

ENERGY POVERTY AND ECONOMIC DEVELOPMENT IN NIGERIA: EMPIRICAL ANALYSIS

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ABSTRACT

In consideration of Nigeria's low access to electricity which has consistently been below 60% for nearly three decades, the study examines the development effect of energy poverty in the country. The S-estimation method of the robust least squares estimator was employed for analysis of annual time series data spanning the period from 1990 to 2017. The study finds that energy poverty adversely affects the nation's economic development, implying that improved access to electricity is development-enhancing. Domestic investment and labour force are also found to be crucial development factors in the country. However, FDI inflows, trade openness and currency depreciation are found to have adversely affected the development of the nation's economy, highlighting the (low) extent of preparedness of the country for the vagaries of globalization. In view of the empirical evidence, to enhance the development of the nation's economy (and the standard of living therein), the study recommends expansion of rural and urban electrification; reduction of electricity tariffs; design and implementations of policies and programmes to encourage domestic investment; labour force development; import controls and export promotion; prevention of excessive depreciation of the domestic currency; and implementation of appropriate FDI policies to mitigate its adverse effects on development.

Keywords: Energy Poverty, Access to Electricity, Standard of Living, Economic Development, Nigeria, Robust Least Squares, S-estimation.

INTRODUCTION

Energy poverty refers to lack of access or inadequate access to electricity or energy services (Chevalier & Nadia, 2009; Timms, 2015; González-Eguino, 2015; Njiru & Letema, 2018). In Nigeria, access to electricity has been quite low. Data from the World Development Indicators (2019) shows that between 1990 and 2017, the proportion of the country's population that had access to electricity was consistently

less than 60%. This is quite worrisome considering that the country is one of the largest economies in West Africa and in the continent of Africa. Access to electricity in the urban area is far greater than access to electricity in the rural areas of the country. This reflects the low level of rural electrification in the country. The huge gap in access to electricity in both areas is shown in Figure 1.

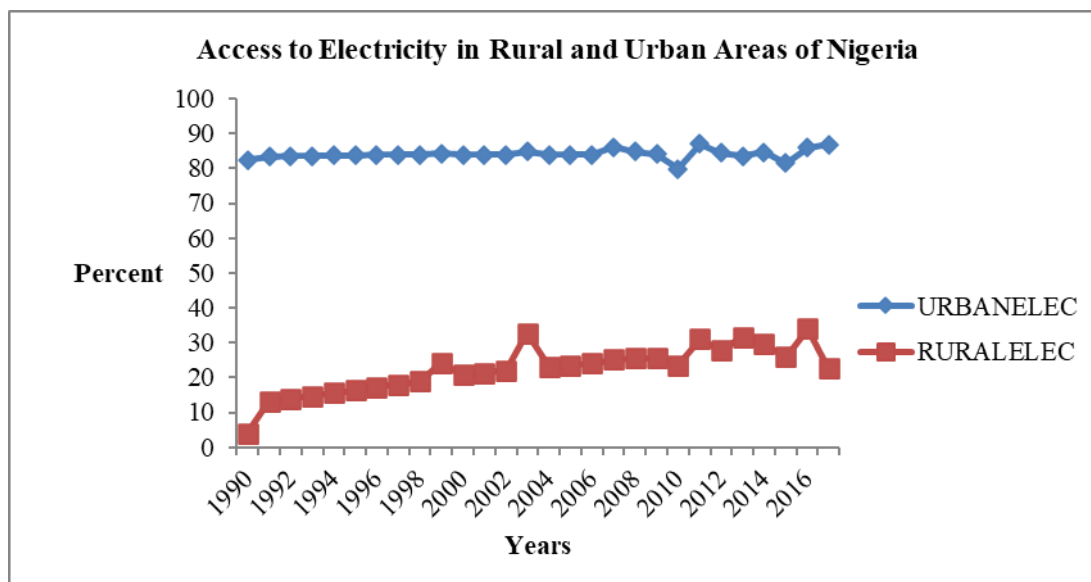


Figure 1. Nigeria: Access to Electricity in Urban and Rural Areas

Source: Data from World Bank's World Development Indicators (2019)

The low level of access to electricity in the rural areas may be fingered as a causal factor of low level of economic activities and low quality of life therein, engendering rural-urban drift, leading to reduction in supply of labour (especially required for agricultural activities which take place mainly in the rural areas), further plunging the economy to deeper developmental woes.

The World Bank (2009, p.1) identifies "chronic investment in the energy sector, ... sub-optimal policies and weak institutions" as causal factors of lack of access or inadequate access to energy services in International Development Association (IDA) countries, of which Nigeria is a part. According to Clark (2011), sustainable access to energy (electricity) is critical for poverty reduction and development in Africa. The role of unbridled access to electricity or clean energy cannot therefore being overemphasized.

