FINANCIAL DEVELOPMENT AND ENERGY CONSUMPTION NEXUS IN NIGERIA

by

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Abstract
This study examined financial development as a driver of energy consumption in Nigeria for the period 1981-2018. The study employed the Autoregressive Distributed Lag (ARDL) model to analyse the effect of financial development on energy consumption in Nigeria. The study found long-run relationship only in the model where market capitalisation as a share of output was used as the measure of financial development. The result showed that financial development had a positive impact on energy consumption in both the short-run and the long-run. The results suggest that developments in the financial sector could increase the extent of energy consumption in Nigeria, however, the choice of the measure of financial development matters in the relationship. This has great implications for Nigeria as the major component of energy consumption which seems to rise with an improvement in financial development. The study, therefore, recommends an efficient use of energy as financial sector improves.

Keywords: Financial development, energy consumption, ARDL, Nigeria
JEL Codes: C13, Q43

5.0 Introduction

The question of how financial development drives energy consumption in Nigeria probes into responses of energy users to developments in the financial sector. The International Energy Agency (IEA) in its 2017 report ranked Nigeria as the 10th and 6th net exporter of natural gas and crude oil, respectively. This vantage position notwithstanding, Nigeria has not been able to meet its domestic demand due to several capacity and management challenges. Hence, consumers opt for biofuel and imported oil products. The seemingly 'costless' biofuel and waste that constitutes about 90 percent of final energy consumption are used mainly by residential, while industry and transport sectors use oil products and natural gas (IEA, 2017). The major component of this biofuel is the fuelwood or firewood hence its increased use compelled by any factor could worsen the problem of deforestation in Nigeria.

In addition, Nigeria has also suffered inadequate electricity supply over the years. Hence, production and residential power supply are mainly through the use of oil products, which are mainly imported. Oil products (petroleum and products) import constitutes more than

50 percent of the total mineral imports into the country. The demand for oil products has also heightened in the recent years due to high demand by users of automobiles. The financial sector plays a major role in facilitating the ease of import of these products and any development in the sector tend to have an overarching impact of the capacity of the country to supply power. The ability of the financial sector to facilitate credit at a low cost to oil products importing firms depends on the overall domestic macroeconomic conditions and other extraneous factors. If these factors increase the cost of credit to the firms, the supply of oil products will be hampered, and thus leading to increasing demand for biofuel and thereby aggravating the problem of deforestation (see Zaku, et al., 2013, Audu, 2013, Al-Amin, 2014, and Ahmed, 2017).

The growing demand for energy around the globe has attracted studies to examine its impact on the economy. There is no distinct consensus on the direction of the relationship between energy consumption and economic growth (Ozturk, 2010). Investigation in the relationship has therefore delved to other associated issues including the role of financial development. Some studies such Shahbaz, Nasir, and Roubaud (2018) opined that although financial development may increase industrial capacities which in turn may increase energy demand; increased energy consumption thus leads to CO2 carbon emission, industrial pollution, and damages to the environment. The narrative seems to support countries in Africa with a weak policy guiding the use of energy or its governance.

Fung (2009) argued in his examination of the relationship between financial development and economic growth that through its efficient use, financial development increases the demand for energy and subsequently propels economic growth. Also, Sardosky (2011) confirmed that financial development affects energy consumption through three channels: First, the direct effect which allows consumers the access to get loans cheaply and afford them the capacity to acquire capital intensive assets like automobiles. 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.

Although there is a wide range of literature on the relationship between financial development and economic growth or energy consumption and economic growth. The growing demand for energy around the globe and its negative impact on the environment has led to the pursuit of clean energy. In this process, the financial sector has a potent role to play towards making the clean energy affordable thus increasing its accessibility. It is of great relevance therefore to examine the relationship between financial development and energy consumption. Fortunately, few studies (See Mielnik and Goldemberg, 2002; Sadorsky, 2011; Islam et al., 2013) have been carried out in this regard. Nonetheless, there is yet to be a conclusive relationship between these two variables. For instance, Sadorsky (2011) showed that financial development promotes access to financial funds that expand demand for big-ticket items and adds to energy demand which in turn boost business activity. Also, Islam et al. (2013) found causality from financial development to energy demand in Malaysia while Shahbaz et al. (2017) showed that financial development reduces energy consumption which contradicts the findings of earlier study that argue for financial development intensifying energy consumption.

