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Electricity Access and Participation in Global Value Chains in Africa: An Empirical Panel Study

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About Article

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ABSTRACT

This study analyses the effect of electricity access on participation in global value chains (GVCs) in 41 African countries between 1990 and 2018. By mobilizing static (fixed effects) and dynamic (two-stage GMM) panel estimation methods, and data from UNCTAD-EORA and World Development Indicators databases, the results show that a one-point increase of access to electricity significantly favours the rise of African countries' integration into GVCs by about 0.0234%. This effect is robust to different measures of access to electricity and GVC participation. The results also show that gaps in access to electricity between urban and rural areas can reinforce unequal integration into global value chains, and that GVC participation is largely determined by the use of fossil fuels. Based on these findings, the study recommends investing in inclusive and sustainable electrification, particularly in rural and industrial areas, and establishing green regulatory frameworks to encourage the adoption of cleaner energies.

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1. INTRODUCTION

The international fragmentation of production strongly dominates contemporary globalization. A UNCTAD report (2013) reveals that approximately 80% of international trade consists of activities within global value chains. These represent all the stages of the production of goods or services that are distributed among several countries (OECD, 2013). This observed disaggregation of production at the global level offers developing countries a strategic opportunity to integrate into international trade without having to master the entire production process of the goods to which they can contribute.

Participation in GVCs is often associated with economic and social gains. For example, we observe faster technological transfers that support better productivity and more sustainable growth gains (Kowalski *et al.*, 2015; Jangam & Rath, 2021; Wang *et al.*, 2022), as well as increasing female employment (Pham & Jinjarak, 2023; Bamber & Staritz, 2016), particularly in light manufacturing industries. Nevertheless, the effects of participation in GVCs are not automatic or uniformly positive; they depend on the positioning within the GVCs. Numerous studies have shown that participation in GVCs from high value-added segments such as advanced technology industries, heavy industries, research and development, software design, etc., has a more profitable impact on the economies of countries than downstream participation (Cai *et al.*, 2023; Montalbano & Nenci, 2020; Mao, 2022). However, be it upstream or downstream integration, GVC participation is not without challenges.

Participation in GVC requires the availability of various infrastructures such as transportation (Rodrigue, 2006; Lanz & Piermartini, 2018; Gereffi, 2015), ICTs (Gniniguè *et al.*, 2023). A recent study has explored and highlighted the role of sanitation, transport, ICT, and energy infrastructures on GVC participation in Africa (Ketu & Wirajing, 2024). Only with regard to the energy variant, this latter study considers the production aspect, which does not necessarily reflect the reality of energy access and consumption by the populations. Indeed, there is a significant distinction between energy production and actual consumption within a country. This is due both to the losses observed in distribution transits and the significant portions of domestic energy production that are sold to other countries.

Electricity is a critical determinant of productivity and growth, facilitating the rise of entrepreneurial activities, the automation of production processes, and even the attractiveness of regions for investments (Inglesi-Lotz & Ajmi, 2021; Aliu, 2021; Vernet *et al.*, 2019; Grimm *et al.*, 2013). Production systems are powered by electricity, which also supports communication and logistics technologies and facilitates reaching the quality standards demanded on the international market (Mensah *et al.*, 2023). Both domestic entrepreneurs and foreign investors are deterred from integrating into or locating production facilities within African nations, by the higher production costs, decreased productivity, and increased operational uncertainty that result from inadequate energy access (Foster & Steinbuks, 2009). This foretells the fundamental need of access to reliable and affordable electricity for significant GVC participation.

According to empirical research, electrification and the growth of manufacturing capacities are positively correlated, and this in turn influences a nation's capacity to move up the GVCs (Andersen *et al.*, 2020; World Bank, 2020). Participation in the GVC is based both on capitalizing on the countries' strengths (social, natural, geographical, institutional...) and the requirement for profitability of the activities developed and integrated with the GVC. The level of access to electricity can be perceived as an incentive component encouraging (discouraging) investments in GVC or a catalyst (obstacle) to the efficiency and profitability of the targeted production sectors.

Access to electricity is still a concerning reality in Africa. In 2023, approximately 600 million Africans, or more than 42% of the continent's population, still did not have access to a reliable source of electricity, the majority residing in sub-Saharan Africa. This energy deficiency represents a structural obstacle to economic and social development, to the industrialization of Africa (Djeunankan *et al.*, 2024; Maruta, 2025). Moreover, with climate considerations increasingly taken into account in development policies, the challenge of universal access to electricity is becoming more complex. Therefore in this work, we analyse the effect of access to electricity on participation in GVC in Africa.

This study brings four significant additions to the literature. First, it fills a gap by examining the effect of real electricity access rather than just production capacity on African nations' participation in global value chains (GVCs). Second, focusing the analysis on the sample Africa, the study offers empirical support to highlight continent specific infrastructure issues. Third, it provides specific insights for infrastructure investment and development planning by highlighting energy access as a crucial policy tool for boosting industrialization and export diversification. Lastly, by empirically connecting energy access to advancements on Sustainable Development Goals (SDGs), specifically SDG 7 (Affordable and Clean Energy) and SDG 9 (Industry, Innovation, and Infrastructure), the paper adds to discussions on global development by showing how better energy access can act as a stimulant for economic upgrading and deeper GVC integration throughout Africa.

