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Firm participation in global value chains in francophone Africa: Can adoption of innovation make a difference?

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Firm Participation in Global Value Chains in Francophone Africa: Can Adoption of Innovation make a Difference?

Andre Dumas Tsambou[1] and Thierno Malick Diallo[2]

Abstract

Despite the growing evidence on the importance of African countries' participation in global value chains (GVCs), relatively little is known about the role of innovation. This paper tends to fill this gap by examining the effects of innovation on firms' GVC participation in francophone Africa. We rely on survey data covering over 9535 firms in 18 countries. Using propensity score matching and instrumental variable methods, we find strong evidence that innovation is positively related to firms' GVC participation, with large variation across innovation and GVC measures. We also find that the innovation impact varies according to firm size, with significant effects for small firms.

Keywords: Innovation, Global Value Chains, Firm, Francophone Africa
JEL: Q55; F14; D24; O55.

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1. Introduction

In recent decades, the global economy has witnessed a rapid and continuous development of value chains (Kano et al., 2020; Antràs, 2020). Sampath and Vallejo (2018) estimate that 85% of global trade in 2016 was linked to global value chains (GVCs). This boom in GVCs has several advantages. According to the World Bank (2020), a 1% increase in participation in value chains can increase per capita income levels by more than 1%, which is very high from an economic point of view but also higher than standard gains from international trade.

Today, the development of GVCs is essential not only for the better integration of Africa into world trade but also for the structural transformation of the continent (Abdul-Rahaman and Abdulai, 2020). Nevertheless, the effective participation of African countries in GVCs is still low (Efogo, 2020b). Indeed, the African continent remains a marginal player in world trade, accounting for only 1.7% of GVC-related trade in 2019, compared with 1.5% in 2000. Regional value chains represent only 2.7% of GVCs for Africa, compared with 26.4% for Latin America and the Caribbean and 42.9% for developing Asia (OECD, 2022). Despite Africa's low participation in trade flows compared to other regions, GVCs present Africa with enormous opportunities in terms of strong trade and investment links (AfDB, 2014).

With the establishment in January 2021 of the African Continental Free Trade Area, African countries are presented with a real opportunity to increase its integration in GVCs. In this context, Taglioni and Winkler (2016) argue that strengthening policies that encourage innovation is essential to support African firms' participation in regional and global value chains. At the micro level, innovation refers to the process by which a firm accepts, integrates, and implements a new idea, technology, product, production process, or practice into its existing business operations (OECD, 2005). This can include the adoption of new production methods, new technologies, new business models, new products or services, and new organizational and marketing strategies. Innovation can help reduce production costs and increase the possibility of product differentiation, making it easier to enter international markets (Krugman, 1980; Tavassoli, 2018; Castellani and Fassio, 2019). In fact, there are two ways to view the relationship between innovation and participation in GVCs: on the one hand, innovation promotes entry in international markets. As an essential driver of production, it allows companies to stand out by developing unique products, processes, or business models; to create superior added value from differentiated products or services; and to find opportunities in GVCs (Bontadini et al., 2024). Innovative companies are better positioned to attract GVC partners by revealing distinct competitive advantages, such as better-quality products, lower costs, increased efficiency, or superior functionalities (Lu et al., 2018; Del Prete et al., 2018). On the other hand, trade with the rest of the world can foster innovation. In fact, participation in international trade allows access to advanced knowledge and cutting-edge technologies from different countries and value chain actors (Ito et al., 2019; Brancati et al., 2017). This collaboration with international partners allows companies to learn and absorb new ideas, share good practices, and adopt innovative technologies, thus promoting knowledge transfer and stimulating the innovation process (Tajoli & Felice, 2018; Kergroach, 2019; Gereffi, 2014; Kimseng et al., 2020).

Several studies have investigated the determinants of firm participation in GVCs (Harvie et al., 2010; Wignaraja, 2013; Arudchelvan & Wignaraja, 2015; Criscuolo et al., 2016; Lu et al., 2018; Del Prete et al., 2018; Bontadini et al., 2024). However, there is a notable absence of debates on the importance of innovation in firms' participation in GVCs (Pietrobelli & Rabellotti, 2011;

Van Assche, 2017). Most studies have examined the importance of GVCs in improving firms' innovation capabilities (Ito et al., 2019; Brancati et al., 2017; Tajoli & Felice, 2018; Kergroach, 2019; Yu et al., 2023; Gao et al., 2024). However, there is little analysis of the reverse, i.e., the effect of innovation adoption on firm participation in GVCs. This constitutes an important gap in the literature. Chen et al. (2018) estimate that intangible capital currently accounts for around a third of the output value created in GVCs and that this share has increased over time.

Our study makes an important contribution to the economic literature on GVCs. To the best of our knowledge, our study is the first to examine the role innovation plays in integrating francophone African firms into GVCs. Francophone Africa occupies an important place on the continent. In 2018, it was home to more than 324,334,000 people, or 25.2% of Africa's population. Francophone African countries are also part of various economic zones that promote the development of regional value chains. The most important of these are the Economic Community of West African States (15 countries, nine of which are French-speaking), the Economic Community of Central African States (11 countries, nine of which are French-speaking), and the Southern African Development Community (16 countries, five of which are French-speaking), with the Democratic Republic of Congo a member of the last two groups. French-speaking countries have closer economic ties with French-speaking countries, which can influence trade diversification, investment flows, and economic policies. These countries tend to favor French-speaking commercial partnerships, a concentration of trade with other French-speaking countries, and a limited use of English in commercial transactions. Compared to English-speaking African countries, French-speaking countries have their own historical, political, economic, and cultural contexts that can influence trade patterns. By considering innovation adoption as an important factor in firm participation in GVCs, our study adds to the literature that has often been limited to macroeconomic determinants of GVC participation (Kersan-Skabic 2019; Amador and Cabral 2016).

The main objective of this study is to examine the relationship between the adoption of innovation and the firm GVC participation in Francophone Africa using data from the World Bank Enterprise Survey (WBES) in 18 countries. More specifically, we aim to identify factors that limit/promote firm GVC participation in Francophone Africa, assess their level of participation and examine the effects of innovation on firm GVC participation. In Africa, innovation within firms is generally characterized by its incremental, adaptive nature and depends largely on non-research and development activities (Zanelo et al., 2016). From a conceptual point of view, we show that the adoption of innovation can facilitate participation in global value chains.

The literature on what makes GVCs work (Avom, 2020; Okah-Efogo, 2020a; Urata and Baek, 2020; Reddy et al., 2021) and how firms adopt new technologies when they trade with other countries (Kergroach, 2019; Yu et al., 2023; Gao et al., 2024) is relatively well established. However, not much has been written about how innovation affect African firms' ability to join GVCs. Examining the relationship between innovation adoption and GVC participation is particularly relevant, as several empirical studies mentioned above show that most African firms specialize in the upstream phases of the GVC, supplying primary inputs and products with less scope for quality differentiation.

We use seven innovation indicators, four GVC measures, and a dataset of 9535 firms, collected by the World Bank in 18 French-speaking African countries. Our findings show that implementing a new process and investing in R&D significantly enhance a firm's ability to integrate into GVCs.

The rest of the paper is structured as follows. Section 2 presents the literature review. Section 3 describes the methodology. Section 4 presents the results. Finally, Section 5 concludes.

2. Literature review

A global value chain encompasses all the activities required to design, produce, market, and distribute a product, from the sourcing of raw materials to delivery to end consumers (Gereffi et al., 2005). With technological advances, GVCs have become complex and interconnected (Kaplinsky and Morris, 2001). This has led enterprises to optimize their participation in GVCs by identifying competitive advantages, seeking strategic partnerships, and improving operational efficiency, to remain competitive in the global marketplace. The adoption of innovation within firms is a process that takes place in several stages (Rogers, 2010) and involves organizational adjustments, investments, changes in work processes, staff training, and the introduction of new systems (Damanpour, 1991). This adoption can thus have an impact both on the firm's output and on its participation in GVCs. Innovation is therefore essential for seizing opportunities and managing challenges in global value chains (Gereffi et al., 2005). It can also facilitate value co-creation by encouraging collaboration, exchange of ideas, and interaction between chain actors to generate value for end consumers and stakeholders (Prahalad and Ramaswamy, 2004).

