P., 2011. Foreign direct investment and export spillovers: evidence from Vietnam. Int. Bus. Rev. 20 (2), 177–193.

Avenyo, E.K., Konte, M., Mohnen, P., 2019. The employment impact of product innovations in sub-Saharan Africa: firm-level evidence. Res. Pol. 48 (9), 103806.

Ayyagari, M., Demirguc-Kunt, A., Maksimovic, V., 2014. Who creates jobs in developing countries? Small Bus. Econ. 43, 75–99.

Baldwin, R., Lopez-Gonzalez, J., 2015. Supply-chain trade: a portrait of global patterns and several testable hypotheses. World Econ. 38 (11), 1682–1721.

Baldwin, J., Yan, B., 2014. Global value chains and the productivity of Canadian manufacturing firms. In: Economic Analysis (EA) Research Paper Series Catalogue No. 11F0027M — 090.

Barbosa, N., Faria, A.P., Eiriz, V., 2014. Industry- and firm-specific factors of innovation novelty. Ind. Corp. Change 23 (3), 865–902.

Bas, M., Strauss-Kahn, V., 2015. Input-trade liberalization, export prices and quality upgrading. J. Int. Econ. 95 (2), 250–262.

Buera, F.J., Oberfield, E., 2020. The global diffusion of ideas. Econometrica 88 (1), 83–114.

