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 has a positive significant impact on energy consumption in the short-run, while it was significantly negative in the long-run. GDP in the long-run and short-run positively relates with energy consumption. Population growth rate in the short-run negative impact on energy consumption, while in the long-run was positive. The findings propel the conclusion that financial development and investment are an important determinant of energy consumption in Nigeria and government should consider a policy that incorporate credit availability on energy issues into its plan.

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

JEL Clasiffication: G24; O11; Q43

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 an important factor to growth and development. Its link to energy consumption is a current discussion in literature. Jensen (1996) noted that financial development increase industrial activities, which demands for more energy leading to industrial pollution. Frankel and Romer (1999) further confirmed this submission through economic growth-energy link, as more investment transforms the growth of the economy and using more energy which at the end interrupts the performances of the environment. In addition to these submissions, Islam et al., (2013) submitted that as the aim to increase economic wealth by the emerging countries becomes more prioritized, the

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importance of the topic will gain more attention. Energy is considered to be needed for production of all goods and services, and as production increases, the energy sector needs major investment to meet the increasing demand. This therefore makes investment and financial development important determinants of energy consumption.

Karanfil (2008) and (2009) having noted the gap in the determinants of energy consumption argued that adding financial variables such as domestic credit to private sector, stock market capitalization or liquid liabilities into the energy determinants model makes it more justifiable, rather than just a simple bivariate model. This is supported by Fung (2009) that financial development creates more output and increase demand for energy as the inputs increases. Sardosky (2011) confirmed that financial development affect energy consumption through three channels: First, the direct effect through consumers' purchasing power on energy which depends on if financial development increases or decreases. Secondly, it increase production through access to finances by investors and calls for more energy. Thirdly, more financial credits translate which gives confidence to consume more energy.

Different methods have been used on the empirical front on the relationship between financial development and energy consumption since the early discussion of considering it as a determinant of energy consumption. The econometric approach of the empirical studies are often based on: linear dynamic panel models (Sadorsky, 2010; Ozturk & Al-Mulali, 2015; Shahbaz et al., 2017), Auto-regressive Distributed Lag (ARDL) (Fuinhas & Marques 2012; Shahbaz et al., 2016; Bekhet et al., 2017), cointegration model (Islam et al., 2013; Mahalik et al., 2017), or Granger causality model (Dan & Lijun, 2009; Furuoka, 2015). Few studies on Nigeria, identifiably: Ali, Yusop and Hook (2015) and Odusanya et al. (2016) used Auto-regressive distributed lag to capture the short-run and 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, 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), Shaw (1973) and environmental theory of Kuznets (1956) and has continued gaining interest of researchers to empirically test the submissions from different perspectives.

Jalil and Feridun (2011) empirically submitted for the economy of China that, there is a positive impact of financial development on environmental quality. That is, more financial development advocates the use of cleaner energy which reduces the amount of carbon emission in the environment. They also verified that carbon emission is captured more in the long-run by financial development with the aid of cleaner energy consumption. Coban and Topcu (2013) found a positive link between financial development and energy consumption in the EU countries.

Taking a sample of 9 Central and Eastern European countries, Sardosky (2011) observed a positive significant relationship between financial development (proxy as banking variables such as: deposit money bank assets to GDP, financial system deposits to GDP, or liquid liabilities to GDP) and energy consumption. Between 1980 and 2009 in Gulf Cooperation Council (GCC) Countries, Al-Mulali and Lee (2013) noted existence of coitergration relationship and a positive long-run relationship between financial development, economic growth, urbanization, total trade and energy consumption. The study also noted a bidirectional causal link running from financial development to energy consumption.

Islam et al., (2013) in Malaysia asserted that energy consumption is predisposed by economic growth and financial development in the short and long run, while population onlys significantly impact on energy consumption in the long-run. Komal and Abbas (2015) confirmed in Pakistan that financial development positively and significantly impact on energy consumption through economic growth channel. Shahbaz et al., (2013) while incorporating financial development, trade and capital into the general growth model in china to test for their impact on energy use noted that, bidirectional causal relationship exist between financial development and energy use. This confirms financial development as an important factor of energy consumption.