The rest of the study is structured as follows. Section 2 provides a brief literature survey. Section 3 presents the data and empirical methodology used. Section 4 displays the obtained results and discussions. Section 5 presents the conclusion, and Section 6 summarizes policy recommendations, and directions for future research.

2. LITERATURE REVIEW

While Hirschman (1958) addressed backward and forward linkages, Porter (1985) introduced the concept of value chains within the industrial sector, delineating the activities that must synergistically collaborate to produce and market a product, thereby enabling participants at all levels to maximise profits. Nonetheless, the application of the notion has expanded throughout the years beyond industry, coinciding with the evolution of international trade since the early 1990s, marked by the growing integration of the global economy. Consequently, value chains have been increasingly separated on an international scale (Fabe *et al.*, 2009; Gereffi & Fernandez-Stark, 2011). Previously fragmented production processes are now interconnected, presenting a significant opportunity for numerous countries to enhance their comparative advantages.

The production of a single product is conducted by various firms across multiple countries. Global Value Chain (GVC) trade, from which Asia and Latin America have significantly profited, was introduced in the early 2000s (Bair, 2005; Gereffi *et al*., 2005; Gereffi & Korzeniewicz, 1994) to denote the fragmentation of production processes and trade among nations. It elucidates why the advantages of economic integration do not extend to developing nations and their impoverished populations.

The level of a country's involvement in the GVC is assessed by distinguishing the value added in products according to their sources of origin and final destinations. This method delineates foreign value added (FVA) and domestic value added (DVA) as defined in the literature (Lenzen *et al*., 2013). The Foreign Value Added (FVA), referred to as backward integration, represents the proportion of imported value added from foreign suppliers upstream that is incorporated into a country's exports. This signifies the nation's position in the value chain. The DVA comprises the total domestic value added of items consumed within the exporting country and the domestic value added of products utilised in the manufacture of exports from other nations. The proportion of domestic value added in exports that is represented in the exports of other nations (DVX) is termed forward integration. In this scenario, the country supplies resources for the manufacturing of another country (Tinta, 2017). The amalgamation in backward and forward integration provides an assessment of a nation's overall participation in backward and forward integration provides an assessment of a nation's overall participation in GVC. The participation of African countries in the latter has been shaped not only by economic determinants but also by social, institutional, and geographic factors, as well as the quality and sustainability of involvement in global production systems.

First, some empirical works show that geographical factors might help or hamper GVC integration in the sense that being close to big global markets like Europe and Asia makes a business more competitive by cutting shipping time and costs (Vanables, 2023). The AfCFTA is an example of regional integration that can help GVC participation by lowering trade costs and making it simpler to access markets (Mélo & Solleder, 2025). But a lot of African countries are landlocked or distant from commercial hubs, which makes it harder for them to trade (Limao & Venables, 2001). Additionally, Africa's underdeveloped infrastructure, especially in transportation and logistics, makes transactions more expensive and makes the continent less competitive in global production chains that need to be done quickly (UNCTAD, 2014). To get beyond those geographical constraints and open up more prospects for genuine GVC participation, regional integration and investment in cross-border infrastructure are needed. Furthermore, while having natural resources makes it possible to take part in primary commodity chains, this typically leads to specialisation in low-value-added activities with few chances for improvement (Kaplinsky & Morris, 2003).

The quality of institutions, governance frameworks and the people who run them are also presented as important, crucial, and profoundly influencing involvement in Global Value Chains (GVCs), not only in Africa but also at the global level. One can only observe the recent global economic moves since the arrival of President Donald Trump at the head of the United States of America. Robust regulatory frameworks, streamlined customs procedures, and robust enforcement of property rights collectively mitigate risks and costs for multinational corporations (Dollar *et al*., 2005). Robust property rights and effective governance can enhance domestic participation in global value chains (GVCs), where firms source inputs locally, as well as overall GVC engagement (Alhassan *et al*., 2021). Research suggests that countries with favourable business environments, marked by improved finance availability, efficient trade procedures, and robust contract enforcement, are more likely to participate in GVCs (Hammoudeh *et al*., 2023; Chala, 2024; Ajide, 2023). Additionally, poor institutions hinder enterprises from engaging in long-term investments and participating in complex segments of global value chains (GVCs). Reforms that facilitate trade and participation in international accords can enhance Africa's economic competitiveness and reduce non-tariff obstacles (Hoekman, 2014). The African Continental Free Trade Area (AfCFTA) is advantageous as it may enhance the uniformity and transparency of trade regulations and facilitate African nations' integration into global value chains (GVCs) (UNECA, 2021). Effective engagement in global value chains necessitates that institutional reforms align with economic and industrial agendas.

