

Can we participate in global value chains in the dark? An empirical study in Africa

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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 methods, the results show that better access to electricity significantly favours integration into GVCs. The effect remains robust to different measures of electrification and GVC participation. The results also highlight that disparities in access to electricity between urban and rural areas can reinforce unequal integration into global value chains, and that 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.

Keywords: Access to electricity, global value chains, Africa.

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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 and Rath, 2021; Wang et al., 2022), as well as increasing female employment (Pham and Jinjark, 2023; Bamber and 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 and Nenci, 2020; Mao, 2022). However, whether it is upstream or downstream integration, it is not without challenges.

Participation in CVM requires the availability of various infrastructures such as transportation (Rodrigue, 2006; Lanz and Piermartini, 2018; Gereffi, 2015), ICTs (Gniniguè et al., 2023). More recently, a study explored and specifically highlighted the crucial role of sanitation, transport, ICT, and energy infrastructures on participation in CVM in Africa (Ketu and 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

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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 (Inglese-Lotz and Ajmi, 2021; Aliu, 2021; Vernet et al., 2019; Grimm et al., 2013).

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 shortfall goes far beyond a mere infrastructure deficit; it reflects a structural obstacle to economic and social development, to the industrialization of Africa (Djeunankan et al., 2024; Maruta, 2025). As climate considerations are increasingly taken into account in development policies, the challenge of universal access to electricity is becoming more complex.

Access to reliable and affordable electricity is a foundational enabler of industrialization and economic upgrading, which are essential for meaningful GVC participation. Production systems are powered by electricity, which also supports communication and logistics technologies and makes it easier to meet the quality standards demanded by multinational lead companies (Mensah et al., 2023). Both domestic businesses 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). 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. We are therefore interested in this work in the effect of access to electricity on participation in GVC in Africa.

Four significant additions to the body of literature are made by this study. First, it fills a gap in the literature by examining the effect of real electricity access rather than just production capacity on African nations' capacity to engage in global value chains (GVCs). Second, by concentrating solely on data relevant to Africa, the study offers empirical support for the continent's distinct institutional and infrastructure issues. Third, it provides specific insights for infrastructure investment and development planning by highlighting energy access as a crucial policy tool for boosting industrialisation 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 summarizes conclusion, 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 (Faße 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, Humphrey, & Sturgeon, 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 inside 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 of backward and forward integration provides an assessment of a nation's overall participation in global value chains (GVC). The participation of African countries to the later, have been shape not only with economics determinants but also with social, institutional and geographical factors. Each of these factors shapes not only the extent of integration but also the quality and sustainability of involvement in global production systems.

Empirical works demonstrate that economic factors such as market size, trade openness, labor costs, and infrastructure quality are central to GVC participation in Africa. Countries with expansive domestic markets and heightened integration into global trade tend to attract a greater influx of foreign direct investment (FDI) and global production networks. While low labor costs may initially serve as an enticing entry point, without concomitant productivity enhancements, this advantage remains ephemeral (Kowalski et al., 2015). Additionally, weak infrastructure, particularly in transport and logistics, raises transaction costs and undermines Africa's competitiveness in time-sensitive global production chains (UNCTAD, 2014). As Taglioni and Winkler (2016) underscore, macroeconomic stability and robust trade policies are imperative for fostering predictable conditions for enterprises engaged in Global Value Chains (GVCs). Consequently, fortifying economic fundamentals remains an essential prerequisite for attaining deeper integration into global production networks. Technology adoption and innovation capacity also shapes the depth and quality of Africa's GVC engagement, particularly in terms of access to digital infrastructure and automation, influences the ability of African firms to comply with global production standards and timelines (Gereffi, 2019). Nevertheless, numerous enterprises in the region are hindered by restricted access to production technologies and inadequate capacities for industrial learning and advancement (Humphrey & Schmitz, 2002). The deficiency of robust research and development (R&D) ecosystems also hinders value enhancement. Beneficial externalities from multinational corporations and engagement in learning-by-exporting can promote technological progress (Morrissey & Filatotchev, 2000). Therefore, improving Africa's innovation systems and digital infrastructure is essential for empowering firms to ascend to higher-value segments of global supply chains.

In addition to economic factors, GVC outcomes are greatly impacted by social determinants, especially human capital, demographics, and inclusion. The kinds of positions a nation can hold in the value chain depend on the workforce's education and skill level; functional upgrading is made possible by more skilled workers (Auktor, 2020). Labour-intensive manufacturing could benefit from Africa's expanding youth population, but only if funds are allocated to vocational and technical education (AfDB, 2020). Furthermore, multinational corporations that care about ethical and sustainable supply chains are increasingly considering social inclusion, including gender equity in labour markets, when making sourcing decisions (Barrientos et al., 2011). African nations run the risk of being restricted to the low-value GVC segments if social inequality and skills gaps are not addressed.