The econometric approach of empirical studies often is based on a linear dynamic panel model (Sadorsky, 2010; Al-Mulali, and Lee Janice, 2013; Ozturk and Al-Mulali, 2015; Shahbaz, et al., 2017), autoregressive distributed lag (ARDL) bounds (Odhiambo, 2009; Fuinhas and Marques 2012; Shahbaz et al., 2017; Bekhet, Matar, and Yasmin, 2017), a cointegration model (Islam et al., 2013; Mahalik et al. 2017), or Granger causality (Dan and Lijun, 2009; Furuoka, 2015). However, the majority of these studies were carried out in developed countries and even adopted panel analysis. Most of the time, benchmarking the response of a variable to another for different countries with different characteristics may result in spurious forecast or regression, hence the focus on Nigeria. Of more importance as to the choice of Nigeria is the apparent energy deficit even though the country is a net exporter of energy.

This study is unique in its narrative in the context of Nigeria. Nonetheless, some previous studies share in the spirit of the present inquiry. Studies such as Ali, Yusop, and Hook (2015) and Odusanya, Osisanwo, and Tijani (2016), both of which used Auto-regressive distributed lag to capture the short-run and the long-run impact of financial development on energy consumption in Nigeria. Remarkably, the two studies turned out different results; Ali *et al.* (2015) found positive and negative impact in the short run and long run, respectively, and Odusanya et al. (2016) found positive impact in both the short run and long run. Thus, the essence is to further deepen the understanding in the context of the implications for energy consumption in Nigeria. Interestingly, there are a lot of debates going on in the research milieu in this area, thus, exploring the extent to which financial development intensifies the use of energy is necessary for a country like Nigeria which could fully diversify its downstream oil sector as crude oil price increases.

In addition to the foregoing, Nigeria has the capacity to expand and deepen its financial sector given the resource endowment, population size, and investment capacity. It is important to examine how such developments affect the energy use in Nigeria, especially as its population burgeons and the implications on the environment.

Following the introductory part are four sections. Section 5.1 captures the literature review, section 5.2 focuses on the data sources and methodology. In section 5.3, the empirical results and discussion are captured while section 5.4 contains the conclusion and recommendations.

5.1 Brief Review of the Literature

The development of the financial sector can spur energy consumption via certain channels. Sadorsky (2011) identifies three ways through which financial development affects energy consumption: direct, business and wealth effects. The direct effect is when consumers have easy access to finance which enable them to buy durable consumer goods. Ozturk and Acaravci (2013) are of the opinion that efficient financial intermediation makes consumers' loan activities very conducive, thereby making it easier for them to buy items like refrigerators, washing machine, and cars which leads to increase in their demand for energy. The business effect arises as improved financial development makes it possible for businesses to have easier access to financial capital that is explored in expanding their business. This eventually culminates in higher energy consumption (Sadorsky, 2011). In the same vein, developed stock market enables companies to have a wider range of financing channels, minimize financing costs and optimize asset/liability structure, in order to procure new installations and invest in new projects, which ultimately results into increased energy demand (Ozturk and Acaravci, 2013).

Sami (2011) examines the impact of exports on energy consumption by incorporating income per capita in energy demand. The result shows that there exists cointegration between the variables and VEC Granger causality confirmed unidirectional causality among exports and economic growth to energy consumption. Sardosky (2010) investigates the impact of financial development on energy consumption in 22 emerging economies. The generalized method of moments technique was used and the findings show that financial development has a direct relationship with demand for energy. Mallick and Mahalik (2014) used annual data from 1971 – 2011 in India and China. They employ the ARDL approach to cointegration model and their results show that energy consumption is adversely linked with financial development in India and China. Kakar *et al*. (2011), in their study, financial development and energy consumption in Pakistan from 1980 – 2009. They employ cointegration and error techniques as well as the Granger causality test. Their findings show a significant relationship between financial development and energy consumption in the long-run for Pakistan while the relationship in the short-run was insignificant for the period under consideration. The Granger causality indicates that financial development does affect energy consumption. Similarly, unidirectional causality was found between money supply and energy consumption while bi-directional causality was found between domestic credit and energy consumption.

