FINANCIAL DEVELOPMENT, INVESTMENT AND ENERGY CONSUMPTION IN NIGERIA: ARDL APPROACH*

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Abstract: The study investigates the link between financial development, investment and energy consumption in Nigeria. The aim of the study is to re-examine financial development and energy consumption model by considering investment as a factor that contributes to more energy demand for consumption. The study employs an annual data within the period 1981 and 2015. The Auto-regressive Distributed Lag (ARDL) Method is used to analyse the data. From the results, financial development had a negative impact on energy consumption both in the short-run and the long-run, investment, population growth and economic growth had a positive impact on energy used. This propels the conclusion that financial development is an important determinant factor of energy consumption in Nigeria and government should consider a policy that incorporate financial development into its plan.

Keywords: Financial development, energy consumption, Investment, GDP, ARDL

1 Introduction

Over the years in literature, energy consumption and economic growth has gained a major concern. The role of energy in economic growth and development has been argued with much importance in literature as it is considered as a factor that contributes to rapid changes in growth and development. Jensen (1996) noted that financial development may lead to increased industrial activities, which, increase energy demand and in turn, may lead to industrial pollution. Similarly, Frankel and Romer (1999) agreed that increased economic growth calls for more finances which attract foreign direct investment and higher degrees of research and development (R&D), increase the consumption of energy and hence, affect the dynamics of environmental performance. In agreement to these submissions, Islam et al., (2013) submitted that as the aim to increase economic wealth by the emerging countries becomes more prioritized, the importance of the topic will gain more attention. Energy is considered to be needed for production of all goods and services, and as production increase, there would be need to finance the energy sector of the economy in order to meet the increasing demand.

In furtherance, Karanfil (2008) and (2009) having noted the gap in the determinants of energy consumption argued that adding one of the financial variables such as domestic credit to private sector, stock market capitalization or liquid liabilities into the improved energy availability model makes it more justifiable rather than just a simple bivariate model. Similarly, based on the inclusion of financial development into the determinants of energy consumption model, Fung (2009) also submitted that financial development creates more output and increase demand for energy as the inputs increases, while Sardosky (2011) confirmed that financial development affect energy consumption through three channels: First, the direct

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effect which occurs as the consumers purchasing power towards energy consumption increases as financial development increases. Secondly, improved financial development increase accessibility of investors to cheap funds which increases their production capacity and attract more energy to be consumed. Thirdly, the wealth effect which is explained in terms of the confidence consumers has when the stock activities increases which lead to more energy demand.

The relationship between financial development and energy consumption has been discussed in recent and previous studies (Mielnik and Goldemberg, 2002; Sadorsky, 2011; Islam et al., 2013; Shahbaz et al., 2016). The econometric approach of empirical studies often is based on a linear dynamic panel model (Sadorsky, 2010; Ozturk and Al-Mulali, 2015; Shahbaz et al. 2017), autoregressive distributed lag (ARDL) bounds (Fuinhas and Marques 2012; Shahbaz et al., 2016; Bekhet et al., 2017), a cointegration model (Islam et al., 2013; Mahalik et al. 2017), or Granger causality (Dan and Lijun, 2009; Furuoka, 2015). To the best of our knowledge, only few studies has been carried that in the context of Nigeria, identifiable; Ali, Yusop and Hook (2015) and Odusanya et al. (2016) of which they both used Auto-regressive distributed lag to capture the short-run and the long-run impact of financial development on energy consumption in Nigeria. This study therefore deviates by investigating the link between financial developments, investment and energy consumption in Nigeria.

The study is considered to be important in the context of Nigeria because, Nigeria is one of the countries with huge financial capacity in the world and also generate a larger percentage of its income from the oil industry. Also, being an oil importing country also, the amount of energy consumed to run daily activities is significant compared to other economies of same level of development with the country. The projection of the country's population increase is also a major concern in its energy demand. Additionally, since energy is needed to increase production and Nigeria being one of the fastest growing economies in Africa, the need to consider financial development and investment nexus with energy consumption is important.