Specifically, the transmission channel from innovation adoption to GVC participation is based on the theory of competitive advantages, which states that a company can obtain a sustainable competitive advantage by adopting a strategy that allows it to differentiate itself from its competitors or to achieve lower costs than its competitors (Porter, 2001). Adopting a specific strategy gives the company a strong position in the market, enabling it to resist competition and perform better over the long term. This differentiation through innovative products and services allows the company to stand out in the market and attract international consumers, thus facilitating its entry in new markets (Bernard and Jensen, 1999) and its engagement in exports (Bernard et al., 2007). Innovative products based on specific standards or international certificates, consumer preferences, and specific international market conditions, lead the innovative company to better integrate into international trade. Drawing on the framework of heterogeneous firms in international trade (Melitz, 2003) numerous studies explore the significance of innovation in enhancing value-added activities and generating value across the entire value chain.

Against this backdrop, our study focuses on product innovation and process innovation, which are closely linked to the idea of product and process improvement in GVCs. Product innovation refers to the improvement of an existing product or the introduction of an entirely new product to the market. Process innovation refers to the improvement of existing production processes or the introduction of an entirely new process into its production system. These innovations, which comply with the standards and requirements of international markets, lead to the adoption of quality standards, international certifications, environmental standards, and sustainable business practices, which can enhance their credibility and give them access to more demanding international markets.

Empirical analyses have approached the relationship between innovation and firm participation in GVCs from a variety of angles. We first examine empirical studies on innovation as a key determinant of GVC participation. We then proceed to analyze studies that assess the impact of

GVC participation on innovation, and lastly, we review studies that assess the impact of innovations on firms' involvement in GVCs.

Determinants of GVC participation

A significant body of literature examines the determinants of firm participation in global value chains and their impact on firm performance (Amador and Cabral, 2016; Criscuolo et al., 2016; Gereffi, 2014). These studies unanimously find that firm-related characteristics (labour productivity, size, foreign participation and technological capacity, access to finance), factors related to the business environment (trade openness, foreign direct investment flows, intellectual property protection, quality of infrastructure and institutions), structural factors (economic size, a common border, a common colonial heritage, a common language, a common currency, free trade agreements and a stable exchange rate relationship) and institutional characteristics (the application of contracts, the rule of law, human capital and the quality of infrastructures) significantly influence the participation of companies in global value chains (Harvie et al. , 2010; Wignaraja, 2013; Arudchelvan and Wignaraja, 2015; Lu et al, 2018; Del Prete et al, 2018; Criscuolo et al, 2016; Kowalski et al, 2015; Urata and Baek, 2020). Some other studies provide evidence that innovation is a determinant of participation in global value chains. In fact, the company differentiates itself from the competition by developing new products and services with better quality and more competitive products, allowing it to access more highly valued market segments on an international scale (Tinta, 2017; Yameogo and Jammeh, 2019; Fernandes et al., 2022; Banerjee and Zeman, 2022; Sharma and Arora, 2023; Rahman et al., 2024).

GVC participation affects innovation

A strand of the literature uses the value chain theory to show the importance of GVCs in improving firms' innovation capabilities and highlights the positive link between GVCs and the adoption of innovation within firms (Ito et al., 2019; Brancati et al., 2017; Tajoli and Felice, 2018; Kergroach, 2019; Tsambou and Tagang, 2024; Tsambou and Fomba, 2017). These studies point out that firms participating in GVCs have access to diversified resources, knowledge, and specialized skills from different countries, which promotes the adoption of innovation. GVCs can play a key role in the dissemination of knowledge, technologies, and innovative business practices, enabling greater investment in research and development (OECD, 2020), stimulating innovation, and improving enterprise competitiveness (World Bank, 2020). In a study of 25 developed and emerging countries, Piermartini and Rubínová (2021) show that GVCs stimulate the adoption of innovation in industrial companies through knowledge transfer. In the same vein, Tajoli and Felice (2018) show that innovation is positively related to participation in GVCs as the latter allow firms to achieve economies of scale and scope by accessing larger markets. This gives firms the opportunity to increase the return on their research and development investments by creating innovative products that can be marketed internationally. Ito et al. (2023) support this point of view showing that participation in international trade positively increases the demand for patents by Japanese companies.

Similarly, Yang et al. (2020) and Yang and Wang (2024) show in the case of Chinese manufacturing industries that participation in GVCs has an inverted U-shaped effect on innovation performance. In fact, GVCs allow companies to diversify risks by spreading their innovation activities over several countries and regions. This reduces their dependence on a single market or supplier and makes them more resilient in the face of economic shocks, thereby

encouraging the exploration of new ideas and approaches. In addition, Brancati et al. (2017) show in the case of Italian companies that highly qualified relational suppliers have a higher propensity to engage in innovation activities and research and development projects. In the same vein, Brancati et al. (2022) suggest that GVC governance positively affects the innovation performance of Italian input suppliers. While these studies suggest that GVCs are essential for improving companies' innovation capabilities, other suggest a reverse causality.

Innovation as a main driver of GVC participation

This strand of the literature suggests that the adoption of innovation leads to higher productivity, facilitating firms' integration into GVCs by allowing them to provide quality goods and services at competitive costs. Numerous empirical studies have shown that innovation is a determining factor in the diversification of supply, export performance, and the creation of new value chains (Hirsch and Bijaoui, 1985). In the same vein, Bÿçakcÿoÿlu-Peynirci et al. (2019) show that a company's capacity to innovate modifies its behavior on the international market relative to non-innovators. In the case of British and German firms, Roper and Love (2002) find that a firm's probability of internalization increases with its innovative capacity. Barrios et al. (2003) also suggest that a company's R&D activity is an important factor shaping the export activities of Spanish companies. Along the lines of Melitz (2003), firms that adopt innovative practices are better positioned to integrate the global market through GVCs. Being part of a GVC also allows for knowledge transfer and creates inter-firm linkages (De Marchi et al., 2018; Tsambou et al., 2024). This process is shaped by the structure of the GVC in which the lead firms operate, as well as the product innovation cycle (Ambos et al., 2021).

Furthermore, studies indicate that innovation requires the development of advanced skills and knowledge. Companies that invest in research and development, staff training, and the acquisition of new skills strengthen their ability to participate in GVCs through technical expertise and an in-depth understanding of technologies and processes acquired through innovation (Hausmann et al. 2007). The positive effect of innovation on participation in GVCs can therefore vary, depending on the sector of activity, the economic context, and the policies in place.

Although the literature provides evidence on the relationship between innovation and firm participation in GVCs, it is largely limited to developed and emerging economies. As a result, the literature on African countries is sparse. Avenyo et al. (2022) show that African firms that participate in GVC activities are more likely to introduce innovative products to markets. Using data on firm adoption of different generations of technologies in Ghana, Delera et al. (2022) find that firm participation in GVCs is positively associated with technology adoption. With the exception of Reddy et al. (2020), most empirical work does not yet explicitly consider innovation as a driver of participation in GVCs. In this context, this study emphasizes the need to fill this gap, as innovation in developing countries in general and African countries in particular is largely incremental and depends more on non-research and development activities (Avenyo et al., 2022). To this end, innovation adoption can serve as a channel to facilitate firms' participation in GVCs by improving their enterprise competitiveness, creating added value, attracting international partners, accessing new markets, and thereby participating in GVCs (WTO, 2014; Montalbano et al., 2018; Tsambou and Fomba, 2023).

