Assessing the Role of Innovation in Cameroonian Firms' Participation in Global Value Chains

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Working Paper GVC-II-005

AFRICAN ECONOMIC RESEARCH CONSORTIUM
CONSORTIUM POUR LA RECHERCHE ÉCONOMIQUE EN AFRIQUE

Bringing Rigour and Evidence to Economic Policy Making in Africa

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AERC Working Paper GVC-II-005
African Economic Research Consortium, Nairobi
November 2024

THIS RESEARCH STUDY was supported by a grant from the African Economic Research Consortium. The findings, opinions and recommendations are, however, those of the author and do not necessarily reflect the views of the Consortium, its individual members or the AERC Secretariat.

Published by: The African Economic Research Consortium
P.O. Box 62882 - City Square
Nairobi 00200, Kenya

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Abstract

This study aims to contribute to the empirical literature on the drivers of Cameroonian firms' participation in Global Value Chains (GVCs) by examining the role of innovation. We use logistic regressions and matching techniques to analyse pooled cross-sectional data from the 2008 and 2016 Cameroonian Enterprise Censuses. Our findings indicate that investments in innovation, particularly in machinery and equipment, as well as software and technology, significantly enhance the probability of Cameroonian firms participating in GVCs through subsidiary ties with foreign firms. Building upon these results, we discuss the implications of promoting innovation and making strategic investments in critical sectors of the economy to facilitate greater engagement of local firms in GVCs.

Keywords: *Cameroon; Global value chains; Innovation; Firm participation*

JEL Classification: *F14, O14, O33, O5*

1. Introduction

Cameroon stands out within the Central African region as an economic pillar, significantly contributing 40% of the GDP of Central Africa's Economic and Monetary Community (CEMAC), according to the World Bank (2023). However, its economic structure remains primarily aligned with other countries in the sub-region. It is characterised by a heavy dependence on extractive industries such as oil, minerals, and timber, with modest exports of processed products. The country's contribution to global value chains (GVCs) is mainly limited to exporting unprocessed raw materials to other regions of the world. As a result, the added value generated by processing these raw materials is captured by these regions, thereby enhancing their own participation in GVCs.

This study examines the role of innovation as a driver of the country's participation in GVCs. Over the years, the literature has highlighted the benefits of participating in GVCs, emphasising that GVCs can enhance economic growth, create better jobs, and reduce poverty (World Bank, 2020). Consequently, there has been a growing interest in understanding the drivers prompting countries to deepen their integration into GVCs, at both macroeconomic and microeconomic levels. At the macroeconomic level, these drivers are associated with national characteristics such as trade openness and foreign direct investment (Kowalski et al., 2015; Amador and Cabral, 2016; Okah-Efogo, 2020), infrastructure quality encompassing transportation systems and efficient logistics (Luo and Xu, 2018); tariff policies affecting intermediate inputs; the state of information and communication technologies (ICT) with its digital connectivity challenges (de Melo and Twum, 2020); and the quality of institutions (Dallas et al., 2019; Nadeem et al., 2021). At the microeconomic level, studies on firm characteristics have identified factors such as capital-labour ratio, firm size, ownership structure, industry sector, and the presence of skilled labour (Wignaraja, 2013; Nagaraj, 2014; Harvie and Charoenrat, 2015; Yameogo and Jammeh, 2019).

In the African context, case studies on African firms in GVCs highlight various factors. For instance, in Kenya, issues such as fragile governance, exporter-importer status, and tariff fluctuations, play significant roles (Pasquali et al., 2021; Chacha et al., 2024). Inter-firm externalities are essential in other countries such as Malawi, Mali, Senegal, and Tanzania (Cadot et al., 2013). Ghana's case emphasises the factors such as firm age, size, and export intensity (Mohammed, 2018), while for Côte d'Ivoire and Cameroon, export emphasis emerges as a critical factor (Coulibaly et al., 2023).

These findings underscore the diverse drivers shaping African firms' participation in GVCs. However, among these factors, the role of innovation remains relatively unexplored, particularly at the microeconomic level of African firms. This may be attributed, in part, to the general assumption that innovation is not critical in these contexts, often perceived as being imported from abroad (Morrison and Pietrobelli, 2007). Moreover, existing studies mainly posit a reverse effect, meaning that participation in GVCs induces innovation. For example, studies such as those by Avenyo et al. (2022), De Marchi et al. (2018), and Rodrik (2018,) argue that integration into GVCs enhances the innovation capacities of businesses in developing countries through technological spillovers. However, they still acknowledge the plausibility of innovation as a driver of participation in GVCs. To our knowledge, literature in this regard includes that of Reddy et al. (2021) and Dovis and Zaki (2020). For instance, Reddy et al. (2021) found, in a sample of 90 countries, including 25 African nations, that a firm's innovation capability alters its behaviour in international markets and promotes its participation in GVCs.

Building on this empirical literature, and like the authors who recognise the dual causality between innovation and participation in GVCs, this study aims to extend research at two levels. Firstly, unlike studies focusing on innovation in terms of R&D spending or new products and production processes, this study examines the role of investment in new machinery and equipment, as well as software and technologies. We posit that in many African countries, including Cameroon, investments in research and development (R&D) may be limited due to financial constraints and infrastructure. Conversely, adopting new software, technologies and equipment may be more accessible and suitable for the local economic environment. Additionally, in many developing sectors, such as agriculture and manufacturing, adopting new technologies and equipment may be essential to improve yields, product quality, and competitiveness in international markets. Furthermore, new software, technologies, and equipment may lead to more rapid improvements in the economic performance of firms than the introduction of new products or processes, which may require more significant investments and take longer to materialise.

Secondly, to our knowledge, this evidence has yet to be tested in Cameroon. The literature on the drivers of the country's participation in global value chains includes studies by Coulibaly et al. (2023) and Epede and Wang (2022), which are among the first to explore the characteristics of local Cameroonian firms involved in global value chains. The authors highlighted the importance of comparative disadvantage and exports. Thus, this research aims to contribute to this literature by questioning the role of innovation. This is particularly relevant given that Cameroon is one of the six countries in Central and Eastern Africa that have developed science, technology, and innovation (STI) policies. Policies and initiatives promoting STI development have been implemented at various levels, reflecting a desire to enhance economic competitiveness and integrate into the global economy. Therefore, this study aims to provide empirical evidence of the importance of innovation in this country, especially in terms of integration into global value chains.

To study the role of innovation in the participation of Cameroonian firms in GVCs, we use a unique database obtained by merging the first two general censuses of Cameroonian firms from 2008 and 2016, obtained from the National Institute of Statistics of Cameroon. We use logistic models and the Propensity Score Matching method to study the causal effect of innovation on the participation of local firms, approximated by affiliation with foreign firms.

Following this introduction, the rest of the paper is structured as follows: Section 2 provides an overview of the landscape of Cameroonian firms. Section 3 presents a brief literature review and discusses the transmission mechanism. Section 4 presents the data and methodological strategy. Section 5 discusses the results, while Section 6 provides the conclusion.