The study by Ozturk and Acaravci (2013) investigates long-run and causal analysis of energy, growth, openness and financial development on carbon emissions in Turkey using ARDL and error correction based Granger causality test. They found evidence of short-run unidirectional causal relationship from financial development to per capita energy consumption, per capita real income and square per capita real income between 1960 and 2007. They inferred that improvements in the financial sector will result into increase in energy consumption and income in Turkey in the short-run. Sadorsky (2011) examines the impact of financial development on energy consumption in the case of Central and Eastern European frontier economies using dynamic panel demand models. The results showed a positive relationship between financial development and energy consumption. In the case of China, following Karanfil (2008); Dan and Lijun (2009) applied the bivariate model to explore the relationship between financial development and energy consumption. Their empirical evidence reported that primary energy consumption Granger causes financial development. Xu (2012) revisited the relationship between financial development and energy consumption in 29 Chinese provinces. The existence of a long-run relationship was conditioned by the measure of financial development.

In Nigeria, a number of studies have investigated the relationship between financial development and energy consumption [see for example Ali, Yusop, and Hook (2015) and Odusanya, Osisanwo, and Tijani (2016)]. These two studies produced dissimilar results even though they used similar modelling technique and timeframe in addition to using the domestic credit to private sector by banks as a share of GDP as measure of financial development. This therefore calls for further inquiry in the relationship between financial development and energy consumption. The present study differs on two main grounds. First, the period of analysis has been expanded to include recent events that could possibly further explain the nexus. Second, the measure of financial development has been expanded to include the ratio of broad money to GDP and market capitalisation to GDP ratio following Ito and Kawai (2018). Thus, energy use in Nigeria can be implicated if by increasing access to finance in the economy, there is an increase in economic activities, thereby, in energy consumption for industrial or residential use.

5.2 Data and Methodology

An annual time series data which spans between 1981 and 2018 is used. The data were obtained from the Central Bank of Nigeria Statistical Bulletin 2018[1] and the World Bank World Development Indicators 2019. This study followed the model of Shahbaz and Lean (2012), Coban and Topcu (2013) and, Islam *et al.* (2013), Mahalik *et al*. (2017) and Odusanya *et al*. (2016) to examine the relationship between energy consumption and financial development in Nigeria. The functional form of the model is given as;

$EC_t = f(FD_t, Y_t, K_t, POP_t, \cup_t)$ -- (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 (FD1), broad money (M2) as a share of GDP (FD2) and market capitalisation to GDP ratio (FD3), Y is Gross domestic product measured as the growth rate of the GDP in

[1] https://www.cbn.gov.ng/documents/Statbulletin.asp

the economy, K represents investment which is measured by gross fixed capital formation as a share of GDP, 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.

We transformed all the variables in equation (1) into a log-linear specification in equation (2) as below. Log transformation of all variables makes the dependent and explanatory variables to be expressed in the same unit of measurement (natural log) and also facilitate meaningful interpretation. Specifically, upon the log transformation of all variables, the coefficients can be interpreted as elasticities, which make more meaningful economic sense.

$$InEC_t = \beta_0 + \beta_1 lnFD_t + \beta_2 lnY_t + \beta_3 lnK_t + \beta_4 lnPOP_t + \cup_t \text{ ---------------------- } (2)$$

Mahalik *et al.* (2017) in agreement with Shahbaz *et al.* (2013) argued that energy demand increases as credit allocation to firms (financial development) increases, but after a threshold is reached. In order to test for the relationship among the variables employed in this study, Auto-Regressive Distributed Lag (ARDL) approach developed by Pesaran and Shin (1999) and Pesaran et al. (2001) was adopted based on its advantage over Johansen cointegration test, which is the alternative cointegration test. Basically, the ARDL approach permits combination of variables with a different order of integration [I(1) or I(0)]. This implies that the variables do not necessarily need to be in the same order. Also, the method is capable of estimating both the short-run and the long-run dynamics of the relationship among the variables through Bounds test.