Nigeria was recently classified by the World Bank as a lower middle-income country (World Bank, 2019). Other countries classified as lower middle-income countries in West Africa sub-region are Ghana, Côte d'ivoire and Cape Verde. Figure 2 shows the trends in access to electricity of these countries at same level of development from 2002 to 2017.

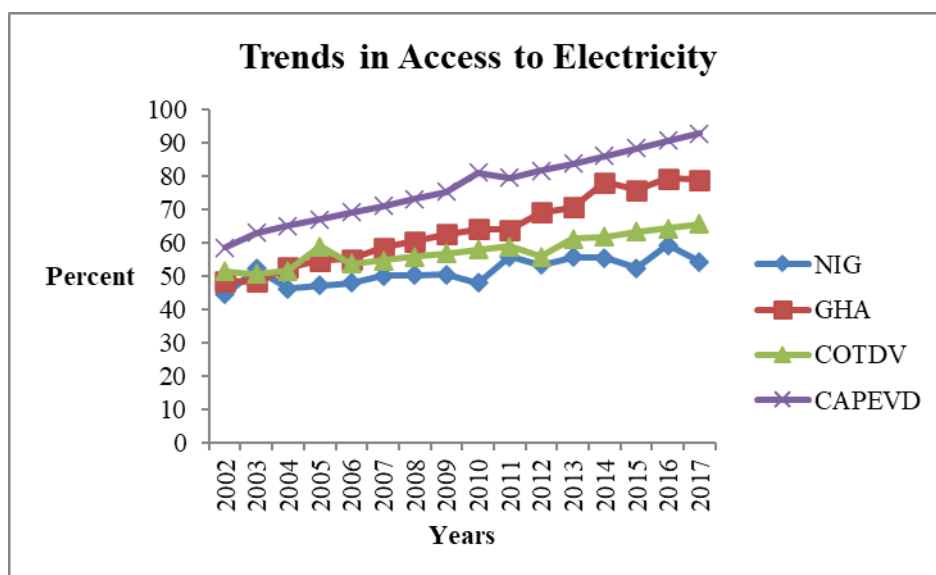


Figure 2. Trends in Access to Electricity of Nigeria, Ghana, Cote d'Ivoire and Cape Verde
Source: Data from World Bank's World Development Indicators (2019)

Figure 2 shows that Nigeria has the least access to electricity (or the highest energy poverty rate) among the four lower middle countries in West Africa. Interestingly, but regrettably, the country supplies electricity to several countries in the sub-region including Ghana (which has far greater access to electricity than Nigeria), Benin Republic, Togo and Niger (International Water Power Magazine, 2007; Asu, 2020).

Most of the previous studies on Nigeria examined the effect of electricity (or energy) consumption (measured in kilowatt hour, kWh) on economic growth and economic development. This study focuses on, and differs from previous studies by empirically examining the effect of access to electricity (measured as the percentage of the population that has access to electricity) on economic development of Nigeria. Low access to clean energy is referred to as energy poverty. Energy consumption does not reflect the population having access to electricity, as it may be concentrated in a small segment of the population or economy. However, the proportion of the population (including individuals and firms) having access to electricity or not having access to electricity (which is actually a measure of energy poverty) could be key factors affecting the level of development of the economy. The objective of this study therefore is to examine the effect of energy poverty on economic development in Nigeria. The study is significant considering that the seventh goal of the United Nations sustainable development goals (SDGs) is to ensure access to affordable, reliable, sustainable and modern energy for all by 2030 (UNDP, 2016). The World Bank (2018) noted that access to energy is at the heart of development.

The study is motivated by the need to improve access to electricity in the country in view of the fact that poor access to energy and erratic power supply has been a major bane of the country's economy over the last 3-4 decades. This may have had adverse effects on the nation's economic development as it takes its toll on virtually all sectors of the economy. Inadequate access to electricity increases the cost of

doing business in the country, and this in turn engenders cost-push inflation, reduces the competitiveness of the nation's output in both domestic and foreign markets, reduces the attractiveness of the country to foreign investors, discourages domestic investment, as well as reduces the quality of life therein.

Brief Literature Review

Several studies have attempted investigation of the relationship between energy poverty and economic development. Some of the studies are reviewed in this section.

Bridge (2017) investigated the relationship between access to electricity and various indicators of human development in Nicaragua using household survey data, geographic data and the country's population density data for 2005. Systems of simultaneous equations were specified and estimated using the two-stage-least-squares estimation technique. The study found that access to electricity improved individual and household income levels and consumptions and completion of primary school education. The relationship between electricity, firewood and respiratory problem was examined using correlation analysis. The matrix of correlation coefficient showed negative correlation between electricity and respiratory problem, and positive correlation between firewood and respiratory problem. This suggests that use of (or improved access) to electricity is associated with less respiratory problems.