2. GVC firms: Defining and assessing the landscape in Cameroon

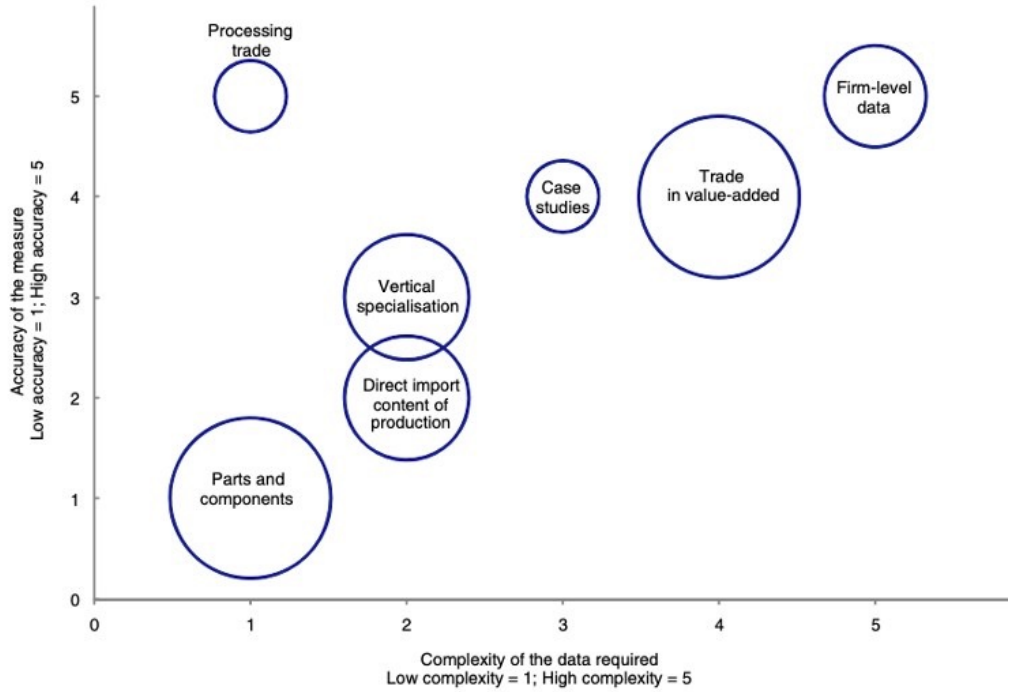
In the literature on international trade, the definition of GVCs relies on several methodological approaches that offer complementary perspectives to quantify them. Figure 2.1, drawn from Amador and Cabral (2016), provides a summary of these approaches, highlighting the complexity of the data needed to calculate the measure (x-axis), the precision of the quantification (y-axis), and the global scope of GVCs (circle size).

Overall, the literature considers the most straightforward approach to be comparing international trade statistics of parts and components with the trade of final products. However, its weakness lies in its low precision and heavy reliance on product classifications in trade statistics. The second least complex approach analyses customs statistics on processing trade and provides information on trade associated with specific customs regimes. Since customs authorities administer these data, the trade of these goods is recorded accurately at a highly disaggregated level. The third approach relies on Input-Output (I-O) tables, typically using information from classical I-O tables. However, the precision of this approach depends on the product breakdown available.

In addition to these approaches, the literature also focuses on firm-level data, which was chosen for this study. They are recognised as the most complex but also the most accurate. Empirical studies use World Bank Enterprise Surveys, business census data available in specific countries, and Customs data. Empirical studies using such data follow different definitions of GVC firms. They are notable, considering firms that simultaneously export and import, typically adding possession of an international certification, a quality sign sometimes required to join a GVC, or having a share of capital held by a foreign company (Dovis and Zaki, 2020; World Bank, 2020; Coulibaly et al., 2023).

This study will focus on the data from the first two general censuses of Cameroonian businesses from 2008 (RGE 1) and 2016 (RGE 2), retaining two definitions of GVC firms. The first definition concerns firms with one or more subsidiaries abroad (GVC1), suggesting a direct involvement in GVCs. The second definition concerns firms that are subsidiaries of a foreign-based company (GVC2), highlighting their integration into an international chain of command.

Figure 2.1: Summary of main strands of the empirical research on GVCs

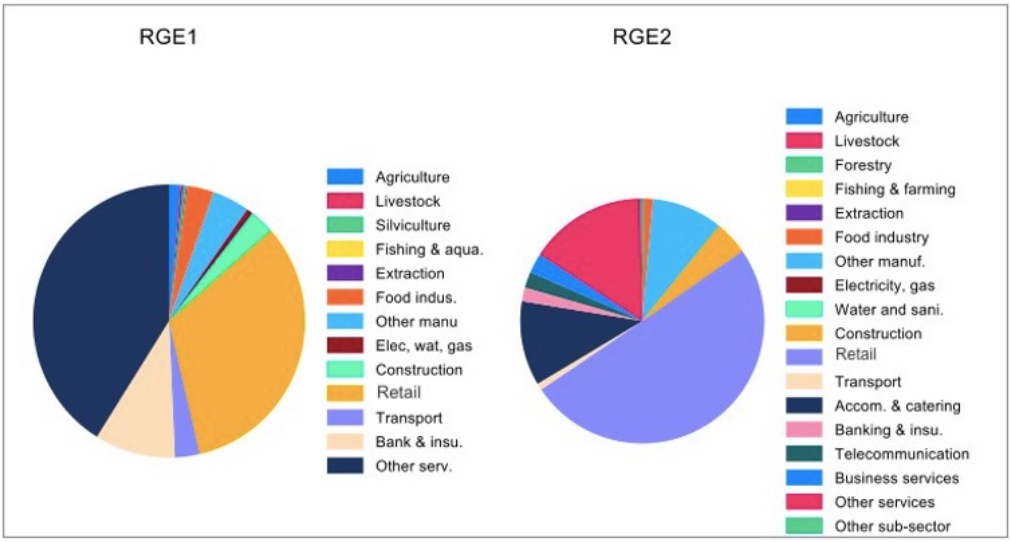


Source: Amador and Cabral (2016)

Examining the landscape of Cameroonian firms, we observe a dominance of the tertiary sector, particularly trade and services, in the country's economy (Figure 2.2). In 2008, retail services accounted for the largest share of firms, followed by other services. This trend strengthened in 2016, when retail became even more dominant, with an increase compared to 2008. Similarly, the accommodation and food services sector also experienced growth in 2016. However, some sectors recorded a decline, notably extraction and construction.

Using the definitions above (GVC1, GVC2), two main trends emerge regarding their participation in GVCs (Figure 2.3). Firstly, firms in the retail sector constitute the majority of GVC participants, followed by those in the other services, manufacturing, banking, and insurance sectors. This distribution reflects these sectors' more pronounced international orientation, often in direct contact with foreign markets or integrated into global supply chains.