Cabagnols, A., Le Bas, C., 2002. Differences in the determinants of product and process innovations: the French case. In: Innovation and Firm Performance: Econometric Explorations of Survey Data. Palgrave Macmillan UK, London, pp. 112–149.
Cabrer-Borras, B., Serrano-Domingo, G., 2007. Innovation and R&D spillover effects in Spanish regions: a spatial approach. Res. Pol. 36 (9), 1357–1371.
Cinelli, C., Forney, A., Pearl, J., 2024. A crash course in good and bad controls. Sociological Methods & Research 53 (3), 1071–1104.
Coe, D.T., Helpman, E., 1995. International R&D spillovers. Eur. Econ. Rev. 39 (5), 859–887.
Coe, D.T., Helpman, E., Hoffmaister, A.W., 2009. International R&D spillovers and institutions. Eur. Econ. Rev. 53 (7), 723–741.
Cohen, W.M., Klepper, S., 1996. Firm size and the nature of innovation within industries: the case of process and product R&D. Rev. Econ. Stat. 78, 232–243.
Colovic, A., Misganaw, B.A., Assefa, D.Z., 2022. Liability of informality and firm participation in global value chains. J. World Bus. 57 (1), 101279.
De Marchi, V., Giuliani, E., Rabellotti, R., 2018. Do global value chains offer developing countries learning and innovation opportunities? Eur. J. Dev. Res. 30 (3), 389–407.
Del Prete, D., Giovannetti, G., Marvasi, E., 2017. Global value chain participation and productivity gains for North African firms. Rev. World Econ. 153 (4), 675–701.
Dovis, M., Zaki, C., 2020. Global value chains and local business environments: which factors really matter in developing countries? Rev. Ind. Organ. 57 (2), 481–513.
Ethier, W.J., 1982. National and international returns to scale in the modern theory of international trade. The American Economic Review 72 (3), 389–405.
Farole, T., Winkler, D. (Eds.), 2014. Making Foreign Direct Investment Work for Sub-saharan Africa: Local Spillovers and Competitiveness in Global Value Chains. World Bank Publications.
Fernandes, A.M., Kee, H.L., Winkler, D., 2022. Determinants of global value chain participation: cross-country evidence. World Bank Econ. Rev. 36 (2), 329–360.
Foster-McGregor, N., Kaulich, F., Stehrer, R., 2015. Global value chains in Africa. In: UNU-MERIT Working Paper Series Vol. 2015-024.
Freitas, I.M.B., Clausen, T.H., Fontana, R., Verspagen, B., 2011. Formal and informal external linkages and firms' innovative strategies. A cross-country comparison. J. Evol. Econ. 21, 91–119.
Fritsch, U., Görg, H., 2015. Outsourcing, importing and innovation: evidence from firm-level data for emerging economies. Rev. Int. Econ. 23 (4), 687–714.
Goedhuys, M., 2007. Learning, product innovation, and firm heterogeneity in developing countries: evidence from Tanzania. Industry & Corporate Change 16, 269–292.
Goedhuys, M., Veugelers, R., 2012. Innovation strategies, process and product innovations, and growth: firm-level evidence from Brazil. Struct. Change Econ. Dynam. 23 (4), 516–529.
Goldberg, P.K., Khandelwal, A.K., Pavcnik, N., Topalova, P., 2010. Imported intermediate inputs and domestic product growth: evidence from India. Q. J. Econ. 125 (4), 1727–1767.
Gopalan, S., Reddy, K., Sasidharan, S., 2022. Does digitalization spur global value chain participation? Firm-level evidence from emerging markets. Inf. Econ. Pol. 59, 100972.
Grossman, G.M., Rossi-Hansberg, E., 2008. Trading tasks: a simple theory of offshoring. Am. Econ. Rev. 98 (5), 1978–1997.
Guisado-González, M., Vila-Alonso, M., Guisado-Tato, M., 2016. Radical innovation, incremental innovation and training: analysis of complementarity. Technol. Soc. 44, 48–54.
Halpern, L., Koren, M., Szeidl, A., 2015a. Imported inputs and productivity. Am. Econ. Rev. 105 (12), 3660–3703.
Haskel, J.E., Pereira, S.C., Slaughter, M.J., 2007. Does inward foreign direct investment boost the productivity of domestic firms? Rev. Econ. Stat. 89 (3), 482–496.
Hewitt-Dundas, N., 2006. Resource and capability constraints to innovation in small and large plants. Small Bus. Econ. 26, 257–277.
Hullova, D., Trott, P., Simms, C.D., 2016. Uncovering the reciprocal complementarity between product and process innovation. Res. Pol. 45 (5), 929–940.
Ito, K., Ikeuchi, K., Criscuolo, C., Timmis, J., Bergeaud, A., 2023. Global value chains and domestic innovation. Res. Pol. 52 (3), 104699.
Javorcik, B., 2004. Does FDI increase the productivity of domestic firms? In search of spillovers through backward linkages. Am. Econ. Rev. 94 (3), 605–627.
Kariuki, T., Mutimura, E., Kadzamira, G., 2023. The innovative approaches for unlocking R&D funding in Africa. World Economic Forum Retrieve from. https://www.weforum.org/stories/2023/11/innovative-approaches-for-unlocking-research-and-development-funding-in-africa/.
Keller, W., Yeaple, S.R., 2009. Multinational enterprises, international trade, and productivity growth: firm-level evidence from the United States. Rev. Econ. Stat. 91 (4), 821–831.
Keller, W., Yeaple, S.R., 2013. The gravity of knowledge. Am. Econ. Rev. 103 (4), 1414–1444.
