Financial Development and Energy Consumption Nexus in Nigeria

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Abstract: This paper re-examines the link between financial development and energy consumption in Nigeria both in the long run and the short run. Earlier study reported a negative relationship between financial development and energy consumption in Nigeria which is quite contrary to theoretical expectation and findings for developed and developing economies. The study employed the ARDL Bounds cointegration approach and a sample period of 1971-2014. A significant long-run relationship was confirmed between financial development and energy consumption in Nigeria. It was also deduced that the development of the financial sector exerted positively and significantly on energy demand in the Nigerian economy, both in the short-run and the long-run periods. It is evident that policies aimed at developing the financial sector have direct and far-reaching implications on energy demand in Nigeria. The paper vividly revealed how development in the Nigerian financial sector exerted on energy demand over a period of 40 years.

Keywords: Financial services; energy demand; ARDL Bounds Cointegration

JEL Classification: C32; D53; E44; G21; G32; P28; Q41

1. Introduction

The role of financial development in an economy is widely discussed in the literature. Both cross-country and country-specific studies discussed the significance of financial development in driving an economy (Shahbaz & Lean, 2012, p. 473; Mehrara & Musai, 2012, p. 473). While the literature is replete with studies examining the link between financial development and economic growth, only paltry studies investigated the relationship between financial development and energy consumption, especially for developing countries like Nigeria. Moreover, a number of studies have also examined the link among energy consumption, financial development and economic growth with divergent and inconclusive

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findings (Dritsaki & Dritsaki, 2014, p. 310; Chtioui, 2012, p. 150; Sardosky, 2010, p. 2529).

This study examines the nexus between financial development and energy consumption in Nigeria for a number of obvious reasons. Nigeria has one of the most developed financial sector in Africa. Despite the rapid transformation and the development in the Nigerian financial sector over the years, energy consumption in the country has remained abysmally low compared to those of the contemporary economies. Also, the consumption of energy, particularly petroleum products is very high owing to her teeming urban population. Additionally, since energy consumption is indeed a core component of growth and Nigeria being one the fastest growing economies in Africa, a nexus is anticipated between energy use and the development of the financial sector. And for an economy like that of Nigeria that is developing but not yet service-driven, energy consumption is expected to be very high as production activities have to be energy-driven. It is therefore apt to investigate the effect of the financial sector on energy consumption.

2. Review of Literature

2.1 Theoretical Underpinnings

The development of the financial sector can spur energy consumption via certain channels. Financial development contributes to economic growth by improving investment via *level* and *efficient* effects. The *level* effect relates to the fact that the financial sector facilitates the transfer of idle resources from non-profitable investment to lucrative ventures, through the attraction of both domestic and foreign investments (Sadorsky, 2010, p. 2529). On the other hand, the *efficiency* effect arises when the development of the financial sector facilitates the provision of more financial resources for highly efficient investment, thereby increasing the demand for energy (Mehrara & Musai, 2012, p. 93). Accordingly, Sadorsky (2011, p. 1000) identifies three key avenues through which financial development affects energy consumption: *direct*, *business* and *wealth* effects. The *direct* effect is observed when financial development aids consumers to borrow easily and cheaply to buy durable consumer goods. This is corroborated by Ozturk and Acaravci (2013, p. 262) as they opine that prosperous and efficient financial intermediation make consumers' loan activities very conducive, thereby making it easier for them to buy items like refrigerators, washing machine and cars which obviously increase their demand for energy. The *business* effect arises as improved financial development makes it possible for businesses to have easier and less costlier access to financial capital that are explored in expanding their business. This eventually culminates into higher energy consumption (Sadorsky, 2011, p. 1001; Safaynikou & Shadmehri, 2014, p. 122). In the same vein, developed stock market aids listed

companies to have 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). Moreover, the increased stock market activities usually impact positively on the confidence of consumers and businesses, and thus create the *wealth* effect (Safaynikou and Shadmehri, 2014; Sardosky, 2011).