Figure 2.2: Distribution of Cameroonian firms, 2008 and 2016



Source: Authors, data from the National Institute of Statistics of Cameroon

Figure 2.3: Distribution of GVC firms per sector

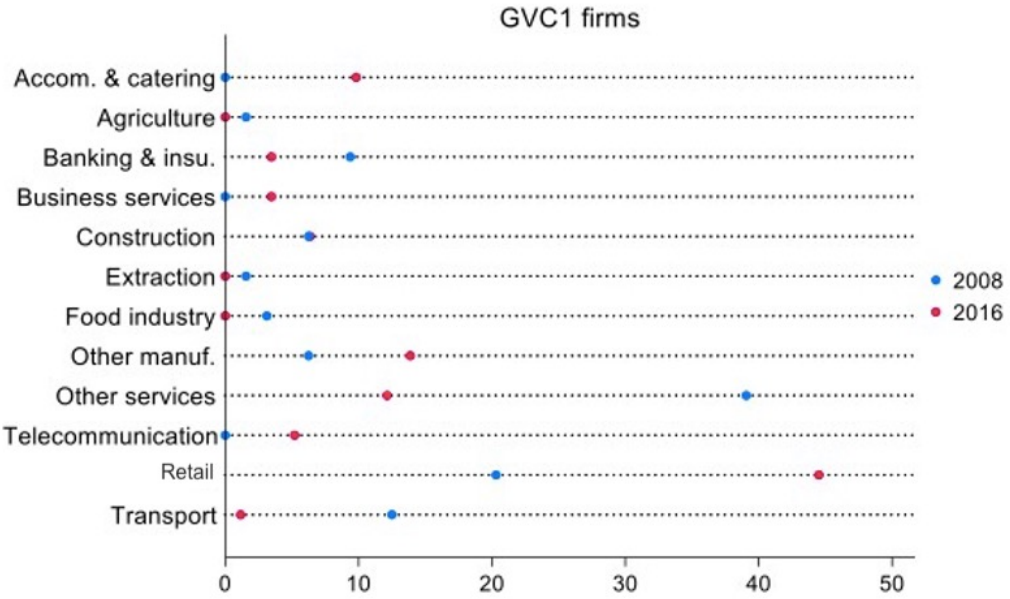


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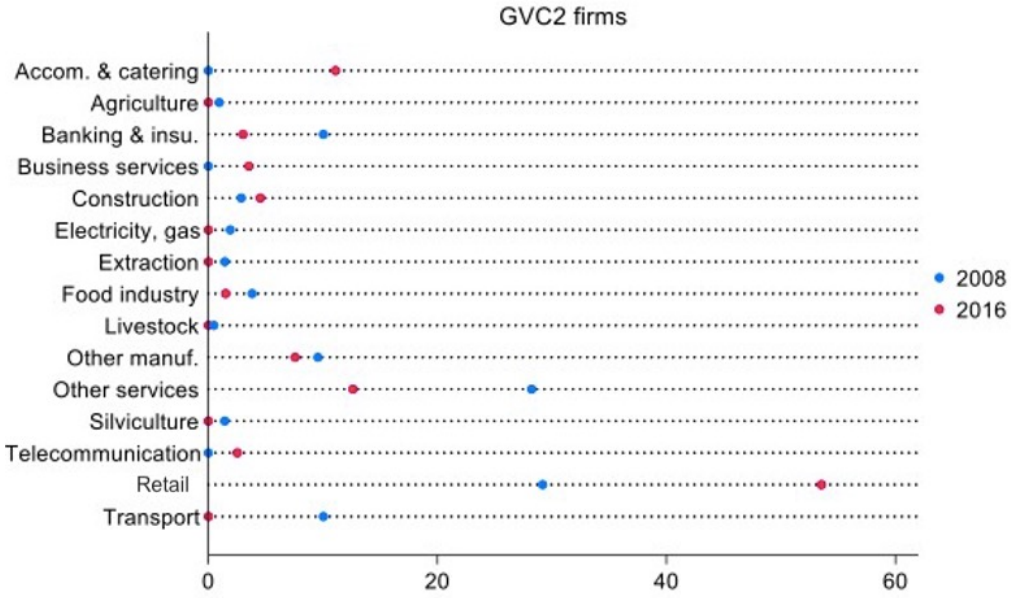
Figure 2.3 Continued

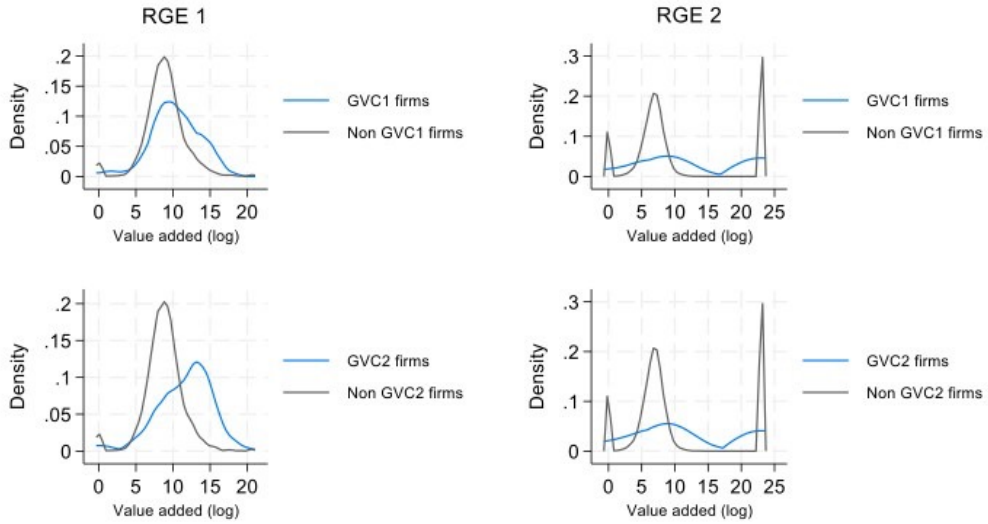


Source: Authors, data from the National Institute of Statistics of Cameroon

Secondly, there is a decrease in some sectors between 2008 (in blue) and 2016 (in red). While the participation of firms in retail, accommodation and food services, business services, and telecommunications has significantly increased as a percentage of total GVC firm participation between 2008 and 2016, there is a decrease in the involvement in the agriculture, extraction, food industry, and transport sectors. The decline in agriculture and extraction participation could reflect challenges such as natural resource degradation, fluctuations in commodity prices in global markets, or increased competition from emerging countries. In the food sector, the decline in GVC firms could be related to compliance issues with international quality and food safety standards, or difficulties in accessing export markets. As for transport, the decrease could be attributed to infrastructure and logistics problems, and trade and regulatory barriers hindering international trade.

Concerning the performance of these firms, the kernel density curves of participating and non-participating GVC firms in 2008 and 2016 (Figure 2.4) offer insights into the distribution of value-added within these two groups. A striking observation is the trend towards a more spread out and less concentrated distribution of value-added among GVC-participating companies, a characteristic that has strengthened in 2016 compared to 2008. This evolution suggests diversifying value-added sources within GVC-participating companies, likely due to their access to more extensive international networks and resources. Moreover, although these companies potentially have higher levels of value-added, the overlap of GVC firms' curves with those of non-GVC firms indicates that some non-participants also compete in value-added, thus highlighting the diversity of situations within each group.

Figure 2.4: Comparison of the value-added distributions of GVC firms and non-GVC firms



Source: Authors, data from the National Institute of Statistics of Cameroon

Though not exhaustive, these observations motivate our interest in understanding the drivers of local firms' participation in GVCs and the factors influencing whether they maintain their presence in these chains. To this end, within the framework of this study, we posit that innovation can be a relevant driver.

3. Why is innovation a driver for Cameroonian Firms' participation in GVCs?

Previous observations on the landscape of Cameroonian firms' participation in GVCs have presented diverse trends. We observed an increase in specific sectors and stability in others, while some industries have experienced declines. Faced with this diversity of trends, we hypothesise that innovation drives firm participation in GVCs.

This hypothesis is based on the mechanism that innovation can enhance firms' competitiveness on the global stage. Indeed, firms that invest in innovation are often better positioned to integrate into international trade networks and capitalise on opportunities offered by GVCs. For instance, firms in the trade and telecommunications sectors, whose percentage in GVCs has increased in Cameroon, may have invested in new software to enhance connectivity and digital services, making them more appealing to international trading partners. Conversely, progress in agricultural techniques and adoption of new machinery in the agriculture sector may not have been rapid enough to maintain the competitiveness required to participate significantly in GVCs.