The rest of the study is section into four parts. Section two captures the literature review, section three holds the data source and model specification, section four handles the analytical framework, while section five contains the conclusion and recommendations.

2 Literature Review

The theoretical background of most of the empirical studies on the nexus between financial development and economic growth is guided by various theories that argued on the importance of financial development on economic growth. Among these theories are Schumpeter (1932), Goldsmith (1969), McKinnon (1973) and Shaw (1973) and continues to be of interests for many researchers in the economic theory literature. On the empirical front, in the developed and developing countries, studies such as; Jalil and Feridun (2011) submitted from their findings a positive impact of financial development on environmental quality, in that the more financial development advocates the use of cleaner energy which reduces the amount of carbon

emission in the environment. They also verified a carbon emission is captured more in the long-run by financial development with the aid of cleaner energy consumption in China. Coban and Topcu (2013) found a positive link between financial development and energy consumption in the EU countries regardless of the financial source or stock market and for the new members the impact largely depends on the measurement of financial development, but no significant impact when stock index was used, only revealed an invert U-shaped relationship.

Taking a sample of 9 central and Eastern European countries, Sardosky (2011) observed a positive and statistically significant relationship between financial development and energy consumption when financial development is measured using banking variables like deposit money bank assets to GDP, financial system deposits to GDP, or liquid liabilities to GDP. Of the three stock market variables investigated, only one, stock market turnover, has a positive and statistically significant impact on energy consumption. Between 1980 and 2009, Al-Mulali and Lee (2013) estimated the relationship between financial development and energy consumption, a coitergration relationship was identified and also a positive long-run relationship between financial development, economic growth, urbanization, total trade and energy consumption. Also, a one way positive causal relationship was found from Financial Development to Energy Consumption and from Urbanization to Energy Consumption. The study also argued that the financial development is one of the factors that increased energy consumption in the GCC in the short and the long run.

Islam et al., (2013) similarly in Malaysia noted that energy consumption is predisposed by economic growth and financial development, both in the short and the long run, but the population–energy relation holds only in the long run. Similarly, Komal and Abbas (2015) confirmed in Pakistan that financial development positively and significantly impact on energy consumption through the economic growth channel. Shahbaz et al., (2013) while incorporating financial development, trade and capital into the general growth model in china to test its impact on energy use noted that the bidirectional relationship exist between financial development and energy use which validates financial development as an important factor which propels energy consumption.

Aslan et al., (2014) in the Middle Eastern Countries confirmed that in the long-run all banking sector indicator positively relates to energy consumption and the relationship ranges between 0.169 and 0.396, while in terms of causality, they confirmed that an evidence of a one way short-run relationship was found in existence between financial indicators and energy consumption, while the long-run reveals a bi-feedback relationship. Chang (2015) extends the work of Sardosky (2010) which argued a positive and significant linear impact of financial development on energy consumption through a linear model. Chang (2015) focused on the non-linear effect of financial development and income on energy consumption in 53 countries of high income and low income countries. it was proved that energy consumption increases in both income class (high or low) as income increases which can traced to financial developments in the countries.

Rafindadi and Ozturk (2016) noted in Japan that a 1% change in the financial indicator exerts 24% pressure on the electricity consumption while 1% dynamic in the short run exerts 22% predicaments on electricity consumption which implies that financial development is also considered as an important factor in the economy. Also while trying to know if financial development intensify energy consumption in Saudi Arabia, Mahalik et al., (2016) findings confirmed that in the long-run financial development adds in energy consumption and also a non-linear and inverted U-shaped relationship is confirmed to exist between financial development and energy consumption and a unidirectional causality running from financial development is also confirmed.