Aslan et al., (2014) in the Middle Eastern Countries confirmed all banking indicators positively relate to energy consumption in the long-run and the relationship ranges between 0.169 and 0.396. Their causality result confirms a one way short-run relationship between financial indicators and energy consumption, while in the long-run reveals a bidirectional relationship. Chang (2015) extends the work of Sardosky (2010) which noted a positive significant linear impact of financial development on energy consumption using a non-linear model in 53 countries of high income and low income countries. Chang (2015) verified that energy consumption increases in both income groups as their income increases via increase in their financial development.

In Japan, Rafindadi and Ozturk (2016) noted that 1% change in the financial indicator exerts 24% pressure on electricity consumption, while 1% dynamic in the short run exerts 22% predicaments on electricity consumption. In Saudi Arabia, Mahalik et al. (2016) findings confirm that financial development increase energy consumption in the long-run. The study also verified a non-linear and inverted U-shaped relationship between financial development and energy consumption and a unidirectional causality running from financial development to energy consumption.

Ali et al. (2015) used quarterly data between 1971Q1 and 2011Q4 to examine the nexus between financial development and energy consumption in Nigeria. Their findings reveal that financial development has a negative insignificant impact on energy consumption, while economic growth has negative significant impact on energy consumption. 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.

From the empirical literature, 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 considering investment as an important factor in the model of financial development and energy consumption nexus in Nigeria using ARDL.

3. Data and Methodology

The data used for this study is secondary in nature spanning from 1970 to 2016. 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 were analysed using E-views 9. The study followed the model of Shahbaz and Lean (2012), Coban and Topcu (2013), 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;

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

Mahalik et al. (2016) in agreement with Shahbaz et al. (2013a, b) argued that increase in credit (financial development) allocation to investors increase energy demand. However, as the firm expands, financial sector monitors the credit allocation investment decisions toward energy efficient technologies for their own business efficiency and environmental benefits. 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.

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

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 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 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:

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

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

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

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.

Testing for the existence of long-run cointegrating relationship, the null hypothesis of no long-run cointegration is stated as: $H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ against the alternative hypothesis of long-run cointegration existence stated as: $H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$. In testing for this existence, the decision criteria depends on the T-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 relationship exist. If otherwise, we do not have any reason to reject the null hypothesis of no long-run cointegration. If the F-Statistic lies in between, then the result will be agreed inconclusive.

4. Findings and Discussion

The ADF unit root result in table 1 shows that, the variables are stationary at levels and first difference [(i.e. I(0) and I(1)]. GDP and K were found to be stationary at both levels and 1st difference at 10% significance level, while FD, POP and EC were strictly stationary at 1st difference at 10% all level of significance. This implies that there is present of unit root problem among the variables and validate the need for ARDL bounds co-integration test to verify the existence of long-run co-integration relationship among the variables.

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***

Source: Author's Computation (2018)

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

From the result below in table 2, the bounds test reveals a long-run cointegration relationship among the variables F-statistics is greater than the upper and the lower bound class. The study however proceed to estimate the long-run and short-run dynamic relationship between financial development, investment and energy consumption using ARDL estimates.

Table 2. ARDL Bounds Test

Model Estimation	**F-Statistics**	**Lower-Upper bound I(0) at 5%**
$EC_t/FD_t/K_t/GDP_t/POP_t$	**6.81**	3.47 - 4.57

Source: Author Computation (2018)

ARDL Estimates

The ARDL estimate result is presented in table 3 for both short-run and long-run. It was established from the result that in the short-run, financial development has a negative 5% significant impact on energy consumption. This translates that, as financial development increase by 1unit, energy consumption decreases by 0.003%. Population growth rate has a positive insignificant impact on energy consumption. This implies that population growth rate insignificantly increase energy consumption by 0.58% in the short-run. GDP in the short-run had an insignificant positive impact on energy consumption. That is, as GDP changes by 1unit, energy consumption increases insignificantly by 0.0003%. Investments also show a positive elastic impact on energy consumption in the short-run. The implication of this is that, energy consumption is favoured significantly by 0.007% by every 1unit increase in investment. The error correction model result also

confirm strong correction ability of approximately 70% of energy consumption back to equilibrium in the long-run for deviations in the short-run.

