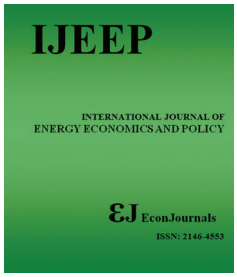

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Human Capital and Energy Infrastructure: Implications for Economic Growth in Nigeria

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ABSTRACT

Both hypothetical and empirical evidences have found the roles that human capital and energy infrastructure in spurring the economic growth of a nation as very germane. These key variables are undoubtedly working together in a quest to achieve equitable redistribution of the nation's economic resource and ensuring poverty reduction. This study is based on an attempt to use co-integration and ARDL modeling framework to examine the empirical evidence of the impact of the different components of human capital and energy infrastructure on economic growth in Nigeria between 1981 and 2018. Findings from the study showed that the quality of educational, transportation and communication facilities had a significant and contemporary influence on economic development. In the same way, investment in physical resources calculated by gross fixed capital development, quality of healthcare facilities, availability of power supply were also found to have a positive impact with a lag effect on economic growth. Implicitly, an increase in these facilities over the past decade in terms of their availability and efficiency would boost economic development over the current period. The study therefore recommended that education and health should be given an unwavering focus on investment by the policy maker as components of human capital coupled with energy infrastructure if the desired growth for which Nigeria aspires is to be attained.

Keywords: Human Capital, Energy Infrastructure, Economic Growth
JEL Classification: F, O4, Q4

1. INTRODUCTION

The literature on growth acknowledges that infrastructure serves as a catalyst for economic development by enhancing access to capital and through the influence of policy action. Other scholars such as Cesar and Surphid (1992), Ogbuozobe (1997), Munir and Khan (2018); Boisso et al. (2000), Babalola (2015) and Aregbesola and Kolawole (2015) have written all in favor of the value of sustainable growth and construction services. Infrastructure is divided into physical and social infrastructure, physical infrastructure is directly engaged in the production sectors, such as in agriculture, industry and trade. These include transport, power supply, irrigation and telecommunication. On the other hand, social infrastructure include health, education, nutrition, housing and water supply. These improve the standard of living, human development, economic growth and development of a nation. Rural infrastructural facilities constitute the substance of rural welfare. Efforts to raise rural welfare must necessarily go beyond the traditional and limited approach of rising per capital income through oil and agricultural development projects to the provision of basic needs for the populace. These may include electricity, treated pipe-borne water, good or accessible roads, health and medical facilities, telecommunication services, banks and schools.

Also, human capital development is essential because it is the only factor that co-ordinates all other factors of production for increasing productivity and economic growth. Both infrastructure and human capital are working hand in hand for economic growth. Many researchers have written on the importance of human capital and infrastructure on economic growth, Udah and Ebi (2017); Munir and Khan (2018); Enilolobo and Sodeinde (2019), and Bongani and Fyth (2013). Furthermore, notable researchers have

examined the relationship between human capital and performance of an economy. Mba et al. (2013), Eigbiremolan and Anaduaka (2014), Amassoma and Nwosa (2011) and Fashina et al. (2018). The findings from these work posits that there exist a direct nexus between human capital and growth of the nation's economy.

Infrastructure is divided into physical and social infrastructure, physical infrastructure is directly engaged in the production sectors, such as in agriculture, industry and trade. These include transport, power supply, irrigation and telecommunication. While the social infrastructure on the other hand comprises health, education, nutrition, housing and water supply. These improve the standard of living, human development, economic growth and development of a nation. Rural infrastructural facilities constitute the substance of rural welfare. Efforts to raise rural welfare must necessarily go beyond the traditional and limited approach of rising per capital income through oil and agricultural development projects to the provision of basic needs for the populace. These may include electricity, treated pipe-borne water, good or accessible roads, health and medical facilities, telecommunication services, banks and schools. Different authors have defined infrastructure in different ways, Adeyemi (1989) sees physical infrastructure as the totality of basic physical facilities upon which all other economic activities in the system significantly depend upon; from the view of Kusharjanto and Kim (2011), infrastructure is seen as the aggregate of resources in terms of facilities and mechanisms that support education, employment, health-care, community development, income distribution and social welfare. Akinyosoye (2010) considered infrastructure as an unpaid factor of production which tends to raise productivity of other factors while serving as intermediate inputs to production. Based on the opinion of Babatunde (2018), infrastructure is ranked as a strategic economic diver and serves as a catalyst for public development.