Moreover, GVC outcomes are profoundly influenced by social variables, particularly human capital, demographics, and inclusiveness. The positions or level at which a nation is found in the value chain are contingent upon the education and skill level of its workforce; functional upgrading is eased by a more skilled labour force (Auktor, 2020). Labour-intensive manufacturing may leverage Africa's burgeoning youth demographic, contingent upon the allocation of resources to vocational and technical education (AfDB, 2020). Moreover, global firms prioritising ethical and sustainable supply chains are increasingly factoring in social inclusion, particularly gender parity in labour markets, when making sourcing decisions (Barrientos *et al*., 2011). African nations risk being confined to low-value global value chain sectors if social inequalities and skill deficiencies are not addressed.

Lastly, economic factors, including the size of the market, trade openess, labour costs and how good the infrastructure are all very important for GVC participation in Africa. Countries with big domestic markets and more integration into global trade tend to get more foreign direct investment (FDI) and global production networks. Low labour costs may seem like a good way to get started, but this benefit will only last as long as productivity improvements are made at the same time (Kowalski *et al*., 2015). Taglioni & Winkler (2016) posit that macroeconomic stability and strong trade policiers are necessary to make conditions more predictable for businesses that are part of value chains. As a result, strengthening the basics of the economy is still an important step towards becoming more deeply integrated into global production networks. Technology adoption and innovation capacity also shape the depth and quality of Africa's GVC engagement, particularly in terms of access to digital infrastructure and automation, which influences the ability of African firms to comply with global production standards and timelines (Gereffi, 2019). However,

many firms or businesses in the area are facing challenges since they can't access production technology and don't have enough resources for industrial learning and growth (Humphrey & Schmitz, 2002; Quaye *et al.*, 2024). The lack of strong research and development (R&D) ecosystems also makes it harder to add value. Multinational firms can help technology growth by creating good externalities and getting involved in learning-by-exporting (Morrissay & Filatotchev, 2000; Gong, 2023). Hence, for businesses in Africa to move up to higher-value parts of global supply chains, the continent needs to improve its digital infrastructure and innovation processes.

Talking about infrastructure to participate and grow in GVC, Africa needs, in addition to digital infrastructure and the transportation ones mentioned above, very basic infrastructures such as electricity. Electricity is at the core needs of industrialisation and globalisation (Maruta, 2025; Alley *et al.*, 2016; Khan *et al.*, 2018). In fact, reliable electricity powers industries, communications', transports' and digital infrastructures. For example, Maruta (2025) shows that energy use and electricity access impact positively industrial growth in Africa. More specifically, the study of Ketu & Wirajing (2024) finds that the volume of electricity produced and available in African countries positively influences their participation in GVCs. Yet, electricity production does not assure electricity affordability and equitable access. Moreover, in the lens of sustainable participation to GVC, the quality of the electricity used needs to be checked. This study will contribute to fill this existing gap in the literature on African countries' GVC participation.

3. METHODOLOGY

3.1. Data

We use, in this study, data of 41 African countries, obtained from different sources. (1) The data on GVC participation are from the United Nations Conference on Trade and Development (UNCTAD) EORA database, available for the 1990-2018 period. (2) The electricity access and control variables data are obtained from the World Development Indicators (WDI). The sample size and the time frame considered in the study are constrained by limited data on GVC participation. Table 1 presents the descriptive statistics of the variables.

3.1.1. Dependent variable: GVC participation

Participation in global value chains is approximated by numerous measures in the literature. For our research, we use the data provided by UNCTAD-EORA database (Casella *et al.*, 2019) because of the wide range of countries this database covers, as well as the longer period, over which it extends. We obtain data for 41 African countries over the period 1990 to 2018.

From this dataset, we will mainly use the GVC variable, which measures participation in global value chains by country (in thousands of US dollars). This index is built up from two key variables, namely DVX and FVA. The 'DVX' variable measures a country's exports of intermediate goods used as inputs in the production of goods and services destined for export from another country to a third country. The 'FVA' variable corresponds to the value added of intermediate inputs imported by a country and used to produce goods for export. The 'DVX' and 'FVA' variables thus measure the position of the country concerned in the vertical structure of GVCs. DVX in particular represents upstream participation, i.e. the country's integration in the higher stages of production chains. These are precisely the stages that produce more added value, such as research and development, design, high-tech services and specialized logistics (Baldwin, 2016). FVA represents downstream participation, i.e. the country's integration in low value-added production stages such as assembly and raw materials extraction. These last two variables will also be used for robustness purposes, to examine whether the social effect of countries' positioning in GVCs differs from the effect of GVCs taken as a whole. The GVC participation measure for each country i (GVCi) is then obtained as follows:

$$GVC_i = DVX_i + FVA_i \quad \text{....(1)}$$

3.1.2. Independent variable: access to electricity

Access to electricity is the percentage of population (total, urban or rural) with access to electricity. This measure reflect accessibility across the population and, what is still to be done with regards to the spread of electricity infrastructure. Given that Africa is the region of the world with the lowest access to electricity, we believe that the use of the electricity access variable is more important for it concerns. We will also use the renewable energy consumption in total final energy consumption variable and the fossil fuel energy consumption to check if the energy cleanness has a specific impact on GVC participation. Renewable energy are essential for reducing greenhouse gas emissions and combating climate change. It decreases dependence on fossil fuels, enhancing thus energy security and price stability.