2.2. Empirical Studies

Sardosky (2010, p. 2534) examines the impact of financial development on energy consumption in 22 emerging economies using the generalized method of moments estimation techniques to control for endogeneity, and finds that increase in financial development (measured using stock market variables) increased the demand for energy. These stock market variables include stock market value traded to GDP, stock market capitalization to GDP, and the stock market turnover. However, other financial development variables like net FDI and deposit money bank assets as a percentage of GDP were found not to have statistically significant effect on energy consumption. Coban and Topcu (2013, p. 87) in a study on EU countries also reported strong evidence of the impact of financial development (emanating from neither the stock market nor the banking sector) on energy consumption for the old member countries while an inverted U-shaped relationship was found between financial development and energy consumption for the new member countries.

Kakar *et al*. (2011, p. 471) found 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 of 1980-2009 using the cointegration and error techniques as well as the Granger causality test. 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. With the aid of ARDL bound cointegration test and the Vector Error Correction Model (VECM), Islam *et al.* (2013, p.441) find that energy consumption is influenced by financial development and economic growth both in the short and long run in Malaysia. A bi-directional causality was also found between energy consumption and financial development in the long run while it runs from financial development to energy consumption in the short run. Also, population exerts a significant positive influence on energy consumption in the long run with its influence found to be insignificant in the short run.

Ozturk and Acaravci (2013, p. 262) also examine 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.

The link among economic growth, financial development and energy consumption in Tunisia was significant and a positive correlation was found between energy consumption and financial development (Chitioui, 2012, p. 157). Likewise, a cointegrating relationship was found among real GDP, energy consumption, capital stock, oil revenues and financial development In Iran based on ARDL bound test (Mehrara & Musai, 2012, p. 98). Similarly, Safaynikou and Shadmehri (2014, p. 131) report significant relationship among energy consumption, economic growth, financial development and trade openness in Iran using the ARDL model for the period of 1967-2010. The effect of financial development, trade openness and economic growth on energy consumption was mainly positive.

Furthermore, Shahbaz and Lean (2012, p. 478) reveal that financial development, industrialization, urbanization and economic growth, increased energy consumption in Tunisia, especially in the long-run, while they observe the existence of cointegration among these variables. It was also revealed that long-run bidirectional causal relationship existed between financial development and energy consumption. Siddique and Majeed (2015, p. 678) find long-run relationship exist among economic growth, energy consumption, trade and financial development in South Asian countries of India, Nepal, Pakistan, Sri Lanka and Bangladesh. They also established non-existence of link between energy consumption and financial development in the short-run. In the same vein, CO_2 emissions, energy consumption, financial development and economic growth have long-run relationship in the presence of structural breaks in Greece. Financial development is positively related with energy demand while economic growth reduces with energy demand in the economy (Dritsaki & Dritsaki, 2014, p. 318)

A notable study that examined the nexus between financial development and energy consumption in Nigeria was by Ali *et al*. (2015, p. 820). They reported that both economic growth and financial development have negative impact on energy consumption (proxy by fossil fuel consumption) in the short-run and long-run periods. This submission is clearly not in tune with theoretical exposition and is in contrast to findings from empirical studies for many economies, including developing countries. This could have emanated from specification problem as the authors expressed variables that are originally in percentages in logarithmic form. Therefore, this study re-examines the nexus between financial development and energy consumption in Nigeria.

3. Data and Methodology

The sample used is annual data covering the period 1971 to 2014. The data were sourced from the World Development Indicators of the World Bank. Energy consumption is measured energy use per capita (kg of oil equivalent), financial development is measured as the domestic credit to private sector by banks as a percentage of GDP, growth rate of the GDP is the proxy for economic growth and the growth rate of the population is the proxy for the population of the country. This paper examines the link between energy consumption and financial development in Nigeria. Following the studies of Coban and Topcu (2013, p. 82) and Shahbaz and Lean (2012, p. 475), and Islam *et al.* (2013, p. 437), the relationship between energy consumption, financial development, economic growth, and total population is specified in the following model:

$$EN = f(FD, GDP, POP) \quad \text{.....(1)}$$

The model is specified in econometric form as:

$$\ln EN_t = \alpha_0 + \beta_1 FD_t + \beta_2 GDP_t + \beta_3 POP_t + \mu_t \quad \text{.....(2)}$$

where EN is energy consumption, measured as energy use per capita (kg of oil equivalent) and it is expressed in logarithmic form; FD is financial development, measured with domestic credit to the private sector by banks as share of GDP;

GDP is Gross Domestic Product, measured as the annual growth rate of the Gross Domestic Product; and POP is the growth rate of the total population.