On the significance of public spending on infrastructure, Nwachukwu and Emoh (2011); Babalola (2015); Aregbesola and Kolawole (2015) and Connolly and Li (2016), all agreed that government investment in infrastructural development have positive effects on productivity and economic growth. Some writers have also established adirect linkage of infrastructure supply and foreign direct investment. According to the findings of Loree and Guisinger (1995); Morisse (2000); Asiedu (2000); Edun et al. (2013) an improved infrastructure can stimulate Foreign Direct Investment, encourage employment opportunities, increases the level of productivity and economic growth, from the above submission, the existience of energy infrastructure accelerates the establishment of industries, lay a solid foundation for a general boost in the productivity of the entire nation. This development is no doubt a catalysit for social welfare augmentation of the country. Invest in public infrastructure can cause GDP to rise (Rioja, 1999). Also, Boisso et al. (2000) wrote on the public infrastructure in U.S. productivity, Lim (2001) considered have infrastructure boost economic development in some regions in China, in their worked on productivity efficiency in Spain, while Teruel and Kuronda (2005) studied on Philippine agriculture sector. All these researchers examined the roles in which good infrastructure base can play in productivity and development of the countries involved and their contributions showed a positive effect on their economies.

Education is one of the major components of human capital development; others include health services and training. It increases skills and competencies of individuals as well as their productivity. Majority of developing economies (Nigeria inclusive) are blessed with abundant natural resources, but still unable to tap these resources and therefore remained under-developed, because of lack of well trained personnel to harness the resources. Human capital and economic growth can only be achieved and sustained through massive investment on education. Also, technological and efficiency as supported theoretically by Solow (1956) and empirically supported, developing economies should massively invest in human capital. It is when a country has a well-trained professionals and labour force that can match-up in the adoption of meaningful technology from the advanced economies.

Aparently, the robust and reliability of all these previous studies cannot be subjected to questioning. However, the identification of the core significance of energy infrastusture coupled with human capital development on Nigeria's growth performance is yet to be investigated from these scorlarly research output. Therefore, this creates the knowledge gap in which this study aims to fill. The objective of this study is therefore to examine the impact of human capital and energy infrastructure on economic growth in Nigeria.

2. REVIEW OF LITERATURE

On the impact of infrastructure development on economic growth in China, Pravakar et al. (2010) saw the country as a fastest growing economy. They therefore investigated the role of infrastructure in promoting their economic growth between 1975 and 2007 using a generalized Cobb-Douglas production to analyses their data. The study indicated that developing an economic policy that improves physical infrastructure and the development of human capital for long-term sustainable economic growth is important in order to develop economies. In addition, pointing to infrastructure position, Haider et al. (2012) studied how infrastructure impacts Pakistan's economic growth between 1972 and 2009. Information from the time series were obtained and their data were analyzed using OLS and Johansen co-integration methods. Their findings showed that infrastructure has contributed to Pakistan's economic growth in a positive and important way. Based on their results, they recommended that government and policy makers should concentrate more directly and indirectly on the development of Pakistan's infrastructure due to its contribution to economic growth. Manufacturing sector can not be left out in an effort to better create the link between infrastructure and economic development. It is because; formidable infrastructure base triggers manufacturing sector output while manufacturing sector performance in turn boosts economic growth. In an effort to accomplish this, Falaye et al. (2019) aalso argued that, some other variable such as inflation rate, exchange rate and utilization of resources must be well controlled.