Our hypothesis finds its foundations in various economic theories, first through the works of Schumpeter, who distinguished the different forms of innovation, notably product innovation, process innovation, and organisational innovation. These forms of innovation can influence firm participation in GVCs differently, for example, by stimulating product competitiveness, improving production process efficiency, or strengthening organisational capacity to integrate into global commercial networks (Becker and Knudsen, 2002). The analysis of this hypothesis is also informed by the theory of new economic geography (Krugman, 1997), which emphasises the role of innovation in nations' competitiveness in the global market. By fostering the creation of new products, processes, and technologies, innovation enables companies to become more efficient and diversify their offerings, making them more attractive to foreign trading partners.

Additionally, Romer's (1990) theory of endogenous growth highlights the crucial role of innovation in stimulating long-term economic growth. By investing in adopting new technologies, Cameroonian companies can strengthen their position in the global market and increase their participation in GVCs. Furthermore, the smile curve theory (Meng et al., 2020) posits that as companies continue to innovate and improve their

processes, products, or services, the benefits outweigh the costs, leading to increased performance.

The empirical validation of the relationship between innovation and participation in GVCs at the firm level still needs to be explored in the existing literature. Although innovation is widely documented as a critical driver of productivity and exports, its direct impact on the participation of African firms, particularly in GVCs, still needs to be explored. Most empirical studies on this relationship are conducted in regions such as Europe, North America, and South Asia, leaving Africa largely uncharted territory. To understand the absence of studies in African countries, authors such as Morrison and Pietrobelli (2007) argue that in these countries, technological capacity often extends beyond importing technology rather than creating or developing it internally. This means that these countries heavily rely on technologies developed in more advanced countries, which may limit their ability to innovate and fully participate in global value chains. However, Taglioni and Winkler (2016) emphasise that policies promoting innovation and capacity building are crucial for enhancing the productivity of local firms. Due to its R&D activities, assembly, and manufacturing, China is often cited as an example illustrating the importance of such policies (Del Prete et al., 2017; Lu et al., 2018).

Moreover, most studies that have examined integration into GVCs do not explicitly consider innovation as a driver of this participation. Instead, they focus on the reverse effect, namely how GVCs foster innovative capacities within firms. For example, one of the conclusions from the study of Tajoli and Felice (2018) is that GVC participation positively impacts innovation outcomes in developing countries, primarily those importing inputs from advanced countries. Similarly, Avenyo et al. (2022) acknowledge the existence of a reverse causality between innovation and firms' participation in GVCs, but they focus on how firms' participation in GVCs affects innovation. Based on a sample of African firms, they find that those engaging in GVC activities are more likely to introduce innovative products to markets.

This study aims to contribute to this literature by revisiting this relationship in the context of Cameroon, thereby addressing the gap in studies focusing on Central Africa. Despite the need for more research in this direction, it is essential to analyse the case of Cameroon, which could serve as an interesting case study due to its status as the leading economy in the sub-region, and its specific dynamics.

4. Empirical strategy

Data and measurement

We use data from the first two general censuses of Cameroonian enterprises conducted in 2008 and 2016, available from the National Institute of Statistics of Cameroon (NIS, 2008; 2016). These censuses aimed to produce indicators on the Cameroonian productive fabric, including information on business demographics, production, employment, and the business environment. The collected data provide economic and social information on active enterprises and establishments in Cameroon. In contrast to other surveys on Cameroonian enterprises, such as the World Bank Enterprises Survey, which only covers the manufacturing and service sector and three out of ten regions in the country, the NIS data encompass all sectors of activity and the entire territory. After processing and filtering the data, we exclude firms with missing information on innovation and GVCs, thus reducing our analytical sample to 3,828 firms.

GVC firms

As discussed in Section 2, the literature on firm participation in GVCs generally defines a participating firm as one that imports intermediate goods while simultaneously exporting intermediate or finished products. Recent studies, such as those by Del Prete et al. (2017), World Bank (2020), and Coulibaly et al. (2023), define a participating firm as one that both exports and imports within the same year based on customs data, while also exhibiting positive production value in enterprise surveys. Others rely on measures of vertical specialisation to identify firms involved in GVCs (Hummels et al., 2001; Amador et al., 2008), distinguishing between processing trade and ordinary trade to better understand firm participation (Kee and Tang, 2016; Lu et al., 2018).

However, this distinction is not feasible in our dataset as information on firm imports is unavailable. In this study, we measure a firm's participation in GVCs through binary variables: whether the firm has one or more subsidiaries abroad (GVC1) or is a subsidiary of a foreign-based company (GVC2). Although this measure may be limited as it does not account for more complex relationships, such as collaborations with global suppliers, strategic partnerships, and import-

export activities, we posit that owning international subsidiaries suggests global presence and may indicate vertical integration, exerting control over different stages of production on a worldwide scale. This may also imply easier access to foreign markets, global coordination of operations, and an international expansion strategy.

Innovation

In the literature, one of the standard measures of innovation at the firm level is to use R&D expenditure as an indicator. However, this approach often excludes small businesses that innovate, but must report R&D investments due to the absence of a formal R&D unit or the lack of more financial resources for such investments (Reddy and Sasidharan, 2021). Moreover, as Tavassoli (2018) emphasised, R&D is, at best, a part of the input necessary for innovation and may only partially be suitable for measuring innovation. To overcome this limitation, other studies adopt an alternative measure of innovation: a binary variable indicating whether the firm has introduced a new product or process (Castellacci and Lie, 2015; Avenyo et al., 2022).

The current study focuses on innovation through investments in new software and technologies, and new machinery and equipment, due to their accessibility, adaptability, and sectoral relevance. Indeed, R&D investments may be limited due to financial and infrastructural constraints. However, adopting new machinery, equipment, software, and technologies may be more affordable and better suited to the local economic environment. Additionally, introducing new machinery and equipment in sectors such as agriculture, mining, and industry, and adopting new software and technologies in sectors such as services and communications, can lead to faster improvement in business performance compared to introducing new products or processes, which may require more significant investments and take longer to materialise.

Control variables

The effect of innovation is controlled by a set of covariates specific to each firm, and likely to influence a firm’s decision to engage in GVCs. These include the firm's age, defined as the years since its establishment. Research indicates that mature companies exhibit lower sunk costs and are less financially constrained than younger firms (Nagaraj, 2014). We also control the education level of the principal executive. A well-educated executive may be better equipped to understand the intricacies of international trade and GVCs and make informed decisions regarding global strategy (Mayer and Ottaviano, 2008). The firm’s sales volume is also controlled. A substantial investment capacity resulting from a significant turnover allows the firm to innovate, negotiate strategic partnerships, and expand

its international presence, strengthening its position in GVCs (Görg and Hanley, 2005; Avenyo et al., 2022). Given the effect of scale economies, firm size may influence participation in GVCs (Minetti et al., 2019; Reddy et al., 2021). We define firm size as the logarithm of the number of employees in the firm. The role of firm productivity is well documented in the literature on firm internationalisation, with more productive firms finding it more accessible to participate in global markets (Melitz, 2003; Lu et al., 2018). Therefore, we control for firm productivity, measured as the value added to the firm, positing that an increase in value-added may indicate improved efficiency and productivity. We also control for the firm's skill level, approximated by the number of employees capable of using a computer, positing that having skilled personnel in computer usage may indicate an increased propensity to adopt and integrate new technologies, thereby enhancing participation in GVCs.

Additionally, we control for the training of the firm's manager, assuming that their education and expertise can directly influence the firm's strategic decisions and investment choices, including its participation in GVCs. Finally, we control the sector of activity of each firm. Sectoral research, like that of Gereffi and Fernandez-Stark (2016), shows that highly integrated sectors, such as ICT, may encourage more extensive participation, unlike resource-dependent sectors where pursuing cost competitiveness can motivate more intense involvement in GVCs.

