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**INFRASTRUCTURAL DEVELOPMENT AND ECONOMIC GROWTH IN  
SUB-SAHARAN AFRICA**

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**Abstract**

The impact of infrastructure on economic growth in Africa is still not clear as some argued that its impact is not significant, others posited that it is significant to developed economies alone. This study examined the relationship between infrastructural developments using electricity on economic growth in Sub-Saharan Africa (SSA). The study also examined the causal link between the variables that will influence economic growth in SSA countries. The study employed descriptive and panel econometric procedure. Annual secondary data, spanning from 1990 to 2021 and encompassing ten strategically selected countries grouped into landlocked (Central African Republic, Ethiopia, Zimbabwe & Congo, Sudan), costal (Nigeria, Mozambique, Gabon & Senegal) and insular (Mauritius). The data for the analysis were sourced from World development indicators (WDI) and Worldwide Governance indicators (WGI), Data were analysed using tables, graphs, panel autoregressive distribution lag. Fully modified ordinary least square and Dumitrescu & Hurlin and Granger causality test. The findings revealed a short-term insignificant but positive impact of electricity supply infrastructure on development and foreign direct investment on economic growth. The causality tests confirmed bidirectional relationships, emphasizing the interdependency nature between economic growth and infrastructural development in Sub-Saharan African countries. This study therefore concludes that SSA's economic development significantly depend on functional infrastructure provision and thus suggesting that government needs to formulate and implement sustainable policy strategies that encompass diverse infrastructural components to promote economic growth in SSA. The study also concludes that there is spiral effects and reverse causation which implies that promoting infrastructure development promotes economic growth and higher economic growth also consequently leads to better infrastructure development. It recommends policymakers should adopt an integrated approach to development planning, recognizing the interdependencies among sectors. Comprehensive strategies that synchronise investments in electricity, education, health, and information communication technology can create a synergistic effect that will foster sustainable and inclusive economic growth in SSA countries.

**Keywords; Infrastructure, economic growth, development and Africa.**

## 1.1 Introduction

Recently economic growth is associated with sustainability, that is, economic growth and development has to meet present needs without the risk that future generations will not meet their needs. It is also an important measure of a nation's prosperity, but it does not always translate to the well-being of the population (Lukasz, 2014; Idoko, Olufem & Oyende 2024). The major source of per capita output in any country; whether developing or developed, with a market economy or centrally planned is an increase in productivity. Per capita output growth is however an important component of economic welfare, (Abramowitz, 1981). From experience, it has been revealed that human beings are the most important and promising source of growth in productivity and economic growth. Equipment and technology are products of human minds and can only be made productive by people. The success of any productive program depends on human innovative ideas and creativity. Infrastructure development has gained increased interest from scholars due to its impact on economic growth, particularly in African countries (Davidmac et al., 2021). However, the impact of infrastructure on economic growth in Sub-Saharan Africa is debated, with some arguing it is insignificant or does not improve living standards (Odongo & Ojah, 2016). Economic growth requires factors like technology, human capital development, stable macroeconomic policies, and infrastructure (Akeju et al., 2022). Sub-Saharan Africa faces significant infrastructure gaps compared to other regions, hindering its socioeconomic development (Pieterse & Hyman, 2014; Estache & Garsous, 2012). The region requires substantial infrastructure investments, estimated at 4-15% of its GDP (Estache & Garsous, 2012). Reliable electricity supply is crucial for economic activities and improving living standards, but Sub-Saharan Africa faces an electricity crisis (Egbo, 2018).

Infrastructure drives growth and vice versa through the need for more infrastructure as an economy grows. Chengete and Alagidede (2018) reported that unreliable, insufficient, and costly infrastructure across the African continent has arguably been the damaging weakness to higher and more inclusive growth and socio-economic development of the region. Decades of economic stagnation and declining living standards have made Sub-Saharan Africa the poorest region in the world (Bagnoli et al., 2021; Egbo, 2018). Extensive research has investigated the link between infrastructure and economic growth and productivity, dating back to Aschauer in 1993. Adequate infrastructure services have long been viewed as crucial for economic growth in other regions. However, Sub-Saharan Africa ranks at the bottom of all developing regions due to inadequate infrastructure.