Human capital is also considered as impetus for economic performace in every economy. The importance of human capital as the only factor of production that co-ordinates all other factors have been the focus of many researchers. Campbell and Agbiokoro (2014) took a critical consideration of how government spending in

human capital can spur economic growth of the Nigerian economy between 1980 and 2010. The paper made use of both OLS and three stages Least Square analytical technique to process their time series data. Their results showed that human capital along with technological development and human growth has a grow in the same direction with the growth of the economy of Nigeria. It also showed that effective and efficient training of employees enhances the growth of the economy. Therefore, the study recommended that proactive steps must be taken by policy maker and economic managers to channel more resources in to the development of human capital, and also have effective and efficient training to lay good foundations for private sector growth in the country.

In addition to contributing to the role of human capital in economic growth, Mba et al. (2013) investigated the importance of human capital development to Nigeria's economic growth. For their study they have adopted the Ordinary Least Square (OLS) system. Their study results show that there is a close link between the production of human capital and economic growth. The study suggested that a workable policy should be placed in place which would support the manpower needed in the economy. We also proposed that health and education investments should be used efficiently and effectively to improve the country's quality of health services and education system. In supporting economic development in Nigeria, Fashina et al. (2018) showed that Nigeria 's development is responsive to human resources. By implication government spending on education will foster development in Nigeria with additional aid inflows. In addition, Obasaju et al. (2019) further explored the effect of intermediate tariffs and intermediate intra-national exports on national value chains in the sub-region of the Western African Economic Community (ECOWAS). However, their study's emphasis was on enhancing value chains and how regional trade integration can be boosted through general tariff review.

On the value of human capital, economic growth and infrastructural development, Enilolobo and Shodeinde (2019) focused on how to define some of the key economic and social factors that affect Nigeria's industrial productivity. The work adopted OLS techniques. The result showed that human capital is an important catalysit of productivity of the industrial sector. However, infrastructure also boost but with marginal outcome on the productivity of the industrial sector in Nigeria. Udah and Ebi (2017) analysed time series data from 1970 to 2014 and used OLS technique to analyse it. Dickey-fuller and Phlilps-Perron tests were used for unit root and co-integration as well as two-step Engle-granger procedure and Johnson method for processing and evaluating the study results. The findings showed that causality exists between human capital and electricity supply, indicating that electricity supply provides the enabling environment for knowledge to thrive. In addition, there is causality between electricity supply and trade accessibility, with the assumption that if there is a secure supply of energy, the country will benefit from trade liberalisation. In summary, the study's finding indicates that gross domestic investment, energy supply, and trade openness provide the climate to aspire for industrial sector. The study advised government to prioritize electricity generation and distribution, and to promote investment policy in different sectors to accelerate the country's speed of industrialization.

The short-run dynamics, using EMC by Munir and Khan (2018) have showed that infrastructure has a positive short-run effect on economic growth, and that human capital has a positive impact on economic growth as well. The study further advised policymakers to pay special attention to creditworthy policies for the creation of human resources to promote the growth of health and education sectors to provide more skilled, effective labor for more competitive economy. This also proposed further proposals for infrastructural development to boost infrastructure to achieve high rates of growth in Pakistan.

3. METHODOLOGY

The study adopt Auto-Regressive Distributed Lag (ARDL) model for analysis. Data were collected on human capital (proxy by government annual spendings on education as well as health care facilities in the country), infrastructure (proxy by government expenditure on roads, electricity generation and consumption) and the GDP. Secondary data are used and are sourced through the World Development Reports of various years, Human Development Reports, Bereau of Statistics and from the Central Bank of Nigeria Statistical Bulletins.

3.1. Model Specification

Various researchers made use of different methods of analysis to find out how energy infrastructure spurs economic development. Some made use of primary data while others used secondary data in their methodology. Vijayanolanan made use of the "new growth" production function which was given as

$$Y_t = A(I_t, t)\, f(K_t, L_t, R\, I_t)$$

$Y_t = A_t K_t^{\varnothing} G_t^{\beta} L^{1-\varnothing-\beta}$ Where A is the total factor of productivity at time t.