The autoregressive distributed lag (ARDL) bounds testing approach to cointegration is employed to test the relationship among the series. This approach is applied due to its advantages over other forms of cointegration test. The ARDL cointegration approach is applicable irrespective of whether the series are I(0) or I(1) i.e. the variables need not to be of the same order of integration. Moreover, a dynamic unrestricted error correction model (UECM) which incorporates both the short-run dynamics and long-run equilibrium could be easily derived from the ARDL bound testing.

Since the critical bounds become invalid when the order of integration of any variables exceeds one, then it is very essential to test for the unit root in line with the core assumption of the ARDL cointegration approach. Consequently, the Dickey-Fuller GLS test is used in confirming the order of integration of the variables. We opted for the Dickey-Fuller GLS test due to the inherent problem of the traditional PP and ADF unit root tests. They are considered unreliable for small sample size as a result of their poor size and power properties, and they over-reject the null hypotheses when it is true and accept H_o when it is false (Ozturk &

Acaravci, 2013, p. 264; Shahbaz & Lean, 2012, p. 476). The dynamic unrestricted error correction models (UECM) are expressed in the following equations:

$$\Delta \ln EN_t = \alpha_{0EN} + \sum_{j=1}^{q} \beta_{jEN} \Delta \ln EN_{t-j} + \sum_{k=0}^{r} \beta_{kFD} \Delta FD_{t-k} + \sum_{l=0}^{s} \beta_{lGDP} \Delta GDP_{t-l} + \sum_{m=0}^{t} \beta_{mPOP} \Delta POP_{t-m}$$
$$+ \phi_{1EN} \ln EN_{t-1} + \phi_{2FD} FD_{t-1} + \phi_{3GDP} GDP_{t-1} + \phi_{4POP} POP_{t-1} + \mu_t \quad (3)$$

$$\Delta FD_t = \alpha_{0FD} + \sum_{j=1}^{q} \beta_{jFD} \Delta FD_{t-j} + \sum_{k=0}^{r} \beta_{kEN} \Delta \ln EN_{t-k} + \sum_{l=0}^{s} \beta_{lGDP} \Delta GDP_{t-l} + \sum_{m=0}^{t} \beta_{mPOP} \Delta POP_{t-m}$$
$$+ \phi_{1EN} \ln EN_{t-1} + \phi_{2FD} FD_{t-1} + \phi_{3GDP} GDP_{t-1} + \phi_{4POP} POP_{t-1} + \mu_t \quad (4)$$

$$\Delta GDP_t = \alpha_{0GDP} + \sum_{j=1}^{q} \beta_{jGDP} \Delta GDP_{t-j} + \sum_{k=0}^{r} \beta_{kFD} \Delta FD_{t-k} + \sum_{l=0}^{s} \beta_{lEN} \Delta \ln EN_{t-l} + \sum_{m=0}^{t} \beta_{mPOP} \Delta POP_{t-m}$$
$$+ \phi_{1EN} \ln EN_{t-1} + \phi_{2FD} FD_{t-1} + \phi_{3GDP} GDP_{t-1} + \phi_{4POP} POP_{t-1} + \mu_t \quad (5)$$

$$\Delta POP_t = \alpha_{0POP} + \sum_{j=1}^{q} \beta_{jPOP} \Delta POP_{t-j} + \sum_{k=0}^{r} \beta_{kGDP} \Delta GDP_{t-k} + \sum_{l=0}^{s} \beta_{lFD} \Delta FD_{t-l} + \sum_{m=0}^{t} \beta_{mEN} \Delta LNEN_{t-m}$$
$$+ \phi_{1EN} \ln EN_{t-1} + \phi_{2FD} FD_{t-1} + \phi_{3GDP} GDP_{t-1} + \phi_{4POP} POP_{t-1} + \mu_t \quad (6)$$

where Δ is the first difference operator and the parameters φ_1 to φ_4 are the respective long-run multipliers. Also, the parameters βj, βk, βl, and βm are the short-run dynamic coefficients of the underlying ARDL model in the equations. while denotes the error terms. The existence and significance of cointegrating relationship among the variables or the joint significance of the coefficients of the lagged level of the variables are confirmed using F-test. The null hypothesis specifying that there is no long-run relationship among the variables i.e. H_0: $\phi_1 = \phi_2 = \phi_3 = \phi_4 = 0$, is tested against the alternative hypothesis i.e. H_1: $\phi_1 \neq \phi_2 \neq \phi_3 \neq \phi_4 \neq 0$