3. Methodology

3.1.Data

This study uses the World Bank Enterprise Survey (WBES) to document the effects of innovation on firm GVC participation. The survey includes both manufacturing and service sector and provides a national representative firm-level data stratified by size, location, and sector. The survey also covers a broad range of information on firm characteristics, including innovation, international trade, number of workers, and sales. Given our research objective, we focus only on francophone African countries for which WBES data are available. We consider the most recent survey available for each country and exclude survey with missing information on innovation. Our sample includes data for 9535 firms operating in 18 francophone Africa countries[3] spanning the years 2008 to 2022: Benin, Burundi, Cameroon, Chad, Democratic Republic of the Congo, Djibouti, Guinea Conakry, Ivory Coast, Madagascar, Mali, Mauritania, Mauritius, Morocco, Niger, Rwanda, Senegal, Togo, and Tunisia. Although the number of firms interviewed differs across countries, the WBES uses a standardized methodology that allows cross-country comparisons and increases the level of external validity.

3.2.Empirical Strategy

We use the following specification to estimate the effects of innovation on firm GVC participation:

$$GVC_{ijst} = \beta_0 + \beta_1 Innov_{ijst} + \beta_2 X_{ijst} + \varphi_s + \varphi_j + \varphi_t + \varepsilon_{ijst} \quad (1)$$

Where GVC_{ijst} is the level of GVC participation of firm *i* in country *j* sector s at time *t*.

Following Dovis and Zaki (2020), GVC is measured at the extensive margin, i.e., the probability that a firm participates in a GVC, using four definitions. The first definition of GVC participation includes firms that both export and import (GVC1). The second definition is more stringent, encompassing firms that not only engage in export and import but also hold international certifications (GVC2). The third definition includes two-way trading firms with foreign ownership (GVC3). The most comprehensive definition (GVC4) encompasses firms that not only export and import, but also have an international certification and foreign ownership of capital. At the intensive margin, we capture GVC by the depth of participation in a value chain, i.e., the share of exported products in firm sales and the share of imported intermediate inputs in a firm's total inputs (Aboushady and Zaki, 2023).

Our explanatory variable of interest, $Innov_{ijst}$, is measured using the seven types of innovation indicators provided in the WBES dataset. More specifically, $Innov$ is a dummy variable equal to 1 if the firm: i) has a licensed foreign technology; ii) has introduced a new product/service; iii) has introduced a new product/service that is also new to the firm's market; iv) has introduced a new process; v) spends on R&D; vi) communicates with emails; or vii) has a website, and 0 otherwise.

X is a vector of control variables predicted to affect GVC participation at the firm level, including size, productivity, gender of the top manager, female ownership share, and whether the firm has a credit line from a financial institution. Firm size and productivity have been positively linked to GVC participation in the literature, with more productive and larger firms

[3] Appendix 1 provides the list of countries and available years.

more likely to participate in global markets (Stiebale, 2011; Secchi et al., 2016; Reddy et al., 2020). Similarly, access to finance was found to favour GVC participation in Africa (Fowowe, 2017; Calatayud and Rochina Barrachina, 2023). Gender can affect GVC participation in various ways, with the presence of a female top manager or owner being either positively or negatively correlated with participation in global markets (e.g., Shepherd and Stone, 2017; Garg and Shastri, 2022; Shastri, 2024).

Because we pool data for different countries and years, we include year and country fixed effects ($\varphi_j$and φ_t) to control for control for geographical differences as well as differences over time. We also include industry fixed effects (φ_s) to account for differences across industries. Moreover, we control for time-variant country characteristics using two key macroeconomic variables: the inflation rate and the level of domestic credit accessible to the private sector[4]. ε_{ijst} represents the residual error term.

We estimate the regressions using a probit model (when GVC is measured at the extensive margin) and a pooled Ordinary Least Squares (OLS) estimation method (when GVC is measured at the intensive margin).

Additionally, we control for the potential reverse causality between GVC participation and innovation in two ways. First, we use the Propensity Score Matching (PSM) method that compares a treated group (innovating firms) to a control group (non-innovating firms). Specifically, we compute the average effect related to the choice to adopt innovation by matching exclusively innovating firms with non-innovating firms with similar characteristics. Three matching methods are used: nearest neighbour matching, radius caliper matching and Kernel-based matching. Second, we use an instrumental variable (IV) approach to control for the unobservables, since the PSM estimation method assumes the conditional exogeneity of the treatment only on the observables. We instrument innovation measures by a shift-share of innovation aggregated by country-year-sector-geographical zone (where the firm is located) minus the firm's own innovation. The rationale behind is that if a firm is located an area where there is a concentration of innovating firms, it can experience spillover effects that result in increased innovation for itself.

The definitions of the variables and their summary statistics are provided in Table 1. Our sample shows that the average age of the firms is 24 years. Furthermore, 25% and 12% of firms are top managed and owned by females respectively, with an average experience of 18 years. Only 11% of firms belong to GVC1 and the share of firms integrated into GVC2 (3%), GVC3 (4%) and GVC4 (1%) combined accounts for less than 10%. In terms of innovation, 8.8% of firms have a licensed foreign technology, 23% have introduced a new product/service, 15% have introduced a new product/service that is also new to the firm's market, 15% have introduced a new process, 4.9% have spent on R&D, 40% have a website, and 42% communicate by email.

Table 2 shows the association between different innovation indicators and GVC measures. For the most basic measure of GVC participation (GVC1), 22% of firms that engaged in both exporting and importing also held a licensed foreign technology. Among the firms that were two-way traders and possessed an international certification (GVC2), 31.27% had a licensed foreign technology. With the definition of GVC participation including two-way trade and foreign ownership (GVC3), the share of innovating firms dropped to 28.23%. However, for the strictest definition of GVC participation involving two-way trade, certification, and foreign

[4] These two variables are taken from the World Bank- Prosperity Data360 platform.

ownership (GVC4), the share of innovating firms increased to 38.84%. A key finding is that deeper forms of GVC participation require innovation, or, conversely, that innovating firms are more able to integrate into GVCs through various means that go beyond the scope of traditional two-way trade.

Throughout the different innovation indicators, the share of innovation was higher for firms that exported and imported with an international certification (GVC 2) than for firms that exported and imported (GVC 1), as well as for two-way trading firms with a share of foreign capital (GVC 3). With few exceptions, a higher share of innovation was also found for firms that exported, imported with an international certification (GVC3) compared to firms that engaged in two-way trade with international certification and foreign ownership (GVC 4). Figure A1 in appendix illustrates the share of GVC participation in relation to the various innovation indicators. The data shows that innovating firms have higher shares of GVC participation than their non-innovating peers, regardless of the innovation and GVC measures used.

Table 1. Descriptive statistics

Variable	Construction	Obs.	Mean	S.D	Min	Max
Foreign technology	1 if the firm has a licensed foreign technology, 0 otherwise	9,535	.08851	.28405	0	1
New product/service	1 if the firm has introduced a new product/service, 0 otherwise	9,535	.2300	.4209	0	1
New to firm's market	1 if the firm has introduced a new product/service that is also new to the firm's market, 0 otherwise	9,535	.15028	.3573	0	1
New process	1 if the firm has introduced a new process, 0 otherwise	9,535	.1503	.35747	0	1
Spends on R&D	1 if the firm spends on R&D, 0 otherwise	9,535	.049711	.217359	0	1
Website	1 if the firm has a website, 0 otherwise	9,535	.40115	.4901	0	1
Communicates by email	1 if the firm communicates by email, 0 otherwise	9,535	.4243	.49426	0	1
GVC 1	1 if the firm exports and imports	9,535	.11043	.31344	0	1
GVC 2	1 if the firm exports, imports, and has an international certification	9,535	.03387	.1809	0	1
GVC 3	1 if the firm exports, imports, and has foreign ownership of capital	9,535	.0438	.2047	0	1
GVC 4	1 if the firm exports, imports, and has an international certification and foreign ownership of capital	9,535	.01269	.11193	0	1
Size	Number of permanent, full-time employees at the end of last fiscal year	9,535	64.752	211.137	0	6150
Labor productivity (in log)	Establishments total annual sales in the last fiscal year/Number of workers	9,535	14.036	2.8024	3.442	29.001
Credit line	1 if the firm has a credit line, 0 otherwise	9,535	.2919	.4546	0	1
Female	1 if the top manager is female, 0 otherwise	9,535	.12576	.3316	0	1
Female ownership	1 if there is female owner, O otherwise	9,535	.25125	.433766	0	1