Equally significant are the quality of institutions and the frameworks of governance, which exert a profound influence on participation in Global Value Chains (GVCs), not solely within Africa. This is because clear regulatory frameworks, quick customs procedures, and strong enforcement of property rights all help lower risks and costs for global companies (Dollar et al., 2005). Strong property rights and good governance can help backward GVC participation, which is when companies get their inputs from within the country, as well as total GVC participation (Alhassan et al., 2021). Some research indicates that nations with superior business climates, characterised by enhanced access to credit, streamlined trade processes, and effective contract enforcement, are more inclined to engage in Global Value Chains (Hammoudeh et al., 2023; Chala, 2024; Ajide, 2023). As well, weak institutions, on the other hand, stop companies from making long-term investments and getting into complicated parts of GVCs. Reforms that make trade easier and joining international agreements can help Africa's economy become more competitive and lower non-tariff barriers (Hoekman, 2014). The African Continental Free Trade Area (AfCFTA) is also a good thing because it could help make trade rules more consistent and make it easier for African countries to join global value chains (GVCs) (UNECA, 2021). For effective GVC engagement, institutional reforms must go hand in hand with economic and industrial strategies.

Finally, geographical factors either facilitate or hinder GVC integration. Proximity to major global markets such as Europe and Asia enhances competitiveness by lowering shipping times and costs (Venables, 2003). Through lower trade

costs and easier access to markets, regional integration like that provided by the African Continental Free Trade Area (AfCFTA) can improve GVC participation (Mélo & Solleder, 2025). However, many African countries are landlocked or distant from trade hubs, facing logistical constraints that inhibit trade performance (Limao & Venables, 2001). Additionally, although natural resource endowments allow for participation in primary commodity chains, this often leads to specialization in low-value-added activities with limited prospects for upgrading (Kaplinsky & Morris, 2003). Accordingly, regional integration and investment in cross-border infrastructure are necessary to overcome geographical barriers and expand opportunities for meaningful GVC participation.

3. Methods

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. Some use import-export (Hayakawa and Mukunoki, 2021), MVC participation indices from the TiVA database (Yanikkaya and Altun, 2020; Banga, 2016; Hu et al., 2021; Banerjee and Zeman, 2022), UNIDO's Indstat2 (2016) and many other indicators drawn from national, sub-regional and regional databases. 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 (GVC_i) is then obtained as follows:

$$GVC_i = DVX_i + FVA$$

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 Svirydzienka (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 and Meierrieks, 2021; Kar and Özşahin, 2016; Iddrisu and al., 2024; Kothakapa and 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 and 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 and 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 and Ibhagui, 2021).

Table 1. Correlation matrix

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (10) | (12) | (13) | (14) |
|-------------------------------|---------|---------|---------|---------|---------|---------|---------|--------|---------|---------|---------|--------|
| (1) 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 |

4. Result and Discussions

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 and 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

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

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 favorable 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.