Table 4.1 presents descriptive statistics for all variables, distinguishing between GVC and non-GVC firms. Overall, the statistics indicate that firms participating in GVCs generally make a higher percentage of investments in the acquisition of innovative machinery and equipment (20%), and in software and external technologies (12.7%), compared to non-participating firms (9.2% and 6.4%, respectively). Statistical tests indicate significant differences between the two groups for these innovation variables, suggesting a correlation between innovation and GVC participation.

Regarding other variables such as firm age, size, sales, value-added, and computer skills of employees, significant differences are also observed between GVC and non-GVC firms. For example, GVC firms tend to be younger, more critical in the workforce, and have higher sales and value-added. Additionally, they have a higher percentage of employees proficient in computer skills. These findings suggest substantial differences in the characteristics of firms participating in GVCs compared to those that do not, highlighting the importance of factors such as size, computer skills, and innovation for GVC participation.

Table 4.1: Descriptives

			GVC1				GVC2		
Variables	**Definitions**	**N**		**No GVC firms (%, mean)**	**GVC firms (%, mean)**	**Test**	**No GVC firms (%, mean)**	**GVC firms (%, mean)**	**Test**
Machinery&Equip innovation	Investment in the acquisition of machinery and equipment innovation	3,828	No	90.8%	80%	0.006	90.9%	84.1%	0.003
			Yes	9.2%	20%		9.1%	15.9%	
Software&Tech innovation	Investment in the acquisition of software and external tech innovation	3,817	No	93.6%	87.3%	0.059	93.7%	89.4%	0.028
			Yes	6.4%	12.7%		6.3%	10.6%	
Age	Firm age, difference between creation date and business census date	3,774	7		9	0.170	7	8	0.609
Size	Number of employees in the firm	3,772	26		99	<0.001	21	146	<0.001
Sales	Log of sales of the firm	3,828	9.57		9.59	0.936	9.48	11.60	<0.001
Value added	Log of value added for the year	2,623	9.13		10.15	0.033	9.01	11.738	<0.001
Skill	Log of number of personnel proficient in using computers	3,689	19		37	<0.001	9	49	<0.001

Note: Using test Pearson across levels of GVC for Machinery&Equip innovation and Software&Tech innovation; and test regress across levels of GVC for Age, Size, Sales, Value added and Skill. We report p-values for pooled t-tests, percent% for innovation measures and means for the rest of the variables. The other variables: training, sub-sectors of activity being categorical variables, were not considered in the descriptive analysis but are integrated into the analyses.

Econometric methodology

Our baseline for estimating the effect of innovation on participation in GVCs relies on the estimation of a logit model. Given the binary nature of our dependent variables (GVC1 and GVC2), this model is particularly suitable. The model we estimate is as follows:

$$P(GVC = 1|X) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 Innov + \beta_2 Control + \varepsilon)}} \quad (1)$$

Where *GVC* is a binary variable indicating participation in GVCs, *Innov* represents the innovation variable, *Control* represents the set of control variables (firm age, size, sales, training, and sub-sector), β_0, β_1, β_2 are the coefficients to be estimated, and ε is the error term.

Since marginal effects are more accessible to interpret and communicate than the raw coefficients of a logit model, we focus on interpreting marginal effects rather than β_1 and β_2. The marginal impact of the independent variables (innovation and controls), hereafter Z, on the probability of the event $Y = 1$ (participating in GVC) is given by the partial derivative of the likelihood of $Y = 1$ concerning Z, which is:

$$\frac{\partial P(Y = 1)}{\partial Z} = \theta . P(Y = 1). (1 - P(Y = 1)) \quad (2)$$

Where θ is the estimated coefficient of independent variables in the logit model, and $P(Y = 1)$ is the probability that $Y = 1$ is true. This formula captures the effect of variables included in Z on the likelihood of the event Y = 1, given the values of other independent variables in the model.

Additionally, in the logit model, we use the propensity score matching (PSM) method to enhance the robustness of the results. This method addresses potential issues such as reverse causality between innovation and participation in GVCs, as highlighted in previous studies (Avenyo et al., 2022). Moreover, even with observable variables in the model, unobserved variables may still influence investment in innovation and participation in GVCs. Furthermore, there is a risk of selection bias, where firms participating in GVCs may systematically differ from those that do not regard observable and unobservable characteristics. The PSM method helps correct these issues by creating comparable treatment and control groups based on their propensity scores to participate in GVCs.

Formally, let T be our treatment variable; i.e., the decision to invest in innovation, and let $T = 1$ for firms that have made this decision and $T = 0$ for others. Next, we consider Y, the outcome, i.e., participation in GVCs. Y_1 and Y_1, respectively, denote the average probability of participation observed among firms that have invested in innovation and those that have not. The effect of the decision to invest in innovation on the involvement in GVCs (treatment effect on the treated) is specified as follows:

$$ATT = E[Y_{i1}|T_i = 1] - E[Y_{i0}|T_i = 0] \quad (3)$$

Here, $E[Y_{i1}|T_i = 1]$] represents the observable value, indicating the average probability of participation observed among firms that have invested in innovation, and $E[Y_{i0}|T_i = 0]$ represents the counterfactual term. If the decision to invest in innovation had been a random practice, determining the *ATT* would have been straightforward by comparing the sample mean of the treated group with that of the control or untreated group. However, the decision to invest in innovation is a practice that, in reality, is motivated by several specific factors. Thus, using this approach could introduce selection bias. To overcome this limitation, Heckman et al. (1998) propose estimating the ATT under the assumption that the participation level of the control group is independent of the decision to invest in innovation but conditioned on several observed characteristics (X_i) representing the determinants of this decision. Under this condition, equation (3) can be specified as follows:

$$ATT = E[Y_{i1}|T_i = 1, X_i\ ] - E\,[Y_{i0}|T_i = 0, X_i] \tag{4}$$

Given the multitude of determinants of the decision to invest in innovation, comparing the two groups of firms could be more complex, and there may be firms that need a clear comparison unit. Rosenbaum and Rubin's (1983) approach suggests that matching should be performed not by the set of observable characteristics but by a score that summarises the information in these characteristics. This score, known as the "propensity score," denotes the probability of receiving the treatment assignment. Thus, the predicted probabilities of the decision to invest in innovation serve as estimated propensity scores to match the treated and control groups based on pre-existing observed covariates ($P(X_i)$). The ATT is thus obtained as follows:

$$ATT = E[Y_{i1}|T_i = 1, P(X_i)\ ] - E\,[Y_{i0}|T_i = 0, P(X_i)] \tag{5}$$

To ensure the robustness of our conclusions, we have chosen to use both Logit and Probit models to estimate the propensity score. Although the two models differ in residual distribution function, they produce similar results.

Thus, our PSM approach can be summarised in 3 steps. Firstly, we use the Probit and Logit models to estimate the propensity score. Secondly, we use the propensity scores to generate a sample of firms that have invested in innovation and their matched cases. The matched cases include only those firms that are sufficiently similar to the firms that have invested in terms of propensity scores. We employ Kernel Density Matching for matching purposes, which relies on estimating the probability density functions of propensity scores for exposed and non-exposed individuals (Caliendo and Kopeinig, 2008). Kernel densities are used to estimate these distributions. Subsequently, exposed firms are matched to non-exposed firms whose propensity scores fall within a similar density window. Using a density-based approach creates matched pairs based on the similarity of propensity scores. Finally, we conduct diagnostic tests to assess the quality of the matching.