Table 2. Interaction between innovation and GVC participation

		GVC1		GVC2		GVC3		GVC4	
		NO	YES	NO	YES	NO	YES	NO	YES
Foreign technology	NO	92.81	77.78	91.93	68.73	92.04	71.77	91.53	61.16
	YES	7.19	22.22	8.07	31.27	7.96	28.23	8.47	38.84
New product/service	NO	78.14	67.71	77.53	61.61	77.19	72.73	77.11	67.77
	YES	21.86	32.29	22.47	38.39	22.81	27.27	22.89	32.23
New to firm's market	NO	86.01	76.64	85.41	72.45	85.25	78.95	85.09	76.03
	YES	13.99	23.36	14.59	27.55	14.75	21.05	14.91	23.97
New process	NO	85.77	78.44	85.45	70.90	85.08	82.30	85.04	78.51
	YES	14.23	21.56	14.55	29.10	14.92	17.70	14.96	21.49
Spends on R&D	NO	95.38	92.21	95.34	86.07	95.03	94.98	95.10	89.26
	YES	4.62	7.79	4.66	13.93	4.97	5.02	4.90	10.74
Website	NO	63.10	34.00	61.42	16.10	60.83	39.23	60.38	21.49
	YES	36.90	66.00	38.58	83.90	39.17	60.77	39.62	78.51
Communicates by email	NO	58.65	48.81	58.09	42.72	57.92	49.76	57.81	38.84
	YES	41.35	51.19	41.91	57.28	42.08	50.24	42.19	61.16

4. Results

Table 3 reports the results of the baseline regressions examining the impact of innovation on firm's GVC participation at the extensive and intensive margins, using simple probit and OLS estimation. In all regressions, we clustered standard errors at the country-year level.

We find that the coefficient of innovation, i.e., possessing a foreign licensed technology, is significant for all four definitions of firms' GVC participation. Introducing new products/services, new products/services that are new to the firm's market, as well as communicating by emails, has a positive effect on GVC participation. However, the effect is only significant for GVC 1, GVC 2, and GVC 3. Introducing a new process is also positively and significantly associated with GVC participation, but only for GVC 1 and GVC 2. Additionally, spending on R&D, as well as having a website, significantly increases the likelihood that a firm exports and imports (GVC 1), that a firm exports, imports, and has an international certification (GVC 2), as well as those firm exports, imports, has an international certification and a foreign capital (GVC4). At the intensive margins, the findings reveal that GVC participation is significantly influenced by the possession of a foreign licensed technology, expenditures on R&D, and to a lesser extent email communication.

Overall, the results support the findings of Reddy et al. (2020) demonstrating that innovative firms are 4.7% to 6.4% more likely to participate in GVCs. Our results are also consistent with those of Ngoc Bich et al. (2022), which show that firms that firms that invest in R&D, new products, and quality improvement are more likely to improve their GVC integration. More generally, the results align with the study of Ajide et al. (2023) showing that mobile money innovations increase GVC participation in 90 developing countries.

Regarding the control variables, firm productivity and size, with some exceptions, have a positive and strongly significant effect on all forms of GVC participation. This means that larger and more productive firms are more likely to engage in various activities within GVCs. They are more likely to participate in both upstream and downstream activities, indicating a stronger integration into the global markets, which is consistent with previous research (Stiebale, 2011; Secchi et al., 2016; Reddy et al., 2020). Consistent with previous studies (Fowowe, 2017; Calatayud and Rochina Barrachina, 2023), access to credit is positively associated with GVC participation, but it is only significant for GVC 1 and GVC 2. At the country level, the share of domestic credit to the private sector and the rate of inflation positively and significantly influences GVC 1 and GVC 3. However, both macro variables have negative effects on GVC 2 and GVC 3. The results differ from those of Reddy et al. (2020), who find that macro variables do not have significant effects, except private credit, which is positively and significantly correlated with GVC participation. Contrary to previous findings (e.g., Shepherd and Stone, 2017; Garg and Shastri, 2022; Shastri, 2024), the gender variables all have statistically insignificant coefficients, indicating that the presence of a female owner or top manager does not influence GVC participation.

Table 3. Baseline regressions: Innovation and GVC participation

	GVC 1	GVC 2	GVC 3	GVC 4	Intensive	GVC 1	GVC 2	GVC 3	GVC 4	Intensive	GVC 1	GVC 2	GVC 3	GVC 4	Intensive
Foreign technology	0.493***	0.423***	0.574***	0.408**	0.152**										
New product/service						0.229***	0.167***	0.198**	0.121	0.013					
New to firm's market											0.258***	0.090	0.248**	0.066	0.070
Log size	0.237***	0.372***	0.228***	0.380***	0.084**	0.249***	0.386***	0.240***	0.391***	0.089***	0.248***	0.387***	0.239***	0.393***	0.088***
Log labor productivity	0.080*	0.103***	0.069	0.084	0.033	0.081*	0.107***	0.068	0.089	0.035	0.081*	0.109***	0.068	0.089	0.035
Female ownership	-0.005	0.051	-0.040	-0.016	-0.047	0.004	0.062	-0.023	-0.004	-0.043	0.009	0.069	-0.019	0.004	-0.042
Female top manager	-0.038	0.065	0.190	0.134	0.047	0.020	0.053	0.172	0.120	0.045	0.017	0.059	0.166	0.121	0.043
Credit line	0.251**	0.227***	0.201	0.174**	-0.034	0.234**	0.195***	0.202	0.148	-0.040	0.235**	0.202***	0.201	0.152*	-0.044
Domestic credit to private sector (% of GDP)	0.047***	-0.023**	0.080***	-0.025	0.010	0.054***	-0.018***	0.085***	-0.025	0.009	0.051***	-0.023**	0.083***	-0.029	0.010
Consumer price index	0.058***	-0.060***	0.133***	-0.063***	0.007	0.068***	-0.053***	0.139***	-0.063***	0.006	0.063***	-0.060***	0.137***	-0.068***	0.007
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,311	4,932	4,780	3,940	2,600	5,311	4,932	4,780	3,940	2,600	5,311	4,932	4,780	3,940	2,600
R-squared	0.187	0.282	0.181	0.277	0.122	0.180	0.275	0.164	0.269	0.120	0.180	0.273	0.165	0.268	0.121

Note: *p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors clustered at the country-year level.

Table 3. Baseline regressions: Innovation and GVC participation (Continued)

	GVC 1	GVC 2	GVC 3	GVC 4	Intensive	GVC 1	GVC 2	GVC 3	GVC 4	Intensive	GVC 1	GVC 2	GVC 3	GVC 4	Intensive
New process	0.169**	0.189**	0.122	0.030	0.008										
Spends on R&D						0.243***	0.437***	0.190	0.446**	0.168***					
Website											0.298***	0.563***	0.132	0.371***	0.045
Log size	0.249***	0.384***	0.241	0.393***	0.089***	0.251***	0.382***	0.242***	0.386***	0.088***	0.229 ***	0.353***	0.232***	0.362***	0.086***
Log labor productivity	0.081**	0.106***	0.069	0.090	0.035	0.082*	0.107***	0.070	0.086	0.035	0.0764 *	0.102***	0.067	0.084	0.034
Female ownership	0.009	0.071	-0.016	0.005	-0.042	0.012	0.072	-0.014	-0.004	-0.041	0.005	0.049	-0.024	-0.021	-0.044
Female top manager	0.030	0.057	0.183	0.124	0.046	0.032	0.057	0.184	0.122	0.045	0.042	0.074	0.190	0.147	0.046
Credit line	0.241**	0.189***	0.205	0.153*	-0.039	0.253**	0.212***	0.217	0.164*	-0.040	0.231**	0.155**	0.201	0.109	-0.041
Domestic credit to private sector (% of GDP)	0.051***	-0.017	0.081***	-0.030*	0.009	0.051***	-0.011	0.081***	-0.017	0.013*	0.046***	-0.029***	0.076***	-0.034*	0.008
Consumer price index	0.064***	-0.051***	0.134***	-0.069*	0.005	0.066***	-0.040***	0.135***	-0.047***	0.012*	0.063***	-0.059***	0.130***	-0.070***	0.005
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,311	4,932	4,780	3,940	2,600	5,311	4,923	4,780	3,940	2,600	5,311	4,932	4,780	3,940	2,600
R-squared	0.177	0.275	0.162	0.268	0.120	0.177	0.278	0.1624	0.274	0.121	0.183	0.293	0.163	0.278	0.120

Note: *p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors clustered at the country-year level.