The region's infrastructure lag is attributed not only to financial or technical constraints but also the inability to embrace new business models for integrated regional corridors, urban-rural agglomerations, and evolving value chains with associated infrastructure services that could propel human development. The rate of electricity supply in Sub-Saharan Africa is substantially lower than expected, given the region's income levels and electric grid footprint. Limited access to electricity, good roads, healthcare, and education imposes significant constraints on modern economic activities, quality of life, and the adoption of new technologies across various sectors, including education, agriculture, finance, health, and manufacturing. Social sectors depend heavily on electricity, yet households and firms endure several hours a day without power, and many children are out of school, contributing to high premature death rates. Insecurity and social unrest

are high due to the high cost of living, and frequent blackouts limit the potential utilization of available power.

Many of these problems are blamed on inadequate supply of electricity, poor education, poor health services, poor information systems, and poor road networks. It is argued that if adequate infrastructure supply can stimulate employment and income-generating activities in developed economies, Africans could build assets through micro/small-sized production activities like fashion design if given the same opportunities. However, the level of investment required to enhance this development in Sub-Saharan Africa has not received wide investigation that could bring about meaningful development to alleviate abject poverty. This study therefore seeks to examine the impact electricity infrastructure on economic growth in Sub-Saharan Africa countries. Chapter one is about the introduction, chapter two is on literature review, chapter three is on methodology four is on data analysis and chapter five is on conclusion and recommendation

## 2...0 Literature Review

This section centers on the brief concepts of infrastructural development and economic growth. Infrastructure is defined in various ways depending on the context and purpose of discussion. Stupak (2018) highlights that infrastructure encompasses a wide range of physical and non-physical components, including transport, energy, telecommunications, and basic utilities. Social infrastructure also plays a crucial role in facilitating investment in human capital, thereby enhancing workforce productivity and improving the quality of life (Fedderke & Garlick in Streatfeild, 2018). The impact of infrastructure on economic growth is multifaceted, with several channels through which it influences national output and development (Bronzini & Piselli, 2009). Some scholars view infrastructure as a factor of production that directly induces economic growth, while others argue that it complements other production factors and stimulates factor accumulation (Aschauer, 1993; Barro, 1990; Fedderke & Garlick, 2008). Furthermore, infrastructure investment can boost aggregate demand, direct industrial policy, and indirectly affect economic growth (Kodongo & Ojah, 2016). In sub-Saharan Africa, hard infrastructure is essential for running modern economies, while soft infrastructure, including institutional frameworks and governance mechanisms, supports the operation and development of physical infrastructure (Trisnowati et al., 2021).

The importance of infrastructure in economic growth is further underscored by the classical and neo-classical economists, who emphasize factors such as investments, improvements in productive capacity, and the utilization of land, labour, and capital (Pietak, 2014). While classical economists like Smith and Ricardo focus on production and the "Law of markets," Marx and Keynes highlight the role of effective demand in economic growth (Pietak, 2014). Modern theories of economic growth, as articulated by Sala-i-Martin (2001) and Solow (1957), emphasize the accumulation of physical and human capital, technological development, institutional diversity, and free mobility of factors of production and information. In the context of sub-Saharan Africa, infrastructure development is crucial for fostering economic growth and overcoming the challenges of poverty and inadequate access to basic services (Moussa et al., 2018; Palei, 2015; Whyte et al., 2020). However, the region still faces significant gaps in infrastructure development, particularly in electricity production and transport, which hinder its overall economic progress (Gurara et al.,

2018). To address these challenges, concerted efforts are needed to improve both hard and soft infrastructure, enhance reliability and affordability of utilities, and promote regional cooperation in infrastructure development (Gurara et al., 2018; Trisnowati et al., 2021).

The empirical literature on infrastructure's effects on economic growth highlights its long-term contribution to aggregate income or productivity. Many studies, including Odongo and Ojah (2016) and Whyte et al. (2020), have found a positive relationship between infrastructure and economic growth. Davidmac et al. (2022) further confirm that both aggregate and disaggregated infrastructural development indices positively impact GDP per capita growth in Africa. Alma et al. (2022) discuss different approaches to this relationship, emphasizing the positive effects of infrastructure on growth and convergence, particularly in the context of ICT and transport infrastructure. Apurv and Uzma (2020) argue for more electricity generating capacity, identifying it as having the greatest positive impact on economic growth in Ghana.