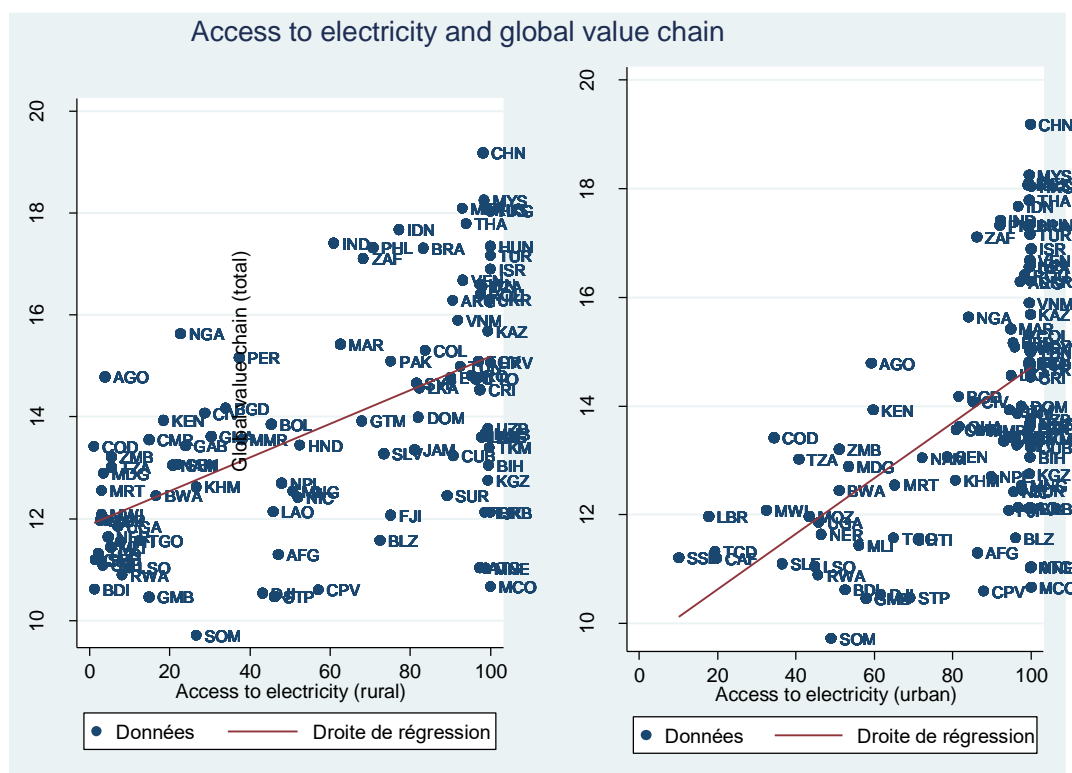


Figure 2. Correlation between access to electricity (rural, urban) and global value chain

Table 3. Alternative measures of access to electricity

| Variables | Dependent variable : GVC participation (ln) | | | |
|--------------------------------|---|------------------------|------------------------|------------------------|
| | (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*** (0.7726) | 2.2107** (0.8586) | 1.6133** (0.6803) | 3.8043*** (0.6745) |
| Internet | 0.0135*** (0.0022) | 0.0114*** (0.0026) | 0.0103*** (0.0023) | 0.0203*** (0.0030) |
| Secondary education | 0.0177*** (0.0025) | 0.0246*** (0.0027) | 0.0256*** (0.0022) | 0.0211*** (0.0025) |
| Inflation | -0.0036*** (0.0011) | -0.0038** (0.0015) | -0.0028** (0.0011) | -0.0045*** (0.0010) |
| Constant | 10.6785*** (0.1566) | 11.5644*** (0.1586) | 13.6853*** (0.3139) | 10.9724*** (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

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 and 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.

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.

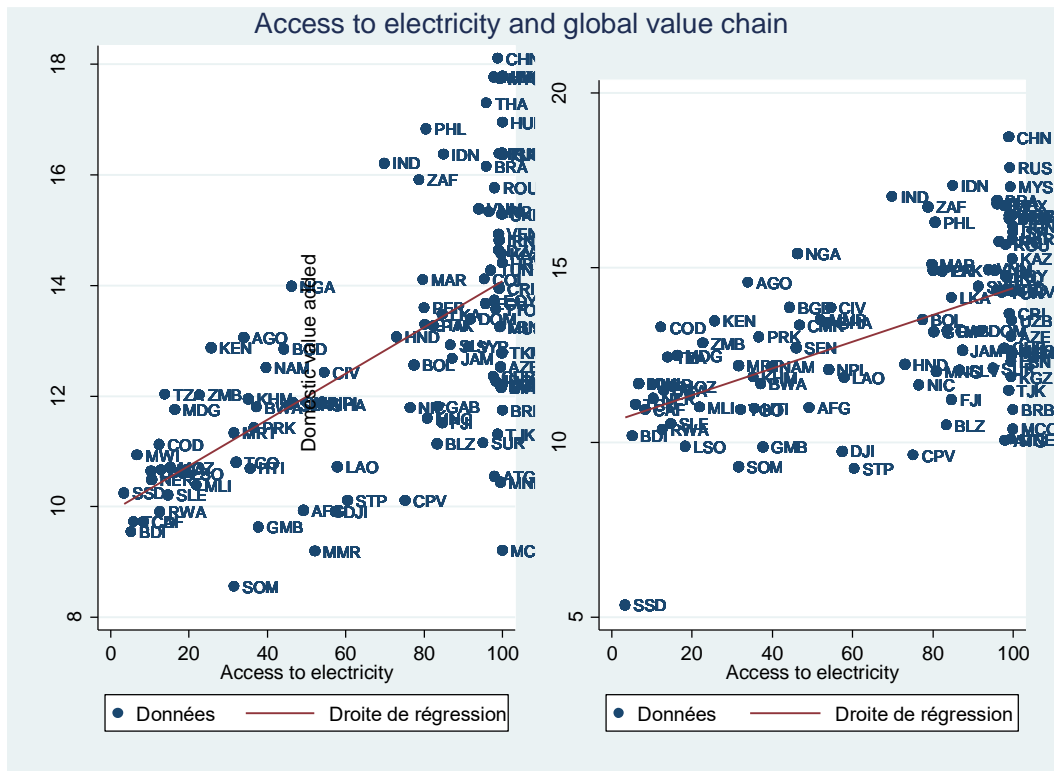


Figure 3. Correlation between access to electricity and domestic and foreign value added