Ali et al (2015) used a quarterly data to examine the nexus between financial development and energy consumption, they noted that financial development has insignificant negative impact on energy consumption, and economic growth has negative but significant impact on energy consumption between 1971Q1 and 2011Q4. Contrary to their findings, Odusanya et al., (2016) re-examined the short-run and long-run link between financial development and energy consumption in Nigeria, they confirmed a positive and significant relationship between financial development and energy consumption in the short-run and long-run of the Nigerian economy between 1971 and 2014. However, from the literature revealed, it can be argued that the lack of consensus among the studies is as a result of the focus, methodology, scope and data used in each study. This study contributes to the existing study by testing considering investment as an important factor in the model of financial development and energy consumption nexus in Nigeria.

3 Data and Methodology

The data used for this study is secondary in nature spanning from 1970 to 2016 is used. The data were sourced from the World Development Indicators (WDI) (2016). Energy Use (kg oil equivalent per capita) is used to capture energy consumption, domestic credit to private sector by banks as a percentage of GDP is used as a proxy for financial development, Investment is proxy as gross capital formation (% of GDP), while population growth rate is used to proxy for population. The data are analysed using E-views 9. This study followed the model of Shahbaz and Lean (2012), Coban and Topcu (2013) and, Islam *et al.* (2013), Mahalik *et al*., (2016) and Odusanya et al., (2016) to examine the relationship between financial development, investment and energy consumption in Nigeria. The functional form of the model is given as;

$$EC_t = f(FD_t, Y_t, K_t, POP_t, \cup_t) \text{ ---------- (1)}$$

where EC is energy consumption proxy as energy used (kg oil equivalent per capita), FD is financial development proxy as domestic credit to the private sector by banks as share of GDP, Y is Gross domestic product measured as the growth rate of the GDP in the economy, POP is population measured as the annual growth rate of the population in the economy, U is the error term, while t is the time covered.

The study further transformed all the variables in equation (1) into a Log-Linear econometrics specification in equation (2) below as;

$$InEC_t = \beta_0 + \beta_1 FD_t + \beta_2 Y_t + \beta_3 K_t + \beta_4 POP_t + \cup_t \text{ ---------- (2)}$$

Mahalik et al (2016) in agreement with Shahbaz et al (2013a,b) argued that energy demand increases as credit allocation to firms (financial development) increases, but after a threshold had been reached, financial sector monitors the credit allocated to the firms and encouraged them to switch or adopt energy efficient technology for their business efficiency which resultantly, declines energy intensity. This implies that the relationship between financial development and energy consumption is inverted U-shaped if $\alpha_1 > 0$and $\alpha_2 < 0$ otherwise relationship would be U-shaped.

In order to test for the relationship among the variables employed in this study, Auto-Regressive Distributed Lag (ARDL) Approach is adopted based on its advantage on other econometric methods. The method is permitted irrespective of the order of integration of the variables at I(1), I(0), or bothe I(1) and I(0). This implies that the variable do not necessarily need to be in the same order of integration. Also, the method is capable of estimating both the short-run and the long-run dynamics among the variables through Bounds test.

In order to validate the order of integration among the variables used in this study, the Augmented Dickey Fuller (ADF) test is employed. The ADF is used in replace of Dickey-Fuller because of it advantage of having the capacity to accommodate more complicated models with unknown orders. The long-run and the short-run model of the variables are therefore stated.

In order to estimate equation (2) the associated conditional standard autoregressive distributed lag ARDL (p, j_1, j_2, j_3, j_4) long run model for EC_t can be expressed as:

$$\mathrm{InEC}_t = c_0 + \sum_{q=1}^{p} \beta_1 \mathrm{InEC}_{t-i} + \sum_{q=0}^{j_1} \beta_2 FD_{t-i} + \sum_{q=0}^{j_2} \beta_3 GDP_{t-i} + \sum_{q=0}^{j_3} \beta_4 \mathrm{POP}_{t-i} + \sum_{q=0}^{j_4} \beta_5 K_{t-i} + \varepsilon_t \text{ ----- (3)}$$