Njiru and Letema (2018) examined the effects of energy poverty in Kirinyaga County in Kenya using statistical and trend analysis. The study found that energy poverty negatively affected living standards, life expectancy, literacy levels and calorific intake in the region. This implies that energy poverty has adverse consequences for economic development.

The effect of energy poverty on economic development in India was investigated by Acharya and Sadath (2019) using household level data. The study found that economic development of India was adversely affected by energy poverty, which was also found to be strongly correlated with social-economic backwardness. The study further found that education and income level played some roles in reducing energy poverty in the country, the role of education being more significant.

Zhang, Shi, Zhang and Xiao (2019) employed Bayesian Model Averaging approach to examine the effects of access to energy on selected socioeconomic indicators in a sample of 48 developing countries. Evidence from the study indicated positive long run relationship between access to electricity and infrastructure, industrialization, education, access to finance and economic development.

Empirical studies on the development effect of energy poverty are quite scanty. This study will therefore add to the existing body of knowledge in this regard. To the best of our knowledge, this is an initial attempt to empirically investigate the effect of

energy poverty on economic development in Nigeria. The study also contributes to knowledge by applying the S-estimation method of the robust least squares estimation which takes account of outliers in regressors of regression model which may affect the reliability of estimated models if ignored.

METHODOLOGY

Model and Estimation Technique

The study model is an augmentation of the basic Solow growth model which expresses output as a function of factor inputs including capital and labour. The augmentation is done by incorporating relevant variables identified by various theories including the endogenous growth theories. The functional form of the model is specified as:

$$\text{GNIPC} = f(\text{ELEACC}, \text{RGFCF}, \text{FDI}, \text{TOPEN}, \text{LF}, \text{EXRT}) \quad (1)$$

Where GNIPC = Gross national income per capita, PPP (constant 2011 international \$) proxy for level of standard of living/economic development as in UNDP (2019); ELEACC = Access to electricity measured as the proportion of the population having access to electricity; RGFCF = Gross fixed capital formation (constant 2010 US\$), proxy for gross domestic investment as in Hejazi and Pauly (2003), Adams (2009), Chakraborty and Mukherjee (2013), Shah and Khan (2014); FDI = Net FDI inflows as a percentage of GDP; TOPEN = Trade openness (Trade (export plus import) as percentage of GDP; LF = Labor force; EXRT = Exchange rate.

The model is specified in stochastic form as:

$$\log(\text{GNIPC}_t) = \delta_0 + \delta_1 \text{ELEACC}_t + \delta_2 \log(\text{RGFCF}_t) + \delta_3 \text{FDI}_t + \delta_4 \text{TOPEN}_t + \delta_5 \log(\text{LF}_t) + \delta_6 \log(\text{EXRT}_t) + \varepsilon_t \quad (2)$$

The *a priori* expectations are $\delta_1 > 0$, $\delta_2 > 0$, $\delta_3 > 0$, $\delta_4 > 0$, $\delta_5 > 0$, $\delta_6 > 0$. ε = error term.

Access to electricity, domestic capital formation, FDI, trade openness, labour force and exchange rate are all expected to be positively related to real gross national income per capita. This is supported by various growth theories (neoclassical and endogenous growth theories) as well as international trade theories (particularly the Marshall-Lerner condition and the J-curve effect which link exchange rate to income through the balance of trade, depending on the elasticity of demand for a country's exports items in foreign markets).

The S-estimation method of the robust least squares (RLS) estimator was applied for estimation of the model. The RLS was adopted because, unlike the classical least squares estimator, it is a more robust estimator and less sensitive to outliers which affect the statistical relationships in regression models. The S-estimation proposed by Rousseeuw and Yohai (1984) is based on minimization of measures of scales

associated with residuals which are insensitive to outliers and it was applied considering that it is suited for cases where the outlier is in the regressor(s) of the model. A careful observation of one of the regressors of the model specified for this study (the exchange rate) reveals some outlying observations in the series between 1990 and 2017.

Data and their sources

The study used annual time series data spanning the period from 1990 to 2017. The scope of the study was dictated by availability of data, particularly data on access to electricity for Nigeria which begins from 1990 as obtained from the World Bank's World Development Indicators (2019). Data on other variables were also obtained from same source.

RESULTS AND DISCUSSION

The estimation results are presented in Table 1.