5. Findings

The baseline analysis presented in Table 5.1 reports average marginal effects for the variables under consideration in predicting participation in GVCs. For both GVC specifications (1 and 2), the average marginal effects of machinery and equipment innovation are positive and statistically significant at the 5% level, indicating that an increase in investment in machinery and equipment innovation is associated with a higher probability of participating in GVCs. Notably, the effect is more substantial for GVC 2 compared to GVC 1. Similarly, software and tech innovation show positive average marginal effects on participation in GVCs for both specifications, although the effects are only statistically significant at the 10% level for GVC 1. Investment in software and external tech innovation may also contribute to increased participation in GVCs, albeit to a lesser extent than machinery and equipment innovation.

Table 5.1: Baseline

	GVC 1				GVC 2			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Machinery & Equip innovation	0.012**		0.011**		0.026***		0.018*	
	(0.005)		(0.005)		(0.009)		(0.009)	
Software & Tech innovation		0.010*		0.011*		0.023**		0.017*
		(0.005)		(0.006)		(0.011)		(0.010)
Age			7.64e-04	7.57e-04			-0.003**	-0.003**
			(7.31e-04)	(7.37e-04)			(0.001)	(0.001)
Age2			-6.71e-06	-6.60e-06			4.26e-05**	4.27e-05**
			(7.11e-06)	(7.19e-06)			(1.67e-05)	(1.68e-05)
Size			2.30e-06	4.05e-06			8.5e-05***	8.7e-05***
			(6.52e-06)	(6.53e-06)			(2.00e-05)	(2.02e-05)
Sales			-1.08e-04	-3.43e-04			0.003***	0.003***
			(5.25e-03)	(5.28e-03)			(0.001)	(0.001)
Training	No	No	Yes	Yes	No	No	Yes	Yes
Year	No	No	Yes	Yes	No	No	Yes	Yes
Sub-sector	No	No	Yes	Yes	No	No	Yes	Yes
N	3828	3817	3626	3616	3819	3808	3660	3650

Note: Delta-method (dy/dx), standard error in brackets. * p<0.10, ** p<0.05, *** p<0.01.

Including additional control variables such as training, year-fixed effect, and sub-sector in specifications 3 and 4, leads to changes in the estimated marginal impact. This suggests that these variables also play a role in determining participation in GVCs, although other unobserved factors may moderate their effect. Firm age and its square harm both GVC specifications, indicating that older firms are less likely to participate in GVCs. This is statistically significant at the 5% level for the squared term, suggesting a non-linear relationship between age and GVC participation. Firm size and sales have positive and statistically significant average marginal effects on GVC participation, particularly for GVC2. This suggests that larger firms and those with higher sales are more likely to be subsidiaries of foreign-based companies.

The results obtained with the PSM method provide a comprehensive perspective on the robustness of the previous findings. Firstly, by examining the propensity score estimates in Table 5.2, we observe consistent patterns regarding firm characteristics on innovation decisions. In the case of machinery and equipment innovation, while the firm's age does not exhibit significance in specification (1), it tends to positively influence the decision to invest in this type of innovation. Moreover, firm size and sales demonstrate positive and statistically significant coefficients across both specifications, indicating that larger firms and those with higher sales are more inclined to invest in machinery and equipment innovation. Conversely, the value added by the firm is relatively insignificant in this decision.

Table 5.2: Propensity score estimates

	Machinery & Equip innovation		Software & Tech innovation	
	(1)	(2)	(1)	(2)
Age	0.012	0.005	0.081*	0.037*
	(0.035)	(0.017)	(0.045)	(0.020)
Age^2	1.08e-04	4.24e-05	-5.60e-04	-3.01e-04
	(3.37e-04)	(1.66e-04)	(4.08e-04)	(1.97e-04)
Size	0.001**	7.02e-04**	5.45e-04	3.15e-04*
	(5.83e-04)	(3.27e-04)	(3.62e-04)	(1.85e-04)
Sales	0.066*	0.034*	0.118*	0.054*
	(0.039)	(0.020)	(0.049)	(0.022)
Value added	-0.050	-0.028	-0.044	-0.022
	(0.035)	(0.018)	(0.041)	(0.020)
Skill	0.003*	0.008*	0.003*	0.002*
	(0.002)	(0.001)	(0.001)	(0.001)
Training	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Sub-sector	Yes	Yes	Yes	Yes
N	2458	2458	2440	2440
LR Chi^2	63.35***	64.32***	60.81***	61.72***
Log likelihood	-732.085	-731.602	-562.817	-562.359
Pseudo R^2	0.041	0.042	0.051	0.052

Note: (1) Logit estimates; (2) Probit estimates. Standard error in brackets. * p<0.10, ** p<0.05, *** p<0.01.

Turning to innovation in software and technology, similar trends emerge regarding the effect of firm age, size, and sales. Both specifications show positive and significant coefficients for these variables. However, it is noteworthy that the coefficient of age squared exhibits a negative and significant relationship, suggesting a more pronounced nonlinear association between age and the decision to invest in software and technology innovation. Employee skills also demonstrate positive and significant effects on this decision across both specifications.

Secondly, the results of kernel matching in Table 5.3 confirm the previous findings that investment in technological innovation enhances the probability of firms participating in GVCs. Notably, for GVC 1 specification, corresponding to the treatment of innovation in machinery and equipment, the results show an average treatment effect on the treated firms (ATT 1) of 0.019, with a standard deviation of 0.011. This indicates a significant increase in the probability of participating in GVCs for firms that have invested in machinery and equipment innovation. Additionally, for GVC 2 specification, which pertains to the treatment of innovation in software and technology, the average treatment effect on the treated firms (ATT 2) is 0.031, also suggesting an increase in the probability of participating in GVCs for firms that have invested in software and technology innovation.

Table 5.3: Kernel matching (Average treatment on treated ATT on GVC)

	GVC 1		GVC 2	
	(1)	(2)	(1)	(2)
ATT 1	0.019*		0.036*	
	(0.011)		(0.020)	
ATT 2		0.031*		0.022**
		(0.016)		0.011
N	2482	2477	2480	2475
Treated	211	148	211	147
Controls	1518	1194	1474	1306

Note: (1)= Machinery & Equip innovation treatment; (2) = Software & Tech innovation treatment. Epan kernel matching. Logit estimates of propensity scores; Standard error in brackets. * p<0.10, ** p<0.05, *** p<0.01.

Finally, Appendix Table A1 presents the diagnostics after matching to assess the balance between the treated and untreated groups on observed characteristics post-treatment. For the GVC 1 specification, in the first column, the raw values of variables such as age, age squared, firm size, sales, value-added, and employee skills are provided for both treated and untreated firms. The standard deviation values (StdDif) are also indicated, allowing for a comparison of balance between the two groups. After matching (Matched (ATT)), the mean values of the characteristics for treated and untreated firms are again provided, along with the corresponding standard deviations. These values enable evaluation of the matching quality and determination of whether the two groups are balanced on observed characteristics. The same structure is repeated for GVC 2 specification.

The results show that most observed characteristics' standard deviation values are relatively low after matching, indicating a good balance between the treated and untreated groups. This suggests that the groups are comparable in observed characteristics after matching. Similarly, from visual inspection of the standard support (Appendix Figure A1), it is observed that the matched sample (on the right) only has a single line, indicating no significant discrepancies. This suggests that after matching, the two groups are, on average, nearly similar.

6. Implications

This study investigated the role of innovation in Cameroonian firms' participation in GVCs. Our main objective was to assess how investment in innovation, both in machinery and equipment, and in software and technology, influenced the likelihood of Cameroonian firms establishing foreign subsidiaries or being subsidiaries of foreign-based companies. To achieve this, we used data compiled from the 2008 and 2016 censuses and applied an econometric methodology, including logistic models and Propensity Score Matching.