Kleinknecht, A., Verspagen, B., 1990. Demand and innovation: Schmookler re-examined. Res. Pol. 19 (4), 387–394.
Klepper, S., 1996. Entry, exit, growth, and innovation over the product life cycle. Am. Econ. Rev. 562–583.
Krugman, P., 1980. Scale economies, product differentiation, and the pattern of trade. American economic review 70 (5), 950–959.
Lema, R., Quadros, R., Schmitz, H., 2015. Reorganizing global value chains and building innovation capabilities in Brazil and India. Res. Pol. 44 (7), 1376–1386.
Madsen, J.B., Islam, Md R., Ang, J.B., 2010. Catching up to the technology frontier: the dichotomy between innovation and imitation. Can. J. Econ./Rev. Can. Economique 43 (4), 1389–1411. http://www.jstor.org/stable/40925281.
Melitz, M.J., 2003. The impact of trade on intra-industry reallocations and aggregate industry productivity. Econometrica 71 (6), 1695–1725.
Melitz, M.J., Redding, S.J., 2021. *Trade And Innovation* (No. W28945). National bureau of economic research.
Morandi Stagni, R., Fosfuri, A., Santaló, J., 2021. A bird in the hand is worth two in the bush: technology search strategies and competition due to import penetration. Strateg. Manag. J. 42 (8), 1516–1544.
Naveed, A., Wang, C., 2023. Innovation and labor productivity growth moderated by structural change: analysis in a global perspective. Technovation 119, 102554.
Ndubuisi, G., Owusu, S., 2021. How important is GVC participation to export upgrading? World Econ. 44 (10), 2887–2908.
Ndubuisi, G., Owusu, S., 2022. Sub-Saharan Africa's prospect of economic development through global chain. Sustainable Global Supply Chains Report 2022. Research Network Sustainable Global Supply Chains.
Ndubuisi, G., Owusu, S., 2023. Global value chains, job creation, and job destruction among firms in South Africa. STEG Working Paper No. WP073.
Niosi, J., 2010. Building National and Regional Innovation Systems. *Books*. Edward Elgar Publishing number 14006.
Piermartini, R., Rubínová, S., 2021. How much do global value chains boost innovation? Canadian Journal of Economics 54 (2), 892–922.
Pietrobelli, C., Rabellotti, R., 2011. Global value chains meet innovation systems: are there learning opportunities for developing countries? World Dev. 39 (7), 1261–1269.
Posen, H.E., Levinthal, D.A., 2012. Chasing a moving target: exploitation and exploration in dynamic environments. Manag. Sci. 58 (3), 587–601.
Reddy, K., Chundakkadan, R., Sasidharan, S., 2021. Firm innovation and global value chain participation. Small Bus. Econ. 57 (4), 1995–2015.
Reddy, K., Sasidharan, S., Chundakkadan, R., 2024. Firm automation and global value-chain participation: cross-country analysis. Appl. Econ. 1–21.
Rigo, D., 2021. Global value chains and technology transfer: new evidence from developing countries. Rev. World Econ. 157 (2), 271–294.
Rodrik, D., 2018. New Technologies, global value chains, and the developing economies. Pathways for Prosperity Commission Background Paper Series, October.
Romeo, A.A., 1977. The rate of imitation of a capital-embodied process innovation. Economica 63–69.
Rouvinen, P., 2002. Characteristics of product and process innovators: some evidence from the Finnish innovation survey. Appl. Econ. Lett. 9 (9), 575–580.
Saliola, F., Zanfei, A., 2009. Multinational firms, global value chains and the organization of knowledge transfer. Res. Pol. 38 (2), 369–381.
Schmitz, H., 1982. Growth constraints on small-scale manufacturing in developing countries: a critical review. World Dev. 10 (6), 429–450.
Schmookler, J., 1966. Invention and Economic Growth. Harvard University Press, Cambridge, MA.
Shefer, D., Frenkel, A., 2005. R&D, firm size and innovation: an empirical analysis. Technovation 25 (1), 25–32.
Stieglitz, N., Knudsen, T., Becker, M.C., 2016. Adaptation and inertia in dynamic environments. Strateg. Manag. J. 37 (9), 1854–1864.
Sturgeon, T., Van Biesebroeck, J., Gereffi, G., 2008. Value chains, networks and clusters: reframing the global automotive industry. J. Econ. Geogr. 8 (3), 297–321.
Tajoli, L., Felice, G., 2018. Global value chains participation and knowledge spillovers in developed and developing countries: an empirical investigation. Eur. J. Dev. Res. 30 (3), 505–532.
Utterback, J.M., Abernathy, W.J., 1975. A dynamic model of process and product innovation. Omega (Amityv. N. Y.) 3 (6), 639–656.
Van Biesebroeck, J., Mensah, E.B., 2019. The extent of GVC engagement in sub-Saharan Africa. World Bank policy research working paper 8937.
von Hippel, E, 1988. The sources of innovation. Oxford University Press, New York.
Wang, C., Hu, Q., 2020. Knowledge sharing in supply chain networks: effects of collaborative innovation activities and capability on innovation performance. Technovation 94, 102010.
Yang, N., Hong, J., Wang, H., Liu, Q., 2020. Global value chain, industrial agglomeration and innovation performance in developing countries: insights from China's manufacturing industries. Technol. Anal. Strat. Manag. 32 (11), 1307–1321.