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

| Variables | FVA | | | | | DVX | | | | |
|--------------------------------|---------------------------|---------------------------|----------------------------|----------------------------|---------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| Electricity_access (total) | 0.0254** * (0.0034) | | | | | 0.0189*** (0.0034) | | | | |
| Electricity_access (urban) | | 0.0222** * (0.0021) | | | | | 0.0142*** (0.0022) | | | |
| Electricity_access (rural) | | | 0.0066** (0.0028) | | | | | 0.0038 (0.0029) | | |
| Renewable energy consumption | | | | -0.0319*** (0.0044) | | | | | -0.0336*** (0.0044) | |
| Fossil fuel energy consumption | | | | | 0.0273** * (0.0048) | | | | | 0.0212*** (0.0050) |
| Financial development | 2.0994** * (0.8085) | 2.7536** * (0.7677) | 2.4798*** (0.8543) | 2.0948*** (0.7033) | * (0.6660) | 2.1599*** (0.8258) | 2.6139*** (0.8165) | 2.4066*** (0.8750) | 1.7526** (0.6946) | 3.6920*** (0.6931) |
| Internet | 0.0075** * (0.0023) | 0.0127** * (0.0022) | 0.0107*** (0.0026) | 0.0092*** (0.0024) | * (0.0029) | 0.0090*** (0.0024) | 0.0127*** (0.0023) | 0.0107*** (0.0027) | 0.0096*** (0.0023) | 0.0205*** (0.0031) |
| Secondary education | 0.0196** * (0.0027) | 0.0172** * (0.0025) | 0.0232*** (0.0027) | 0.0267*** (0.0022) | * (0.0025) | 0.0197*** (0.0027) | 0.0193*** (0.0026) | 0.0251*** (0.0028) | 0.0257*** (0.0022) | 0.0229*** (0.0026) |
| Inflation | -0.0022* (0.0012) | -0.0014 (0.0011) | -0.0027* (0.0015) | -0.0005 (0.0012) | -0.0020* (0.0010) | -0.0047*** (0.0012) | -0.0043*** (0.0012) | -0.0040** (0.0016) | -0.0035*** (0.0012) | -0.0052*** (0.0011) |
| Constant | 9.7072** * (0.1511) | 9.2785** * (0.1556) | 10.3872** * (0.1578) | 12.2393** * (0.3245) | 9.6268** * (0.2545) | 10.6692** * (0.1543) | 10.4513** * (0.1655) | 11.0712** * (0.1616) | 13.1408** * (0.3205) | 10.5670** * (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

Table 5. Additional control variables

| Variables | Dependent variable : GVC participation (ln) | | | |
|----------------------------|---|------------------------|------------------------|------------------------|
| | (1) | (2) | (3) | (4) |
| Electricity_access (total) | 0.0234*** (0.0033) | 0.0218*** (0.0032) | 0.0204*** (0.0033) | 0.0174*** (0.0030) |
| Financial Development | 1.9015** (0.7968) | 1.8354** (0.7727) | 1.7038** (0.7729) | 1.5909** (0.6986) |
| Internet | 0.0089*** (0.0023) | 0.0099*** (0.0022) | 0.0101*** (0.0022) | 0.0076*** (0.0020) |
| Secondary education | 0.0190*** (0.0026) | 0.0196*** (0.0026) | 0.0213*** (0.0026) | 0.0120*** (0.0025) |
| Inflation | -0.0042*** (0.0012) | -0.0058*** (0.0012) | -0.0065*** (0.0012) | -0.0065*** (0.0011) |
| Natural resources rent | | 0.0202*** (0.0036) | 0.0220*** (0.0036) | 0.0223*** (0.0033) |
| Employers | | | -0.0641*** (0.0218) | -0.0527*** (0.0197) |
| Livestock production | | | | 0.0116*** (0.0011) |
| Constant | 11.0099*** (0.1489) | 10.8633*** (0.1468) | 11.1026*** (0.1599) | 10.6723*** (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 6. GMM estimation technique

| Variables | Dependent variable : GVC participation (ln) (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. Conclusions

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.

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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