Table 1. Robust Least Squares Estimation (S-Estimation)

Dependent Variable: LOG(GNIPC)			
Method: S-estimation			
Variable	Coefficient	z-Statistic	Prob.
C	-28.699	-15.869	0.000
ELEACC	0.004	1.853	0.064
LOG(RGFCF)	0.171	3.403	0.001
FDI	-0.030	-7.719	0.000
TOPEN	-0.003	-6.002	0.000
LOG(LF)	1.911	20.852	0.000
LOG(EXRT)	-0.208	-17.172	0.000
Robust Statistics			
R-squared	0.889	Adjusted R-squared	0.857
Scale	0.040	Deviance	0.002
Rn-squared statistic	2679.865	Prob(Rn-squared stat.)	0.000

Source: Authors' Estimation using EViews 9.

Access to electricity positively affects economic development, though the effect is significant at the 10% level. Improved access to electricity will enhance the development of Nigeria's economy. The positive effect conforms to *a priori* expectation, and also implies that reduction in access to electricity (which implies increase in energy poverty) adversely affects economic development of the country. This is in sync with previous empirical studies such as Njiru and Letema (2018), Sadath (2019) and Zhan *et al.* (2019) which also found that energy poverty negatively affects development.

Domestic investment positively affects economic development. The effect is highly significant at the 1% level. This conforms to *a priori* expectations, and corroborates

evidence from studies by Adams (2009), Kalu and Mgbemena (2012), and Oyedokun and Ajose (2018). FDI negatively affects economic development or living standard in the country. The effect is significant at the 1% level. The negative sign on the coefficient of FDI contradicts *a priori* expectation and suggests that FDI in the country adversely affects its economic development. This may be attributed to the crowding-out effect of FDI as well as the adverse effect of operations of multinational corporations, MNCs (especially those in the resources sectors) on the environment in host communities, and other country-specific socio-economic and political factors including corruption (Herzer, 2010; Moura and Forte, 2010; Carbonell & Werner, 2018). Trade openness also negatively affects standard of living, and the effect is significant at the 1% level. Greater openness of the economy to global trade adversely affects the development of the economy. Though this observation runs contrary to *a priori* expectation, it may be attributed to the low level of output which partly engenders high import-dependence of the country's economy. It indicates that Nigeria's economy is ill-prepared for the competition associated with international trade; hence its economy is adversely affected by it. This observation is corroborated by Jawaid (2014), and a more recent study by Nwamuo (2019). Considering that the trade openness and FDI are key variables of globalization, it can be inferred that economic globalization adversely affected economic development in the period under consideration.

The estimated positive and significant coefficient of labour variable conforms to *a priori* expectation. Expansion in the labour force will engender improvement in living standards and economic development. The study by Yakubu, Akanegbu and Jelilov (2020) give credence to this finding. Economic development of Nigeria is adversely affected by depreciation of the domestic currency (increase in its exchange rate), and the effect is significant at the 1% level. Currency depreciation has been counterproductive. This runs contrary to *a priori* expectation. However, it further highlights the low level of output responsible for low (nonoil) export volume as well as the high dependence of the economy on imports and the associated inflation in the economy as a result of the increase in the prices of imports engendered by increase in the exchange rate of the domestic currency. This result is in agreement with Ayodele (2014) which also found that currency depreciation adversely affects Nigeria's economy.

The R-squared and adjusted R-squared indicate the model has a high goodness of fit. This is buttressed by the deviance statistic which justifies this observation. The scale statistic indicates there are no outlier effects in the results. The Rn-squared statistic with a p-value of 0.000 indicates the explanatory variables are jointly significant in the determination of the dependent variable.

CONCLUSION AND RECOMMENDATIONS

The paper investigated the effect of energy poverty on economic development in Nigeria using the S-estimation method of the robust least squares technique. The

study found that Nigeria's economic development is adversely affected by energy poverty, and that improvement in access to electricity will enhance the country's economic development. The study further finds that domestic investment, expansion and labour force will also enhance economic development of the country. However, foreign direct investment, trade openness and currency depreciation were found to have had adverse effects on the nation's economic development.

Based on the empirical evidence, it is recommended that to achieve sustainable development of the nation's economy, there is need for the government (in collaboration with the private sector) to invest massively in urban and rural electrification to enhance access to electricity and reduce electricity tariffs to make electricity-access affordable; formulate and implement policies favourable to domestic investment such as tax incentives, infrastructural development including roads, telecommunication infrastructures, etc., favourable interest rate, general reduction in costs of doing business including reduction in cost of loanable funds (interest rate); invest massively in the development of the labour force; cautiously embrace trade liberalization policies by pursuing and embracing export promotion, ensuring that only sectors that can favourably compete globally are opened up, while protecting the infant industries; regulate activities of MNCs through which FDI flows into the country, so as to protect the environment; and ensure quality exchange rate management to avoid excessive depreciation of the domestic currency.

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