Specifically, all authors on infrastructure believed in its importance to the production function but with much emphasis on its technological inputs and welfare, the inputs of human capital development. In consonance with the assertions of these authors, we express our model for analysis as:

$$D(GDP_t) = f(Capital_t, Labout_t, Education_t, Health_t, Power_t, Transcom_t) \quad (1)$$

The parametric specification of the model in given in (2) and set in linear form in (3) below

$$D(GDP_t) = Capital_t^{\beta_1}.Labout_t^{\beta_2}.Education_t^{\beta_3}.Health_t^{\beta_4}.Power_t^{\beta_5}.Transcom_t^{\beta_6} \quad (2)$$

$$Log(D(GDP_t)) = \beta_1 Log(Capital_t) + \beta_2 Log(Labour_t) + \beta_3 Log(Education_t) + \beta_4 Log(Health_t) + \beta_5 Log(Power_t) + \beta_6 Log(Transcom_t) \quad (3)$$

Where:

$Log(D(GPD_t))$ = Percentage of annual growth rate of real gross domestic product at time t.

Log (Capital) = Log of capital at time t proxied by gross fixed capital formation (GFCF) at time t.

$Log(Labour_t)$ = Log of labour which is proxied by annual total employment to population ratio, 15+, as modeled ILO estimate at period t.

Log (Education) = Log of education which is measured by Human capital index, based on years of schooling and returns to education at period t.

$Log(Health_t)$ = Log of health variable is measured by Life Expectancy at Birth, Total at time t.

$Log(Power_t)$ = Log of power variable is measured by the population of people with access to electricity at time t.

$Log(Transcom_t)$ = Log of annual recurrent expenditure on transportation and communication at time t.

The Auto-Regressive Distributed Lag (ARDL) model specified for this analysis is thus given as:

$$Log(D(GDP_t)) = \beta_1 Log(Capital_t) + \beta_2 Log(Labour_t) + \beta_3 Log(Education_t) + \beta_4 Log(Health_t) + \beta_5 Log(Power_t) + \beta_6 Log(Transcom_t) + \beta_7 Log(D(GDP))_{t-1} + \beta_8 Log(Capital)_{t-1} + \beta_9 Log(Labour)_{t-1} + \beta_{10} Log(Education)_{t-1} + \beta_{11} Log(Health)_{t-1} + \beta_{12} Log(Power)_{t-1} + \beta_{13} Log(Transcom)_{t-1} \quad (4)$$

3.2. Unit Root and Co-integration Tests

The Augmented Dickey-Fuller (ADF) test was used to investigate the presence of unit root in each of the variables, or otherwise. The result of the unit root test as presented in Table 1 showed a none of the variables are stationary at level. Therefore, all variables are stationary at first difference I (1) at 1 per cent meaning point. The consequence of this is that the variables in the model have short-run disequilibrium, thereby knoking out the reliability of the OLS results presented in Table 3. Nonetheless, the presence of a long-term equilibrium between the variables in the model, which is a required condition for establishing ARDL, was defined by the co-integration test shown in Table 2:

Table 1: Result of unit root test

Variable	ADF (t-statistics)	1 percent critical values	Order of integration	Remarks
Log (D(GPD$_t$))	−10.11364	−3.475184	I (1)	Stationary
Log (Capital$_t$)	−12.51815	−3.474265	I (1)	Stationary
Log (Labour$_t$)	−12.29075	−3.474265	I (1)	Stationary
Log (Education$_t$)	−12.06341	−3.476805	I (1)	Stationary
Log (Health$_t$)	−9.194758	−3.477835	I (1)	Stationary
Log (Power$_t$)	−8.695711	−3.492523	I (1)	Stationary
Log (Transcom$_t$)	−12.26490	−3.474265	I (1)	Stationary