Table 3. Baseline regressions: Innovation and GVC participation (Continued)

	GVC 1	GVC 2	GVC 3	GVC 4	Intensive
Communicates by email	0.418***	0.406***	0.462**	0.228	0.182*
Log size	0.241***	0.382***	0.232***	0.389***	0.082**
Log labor productivity	0.073	0.104***	0.061	0.088	0.028
Female ownership	0.008	0.072	-0.011	0.009	-0.044
Female top manager	0.037	0.065	0.187	0.124	0.043
Credit line	0.240**	0.198***	0.200	0.149	-0.045
Domestic credit to private sector (% of GDP)	0.084***	0.0133	0.118***	-0.009	0.025**
Consumer price index	0.125***	0.005	0.202***	-0.032	0.035*
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	5,311	4,932	4,780	3,940	2,600
R-squared	0.180	0.274	0.166	0.268	0.123

Note: *p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors clustered at the country-year level.

To address the potential reverse causality, we use a PSM estimation approach to compare the level of GVC participation of innovating firms with what it would have been if the same firms did not innovate. To do so, we first run a logit regression where the dependent variable takes the value of one if the firm innovates and zero otherwise to determine the propensity score. We match each innovating firm to one or more non-innovating firms on the propensity score, using three matching methods: nearest neighbour matching, radius caliper matching and Kernel-based matching. We then compute an average treatment effect on the treated, which is the difference between the expected level of GVC participation of innovating firms and that of the firm with similar characteristics, but who did not innovate.

As it is common in the literature, it is important to check the matching quality before presenting the results. This requires comparing the situation before and after the matching procedure. Figure 2A in appendix indicates that the propensity score density in the "treated" and "untreated" groups are different before matching. However, we find that the density distributions of the two groups become somewhat similar after matching. Figure 3A in appendix shows the existence of a good overlap between the propensity scores of innovating firms and non-innovating firms, indicating that the two groups have a large enough area of common support. Part of the results of the propensity score models are also presented in appendix. Given the large number of tables, the complete results are available from the authors on request.

By and large, the three matching methods yield similar results both in terms of magnitude and statistical significance, suggesting the robustness of our estimates (Table 4). The results show again that possessing a foreign licensed technology exerts a positive and statistically significant effect on GVC participation, both at the extensive and intensive margins. Introducing new products/services and new products/services that are new to the firm's market positively influences GVC participation, but this effect is significant only for firms that both export and import along value chains (GVC 1), and those that export, import, and hold international certifications (GVC 3). With very few exceptions, introducing a new process and communicating by emails have no significant effect on firms' involvement in GVCs, both at the extensive and intensive margins. The findings reveal that investing in R&D has a positive and significant effect on GVC2, which involves trade and international certification, and to lesser extent on GVC 4, which encompasses two-way trade, certification, and foreign ownership. Finally, we find that having a website is strongly associated with a positive and significant coefficient for GVC 1 (two-way trade), GVC2 (two-way trade and international certification) and GVC 4 (two-way trade, certification, and foreign ownership). Having a website allows firms to reach a broader audience and engage with international markets more effectively. It also enhances their visibility and credibility, which can attract foreign investors.

Table 4. PSM method: Innovation and GVC participation

		GVC 1	GVC 2	GVC 3	GVC 4	Intensive
Foreign technology	Nearest	0.124***	0.042**	0.074***	0.019**	0.116*
	Radius caliper	0.129***	0.049***	0.075***	0.019**	0.140**
	Kernel	0.132***	0.049***	0.078***	0.019**	0.149***
	Observations	5,290	5,290	5,290	5,290	2,576
	Number of replications	100	100	100	100	100
New product/service	Nearest	0.027**	0.004	0.011	0.001	0.031
	Radius caliper	0.026**	0.002	0.013**	0.001	0.019

	Kernel	0.027**	0.004	0.013**	0.001	0.012
	Observations	5,649	5,649	5,649	5,649	2,600
	Number of replications	100	100	100	100	100
New to firm's market	Nearest	0.039***	0.005	0.021**	0.0003	0.062
	Radius caliper	0.037***	0.004	0.017**	-0.00004	0.052
	Kernel	0.041***	0.006	0.018**	0.001	0.058
	Observations	5,647	5,647	5,647	5,647	2,600
	Number of replications	100	100	100	100	100
New process	Nearest	0.014	0.019**	0.007	0.003	-0.065
	Radius caliper	0.013	0.014	0.003	0.002	-0.029
	Kernel	0.012	0.012	0.004	0.001	-0.040
	Observations	5,647	5,647	5,647	5,647	2,600
	Number of replications	100	100	100	100	100
Spends on R&D	Nearest	0.031	0.030	0.010	0.009	0.101
	Radius caliper	0.035	0.042**	0.015	0.017*	0.092
	Kernel	0.029	0.039**	0.014	0.016*	0.098
	Observations	1,993	1,993	1,993	1,993	575
	Number of replications	100	100	100	100	100
Website	Nearest	0.043***	0.039***	0.012	0.011***	0.005
	Radius caliper	0.041***	0.036***	0.005	0.009***	0.003
	Kernel	0.042***	0.038***	0.005	0.010***	0.005
	Observations	5,644	5,644	5,644	5,644	2,597
	Number of replications	100	100	100	100	100
Communicates by email	Nearest	0.031	0.002	0.009	-0.013	0.123
	Radius caliper	0.034	0.003	0.010	-0.013	0.122
	Kernel	0.038	0.004	0.012	-0.009	0.133*
	Observations	3,322	3,322	3,322	3,322	1,431
	Number of replications	100	100	100	100	100

Note: *p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors are bootstraped using 100 replications and clustered at the country-year level.

Since the PSM approach is a quasi-experimental method that only controls for observable factors, we control for unobservable factors using an instrumental variable (IV) approach where innovation is instrumented by a shift share variable of innovations aggregated by country-year-sector-geographical zone minus the firm's own share of innovation.

The results of the instrumental variables (IV) approach are presented in Table 5. Strikingly, having a foreign licensed technology significantly reduces the likelihood that a firm exports, imports, has an international certification and a foreign capital (GVC4). These firms might face restrictions or conditions imposed by the licensor, limiting their ability to seek international certifications or attract foreign investment. Introducing new products/services and new products/services that are new to the firm's market, as well as having a website, have no effect on GVC participation both at the extensive and intensive margins. This suggests that introducing new products or establishing an online presence alone does not ensure integration

into global value chains. These efforts may fall short in addressing other obstacles to GVC participation, like steep entry costs or strict regulatory standards.

The findings show that implementing a new process and investing in R&D can improve efficiency and competitiveness, allowing for easier integration into GVCs. In fact, firms that introduce new processes and spend on R&D are more likely to become two-way traders (GVC 1), two-way trader with international certification (GVC2), or two-way traders with foreign ownership (GVC 3). Also, communicating by email increases a firm's chances of becoming a two-way trader with foreign certification and capital (GVC 4). Finally, we find at the intensive margin that innovation does not significantly affect GVC participation. This result remains consistent across all seven innovation indicators used in the study.