3.1.3. Control variables

The level of financial development is integrated through the global index of financial development (FinDev) constructed by the IMF and presented by Svirydzenka (2016). This index is built on the idea that financial development has several aspects, notably depth, access and efficiency and the different aspects are considered for both financial institutions and financial markets. This variable is essential for capturing the financial system capacity to support GVC participation through efficient financing of firms' activities and financial inclusion (Dutta & Meierrieks, 2021; Kar & Özşahin, 2016; Iddrisu *et al.*, 2024; Kothakapa *et al.*, 2021).

Access to Internet is the percentage of total population that makes use of Internet via a computer, mobile phone or any other mean. Internet is a leading factor of globalisation providing information to the global public. It can help firms to identify market opportunities, communicate on their products and activities, network with other companies and more (Ertürk, 2015; Saba *et al.*, 2025).

Secondary school attainment corresponds to the proportion of children of secondary school age who actually attend secondary school. This variable reflects a critical threshold in the accumulation of skills necessary for productivity, employability, and participation in a globalized economy (Barro & Lee, 2013). Secondary education is in fact the transition stage between the

basic educational foundation and the acquisition of technical or professional skills, particularly in GVC-integrated economies. Inflation consumer price reflects the annual percentage change in the cost to the average consumer of acquiring a given basket of goods and services. Inflation has various sources that interact differently with the economic agents' behaviours. Inflation in the literature is usually attributed a negative impact on investment, growth and its spin-offs (Agudze & Ibhagui, 2021).

Table 1. Correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(10)	(12)	(13)	(14)
lnGVC	1.0000											
lnDVX	0.9848	1.0000										
lnFVA	0.9509	0.8964	1.0000									
Access to electricity (total)	0.5982	0.5614	0.6264	1.0000								
Access to electricity (rural)	0.6103	0.5611	0.6542	0.9475	1.0000							
Access to electricity (urban)	0.5520	0.5342	0.5352	0.9184	0.8120	1.0000						
Renewable energy consumption	-0.5554	-0.5105	-0.6140	-0.7836	-0.7532	-0.6488	1.0000					
Fossil fuel consumption	0.6651	0.6667	0.6457	0.6751	0.6262	0.6208	-0.8160	1.0000				
Financial development	0.7519	0.6866	0.7949	0.4965	0.5416	0.3830	-0.5434	0.5054	1.0000			
Internet	0.5724	0.5327	0.5958	0.5325	0.5667	0.4229	-0.5054	0.4160	0.6991	1.0000		
Secondary education	0.5553	0.5204	0.5867	0.7914	0.7739	0.6880	-0.7500	0.6226	0.5923	0.6095	1.0000	
Inflation	-0.0379	-0.0110	-0.0931	0.0001	0.0118	0.0111	0.0457	0.0193	-0.1969	-0.2162	-0.0777	1.0000

Table 2. Descriptive statistics

	Variables	Obs	Mean	Std. Dev.	Min	Max
Dependent variables	GVC	1 160	2463701	7741611	9190	6.75e+07
	FVA	1 160	623705.7	2090872	0	2.15e+07
	DVX	1 160	1840231	5815702	.76	4.61e+07
Independent variables	Electricity_access (total)	928	39.92737	30.94576	.5338985	100
	Electricity_access (urban)	941	62.00611	26.38343	3.5	100
	Electricity_access (rural)	782	29.629	32.60186	.5085026	100
	Renewable energy consumption	1 137	62.75327	29.83596	.06	98.34
	Fossil fuel energy consumption	561	41.40412	32.64579	0	99.97792
Control variables	Financial development	1 131	.1398328	.1015621	0	.5868213
	Internet	965	8.132222	13.3229	0	64.8
	Secondary education	296	33.57405	20.14524	2.76722	90.54401
	Inflation	1025	53.42085	776.1256	-16.85969	23773.13

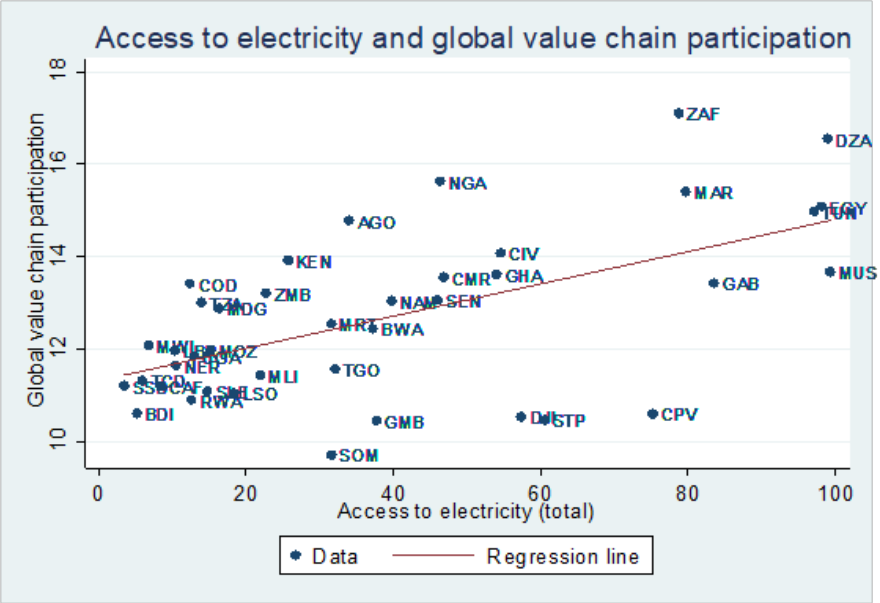

Figure 1. Correlation between Access to electricity and global value chain participation in Africa (Scatter)