The short-run dynamic parameters of the effect of financial development and investment on energy consumption can be obtained by estimating the specified as;

$$\Delta InEC_t = \vartheta + \sum_{q=1}^{p} \rho_1 \Delta InEC_{t-i} + \sum_{q=1}^{j_1} \rho_2 \Delta FD_{t-j} + \sum_{q=1}^{j_2} \rho_3 \mathrm{GDP}_{t-j} + \sum_{q=1}^{j_3} \rho_4 \Delta POP_{t-j} + \sum_{q=1}^{j_4} \rho_5 \Delta K_{t-j} + \delta ecm_{i-1} + \varepsilon_t \text{ ----------(4)}$$

From equations 3 and 4, $\beta_1 - \beta_5$ are the long-run multipliers of the variables. While, $\rho_1 - \rho_5$ are the short-run multipliers of the variables, c_0 *and* ϑ_0 is the long-

run and short-run intercept of the models. $j_1 - j_4$ are the optimal lags length of each of the variables.

In order to test for the long-run cointegrating relationship existence, the null hypothesis of no long-run cointegrating is stated as $H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ against the alternative hypothesis of long-run coitegration existence stated as $H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$. In test for this existence the decision criteria depends on the F-Statistics and the Upper and Lower Bound [I(1) and I(0)] class of the results. If the F-statistics is greater than the Upper bound we accept the alternative hypothesis that a long-run cointegration relation exists, if otherwise, we do not have any reason to reject the null hypothesis of no long-run cointegration. If the F-Statistics lye in between, then our result is inconclusive based on the submission of the method decision criteria.

4 Findings and Discussion

The unit root result in table 1 validates that the variables are stationary at order of integration zero and one [(i.e. I(0) and I(1)]. GDP and K were found to be stationary at both levels and 1st difference between 1% and 10% respectively, while FD, POP and EC were strictly stationary at 1st difference at all level of significance. This implies that there is present of unit root problem among the variables and validate the use of ARDL bounds co-integration test to test for the existence of long-run co-integration relationship among the variables restricting our model to EC model only without considering an unrestricted error correction model.

Table 1: Unit Root Test Results

		Level	
Variables	**None**	**Intercept**	**Trend & Intercept**
FD	-0.98381	-2.68733	-2.71439
GDP	-3.88582***	-4.81095***	-5.27048***
K	-3.02069***	-4.69158***	-3.61745**
InEC	0.971403	-1.20076	-2.68261
POP	-0.49072	-1.91963	-3.0637
	1st Difference		
Variables	**None**	**Intercept**	**Trend & Intercept**
FD	-5.33512***	-5.25262***	-5.16812***
GDP	-8.82119***	-8.68711***	-8.58263***
K	-3.64005***	-3.63836**	-4.08138**
LEC	-5.37495***	-5.38269***	-5.30788***
POP	-5.1379***	-5.06908***	-4.17515***

Note: ***, **. * implies level of significance at 1%, 5% and 10%

Source: Author(s) Computation (2017)

From the result below in table 2, Bounds test revealed an inconclusive result as the F-statistics lies in between the upper and the lower bound class. This implies that

the existence of long-run cointegration is ambiguous which is similar to the result of Sadorsky (2010) that the long-run relationship between financial development, investment and energy consumption is ambiguous (Chang, 2015).

Table 2: ARDL Bounds Test

Model Estimation	F-Stat	Lower-Upper Bound I(1) at 1%	Lower-Upper bound I(0) at 5%	Lower-Upper Bound at 10%
$EC_t/FD_t/K_t/GDP_t/POP_t$	3.689	4.4 - 5.72	3.47 - 4.57	3.03 - 4.06

Source: Author(s) Computation (2017)

ARDL Estimates

From the result in table 3, it was revealed that Financial Development negatively and insignificantly impact on energy consumption in Nigeria. This implies that 1unit change in financial development (FD) brings about 0.002 percent decrease in energy consumption in the long-run. Investment (K), population growth (POP) and economic growth (GDP) positively impact on energy consumption. This implies that a 1 unit increase in capital used (K), population growth (POP) and economic growth (GDP) brings about 0.003%, 0.10% and 0.002% increase in energy consumption respectively in the long-run. It is worthy of note that even though investment and economic growth significantly impact on energy consumption, their contribution percentage is very low (not up to 1 percent).