Comparing the IV findings with the baseline and PSM findings reveals some key insights. While the baseline and PSM approaches suggest that possessing foreign licensed technology significantly boosts GVC participation across most definitions, the IV approach indicates a reduction in likelihood for GVC 4, suggesting potential endogeneity issues. The most robust result across all approaches is that implementing new processes and investing in R&D significantly boosts GVC participation. Indeed, this consistently increases a firm's chance of becoming a two-way trader (GVC1) and achieving two-way trade status with international certification (GVC2).

Table 5. IV method: Innovation and GVC participation

	GVC 1	GVC 2	GVC 3	GVC 4	Intensive	GVC 1	GVC 2	GVC 3	GVC 4	Intensive	GVC 1	GVC 2	GVC 3	GVC 4	Intensive
Foreign technology	-0.608	0.112	-0.883	-0.62**	-0.707										
New product/service						0.478	0.008	0.640	-0.055	-1.048					
New to firm's market											0.119	-0.782	0.371	-0.377	-1.066
Log size	0.269***	0.384***	0.264***	0.402***	0.115***	0.241	0.391***	0.225***	0.396***	0.111	0.251***	0.387***	0.235	0.401***	0.112
Log labor productivity	0.085*	0.106***	0.073*	0.089*	0.045***	0.079	0.109***	0.063*	0.090*	0.052	0.082*	0.105**	0.067	0.090*	0.046
Female ownership	0.011	0.062	0.039	0.035	-0.023	0.013	0.068	-0.037	0.002	-0.017	0.020	0.074	-0.020	0.011	-0.048
Female top manager	0.034	0.060	0.112	0.103	0.040	-0.004	0.060	0.163	0.126	0.083	0.011	0.086	0.164	0.134	0.096
Credit line	0.247**	0.230***	0.192	0.178	-0.058	0.204	0.212**	0.154	0.167*	0.050	0.246**	0.273**	0.192	0.192**	0.042
Domestic credit to private sector (% of GDP)	0.041***	-0.023**	0.054**	-0.023	0.004	0.055*	-0.024	0.085*	-0.032	-0.027	0.051***	-0.050	0.084***	-0.042**	-0.010
Consumer price index	0.047***	-0.061***	0.088*	-0.060***	-0.002	0.068***	-0.062*	0.139**	-0.073***	-0.047	0.063***	-0.097**	0.137***	-0.086***	-0.019
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,651	5,651	5,651	5,651	2,600	5,651	5,651	5,651	5,651	2,600	5,651	5,651	5,651	5,651	2,600

Note: *p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors are clustered at the country-year level.

Table 5. IV method: Innovation and GVC participation (Continued)

	GVC 1	GVC 2	GVC 3	GVC 4	Intensive	GVC 1	GVC 2	GVC 3	GVC 4	Intensive	GVC 1	GVC 2	GVC 3	GVC 4	Intensive
New process	0.725*	0.925***	0.818**	0.260	5.880										
Spends on R&D						1.609***	1.55***	1.120*	0.875	-10.305					
Website											0.300	0.954**	0.305	0.534	-0.679
Log size	0.225***	0.343***	0.214***	0.382***	-0.098	0.228***	0.354***	0.230***	0.377***	0.172	0.228***	0.310**	0.214**	0.345***	0.146
Log labor productivity	0.070	0.090***	0.058	0.085	-0.055	0.078*	0.102***	0.067	0.083	0.045	0.076	0.089**	0.062	0.079	0.061
Female ownership	0.003	0.063	-0.024	0.001	-0.036	0.007	0.069	-0.016	-0.006	-0.114	-0.005	0.022	-0.036	-0.032	-0.018
Female top manager	0.020	0.040	0.171	0.119	-0.097	0.025	0.053	0.178	0.119	0.119	0.042	0.086	0.196	0.153	0.045
Credit line	0.196	0.128**	0.153	0.134*	-0.565	0.216*	0.175**	0.199	0.152	0.051	0.231**	0.123	0.188	0.097	0.003
Domestic credit to private sector (% of GDP)	0.064***	0.001	0.096***	-0.023	0.185	0.051***	-0.011	0.081***	-0.017	-0.229	0.046***	-0.028**	0.077***	-0.034*	0.021
Consumer price index	0.083***	-0.023	0.154***	-0.059*	0.285	0.066***	-0.040**	0.135***	-0.047**	-0.394	0.063***	-0.048***	0.134***	-0.066***	0.007
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,651	5,651	5,651	5,651	2,600	5,651	5,651	5,651	5,651	2,600	5,651	5,651	5,651	5,651	2,600

Note: *p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors are clustered at the country-year level.

Table 5. IV method: Innovation and GVC participation (Continued)

	GVC 1	GVC 2	GVC 3	GVC 4	Intensive
Communicates by email	0.617	0.436	1.502***	0.375	-0.517
Log size	0.230***	0.380***	0.173***	0.382***	0.111***
Log labor productivity	0.068	0.103***	0.032	0.081	0.056*
Female ownership	0.001	0.070	-0.030	0.002	-0.038
Female top manager	0.043	0.066	0.185	0.131	0.054
Credit line	0.219**	0.195***	0.114	0.135	-0.021
Domestic credit to private sector (% of GDP)	0.083	0.013	0.203***	-0.010	-0.036
Consumer price index	0.125	0.005*	0.360***	-0.032	-0.079
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	5,651	5,651	5,651	5,651	2,600

Note: *p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors are clustered at the country-year level.

In what follows, we examine the extent to which the innovation effects vary by firm size. To categorize firms, we utilize the WBES survey methodology, which consists of three distinct groups. According to this classification, a firm falls under the 'small' category if it has fewer than 20 employees, while a 'medium' firm employs between 20 and 99 workers. A firm is considered 'large' if it has over 100 employees. For expositional brevity, we only analyze the results for the innovation indicators. We also only focus on GVC1 and GVC4 as our key dependent variables of interest at the extensive margin. GVC 1 represents the basic form GVC participation through exports and imports, while GVC4 encompasses the most advanced form involving two-way trade, certification, and foreign direct investment (FDI). Table 6 presents the results of the IV approach, which are our preferred regressions.

We find that innovation increases the likelihood that a small firm participates in two-way trade along value chains (GVC 1), but only for small firms that use foreign licensed technology, spend on R&D and possess a website. The effect of innovation on small firms' GVC participation is also positive for the most complex form (two-way trade, certification, and FDI) except for small firms that introduce new products/services and possess a website. For medium firms, innovation positively and significantly affects two-trade participation (GVC1) only among those that communicates by emails. Regarding large firms, spending on R&D and communicating by email significantly increases the likelihood of participating in two-way trade (GVC 1) and participating in two-way trade with foreign certification and capital (GVC 4). Using a website and introducing a new process is also positively associated with GVC participation, but only for GVC 4. Somewhat strikingly, introducing a new product/service that is also new to the firm's market and using a foreign technology negatively influences GVC1 and GVC 4, respectively. At the intensive margin, having a foreign licensed technology negatively affect large firms' GVC participation, albeit at 10%. This suggests that there are underlying factors at play that warrant further investigation.

Overall, the findings indicate that small firms can significantly enhance their participation in global value chains by focusing on innovation. This includes investing in foreign licensed technologies, developing an online presence, allocating resources to research and development, and implementing new processes. These innovation strategies can increase their likelihood of participating in two-way trade and accessing more complex forms of GVCs, such as certification and FDI.