3.2. Empirical methodology

We begin by specifying the model to be estimated as presented in equation (2). Y represents the dependent variable GVC participation (FVA and DVX in robustness), X the explanatory variable access to electricity (renewable energy consumption for robustness), and Z the vector of control variables. The subscripts i and t represent country and period observations, respectively, ɣ taking into account country fixed effects, and ε represents the random term that is independently and identically distributed.

$$Y_{i,t} = \beta_0 + \beta_1 X_{i,t} + \beta_2 Z_{i,t} + \varepsilon_{i,t} \quad ....(2)$$

We first use the fixed effect estimator to analyse the effect of access to electricity on GVC participation. The estimation with the FE method allows to control for unobserved heterogeneity between countries.

In order to test the robustness of our results and to overcome possible endogeneity problems, we finally use the two-step generalized moment estimation technique as developed by Arellano and Bover (1995) and estimate a second specification of our model (equation 3).

$$Y_{i,t} = \beta_0 + \alpha Y_{i,t-1} + \beta_1 X_{i,t} + \beta_2 Z_{i,t} + \eta_i + \xi_t + \varepsilon_{i,t} \quad ....(3)$$

The advantage of this method is that it allows the lag of the dependent variable to be used as an instrument, something that was not possible with the previous technique (Ullah *et al.*, 2018). Indeed, Blundell and Bond (1998) explain that the lag of the endogenous variable used in difference equations, does not lead to robust results. For this reason, they advise using lagged differences of instruments in level equations, and lagged levels of instruments in difference equations. Following Blundell and Bond (1998), we use the system GMM, which includes the correction of Windmeijer (2005), necessary to improve the standard deviations.

4. RESULTS AND DISCUSSION

4.1. Baseline results, fixed effects

Table 2 presents the results of the model estimated with the fixed effects. We find that access to electricity has a significant positive effect on GVC participation in Africa (column 5). This result confirms the idea that energy infrastructure, and specifically access to electricity, promotes participation in GVCs (Ketu & Wirajing, 2024). In other words, in Africa, the greater a country's electricity coverage, the greater its involvement and contribution to global value chains. This explains why access to electricity is indispensable to a country's economic life, through social well-being, the empowerment of individuals to think and seize opportunities in their environment and beyond, and the investment security perceived by entrepreneurs and investors (local and foreign), encouraging them to engage in and develop activities contributing to GVCs. We also find that financial development, Internet access and secondary education have a positive impact on GVC participation in Africa. Inflation, on the other hand, reduces or discourages GVC participation. These results are consistent with the literature reviewed above.

Table 2. Baseline results, fixed effects

	Dependent variable : GVC participation (ln)				
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Electricity_access (total)	0.0479***	0.0450***	0.0368***	0.0247***	0.0234***
	(0.0017)	(0.0019)	(0.0022)	(0.0033)	(0.0033)
Financial development		3.7891***	2.5435***	2.0684***	1.9015**
		(0.4741)	(0.5326)	(0.7835)	(0.7968)
Internet		0.0112***	0.0080***	0.0089***	
			(0.0017)	(0.0023)	(0.0023)
Secondary education				0.0196***	0.0190***
				(0.0026)	(0.0026)
Inflation					-0.0042***
					(0.0012)
Constant	11.0777***	10.6744***	11.1031***	10.8602***	11.0099***
	(0.0677)	(0.0746)	(0.1008)	(0.1412)	(0.1489)
Observations	928	909	840	535	521
R^2	0.4867	0.5651	0.5678	0.6447	0.6501

*Notes: Standard deviations are given in brackets; *** p<0.01, ** p<0.05, * p<0.1*