Our findings revealed that investment in innovation in machinery and equipment, and in software and technology, was associated with a significant increase in the likelihood of Cameroonian firms participating in GVCs. Specifically, we observed that each increment in investment in innovation in machinery and equipment or software and technology corresponded to an increase in the probability of participating in GVCs. However, certain inherent limitations in this study warrant a nuanced interpretation of these findings. We relied on cross-sectional data, limiting our ability to establish definitive causal relationships between innovation and GVC participation. Our analysis did not account for certain contextual factors influencing firm decisions, such as government policies and international economic conditions. Furthermore, approximating GVC participation through affiliation with foreign subsidiaries, in the absence of specific import information, may introduce significant simplifications that might not fully capture the complexity of GVC dynamics.

The implications of this study suggest that firms can access new markets, benefit from knowledge transfers, and enhance operational efficiency by participating in GVCs. This increased participation in GVCs could also lead to the creation of skilled jobs and increased value-added in Cameroon's economy, thereby stimulating employment and income. Successful GVC participation could make Cameroon more attractive to foreign investment, bolstering its position on the global economic stage. By fostering innovation and GVC participation, Cameroon could thus stimulate sustainable and inclusive economic growth.

The government must establish a regulatory and financial environment conducive to innovation to support these efforts and capitalise on these findings to further promote innovation in the country. This may include tax incentives for R&D, grants, tax credits for companies investing in innovation, and measures to reduce bureaucratic barriers to establishing and growing innovative enterprises. Additionally, investments

in education and vocational training are needed to develop a skilled workforce aligned with the knowledge economy's needs. The government should collaborate with businesses and educational institutions to design skills-focused training programmes necessary for technological innovation and GVC participation. Concurrently, efforts must be made to strengthen technological infrastructure and communication networks in Cameroon. This includes expanding access to high-speed Internet, developing technology parks and business incubators, and investing in research and development of cutting-edge technologies. Finally, the government should actively promote collaboration between the public and private sectors, and domestic and foreign firms to encourage innovation and technology diffusion. Effective public-private partnerships can facilitate knowledge transfer, risk-sharing, and the creation of synergies that drive innovation and enhance the competitiveness of Cameroon's economy on the global stage.

References

Amador, J. and Cabral, S. 2016. "Global value chains: A survey of drivers and measures". *Journal of Economic Surveys*, 30(2): 278–301.

Amador, J., Cabral, S. 2008. "Vertical specialisation in portuguese international trade". *Banco de Portugal Economic Bulletin*, 91–107.

Avenyo, E.K., Mensah, E.B., Ndubuisi, G. and Sakyi, D. 2022. *Global value chain participation and innovation: Firm-level evidence from Africa.*

Becker, M.C. and Knudsen, T. 2002. "Schumpeter 1911: Farsighted visions on economic development". *American Journal of Economics and Sociology*, 61(2): 387–403.

Cadot, O., Iacovone, L., Pierola, M.D. and Rauch, F. 2013. "Success and failure of African exporters". *Journal of Development Economics*, 101: 284–296.

Caliendo, M. and Kopeinig, S. 2008. "Some practical guidance for the implementation of propensity score matching". *Journal of Economic Surveys*, 22(1): 31–72.

Castellacci, F. and Lie, C.M. 2015. "Do the effects of R&D tax credits vary across industries? A meta-regression analysis". *Research Policy*, 44(4): 819–832.

Chacha, P.W., Kirui, B.K. and Wiedemann, V. 2024. "Supply chains in times of crisis: Evidence from Kenya's production network". *World Development*, 173: 106363.

Coulibaly, R., Moreno, H., Suwa-Eisenmann, A. and Traore, N. 2023. "African firms in global value chains: What can we learn from firm-level data in Cameroon and Côte d'Ivoire?" *The World Economy*, 46(11): 3301–3324.

Dallas, M.P., Ponte, S. and Sturgeon, T.J. 2019. "Power in global value chains". *Review of International Political Economy*, 26(4): 666–694.

De Marchi, V., Giuliani, E. and Rabellotti, R. 2018. "Do global value chains offer developing countries learning and innovation opportunities?" *The European Journal of Development Research*, 30: 389–407.

de Melo, J. and Twum, A. 2020. "The long road towards supply chain trade in Africa". *FERDI Notes brèves/Policy Briefs*, (B203).

Del Prete, D., Giovannetti, G. and Marvasi, E. 2017. "Global value chains participation and productivity gains for North African firms". *Review of World Economics*, 153(4): 675–701.

Dovis, M. and Zaki, C. 2020. "Global value chains and local business environments: Which factors really matter in developing countries?" *Review of Industrial Organisation,* 57(2): 481–513.

Epede, M.B. and Wang, D. 2022. "Competitiveness and upgrading in global value chains: A multiple-country analysis of the wooden furniture industry". *Forest Policy and Economics,* 140: 102737.

Gereffi, G. and Fernandez-Stark, K. 2016. "Value chain analysis: A primer". *White Paper, Center on Globalization, Governance and Competitiveness, Duke University, Durham, NC.*

Görg, H. and Hanley, A. 2005. "International outsourcing and productivity: Evidence from the Irish electronics industry". *The North American Journal of Economics and Finance,* 16(2): 255–269.

Harvie, C. and Charoenrat, T. 2015. "SMEs and the rise of global value chains". *Integrating SMEs into global value chains: Challenges and policy actions in Asia*, pages 1–26.

Heckman, J.J., Ichimura, H., Smith, J.A. and Todd, P.E. 1998. *Characterising selection bias using experimental data*.

Hummels, D., Ishii, J. and Yi, K.M. 2001. "The nature and growth of vertical specialization in world trade". *Journal of International Economics*, 54(1): 75–96.

Kee, H.L. and Tang, H. 2016. "Domestic value added in exports: Theory and firm evidence from China". *American Economic Review*, 106(6): 1402–1436.

Kowalski, P., Gonzalez, J.L., Ragoussis, A. and Ugarte, C. 2015. Participation of developing countries in global value chains: Implications for trade and trade-related policies.

Krugman, P.R. (1997). *Development, geography, and economic theory*, Vol. 6, MIT Press.

Lu, Y., Shi, H., Luo, W. and Liu, B. 2018. "Productivity, financial constraints, and firms' global value chain participation: Evidence from china". *Economic Modelling*, 73: 184–194.

Luo, X. and Xu, X. 2018. Infrastructure, value chains, and economic upgrades. World Bank *Policy Research Working Paper*, (8547).

Mayer, T. and Ottaviano, G.I. 2008. "The happy few: The internationalization of European firms: New facts based on firm-level evidence". *Intereconomics*, 43(3): 135–148.

Melitz, M.J. 2003. "The impact of trade on intra-industry reallocations and aggregate industry productivity". *Econometrica*, 71(6): 1695–1725.

Meng, B., Ye, M. and Wei, S.J. 2020. "Measuring smile curves in global value chains". *Oxford Bulletin of Economics and Statistics,* 82(5): 988–1016.

Minetti, R., Murro, P., Rotondi, Z. and Zhu, S.C. 2019. "Financial constraints, firms' supply chains, and internationalisation". *Journal of the European Economic Association*, 17(2): 327–375.

Mohammed, A.R.A. 2018. "Determinants of export survival: The case of Ghanaian manufacturers". *Journal of Quantitative Methods*, 2(1): 37–61.

Morrison, A. and Pietrobelli, C. 2007. "Global value chains and technological capabilities: A framework to study industrial innovation in developing countries". In *Dynamic capabilities between firm organisation and local systems of production,* 175–198. Routledge.