Table 6. Effect of innovation on GVC participation-by firm size

		GVC 1	GVC 4	Intensive
Small	Foreign Technology	2.09***	3.894***	6.961
	New product/service	0.139	1.183	-16.35
	New to firm's market	-0.548	-0.261	-50.122
	New process	-0.966*	3.040***	58.096
	Spends on R&D	1.824***	4.713***	-6.563
	Website	1.095***	2.154	7.137
	Communicates by email	0.357	3.327***	1.004
	Control variables	Yes	Yes	Yes
	Observations	3,089	3,089	1,128
Medium	Foreign Technology	-0.233	-0.730	-2527.82
	New product/service	-0.863	-1.024	0.645
	New to firm's market	-0.333	-1.098	1.221
	New process	0.519	0.502	-4.288
	Spends on R&D	-1.15*	-0.351	3.865

	Website	0.251	0.403	0.538
	Communicate by emails	0.753**	0.454	0.964
	Control variables	Yes	Yes	Yes
	Observations	1,762	1,762	890
Large	Foreign Technology	-0.102	-1.060***	-1.545*
	New product/service	0.098	0.567	5.979
	New to firm's market	-1.402***	0.255	-8.075
	New process	-0.083	1.903***	5.319
	Spends on R&D	1.373***	2.338***	-39.38
	Website	0.302	1.202***	-13.88
	Communicates by email	0.253***	0.295**	12.229
	Control variables	Yes	Yes	Yes
	Observations	870	913	582

Note: *p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors are clustered at the firm level.

5. Conclusion

This paper investigates the impact of innovation on firms' GVC participation in francophone Africa using seven innovation indicators and four GVC measures. The findings showed that implementing a new process and investing in R&D can improve efficiency and competitiveness, allowing for easier integration into GVCs. In fact, we find that firms that introduce new processes and spend on R&D are more likely to become two-way traders (GVC 1), two-way trader with international certification (GVC2), or two-way traders with foreign ownership (GVC 3). When examining the extent to which the innovation effects vary by firm size, we found that innovation increases the likelihood that a small firm participates in two-way trade along value chains (GVC 1), but only for small firms that use foreign licensed technology, spend on R&D and possess a website. The effect of innovation on small firms' GVC participation is also positive for the most complex form (two-way trade, certification, and FDI) for small firms that use foreign technology, implement new processes, spend on R&D and communicate by email.

For all firms, the findings suggest that policies encouraging investments in R&D and the adoption of new processes can significantly enhance competitiveness and integration into global value chains. These policies might include tax incentives for R&D, subsidies for technology acquisition, or support for innovation hubs. For small firms, specifically, tailored policies that focus on facilitating access to foreign licensed technology and digital tools, as well as fostering skills for effective online communication, could be crucial in maximizing their participation in complex global trade networks. These strategies can help small firms overcome barriers to participating in GVCs and achieve higher levels of international trade engagement.

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Appendix

Table A1: List of countries and years

Country	Years	Freq.	Percent
Benin	2016	150	1.57
Burundi	2014	157	1.65
Cameroon	2009, 2016	481	5.04
Chad	2018	153	1.6
Democratic Republic of Congo	2010, 2013	888	9.31
Djibouti	2013	266	2.79
Guinea Conakry	2016	150	1.57
Ivory Coast	2008, 2016	453	4.75
Madagascar	2008, 2013, 2022	1047	10.98
Mali	2010, 2016	545	5.72
Mauritania	2014	150	1.57
Mauritius	2008, 2020	818	8.58
Morocco	2013, 2019	1503	15.76
Niger	2009, 2017	301	3.16
Rwanda	2019	360	3.78
Senegal	2014	601	6.3
Togo	2009, 2016	305	3.2
Tunisia	2013, 2020	1207	12.66
Total		9535	100.00

Figure A1. GVC measures by innovation indicators

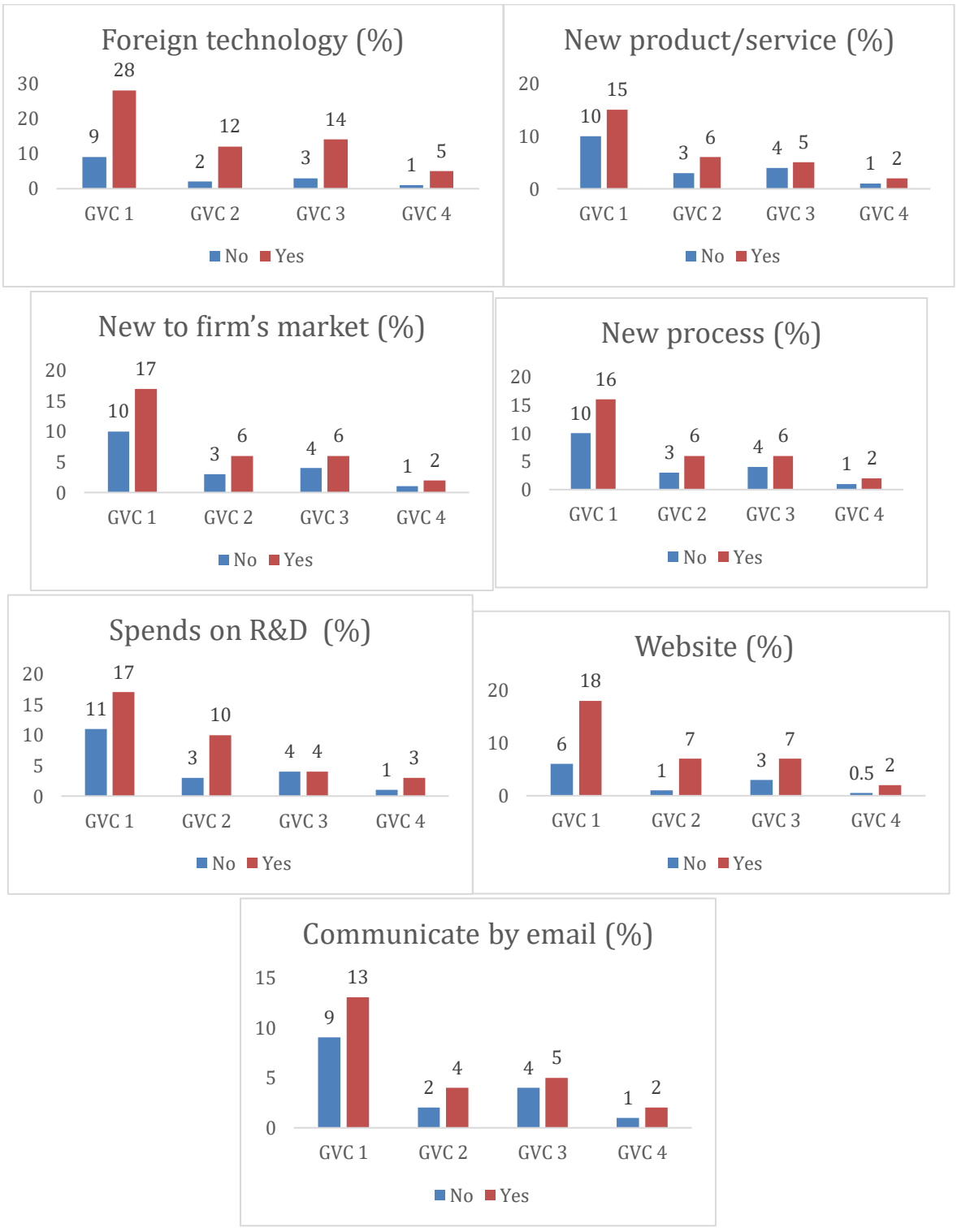

Figure 2A. Distribution of propensity scores before and after matching in treated and untreated groups