4.2. Robustness checks

4.2.1. Robustness to alternative measures of access to electricity

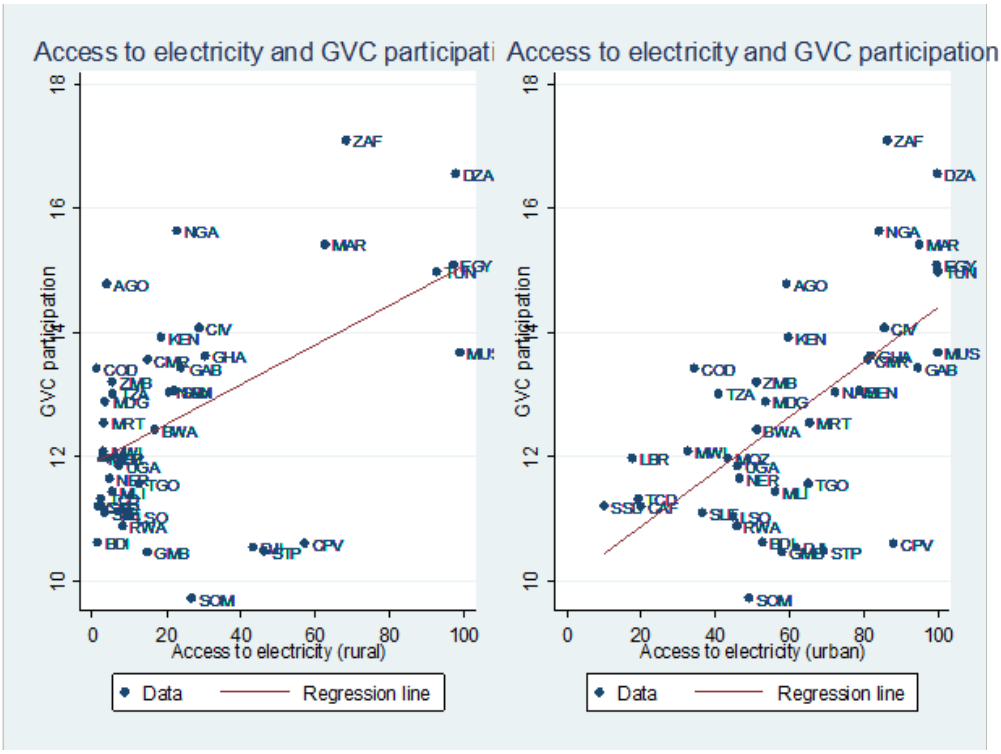

Figure 2. Correlation between access to electricity (rural, urban) and global value chain.

To check if the effect access to electricity found previously is not specific to the measure used, we mobilise access to electricity differentiated in urban and rural areas, which takes into account spatial disparities in electricity access. We also use the renewable energy consumption and fossil fuel energy consumption variables, which consider the environmental quality of the energy consumption in African countries, as alternative measures of access to electricity. Table 3 shows an overall positive effect of access to electricity in both urban and rural areas. More specifically, it reveals that access to electricity in urban areas is more favourable to GVC participation in Africa than access to electricity in rural areas (0.0190*** > 0.0049*). This result suggests that in Africa, companies involved in GVCs are more sensitive to and incentivized by access to electricity in cities. This exposes a city concentration of economic activities integrated into GVCs. In other words, GVCs in Africa are based on, and maintain, urban-rural inequalities.

Turning to renewable energy consumption, we find that it has a negative and highly significant effect on GVC participation, as opposed to fossil energy consumption. This means that countries where renewable energies make up a large and growing share of total energy consumption contribute less to GVCs, while those where energy consumption is predominantly fossil fuel have a greater participation in GVCs. This can be explained by two facts. The first is that Africa's renewable energy infrastructures and technologies are not yet sufficiently capable of producing the volumes of energy needed to support a stable intensification of production or heavy industry activities. The second fact is that African countries do not yet have a rigorous institutional framework to restrict fossil fuel consumption and limit environmental pollution. Companies in countries with high levels of environmental regulation may be encouraged to relocate their fossil fuel-intensive activities to these less demanding countries, which also have a relatively large stock of fossil fuels. This result supports the hypothesis that African countries are pollution havens (Levinson & Taylor, 2008). We can therefore say that participation in GVCs in Africa is not in line with the global vision of sustainable development and resources.

Table 3. Alternative measures of access to electricity

	Dependent variable : GVC participation (ln)			
Variables	**(1)**	**(2)**	**(3)**	**(4)**
Electricity_access (urban)	0.0190***			
	(0.0021)			
Electricity_access (rural)		0.0049*		
		(0.0028)		
Renewable energy consumption			-0.0347***	
			(0.0043)	
Fossil fuel energy consumption				0.0231***
				(0.0049)
Financial development	2.4833***	2.2107**	1.6133**	3.8043***
	(0.7726)	(0.8586)	(0.6803)	(0.6745)
Internet	0.0135***	0.0114***	0.0103***	0.0203***
	(0.0022)	(0.0026)	(0.0023)	(0.0030)
Secondary education	0.0177***	0.0246***	0.0256***	0.0211***
	(0.0025)	(0.0027)	(0.0022)	(0.0025)
Inflation	-0.0036***	-0.0038**	-0.0028**	-0.0045***
	(0.0011)	(0.0015)	(0.0011)	(0.0010)
Constant	10.6785***	11.5644***	13.6853***	10.9724***
	(0.1566)	(0.1586)	(0.3139)	(0.2578)
Observations	521	462	568	299
R^2	0.6704	0.5952	0.6668	0.7395

*Notes: Standard deviations are given in brackets; *** p<0.01, ** p<0.05, * p<0.1*