Nadeem, M., Jun, Y., Niazi, M., Tian, Y. and Subhan, S. 2021. "Paths of economic development: Global evidence for the mediating role of institutions for participation in global value chains". *Economic Research-Ekonomska istraživanja*, 34(1): 687–708.

Nagaraj, P. 2014. "Financial constraints and export participation in India". *International Economics,* 140:19–35.

NIS (2008). National Institute of Statistics. 2008. Cameroon - First general business census. Ministère de l'Economie, de la Planification et de l'Aménagement du Territoire. *https:// slmp-550-104.slc.westdc.net/ stat54/nada/index.php/catalog/106.*

NIS. 2016. National Institute of Statistics. Cameroon - Second general business census 2016. Ministère de l'Economie, de la Planification et de l'Aménagement du Territoire. *https:// slmp-550-104.slc.westdc.net/ stat54/nada/index.php/catalog/106.*

Okah-Efogo, F. 2020. “Does trade in services improve African participation in global value chains?” *African Development Review*, 32(4): 758–772.

Pasquali, G., Krishnan, A. and Alford, M. 2021. "Multichain strategies and economic upgrading in global value chains: Evidence from Kenyan horticulture". *World Development*, 146:105598.

Reddy, K., Chundakkadan, R. and Sasidharan, S.2021. “Firm innovation and global value chain participation”. *Small Business Economics,* 57(4): 1995–2015.

Reddy, K. and Sasidharan, S. 2021. “Financial constraints and global value chain participation: Firm-level evidence from India”. *The Journal of International Trade and Economic Development,* 30(5): 739–765.

Rodrik, D. 2018. "New technologies, global value chains, and developing economies". Technical report. National Bureau of Economic Research.

Romer, P.M. 1990. “Endogenous technological change”. *Journal of Political Economy,* 98(5, Part 2): S71–S102.

Rosenbaum, P.R. and Rubin, D.B. 1983. “The central role of the propensity score in observational studies for causal effects”. *Biometrika*, 70(1): 41–55.

Taglioni, D. and Winkler, D. 2016. “*Making global value chains work for development*”. World Bank Publications.

Tajoli, L. and Felice, G. 2018. “Global value chains participation and knowledge spillovers in developed and developing countries: An empirical investigation”. *The European Journal of Development Research*, 30: 505–532.

Tavassoli, S. 2018. “The role of product innovation on export behaviour of firms: Is it innovation input or innovation output that matters?” *European Journal of Innovation Management*, 21(2): 294–314.

Wignaraja, G. 2013. “Can SMEs participate in global production networks?” In *Global Value Chains in a Changing World*, 279–312. WTO iLibrary.

World Bank. 2020. "Trading for development in the age of global value chains". *World Development Report 2020* Washington, DC: World Bank.

World Bank. 2023. *CEMAC Economic Barometer*, Vol. 5 (English). Washington, DC: World Bank.

Yameogo, N.D. and Jammeh, K. 2019. "Determinants of participation in manufacturing GVCs in Africa: The role of skills, human capital endowment and migration". *World Bank Policy Research Working Paper 8938*.

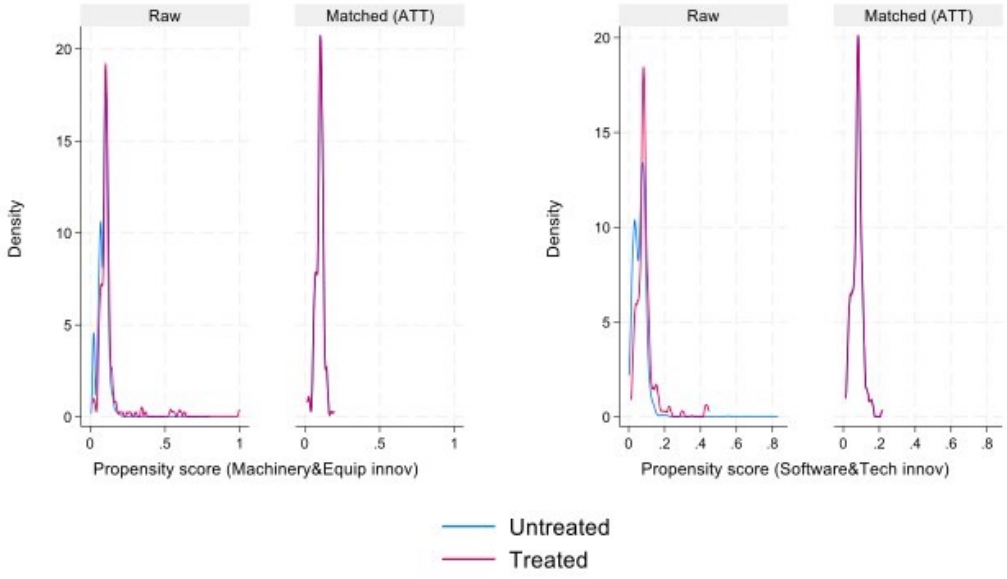
Appendix

Table A1: Diagnostics after matching

GVC 1						
(1)		**Raw**		**Matched (ATT)**		
Means	**Treated**	**Untreated**	**StdDif**	**Treated**	**Untreated**	**StdDif**
age	7.248	7.468	-0.018	6.038	6.100	-0.005
age2	211.439	207.016	0.004	90.986	90.825	0.000
size	86.526	22.625	0.206	24.242	21.943	0.007
ln_sales	11.157	10.637	0.194	10.835	10.831	0.001
ln_value_added	9.330	9.042	0.096	9.070	8.957	0.038
skill	25.087	10.001	0.290	12.773	10.399	0.046
(2)		**Raw**		**Matched(ATT)**		
Means	**Treated**	**Untreated**	**StdDif**	**Treated**	**Untreated**	**StdDif**
age	6.950	7.488	-0.046	5.973	5.780	0.017
age2	163.112	210.904	-0.045	63.203	48.514	0.014
size	86.932	24.531	0.266	36.932	23.057	0.059
ln_sales	11.397	10.636	0.275	11.096	11.177	-0.029
ln_value_added	9.517	9.039	0.161	9.203	9.059	0.048
skill	26.373	10.348	0.303	15.601	11.551	0.077
GVC 2						
(1)		**Raw**		**Matched(ATT)**		
Means	**Treated**	**Untreated**	**StdDif**	**Treated**	**Untreated**	**StdDif**
age	7.248	7.470	-0.018	6.033	6.071	-0.003
age2	211.439	207.175	0.004	90.962	90.589	0.000
size	86.526	22.640	0.206	28.488	24.018	0.014
ln_sales	11.157	10.636	0.194	10.847	10.845	0.001
ln_value_added	9.330	9.043	0.096	9.080	9.058	0.007
skill	25.087	10.007	0.290	12.730	11.531	0.023
(2)		**Raw**		**Matched(ATT)**		
Means	**Treated**	**Untreated**	**StdDif**	**Treated**	**Untreated**	**StdDif**
age	6.950	7.490	-0.046	6.027	5.805	0.019
age2	163.112	211.061	-0.045	63.878	48.831	0.014
size	86.932	24.548	0.266	35.082	24.986	0.043
ln_sales	11.397	10.635	0.275	11.026	11.115	-0.032
ln_value_added	9.517	9.040	0.161	9.066	9.105	-0.013
skill	26.373	10.354	0.303	13.796	10.607	0.060

Note: Covariate "training" included but not displayed. (1) = Machinery & Equip innovation treatment; (2) = Sofware & Tech innovation treatment.

Figure A1: Common support after matching



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