Table 3: Long-run Regression Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FD	-0.00197	0.001159	-1.69934	0.1012
K	0.003233	0.001563	2.068305	0.0487
POP	0.102445	0.126161	0.812021	0.4242
GDP	0.002379	0.001269	1.875358	0.072
C	6.22749	0.301403	20.66168	0.0000

Source: Author(s) Computation (2017)

From the result presented in table 4, in the short-run financial development retained a negative, but significant impact at 5% on energy consumption in Nigeria. This implies that 1unit change in financial development (FD) implies 0.001% decline in energy consumption. The effect is however not too effective as the magnitude is very small. Investment (K), Population growth (POP) and Economic growth (GDP) had a positive impact on energy consumption in the short-run, but only investment (K) was found to be significant. This implies that a unit change in capital used (K), Population growth (POP) and Economic growth (GDP) brings about 0.002%, 0.05% and 0.001% increase in energy consumption in the short-run. On the over-all performances, it was revealed that 54% deviations in energy consumption in short-run are corrected by the independent variables in the long-run annually. This implies that the independent variables are capable of correction 54% shocks in energy consumption in the point of convergence.

Table 4: Short-run Regression Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FD)	-0.00106	0.000523	-2.01637	0.0542
D(K)	0.001731	0.000872	1.985802	0.0577
D(POP)	0.054854	0.067181	0.816511	0.4216
D(GDP)	0.000549	0.000468	1.172596	0.2516
ECM_{t-1}	-0.53545	0.142468	-3.75837	0.0009

Source: Author(s) Computation (2017)

A diagnostic test was also carried out to test the stability of the model. The tests include RAMSEY RESET tests, Heteroscedasticity Test, and Serial Correlation LM test. The results are presented in table. Ramsey Reset test revealed confirmed that the model is well specified, Serial correlation revealed that there is no problem of auto correlation in the model and the Heteroscedasticity test validated the absence of no heteroscedaticity problem in the model. (The decisions are validated by the F-statistics and Probability values which are greater than 10% level of significance). The result is presented below in table 5.

Table 5: Diagnostic Test

Ramsey Reset Test				
F-statistic	2.608717	Prob(1, 25)	0.1188	
Serial Correlation LM Test				
F-statistic	0.882628	Prob. F(1,25)		0.3565
Heteroscedasticity Test				
F-statistic	1.328129	Prob. F(7,26)		0.277

Source: Author(s) computation (2017)

5 Conclusions and Recommendations

The focuses on the link between financial development, investment and energy consumption in Nigeria between 1981 and 2015. The Auto-regressive distributed lag (ARDL) econometric technique was used to estimate the long-run and short-run impact of financial development and investment nexus with energy consumption. It was observed that financial development impacted negatively on energy consumption both in the long-run and the short-run, but significant in short-run and insignificant in the long-run which is contrary to the findings of Odusanya et al., (2016). This implies that there are two possible interpretations to the outcome of the result. Since it is well known that the Nigerian energy sector is deficient in terms of meeting the demand for energy, then it can be said from the findings that the energy sector has not gained enough from the financial sector for more development in the energy sector, and also, it is argued that the finance available also has not been judiciously invested to promote the growth and development of the energy sector. The study also observed that as investment, economic growth and population increases, energy consumption also increase, which implies that as the investment, population and output in the economy increase, energy demand for consumption also increases. The study

therefore concludes that financial development and investment is an important determinant factor of energy consumption as they show a significant nexus with energy consumption in the short-run and is capable of correcting 54% of deviations in the consumption of energy in the long-run.

From the findings, the study recommends that more attention should be given to financial development of the country for the financial sector to be in the right form to provide necessary needs in the energy sector as other factors such as population growth, output, and investment increase the energy demand in the economy.

The study can be further researched on by reconsidering the financial development and energy consumption nexus model in economies that have similar level of development record with Nigeria in Africa and other continents. This can be done to validate the proposition of this study if it is the same with other similar countries. A major constraint in this study is the time frame of the data available.

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