In order to validate the order of integration among the variables used in this study, we employed the Augmented Dickey-Fuller (ADF) and the Phillip-Perron (PP) tests. 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 $(p, q1, q2, q3, q4)$ long-run model for EC_t can be expressed as:

$$\begin{aligned}\Delta InEC_t = {} & \beta_1 InEC_{t-1} + \beta_2 InFD_{t-1} + \beta_3 InGDP_{t-1} + \beta_4 InPOP_{t-1} + \beta_5 InK_{t-1} + \\ & \sum_{i=1}^{p} \lambda_{1i} \Delta InEC_{t-i} + \sum_{j=0}^{q1} \lambda_{2j} \Delta InFD_{t-j} + \sum_{j=0}^{q2} \lambda_{3j} \Delta InGDP_{t-j} + \\ & \sum_{j=0}^{q3} \lambda_{4j} \Delta InPOP_{t-j} + \sum_{j=0}^{q4} \lambda_{5j} \Delta InK_{t-j} + \varepsilon_t \end{aligned} \qquad (3)$$

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

$$\Delta InEC_t = \delta \upsilon_{t-1} + \sum_{i=1}^{p} \lambda_{1i} \Delta InEC_{t-i} + \sum_{j=0}^{q1} \lambda_{2j} \Delta InFD_{t-j} + \sum_{j=0}^{q2} \lambda_{3j} \Delta InGDP_{t-j} + \sum_{j=0}^{q3} \lambda_{4j} \Delta InPOP_{t-j} + \sum_{j=0}^{q4} \lambda_{5j} \Delta InK_{t-j} + \varepsilon_t \quad (4)$$

From equations 3 and 4, $\beta_1 - \beta_5$ are the long-run multipliers of the variables. While, $\lambda_1 - \lambda_5$ are the short-run multipliers of the variables. Also, $q1 - q4$ are the optimal lags length of each of the variables determined using the Akaike Information Criterion (AIC), and δ is the error correction coefficient. This is expected to be negative, less than 1 and significant to determine the long run convergence. In order to test for the existence of cointegration 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 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 depend 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-Statistic lies in between, then the result is inconclusive.

5.3 Results and Discussion

The results of the analysis are presented in this section. The tests for stationarity and cointegration are presented in Tables 1 and 2, while Tables 3 and 4 highlight the long and short runs results. The section ends with some diagnostics reported in Table 5. In setting out, the Augmented Dickey-Fuller and the Phillip-Perron unit roots results in Table 1 confirms 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 levels, while the three measures of FD, POP and EC had to be differenced to attain stationarity. Thus, there is a mix of variables at either zero or one integration order. The main advantage of using the ARDL approach to cointegration over other known approaches, is in its ability to combine series of different orders of integration. This thus prepares the ground for the next step of the analysis: the test of cointegration.

Table 1: Unit Root Test Results

	Augmented Dickey-Fuller				Phillip-Perron			
	Level		First difference		Level		First difference	
	t-Stat.	Prob.	t-Stat.	Prob.	Adj. t-Stat	Prob.	Adj. t-Stat	Prob.
EC	-1.645	0.450	-5.267	0.000	-1.717	0.415	-5.288	0.000
FD1	-1.071	0.717	-5.638	0.000	-1.109	0.702	-5.819	0.000
FD2	-0.855	0.791	-4.875	0.000	-0.868	0.787	-4.747	0.001
FD3	-1.881	0.337	-6.749	0.000	-1.712	0.417	-8.818	0.000

GDP	-4.106	0.003	-	-	-4.120	0.003	-	-
K	-4.692	0.001	-	-	-5.528	0.000	-	-
POP	-5.453	0.000	-	-	-2.349	0.163	-4.353	0.002

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

Source: Author's Computation

Table 2: ARDL Bounds Test

F-Bounds Test						
Model of Estimation	F-Statistics					Selected Model
(LogEC|FD1,GDP,K,POP)	2.796					ARDL(1, 0, 1, 0, 1)
(LogEC|FD2,GDP,K,POP)	2.818					ARDL(1, 0, 1, 0, 1)
(LogEC|FD3,GDP,K,POP)	4.359					ARDL(1, 1, 1, 1, 1)
Lower-upper bound at:*						
	1%		5%		10%	
3.29	4.37	2.56	3.49	2.2	3.09	

**Critical values of the F-statistics are provided by Pesaran and Pesaran (1997) and Pesaran et al. (2001)*

Source: Author's Computation

Table 2 presents the results of the Bounds test, which shows models as differentiated by the choice of the measure of financial development. The Bounds test revealed inconclusive results when FD1 and FD2 are used as measures of financial development as the respective F-statistics lies between the upper and the lower bound class. However, when FD3 is used instead, the null hypothesis of no cointegration is rejected. This implies that the existence of long-run cointegration is dependent on the choice of measure of financial development. Studies such as Sadorsky (2010) and Chang (2015) have found a similar ambiguous long-run relationship between financial development and energy consumption. The submission from this study is therefore that there should be a cautious conclusion on the nature of the financial development-energy consumption nexus. The results of analysis of the model with FD3 is therefore reported subsequently.