Measurement issues and simultaneity complicate the interpretation of infrastructure's impact on growth (Calderón and Servén, 2010). Nonetheless, studies consistently find a positive long-run effect of infrastructure on output and productivity. Infrastructure development can also influence income inequality positively. Andersen and Dalgaard (2013) find that electricity quality significantly affects economic growth in Sub-Saharan Africa, with outages leading to reduced growth rates. Despite progress in infrastructure development, challenges remain, with a substantial portion of Africa's population lacking access to basic services like electricity, roads, and telecommunications. The high cost of addressing the infrastructure deficit underscores the need for sustained investment and improved maintenance (World Bank, 2013).

### 3.0 Methodology

The data used for this analysis are secondary data. Data on electricity generation and economic growth were sourced from World Bank Development indicator (WBDI), reputable Journals, AIDB, World development indicators (WDI) and Worldwide Governance indicators (WGI), with emphases on the selected Countries. This study span through the year 1991 to 2021.

#### Model Specification

Following the theoretical framework of Solow growth model upon which the study anchors, two multiple regression models are specified to capture the interaction between economic growth and electricity infrastructure in SSA between 1990 and 2021. To incorporate the extended Solow growth model into an econometric model to capture the growth model and electricity supply models, we modify the equation thus;

$$\ln(Y_{it}) = \alpha + \beta_1 \ln(K_{it}) + \beta_2 \ln(ELS_{it}) + \beta_3 \ln(GSH_{it}) + \beta_4 \ln(GED_{it}) + \beta_5 \ln(IFR_{it}) + \beta_6 \ln(EXR_{it}) + \beta_7 \ln(E_{it}) + \epsilon_{it} \quad 1$$

Adapting equation 1 into the current study requires the introduction of the current variables with the control variables. The new model will be

$$PGDP_{it} = \alpha_0 + \beta_1 \ln ELS_{it} + \beta_2 \ln GED_{it} + \beta_3 \ln GSH_{it} + \beta_4 \ln GSE_{it} + \beta_5 \ln ICT_{it} + \epsilon_{it} \quad 2$$

Where  $\ln(Y)$  is the natural logarithm of output,  $\ln(K)$  is the natural logarithm of the capital stock,  $\ln(E)$  is the natural logarithm of electricity supply,  $\ln(I)$  is the natural logarithm of infrastructure,  $\ln(AL)$  is the natural logarithm of labour,  $\alpha$  is the intercept,  $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$  and  $\beta_7$  are the coefficients of the respective variables, and  $\varepsilon$  is the error term. Reason for the natural logarithm is due to transformation of the production function (Cobb-Douglas production function) into linearity assumption of OLS estimation technique. Adapting equation 3.8 into the current study requires the introduction of the current variables as expressed in the objectives and the specification of the

**Model**

$$\Delta \ln PGDP_t = \alpha_0 + \sum_{l=1}^k \alpha_{1l} \Delta \ln PGDP_{t-l} + \sum_{l=0}^k \alpha_{2l} \Delta \ln GSE_{t-l} + \sum_{l=0}^k \alpha_{3l} \Delta \ln EI_{t-l} + \sum_{l=0}^k \alpha_{4l} \Delta \ln GFCF_{t-l} + \sum_{l=0}^k \alpha_{5l} \Delta \ln FDI_{t-l} + \sum_{l=0}^k \alpha_{6l} \Delta \ln ED_{t-l} + \sum_{l=0}^k \alpha_{7l} \Delta \ln EG_{t-l} + \beta_1 \ln PGDP_{t-1} + \beta_2 \ln GSE_{t-1} + \beta_3 \ln EI_{t-1} + \beta_4 \ln GFCF_{t-1} + \beta_5 \ln FDI_{t-1} + \beta_6 \ln ED_{t-1} + \beta_7 \ln EG_{t-1} + \beta_8 \ln PGDP_{t-1} + \varepsilon_t \tag{3}$$

Where: PGDP =Per capita gross domestic product which measures Economic growth at time t, ELS =Electricity supply at time t, EG=Stands for electricity generation at time t.(kwi), ED= Connote the electricity distribution at time t.(kwi), GHS =Government spending on health at time t. (\$), GED =Government spending on Education (\$), ICT = Information and communication technology (no of servers),  $\beta_0$ = the constant term also known as the Intercept term,  $\varepsilon_t$  =the Error term and  $\beta_1$  to  $\beta_5$  are the estimated parameters of the regression model,  $\Delta$  =the change Operator while  $\gamma (1 - \sum_{i=1}^p \delta_i)$  represent the speed of adjustment parameters with a negative sign. ECT ( $\ln Y_{t-1} - \theta X_t$ ), represent the error correction term and lastly,  $\beta, \alpha$  and  $\lambda$  are the estimation parameters that represent the short run dynamic coefficient of the model's adjustment long run equilibrium.