In the long-run, financial development reduces energy consumption by 0.006% at 5% significance level. Population growth rate has a positive elastic impact on energy consumption at 5% significance level. This implies that as the population growth rate increases in the long-run, more energy is consumed by 0.94%. Tis however confirms the Kuznet theory which argued more energy needed as population increases. GDP positively and insignificantly impacted on energy consumption. This implies that GDP increases energy consumption insignificantly by 0.0005%. Investment also in the long-run reflects a negative significant impact on energy consumption by 0.012% decrease for every one unit increase.

Table 3. ARDL Estimation Result

	Selected Model: ARDL(1, 1, 3, 0, 3)	Variable	Coefficient	Prob.
		Δ	-0.0022	0.0034
		Δ	0.5820	0.4459
		Δ	2.6091	0.2032
		Δ	-1.9303	0.0362
		Δ	0.0003	0.4662
		Δ	0.0003	0.8946
		Δ	-0.0002	0.9364
		Δ	0.0063	0.0027
			-0.7038	0.0004
		Long Run Coefficients		
		Variable	**Coefficient**	**Prob.**
			-0.0043	0.0012
			0.9414	0.0026
			0.0005	0.4538
			-0.0120	0.0295

Source: Author Computation (2018)

A diagnostic test was also carried out to test the stability of the model. The tests include Ramsey RESET test, Heteroscedasticity test, and Serial Correlation LM test. The results are presented in table 4. Ramsey Reset test confirms that the model is well specified, Serial Correlation result shows that there is no problem of serial correlation among the variables and the Heteroscedasticity test validates the absence of heteroscedaticity problem in the model. (The decisions are validated by the F-statistics and Probability values, which are greater than 10% level of significance).

Table 4. Diagnostic Test

Ramsey Reset Test				
F-statistic	0.1781	Prob(1, 17)	0.6783	
Serial Correlation LM Test				
F-statistic	0.2057	Prob. F(2, 16)		0.8162
Heteroscedasticity Test				
F-statistic	0.3093	Prob. F(1, 29)		0.5823

Source: Author(s) computation (2017)

Discussion of Findings

Financial development showed a negative link with energy consumption both in the long-run and short-run. This implies that the credit available to investors in the Nigerian environment is significantly and sufficiently not tailored towards oil related energy consumption. This could be traced to the exposure of the economy to volatility in the price of oil which affects the refined oil products imported. The result deviates from the findings of Odusanya et al. (2016), but supports the findings of Ali et al. (2015) that the relationship is negative, but significant.

Population growth rate show different signs in the short-run and long-run. In the short-run, the result shows a negative link with energy consumption. The implication of this in the Nigerian environment is that at the early stage of population growth, the traditional source of energy is still considered, as majority could not access the oil refined products as it is expensive and not too close to the people. However, in the long-run, positive link was revealed between population growth rate and energy consumption. This implies that, the economy's population is considering more of oil related energy for consumption as it is the most available as an alternative to meet the increasing energy need in the Nigerian economy.

Gross Domestic Product (GDP) positively impact on energy consumption in the short-run and long-run. This confirms the Kuznets curve theory that as growth increases, energy consumption also increase. Therefore, the study confirms the reality of Kuznet in the Nigerian environment.

Investment proxied as gross capital formation shows different sign effect on energy consumption in the short-run and long-run. Investment has a positive link in the short-run. This implies that investment in the short-run is demands for more energy which may call for sectorial energy policy review, while in the long-run, investment reduces oil related energy consumption. This can be traced to new developments in the energy sector towards renewable energy sources which is enhancing energy diversification.

5. Summary and Conclusion

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 and significantly on energy consumption both in the long-run and short-run. Population growth rate has a positive impact on energy consumption in the short-run, while in the long-run negatively impacted on energy consumption. GDP has a positive impact both in the short-run and long-run. Investment has a positive impact in the short-run and a negative impact in the long-run.

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 long-run. The study also concludes that the Kuznet curve is real in the economy of Nigeria. From the findings, the study recommends that more attention should be given to credits available to the financial sector on energy issues in order to meet the increasing demand of energy.

The study can be further researched on by reconsidering 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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