Table 3: Long-run Regression Result

EC = LOG(EC) - (0.0028*FD3 + 0.0144*GDP -0.0032*K -0.0045*POP + 6.5062)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FD3	0.0028	0.0016	1.7512	0.0913
GDP	0.0144	0.0052	2.7393	0.0108
K	-0.0032	0.0016	-1.9644	0.0599
POP	-0.0045	0.1809	-0.0250	0.9802
C	6.5062	0.4537	14.3402	0.0000

Source: Author's Computation

The result of the long run analysis suggests a positive relationship between financial development and energy consumption, albeit, significantly at the 10% level. A plausible and rational reason for this is that a growing financial sector as indicated by the market capitalisation of the stock market provides the much needed liquidity required for economic activities. Hence, the increase in energy use for industrial and residential purposes. In addition, energy consumption increases with a rise in economic growth whereas investment growth lead to a fall in energy consumption. The impact of population was not significant in the long run. Specifically, a 1% increase in economic growth and investment brings about 0.014% and 0.003% 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 is quite low.

Table 4: Short-run Regression Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FD3)	0.0024	0.0006	3.7884	0.0008
D(GDP)	0.0018	0.0006	2.8385	0.0085
D(K)	-0.0004	0.0002	-2.1381	0.0417
D(POP)	-0.4873	0.1193	-4.0853	0.0004
CointEq(-1)	-0.3341	0.0600	-5.5679	0.0000

Source: Author's Computation

The short-run result is presented in Table 4. Again, financial development has a positive and significant impact on energy consumption in Nigeria. This implies that 1% change in financial development (FD3) implies a 0.0024% increase in energy consumption. Economic growth had a positive impact on energy consumption in the short-run, while Investment and Population growth had negative and significant effect on energy consumption. This implies that a 1% change in economic growth leads to 0.0018% increase in energy consumption while a similar 1% increase in both investment and population growth leads to 0.0004% and 0.4873% decrease respectively, in energy consumption in the short-run. The error correction term is negative and statistically significant as expected. The result shows that about 33% deviations in the short-run are corrected in the long-run annually. This implies that the system converges to equilibrium and the estimated model is stable.

The stability of the model was examined through some diagnostic tests-the Ramsey Reset test, Heteroscedasticity Test, and Serial Correlation LM test. The results are presented in Table 5. Ramsey Reset test confirmed that the model was well specified, while the Serial correlation revealed that there is no problem of autocorrelation in the model and the Heteroscedasticity test validated the absence of no heteroscedasticity problem in the model.

Table 5: Diagnostic Tests

	F-statistic	Prob.	df
Breusch-Godfrey Serial Correlation LM Test:	0.0890	0.9151	(2,25)
Heteroskedasticity Test: Breusch-Pagan-Godfrey	1.0008	0.4630	(9,27)

Ramsey RESET Test	0.0913	0.7650	(1, 26)

Source: Author's Computation

5.4 Conclusion

The study aimed to provide an answer to the empirical question: 'does financial development intensify energy consumption in Nigeria?' The analysis covered the period from 1981 to 2018. The autoregressive distributed lag (ARDL) modeling technique was used to estimate the long-run and short-run impacts between financial development and energy consumption. Findings suggest that financial development had a positive impact on energy consumption both in the long-run and the short-run. However, while the short-run positive impact was more significant than the long run impact.

Evidence from the above result suggests that developments in the financial sector could enhance the extent of energy consumption in Nigeria, however, the choice of the measure of financial development matters in any investigation of the relationship. This has great implications for Nigeria as the major component of energy consumption which seems to increase with improvement in financial development is the biofuel and waste. The study, therefore, recommends an efficient use of energy while improving the financial sector.

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