To prevent a spurious regression, the study conducted a unit root test first to confirm the stationary of each variable. In recent years, several investigators, including Levin, Lin and Chu (2002), Maddala and Wu (1999), Choi (2001), Hadri (1999), and Im, Pesaran and Shin (2003), have developed panel-based unit root tests that are similar to tests carried out on a single series. The Pedroni panel ARDL co-integration approach tests the null hypothesis of no co-integration using the following equation:

$$\Delta y_t = \alpha_i + \beta_i L(\Delta y_t) + \sum_{j=1}^p \gamma_{ij} \Delta x_{tj} + \sum_{j=1}^p \delta_{ij} L(\Delta x_{tj}) + \mu_{it} \tag{4}$$

where  $\Delta$  is the first difference operator,  $y_t$  is the dependent variable,  $\alpha_i$  is the individual-specific intercept,  $L$  is the lag operator,  $\beta_i$  is the coefficient on the lagged dependent variable,  $\Delta x_{tj}$  is the  $j$ th independent variable,  $\gamma_{ij}$  and  $\delta_{ij}$  are the co-efficient on the current and lagged values of the  $j$ th independent variable, respectively,  $p$  is the maximum lag order, and  $\mu_{it}$  is the error term.

One of the estimators commonly used to estimate panel data models is the mean group estimator, which consists of averaging individual estimates for each group in the panel. This estimator, according to Pesaran, Shin & Smith (1999) produces consistent estimates of the parameters' averages while allowing the parameters to be freely independent between groups, and does not take potential homogeneity across groups into account. The random or fixed effects and GMM approaches are the second method. These models need equal parameters across nations, which

may result in inconsistent and misleading long-term co-efficients, an issue that is compounded when the time frame is long. To address this issue, Pesaran et al. (1999) suggested an intermediate estimator that permits short-term parameters to fluctuate between groups while requiring long-term co-efficient to be identical across nations.

#### 4. Results and Discussion

Table 1: Correlation Matrix showing relationship among the variables.

	PGDP	ELS	EG	ED	GSH	GSE	ICT	GFCF	EI
ELS	0.82365								
EG	0.4117	0.650519							
ED	0.827529	0.756361	0.378704						
GSH	-0.16821	-0.23795	-0.11737	0.059212					
GSE	-0.13579	-0.07382	0.110462	0.191605	0.286452				
ICT	0.091239	0.124961	0.189346	0.035382	-0.05934	-0.04052			
GFCF	-0.01788	0.092717	0.225344	-0.21033	-0.21289	-0.11948	0.49851		
EI	0.743491	0.741465	0.314366	0.797194	-0.00314	0.16391	0.15814	0.064016	
FDI	-0.01136	0.058722	0.079475	-0.13199	-0.04224	-0.09445	0.102964	0.608849	0.0

Source: Author's Computation (2023)

From Table 1, the strong positive correlations between per capita GDP and both electricity supply and electricity distribution at 0.82365 and 0.827529, respectively, underscore the essential role of energy infrastructure in driving economic growth.

Notably, the negative correlations between government spending on health and per capita GDP (-0.168206) and government spending on education and per capita GDP (-0.135793) suggest that higher investments in these sectors do not necessarily immediately translate to economic prosperity, pointing to potential lags in impact. The robust positive correlation of 0.743491 between PGDP and the education index emphasizes the critical link between education and economic development. Additionally, the relatively low correlation (0.011359) between foreign direct investment and PGDP suggests that while FDI plays a role, other factors contribute more significantly to a country's overall economic prosperity. Overall, this comprehensive analysis underscores the complex inter-dependencies among key economic indicators in SSA, providing valuable insights for policymakers aiming at fostering sustainable development in the region.