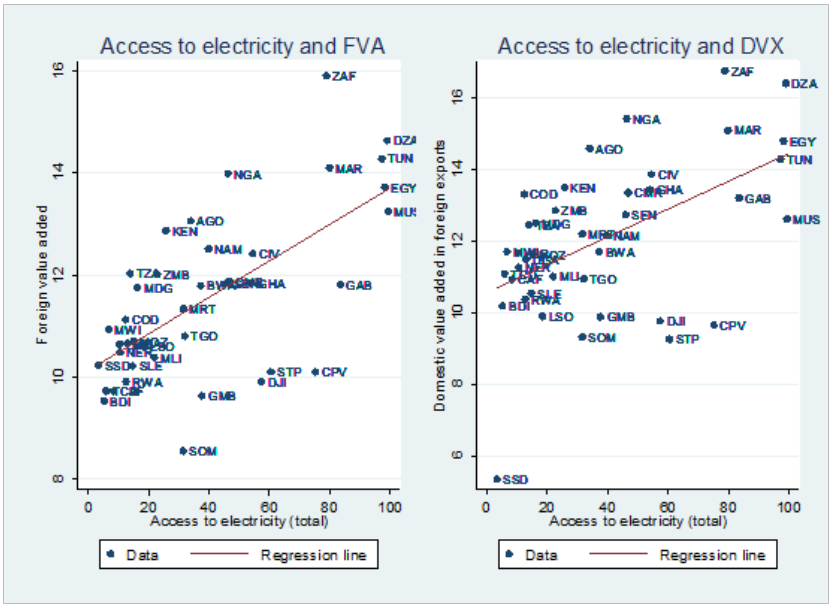

Figure 3. Correlation between access to electricity and domestic value added in foreign exportations and foreign value added

4.2.2. Robustness to alternative measure of GVC participation

We consider the upstream (DVX) and downstream (FVA) position in the GVCs to explore if the effect of electricity access is different from one position to the other. Table 4 leads us to note that access to electricity in Africa has a positive effect on both downstream and upstream position in GVC. Moreover, access to electricity increases downstream participation more than upstream participation. This reveals the stagnation of African countries in the downstream sectors through which they contribute to GVCs. Better access to electricity does not encourage them to move towards more advanced (upstream) GVC sectors, but rather to increase the volume of activities in which they are already invested.

Table 4. Alternative measures of GVC participation (FVA and DVX)

	FVA					DVX				
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
Electricity_ access (total)	0.0254***					0.0189***				
	(0.0034)					(0.0034)				
Electricity_access (urban)		0.0222***					0.0142***			
		(0.0021)					(0.0022)			
Electricity_access (rural)			0.0066**					0.0038		
			(0.0028)					(0.0029)		
Renewable energy consumption				-0.0319***					-0.0336***	
				(0.0044)					(0.0044)	
Fossil fuel energy consumption					0.0273***					0.0212***
					(0.0048)					(0.0050)
Financial development	2.0994***	2.7536***	2.4798***	2.0948***	3.9557***	2.1599***	2.6139***	2.4066***	1.7526**	3.6920***
	(0.8085)	(0.7677)	(0.8543)	(0.7033)	(0.6660)	(0.8258)	(0.8165)	(0.8750)	(0.6946)	(0.6931)
Internet	0.0075***	0.0127***	0.0107***	0.0092***	0.0201***	0.0090***	0.0127***	0.0107***	0.0096***	0.0205***
	(0.0023)	(0.0022)	(0.0026)	(0.0024)	(0.0029)	(0.0024)	(0.0023)	(0.0027)	(0.0023)	(0.0031)
Secondary education	0.0196***	0.0172***	0.0232***	0.0267***	0.0185***	0.0197***	0.0193***	0.0251***	0.0257***	0.0229***
	(0.0027)	(0.0025)	(0.0027)	(0.0022)	(0.0025)	(0.0027)	(0.0026)	(0.0028)	(0.0022)	(0.0026)
Inflation	-0.0022*	-0.0014	-0.0027*	-0.0005	-0.0020*	-0.0047***	-0.0043***	-0.0040**	-0.0035***	-0.0052***

Inflation	(0.0012)	(0.0011)	(0.0015)	(0.0012)	(0.0010)	(0.0012)	(0.0012)	(0.0016)	(0.0012)	(0.0011)
Constant	9.7072***	9.2785***	10.3872***	12.2393***	9.6268***	10.6692***	10.4513***	11.0712***	13.1408***	10.5670***
	(0.1511)	(0.1556)	(0.1578)	(0.3245)	(0.2545)	(0.1543)	(0.1655)	(0.1616)	(0.3205)	(0.2649)
Observations	521	521	462	568	299	521	521	462	568	299
R^2	0.6476	0.6817	0.5934	0.6452	0.7260	0.6170	0.6250	0.5793	0.6537	0.7394

*Notes: Standard deviations are given in brackets; *** p<0.01, ** p<0.05, * p<0.1*

4.2.3. Robustness to additional control variables

In this subsection, we perform a robustness test by introducing three additional control variables into the baseline model. These additional controls are the natural resources rent, employers' percentage in total employment, and the livestock production index. The results are presented in Table 5 and show that the coefficients associated with the electricity access remain positive and statistically significant at the conventional level. This suggests that electricity access increases GVC participation in African countries. Therefore, the baseline results are robust to additional covariates.