Source: Authors' Computation, 2020

4. INTERPRETATION AND DISCUSSION OF RESULTS

The model was estimated using the co-integration and Autoregressive Distributed Lag (ARDL) analysis. Model variables data were obtained from various sources including the CBN Annual Statistical Bulletin and the World Bank

Table 2: Result of co-integration test

Unrestricted Co-integration rank test (trace)				
Hypothesized		Trace	0.05	
No. of CE (s)	Eigenvalue	Statistic	Critical value	Prob.**
None	0.235719	98.83109	125.6154	0.6384
At most 1	0.205335	71.14264	95.75366	0.6837
At most 2	0.158169	47.46964	69.81889	0.7429
At most 3	0.123218	29.73556	47.85613	0.7324
At most 4	0.095396	16.19141	29.79707	0.6988
At most 5	0.055004	5.864888	15.49471	0.7114
At most 6	0.000366	0.037707	3.841466	0.8460

Trace test indicates no co-integration at the 0.05 level,* denotes rejection of the hypothesis at the 0.05 level,**MacKinnon-Haug-Michelis (1999) P values

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE (s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.235719	27.68846	46.23142	0.8915
At most 1	0.205335	23.67300	40.07757	0.8436
At most 2	0.158169	17.73408	33.87687	0.8905
At most 3	0.123218	13.54415	27.58434	0.8527
At most 4	0.095396	10.32652	21.13162	0.7135
At most 5	0.055004	5.827181	14.26460	0.6355
At most 6	0.000366	0.037707	3.841466	0.8460

Max-eigenvalue test indicates no cointegration at the 0.05 level,* denotes rejection of the hypothesis at the 0.05 level,**MacKinnon-Haug-Michelis (1999) P values

Source: Authors' Computation, 2020

Table 3: Ordinary least square (OLS) result

Variable	Coefficient	Std. error	t-statistic	Prob.
Log (Labour)***	−12.37608	2.997182	−4.129239	0.0001
Log (Capital)	−1.899936	2.245140	−0.846244	0.3994
Log (Education)	0.766656	1.347878	0.568788	0.5708
Log (Health)	−1.563683	1.557879	−1.003726	0.3179
Log (Power)	−6.899114	6.620557	−1.042075	0.2999
Log (Transcom)***	2.492571	0.418454	5.956620	0.0000
C	83.17597	22.80196	3.647755	0.0004
R-squared	0.456575	Mean dependent var		4.868654
Adjusted R-squared	0.424292	S.D. dependent var		4.017508
S.E. of regression	3.048301	Akaike info criterion		5.129665
Sum squared resid	938.5059	Schwarz criterion		5.303507
Log likelihood	−270.0019	Hannan-Quinn criter.		5.200151
F-statistic	14.14303	Durbin-Watson stat		0.401293
Prob (F-statistic)	0.000000			

***Statistically Significant at 1 percent, **Significant at 5 percent, *Significant at 10 percent. Source: Author's Computation, 2020

Table 4: Result of auto-regressive distributed lag (ARDL) analysis

Variable	Coefficient	Std. error	t-statistic	Prob.
Log (Labour$_t$)***	−8.033272	2.759341	−2.911301	0.0045
Log (Capital$_t$)***	−9.664301	2.986396	−3.236109	0.0017
Log (Education$_t$)**	2.427011	1.218702	1.991472	0.0494
Log (Health$_t$)***	−4.064137	1.312421	−3.096673	0.0026
Log (Power$_t$)***	−14.96315	4.738607	−3.157710	0.0021
Log (Transcom$_t$)*	0.760262	0.397986	1.910271	0.0592
D (GDP)$_{t-1}$***	0.871523	0.047004	18.54140	0.0000
Log (Labour)$_{t-1}$	4.803093	2.998651	1.601751	0.1126
Log (Capital)$_{t-1}$***	9.865882	3.004727	3.283454	0.0014
Log (Education)$_{t-1}$**	−3.123431	1.242245	−2.514344	0.0136
Log (Health)$_{t-1}$***	4.642249	1.323604	3.507279	0.0007
Log (Power)$_{t-1}$***	17.34032	4.794523	3.616692	0.0005
Log (Transcom)$_{t-1}$*	−0.666305	0.396091	−1.682201	0.0959
C	4.356575	11.88891	0.366440	0.7149
R-squared	0.893867	Mean dependent var		4.929266
Adjusted R-squared	0.879031	S.D. dependent var		3.986492
S.E. of regression	1.386526	Akaike info criterion		3.612933
Sum squared resid	178.7883	Schwarz criterion		3.962649
Log likelihood	−179.2919	Hannan-Quinn criter.		3.754703
F-statistic	60.25054	Durbin-Watson stat		2.004438
Prob (F-statistic)	0.000000			