Table 2: Panel unit root test showing the level of significant at 1%

Variable	Levin-Lin-Chu (LLC)			Im-Pesaran-Shin (IPS)		
	Level	1st Difference	Remark	Level	1st Difference	Remark
LNPGDP	-0.20268	-7.04012*	I(1)	1.65432	-9.37123*	I(1)
LNELS	-6.01229*	-	I(0)	-0.69733	-11.6847*	I(1)
LNEG	-0.93919	-6.70178*	I(1)	-0.66008	-8.37420*	I(1)
LNED	-0.80554	-10.6282*	I(1)	1.18533	-10.3835*	I(1)
LNGSH	-0.28806	-5.28691*	I(1)	-0.82065	-7.76926*	I(1)
LNGSE	-0.87494	-9.38028*	I(1)	-0.71596	-9.52961	I(1)

LNICT	2.05889	-5.05972*	I(1)	0.43086	-5.62968*	I(1)
LNGFCF	1.65316	-6.08618*	I(1)	3.04563	-8.10548*	I(1)
LNEI	-3.87068*	-	I(0)	0.68367	-5.90559*	I(1)
LNFDI	-1.41382	-5.85245*	I(1)	-1.13111	-11.8462*	I(1)

Source: Author's computation (2023)

Note: \* indicate significance at 1% level.

The Panel Unit Root Test, as depicted in Table 2, assesses the stationarity properties of the logarithmic transformations of various variables, using the Levin-Lin-Chu (LLC) and Im-Pesaran-Shin (IPS) tests. The LNPGDP and LNEG exhibit unit root behaviour in their levels but become stationary in their first differences, denoted as I(1). This suggests that these variables are integrated parts of order one and that their growth rates, rather than absolute levels, are more suitable for analysis. Natural Log of Electricity Supply and Education Index remain stationary at level (I(0)), indicating no need for differencing. However, Natural Log of the per capita GDP, Electricity Generated, Electricity Distribution, Government Spending on Health, Government Spending on Education, Information and Communication Technology, Gross Fixed Capital Formation and Foreign Direct Investment, all show unit root behavior in their levels, but become stationary in first differences (I(1)), highlighting the importance of considering growth rates when examining these variables.

#### Panel Co-integration Test

Based on the findings from the panel unit root analysis, the Pedroni Co-integration Test emerges as a more appropriate selection than the Westerlund test in examining potential co-integration among the variables. This preference is rooted in the fact that the Pedroni test accommodates the possibility of distinct levels of integration among the variables, permitting the inclusion of both I(0) and I(1) variables within a single analysis, which aligns with the observations from the panel unit root analysis. In contrast, the Westerlund test assumes that each individual time series variable is integrated at order one, or I(1).

Table 3: Pedroni Co-integration Test Result

Test statistics	Panel	Group
V-statistic	-0.239190 (0.5945)	-
Rho-statistic	1.233587 (0.8913)	2.202236 (0.9862)
t-statistic	-2.050862 (0.0201)	-2.135016 (0.0164)
ADF-statistic	-2.376269 (0.0208)	-2.144145 (0.0160)

Source: Author's Computation from Eviews 13

Note: The probability values are in parenthesis

Based on the majority of alternative test statistics, in comparison to the conventional significance level of 0.05, the null hypothesis suggesting no co-integration is to be rejected, while the alternative

hypothesis indicating the presence of co-integration is to be accepted. This suggests that there is indeed co-integration, implying a long-term relationship among the variables.

#### Panel ARDL Long and Short Run Estimates

##### Impact of Information and Communication Technology on Economic Growth

In the short run, Information and Communication Technology (ICT) its lagged values ( $D(LNICT)$  and  $D(LNICT(-1))$ ) do not exert statistically significant effects on LNPGDP in the short run, thereby indicating that changes in ICT infrastructure may not have an immediate impact on economic output. The education index (LNEI) and its lagged values similarly show non-significant short-term impacts on LNPGDP, suggesting that improvements in education may take time to manifest in immediate economic growth. Foreign direct investment (FDI) and electricity distribution (LNED) also exhibit non-significant coefficients in the short run, indicating that changes in these variables do not immediately impact LNPGDP. The positive and non-significant co-efficient for electricity generated (LNEG) suggest a potential positive impact on LNPGDP in the short term. These findings highlight potentially-delayed effects of education, foreign investment, and energy infrastructure on short-term economic growth in the region.