Table 5. Additional control variables

	Dependent variable : GVC participation (ln)			
Variables	**(1)**	**(2)**	**(3)**	**(4)**
Electricity_access (total)	0.0234***	0.0218***	0.0204***	0.0174***
	(0.0033)	(0.0032)	(0.0033)	(0.0030)
Financial Development	1.9015**	1.8354**	1.7038**	1.5909**
	(0.7968)	(0.7727)	(0.7729)	(0.6986)
Internet	0.0089***	0.0099***	0.0101***	0.0076***
	(0.0023)	(0.0022)	(0.0022)	(0.0020)
Secondary education	0.0190***	0.0196***	0.0213***	0.0120***
	(0.0026)	(0.0026)	(0.0026)	(0.0025)
Inflation	-0.0042***	-0.0058***	-0.0065***	-0.0065***
	(0.0012)	(0.0012)	(0.0012)	(0.0011)
Natural ressources rent		0.0202***	0.0220***	0.0223***
		(0.0036)	(0.0036)	(0.0033)
Employers			-0.0641***	-0.0527***
			(0.0218)	(0.0197)
Livestock production				0.0116***
				(0.0011)
Constant	11.0099***	10.8633***	11.1026***	10.6723***
	(0.1489)	(0.1468)	(0.1599)	(0.1503)
Observations	521	521	518	518
R^2	0.6501	0.6716	0.6750	0.7351

*Notes: Standard deviations are given in brackets; *** p<0.01, ** p<0.05, * p<0.1*

4.2.4. Robustness to alternative estimation technique

Although the results presented above show with strong evidence that electricity access has significant positive effect on the GVC participation for African countries, there may be a risk of reverse causality. We therefore mobilise the two-step GMM estimation technique, which use internal instruments to solve the potential endogeneity in our model. The results using the two-step GMM presented in Table 6 confirm the positive impact of electricity access on GVC participation in Africa. We check the specification diagnostic tests of the results obtained from the empirical analysis. From the AR (1) and AR (2) statistics test for the autocorrelation of the residuals, we reject

the null hypothesis of no first-order residual serial correlation and accept the hypothesis of no second-order serial correlation. The Hansen test statistic of over identifying restrictions is insignificant, which suggests that the set of instruments employed fulfils the exogeneity condition required to obtain consistent estimates in the estimated model. In addition, the number of instruments is lower than the number of countries for our specification. Furthermore, the coefficient of the lagged dependent variable is significant at the 1% level, suggesting the ex-post validity of our system GMM estimates.

Table 5. GMM estimation technique

	Dependent variable: GVC participation (ln)
Variables	**(1)**
L.GVC participation (ln)	0.9693***
	(0.0204)
Electricity_ access (total)	0.0069**
	(0.0031)
Financial Development	1.1258**
	(0.4954)
Internet	-0.0008
	(0.0024)
Secondary education	-0.0141***
	(0.0049)
Inflation	-0.0032*
	(0.0018)
Constant	0.6642**
	(0.2692)
Observations	291
Number of id	27
Instruments	16
AR1	0.00124
AR2	0.585
Hansen	0.227

*Notes: Standard deviations are given in brackets; *** p<0.01, ** p<0.05, * p<0.1*

5. CONCLUSION

Global value chains are omnipresent in today's international trade. To withdraw greater profit from it, African countries should think on strategic assets and amenities to develop. This study has analysed the effect of electricity access on GVC participation in a sample of 41 African countries involved in GVC over the period 1990–2018. To carry out our empirical analysis, we used the fixed effects method and the two-step GMM method. We found interesting results. First, access to electricity increase GVC participation. The robustness of this result have been validated through the use of alternative electricity access measures (urban and rural electricity access, renewable and fossil fuel energy consumption), alternative GVC participation measures (FVA and DVX), and additional control variables (natural resources rent, employers' percentage in total employment, and the livestock production). Second, our analysis revealed that in Africa participation in global value chains is favoured by disparities in access to electricity between urban and rural areas, which may be self-reinforcing. Last we found that GVC participation in Africa is more fossil energy consumption oriented. These results meet those of Maruta (2025) on the positive impact of electricity access on industrial development and open another view to Ketu & Wirajing (2024) on the importance of effective access to electricity and the type of electricity that nurtures GVC participation in Africa. From that point, GVC participation in Africa does not succeed so far, to reconcile the goals of clean and affordable energy (SDG6) and industrialisation and infrastructure development (SDG9) in Africa.

RECOMMENDATIONS

Based on the above findings, we propose a number of policy recommendations. The first is to strengthen reliable and sustainable electricity infrastructures in industrial and rural areas. An inclusive and targeted electrification will boost GVC participation in Africa, reduce spatial inequalities and the concentration of gains in urban areas. Another point is that African countries should develop and communicate on a green institutional framework regulating environmental standards that can incite companies to prioritize the use of clean energies. Given the heterogeneity of development levels on the continent, future research could examine whether the effect of access to electricity on participation in global value chains varies between low- and middle-income countries. Such an approach would provide a better understanding of the conditions for the effectiveness of electrification policies as a function of the level of structural development. Furthermore, given the historical trajectories and dependencies created by former colonial ties, it would be relevant to analyse whether inherited economic partnerships shape the impact of access to electricity on integration into global value chains. This historical perspective could enrich our understanding of the institutional and geopolitical determinants of productive transformation in Africa.

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