***Statistically Significant at 1 percent, **Significant at 5 percent, *Significant at 10 percent. Source: Authors' Computation, 2020

Development Indicator (WDI). The estimated parameter forms most of the variables were in line with the theoretical a priori expectation of the relationship between each of the variables and economic growth. The parameter estimate for education and transcom at the current period are in line with the expected signs. In addition, the sign of estimated parameter for physical capital, health and energy of the past period were positive in line the a priori expectation. Nevertheless, despite the fact that they are statistically significant, the expected signs for parameter estimates for physical capital, labour, health and power of current period negate the a-prior expectations. Also in this category are the lag values of education and transcom variables

The adjusted R-squared (R^2) of the ARDL model in Table 4 shows that about 87 percent of the systematic variation in the dependent variable Gross Domestic Product (GDP) is caused by the explanatory variables which are the various components of human capital and energy infrastructure over the period that the analysis covered(1981-2018) in Nigerian economy. The remaining 23 percent variation is explained by other determinants of growth which are not captured in this study. The Durbin Watson is 2.0 which indicate the absence of first order serial correlation in the analysis. The F-statistics of 60.25054 is statistically significant at 1 per cent level of significance which reveals that the entire model is statistically significant. The co-integration test result reveals that there exists a long run relationship among the variable in the model. Thus, the condition for specification and estimation of the ARDL model presented in Table 4 was established.

Examining the relative influence of each of the independent variables and economic growth, it could be seen from the empirical results that the quality of education, transport and communication facilities has been found to have a significant and contemporary effect on economic growth. By implication, an improvement in these facilities in terms of their availability and quality in past period will boost theoverall performance of the economy in current period. The relatively huge role in whci human capital plays in economic growth from the result showcases its importance. Despite the fact that Nigeria is poorly rate in human development indicator, yet it the country is not lacking behind completely. Likewise, as observed that energy, transport and communication infrastructure variables hold a positive statistically significant impact on growth, that infrastructure is a panacea for growth is now an undeniable fat among development researchers as well as policy policymakers. Adequate attention and funding if given to infrastructure will lead to expansion in investment and development by growing productivity and output. It links energy to factories, employees to employment, and commodities to markets. It can also be deduced that the availability of infrastructure and human resources is crucial to our development. This outcome corroborates the standpoint of Matthew et al. (2018)

5. CONCLUSION

According to the results obtained, economic growth could be seriously affected and slowed down due to energy shortages. Nigeria's inadequate electricity supply has grown to an alarming rate, and every administration that comes into power will put it as its primary agenda to fix. But that it is indeed optimistic demonstrates its significance in the development cycle and its inevitability. Again, there is an immediate need to re-engineer and promote infrastructure growth. Investment in energy infrastructure continues to play a rising role in the Nigerian economy, even though the sector has been privatized. Originally, a small rise in the rate of electricity output per household is related to an improvement in per capita GDP growth

From the finding of this study, we can therefore recommend that education and health as components of human capital coupled with energy infrastructure should be given an unwavering investment focus by the policy maker if the desired growth that Nigeria is aspiring for must be achieved.

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