In the long run, the negative and significant co-efficient for Information and Communication Technology (ICT), in the long run (-0.232583), suggests that, in the absence of other factors, increases in ICT infrastructure may have a dampening effect on long-term economic output. This result might be attributed to challenges associated with rapid technological advancements, such as potential disruptions in traditional economic sectors. The highly significant positive impact of the education index (LNEI) reaffirms the well-established intuition that improvements in education foster sustained economic growth by enhancing human capital. Foreign direct investment (FDI) and electricity distribution (LNED) play pivotal roles in shaping the long-term trajectory of LNPGDP, reflecting their importance in sustaining economic development. These long-run estimates provide insights into the persistent effects of education, foreign investment, and technology on economic growth in the region, guiding policymakers towards effective and sustainable development strategies.

#### Causality test

Table 4: Pairwise Dumitrescu Hurlin Panel Causality Tests

Sample: 1990 2021			
Lags: 2			
Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
PGDP does not homogeneously cause ICT	9.46822	9.72482	0.0000
ICT does not homogeneously cause PGDP	2.73185	0.74385	0.457
PGDP does not homogeneously cause ELS	3.63363	1.94610	0.0516
ELS does not homogeneously cause PGDP	4.39512	2.96132	0.0031
PGDP does not homogeneously cause GSH	4.55313	3.17198	0.0015

GSH does not homogeneously cause PGDP	3.86144	2.24982	0.0245
PGDP does not homogeneously cause GSE	4.87061	3.59526	0.0003
GSE does not homogeneously cause PGDP	5.54942	4.50025	7.E-06

Source: Author's Computation from Eviews 13

The Pairwise Dumitrescu Hurlin Panel Causality Tests provide valuable insights into the directional relationships between key economic indicators in Sub-Saharan African countries. The results indicate a significant homogeneous causality running from per capita GDP (PGDP) to information and communication technology (ICT), suggesting that economic growth stimulates the development and adoption of technological infrastructure. This is intuitive, as higher economic output can afford investments in advanced technologies, fostering innovation and efficiency gains. Conversely, the test reveals that ICT does not homogeneously cause PGDP. This implies that while technological advancements are influenced by economic growth, they do not uniformly drive overall economic output. Notably, the causality tests highlight a bidirectional relationship between PGDP and electricity supply (ELS), emphasizing the symbiotic nature of economic growth and energy infrastructure. The results also suggest that economic growth homogeneously causes government spending on health (GSH) and education (GSE), thus underscoring the role of a thriving economy in facilitating increased investments in these essential sectors. In essence, the causality tests reflect the inter-connectedness of economic growth and infrastructure development in Sub-Saharan Africa, emphasizing the need for a holistic approach whereby improvements in economic conditions drive advancements in crucial infrastructural domains, and reciprocally, strategic investments in infrastructure contribute to sustained economic growth.

### 4.3 Panel ARDL Long and Short Run Estimates

Table 4.5: ARDL Estimates

Dependent Variable: LNPGDP			Dependent Variable: LNPGDP		
Variables	Coefficient	Status	Variables	Coefficient	Status
Short Run			Short Run		
D(LNPGDP(-1))	-0.039045	NS (0.5869)	D(LNGSH)	-0.074305	0.4815
D(LNELS)	1.451403	NS (0.3032)	D(LNGSH(-1))	-0.067239	0.5692
D(LNELS(-1))	-0.357723	NS (0.4817)	D(LNEI)	0.152234	0.9166
D(LNEI)	3.056530	S (0.0020)	D(LNEI(-1))	-4.075703	0.0132
D(LNEI(-1))	-3.510415	NS (0.1245)	D(FDI)	0.179401	0.5832
D(FDI)	0.247587	NS (0.4040)	D(FDI(-1))	-0.005481	0.9659
D(FDI(-1))	0.039572	NS (0.6617)	D(LNED)	0.223516	0.4060
D(LNED)	0.343956	NS (0.0417)	D(LNED(-1))	0.036247	0.8251
D(LNED(-1))	0.282849	NS (0.1953)	D(LNEG)	0.130209	0.4876

D(LNEG)	0.029966	NS (0.9287)	D(LNEG(-1))	0.150092	0.4192
D(LNEG(-1))	0.006430	NS (0.9739)	C	2.786522	0.0073
C	4.442407	S (0.0018)	Long Run		
Long Run			LNGSH	-0.232583	0.0104
LNELS	-0.539738	NS (0.0655)	LNEI	1.431461	0.0000
LNEI	4.856423	S (0.0000)	FDI	1.032126	0.0000
FDI	0.190787	S (0.0000)	LNED	-0.617963	0.0000
LNED	-0.844722	S (0.0003)	LNEG	0.030471	0.3280
LNEG	-0.054118	NS (0.5357)			