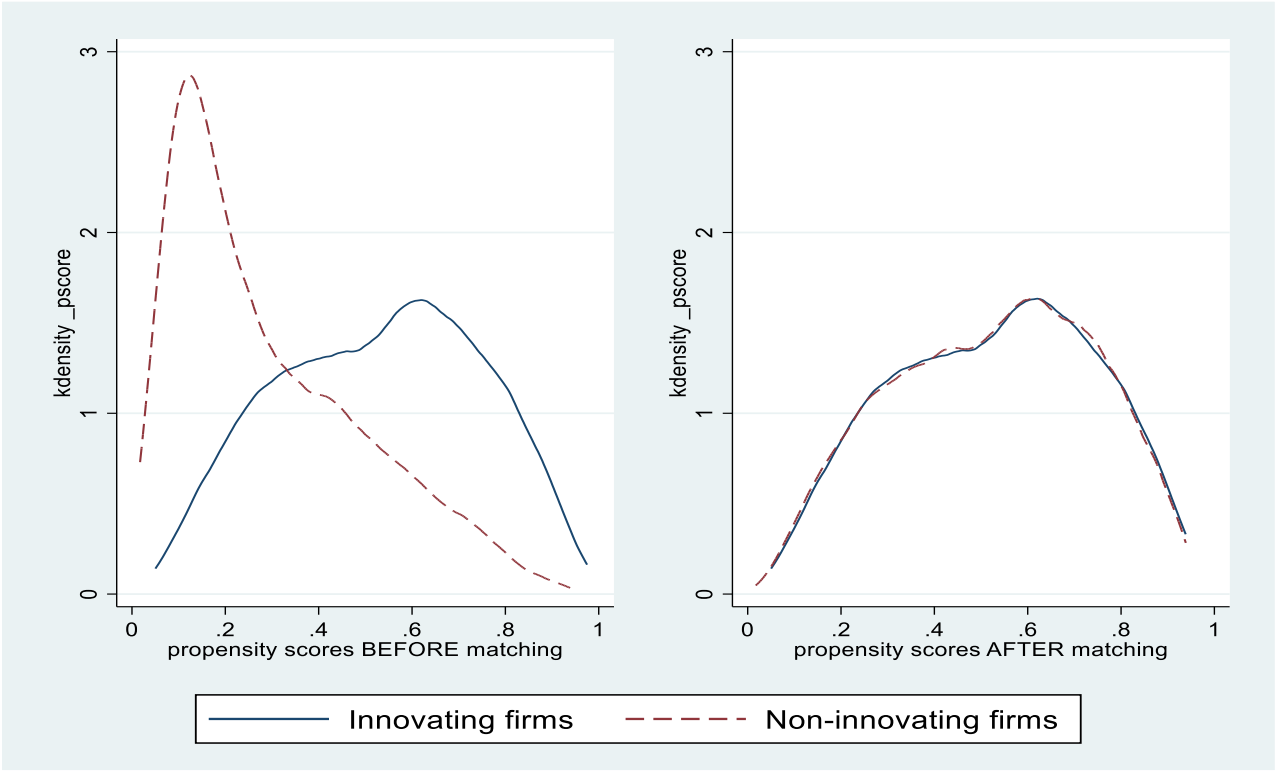

Figure 3A. Common support area

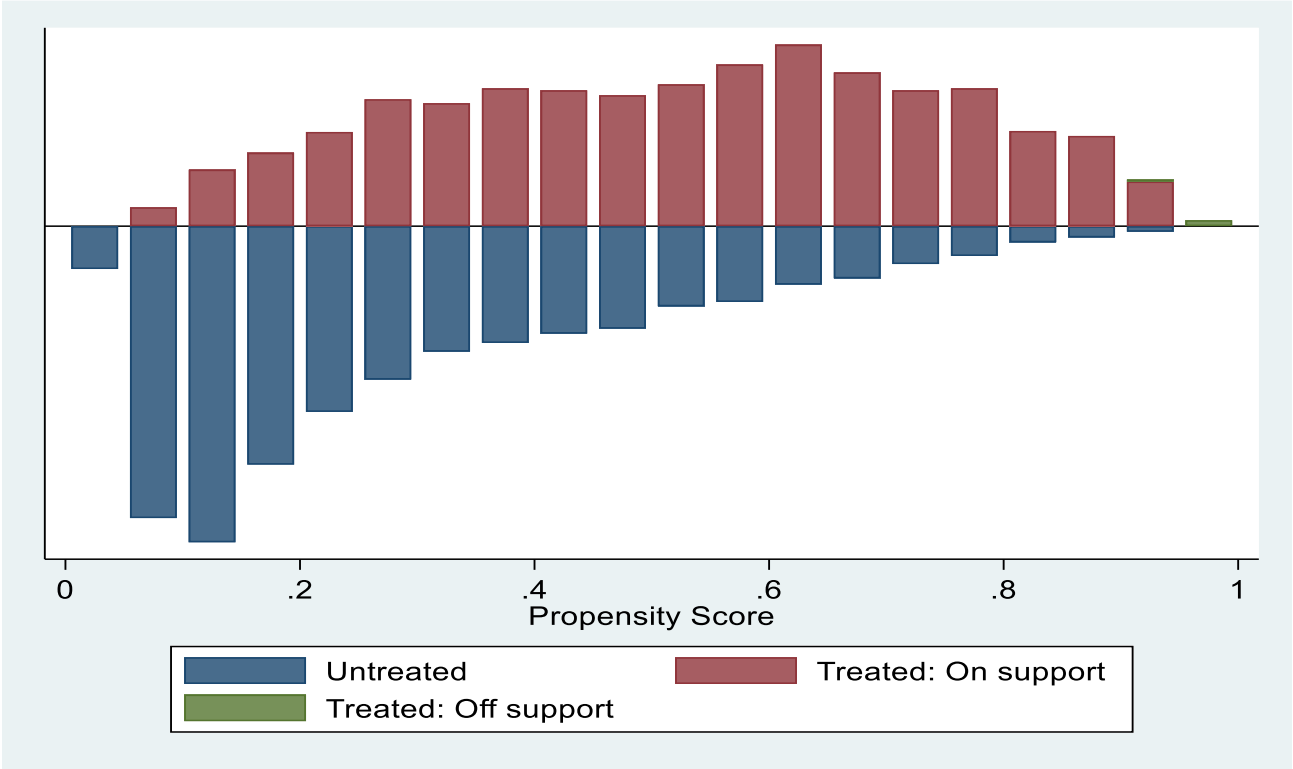

Table A2 : Propensity score estimation: Factors influencing adoption of innovation (Model 1)

Variables	Coef.	Standard errors
Log size	.767***	.0849
Log labor productivity	.380***	.05603
Female ownership	.362**	.1847
Female top manager	-.186	.232
Credit line	.821***	.126
Domestic credit to private sector (% of GDP)	.0686***	.0057
Consumer price index	-.0354***	.0051
Country fixed effects	Yes	
Industry fixed effects	Yes	
Year fixed effects	Yes	
Observations	3,322	
Pseudo R-squared	0.3570	

Note: *p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors are clustered at the firm level.

Table A2: Propensity score estimation: Factors influencing adoption of innovation (Model 2)

Variables	Coef.	Standard errors
Log size	.519***	.0844
Log labor productivity	.148***	.045
Female ownership	.366***	.116
Female top manager	-.178*	.2328
Credit line	.371***	.107
Domestic credit to private sector (% of GDP)	-.141***	.0063
Consumer price index	-.0354***	.0051
Country fixed effects	Yes	
Industry fixed effects	Yes	
Year fixed effects	Yes	
Observations	5,644	
Pseudo R-squared	0.2252	

Note: *p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors are clustered at the firm level.

Table A3: Propensity score estimation: Factors influencing adoption of innovation (Model 3)

Variables	Coef.	Standard errors
Log size	.289***	.0286
Log labor productivity	.084**	.036

Table A4: Propensity score estimation: Factors influencing adoption of innovation (Model 4)

Variables	Coef.	Standard errors
Log size	.267***	.0473
Log labor productivity	.131***	.0221

Female ownership	.097	.251
Female top manager	-.1004	.481
Credit line	.318*	.1738
Domestic credit to private sector (% of GDP)	.0062	.0084
Consumer price index	-.0107	.0155
Country fixed effects	Yes	
Industry fixed effects	Yes	
Year fixed effects	Yes	
Observations	1,993	
Pseudo R-squared	0.066	

Note: *p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors are clustered at the firm level.

Female ownership	.078	.1042
Female top manager	.132	.1303
Credit line	.542***	.0825
Domestic credit to private sector (% of GDP)	-.2310***	.0074
Consumer price index	-.368***	.0057
Country fixed effects	Yes	
Industry fixed effects	Yes	
Year fixed effects	Yes	
Observations	5,647	
R-squared	0.1537	

Note: *p < 0.1; ** p < 0.05; *** p < 0.01. Standard errors are clustered at the firm level.