Source: Author's Computation from Eviews 13

#### 4.3 Long and Short Run P-ARDL Discussion of Results

In the short run, the panel ARDL estimates for the natural logarithm of per capita GDP (LNPGDP) revealed intriguing dynamics. The negative and non-significant co-efficient for the lagged values of LNPGDP (-0.039045) implies that short-term deviations from the equilibrium are self-correcting, although this effect does not reach conventional levels of statistical significance. The positive impact of electricity supply (LNELS) on LNPGDP (1.451403), while not statistically significant, aligns with economic intuition, as a temporary boost in energy availability could stimulate economic activity. Remarkably, the highly significant positive co-efficient for the education index (LNEI) in the short run (3.056530) suggests that improvements in education have an immediate and substantial impact on economic output. While foreign direct investment (FDI) and electricity distribution (LNED) also contribute positively to LNPGDP in the short run, the lack of statistical significance indicates caution in drawing strong conclusions about their immediate effects. These short-run dynamics underscore the relationship between education and economic growth, emphasizing the need for targeted policy interventions to enhance human capital and infrastructure for rapid economic gains.

In the long run, the panel ARDL estimates shed light on sustained relationships among variables. The negative co-efficient for electricity supply (LNELS) in the long run (-0.539738) suggests that an increase in long-term electricity supply may have a dampening effect on per capita GDP. This unexpected result prompts potential structural challenges or inefficiencies associated with increased electricity supply. On the other hand, the highly significant positive co-efficient for the education index (LNEI), in the long run (4.856423), reaffirms the crucial role of education in fostering persistent economic growth. Foreign direct investment (FDI) maintains a positive and statistically significant impact on LNPGDP in the long run (0.190787), emphasizing its role as a driver of sustained economic development. The negative and significant coefficient for electricity distribution (LNED) in the long run (-0.844722) suggests that challenges or inefficiencies in the distribution of electricity could have enduring adverse effects on economic output. The non-significant co-efficient for electricity generated (LNEG) in the long run prompts further exploration of its nuanced role in the region's economic landscape. These long-run estimates provide nuanced insights into the lasting effects of key variables on economic growth, offering valuable guidance for policy makers seeking to cultivate sustained and inclusive development in Sub-Saharan African countries.

## 5.1 Conclusion and Policy Remarks

### 5.2 Conclusion

This study offers an examination of the relationship between infrastructural development and economic growth in Sub-Saharan Africa (SSA). The empirical analysis, spanning 1990 to 2021 and encompassing ten strategically selected countries, reveals complex relationships that extend beyond traditional GDP-centric frameworks. While short-term dynamics underscore the positive impact of electricity supply, education, and foreign direct investment on economic growth, the long-term analysis shows unexpected complexities, particularly regarding the sustained effects of electricity supply this in line with the study of . Mathur, Oliver, and Tripney (2015) that conduct a systematic review of the impact of electricity supply on health, education, and welfare, including 51 studies in 24 countries in 3 continents, among them 14 African countries. The review showed that electricity access had positive and significant impacts on educational outcomes (study time, years of schooling, and school enrolment), with higher impacts for rural areas compared with urban areas. Also on income generation, the pooled estimate effect suggests that electricity access has an overall positive impact on household income in the farming and non-farming sectors.

Causality tests illuminate bi-directional relationships, emphasizing the inter-dependency nature between economic growth and infrastructure development. Bagnoli, Bertomeu-Sanchez, Estache, and Vagliasindi (2021) argued that insufficient power generation capacity limits economic growth in Ghana, and inadequate infrastructure facilities has contributed to high transaction cost of doing business in most sub-Saharan African countries. These resulted in the lowest level of productivity of all low-income countries, which made them the least competitive economies in the world. , Hence, this study contributes significantly to the academic discourse on SSA's development, guiding policymakers with evidence for formulating sustainable strategies that encompass diverse infrastructural components.

### 5.3 Policy Recommendation

Given the positive short-term impact of electricity supply on economic growth, policy makers should prioritise substantial investments in electricity infrastructure. This involves not only increasing generation capacity but also addressing distribution challenges. A reliable and widespread electricity network can serve as a catalyst for economic activities, encouraging industrialization and innovation.

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