implying the existence of long-run relationship i.e. they are tested based on equation (2) above. In testing for the existence of cointegration, two asymptotic critical bounds: upper bound I(1) and lower bound I(0) are used. When the F-statistics exceeds the upper level of the bound, it is inferred that the long-run relationship exists among the variables and the null hypothesis is rejected. However, if the calculated F-statistics falls below the lower level of the bound, the null hypothesis of no cointegration cannot be rejected. When it falls within the bounds, the result becomes inconclusive.

4. Empirical Findings and Discussion

The result of the unit root test are shown in Table 1. From Table 1, it could be deduced that the measure of financial development (i.e. domestic credit to private sector by banks as a percentage of GDP) and the growth rate of GDP are both stationary at levels at 10% and 1% level of significance respectively.

On the other hand, energy use (lnEN) and population growth rate (POP) are both stationary at first difference at 1% and 10% level of significance respectively. Given the different orders of integration of the variables, we can proceed to the ARDL estimation.

Based on the ARDL Bounds testing results reported in Table 2, we found two cointegrating vectors when energy consumption and the growth rate of the GDP were used as dependent variables. Thus, the null hypothesis of no cointegration is rejected.

Table 1. Results of the DF-GLS unit root test

Levels		1st Difference	
Variables	t-Statistic	Variables	t-Statistic
lnEN	-2.2131	lnEN	-6.1261*(c)
FD	-2.9673***(c+t)	FD	-
GDP	-5.3234* (c+t)	GDP	-
POP	-2.0647	POP	-1.6930***(c)
Critical Values:		**Critical Values:**	
	1% : -3.7700		1% : -2.6212
	5% : -3.1900		5% : -1.9489
	10% : -2.8900		10% : -1.6119

c+t include an intercept and linear trend; c has an intercept but not a trend *, **, *** imply significance at 1%, 5% and 10% respectively.

It also indicates the existence of long-run relationship among energy consumption, financial development, economic growth and growth rate of population in Nigeria.

Table 2. Results of ARDL cointegration test

Model for Estimation	**F-statistics**	**Lower-upper bound at 1%**	**Lower-upper bound at 5%**	**Lower-upper bound at 10%**
$F_{EN}(EN_t/FD_t/GDP_t/POP_t)$	4.87**	4.29-5.61	3.23-4.35	2.77-3.77
$F_{FD}(FD_t/EN_t/GDP_t/POP_t)$	1.70	4.29-5.61	3.23-4.35	2.77-3.77
$F_{GDP}(GDP_t/FD_t/EN_t/POP_t)$	6.65*	4.29-5.61	3.23-4.35	2.77-3.77
$F_{POP}(POP_t/GDP_t/FD_t/EN_t)$	1.40	4.29-5.61	3.23-4.35	2.77-3.77

The *,**denote the rejection of the null hypothesis at 1% and 5% level of significance respectively. The critical values are provided by default using E-VIEWS 9.

This results is consistent with the findings of Islam et al. (2013, p. 438) for Malaysia. Table 3 reveals that the impact of financial development on energy

consumption is positive and significant. By implication, 1 percent increase in credit by banks to private sector as percentage of the GDP (financial development) increased energy consumption by 0.705 percent.

It could be inferred that financial development promotes household and business activities and could raise energy consumption. This conforms with findings from Sadorsky, 2010, p. 2534; Coban and Topcu, 2013, p. 87; Kakar et al., 2011, p. 471; Islam et al., 2013, p. 441; Ozturk and Acaravci, 2013, p. 262; Chitioui, 2012, p. 157, among other similar studies.

Table 3. Statistical output for long-run regression model

Dependent variable: $InEN_t$

Variables	Coefficient	Std.Error	t-Statistics	p-value
FD_t	0.0075*	0.0014	5.4057	0.000
GDP_t	0.0070*	0.0014	5.0034	0.000
POP_t	-0.1431*	0.0412	-3.4724	0.002
Constant	6.8012	0.1106	61.5008	0.000

* denotes significance at 1%

Also, the effect of growth rate of GDP on energy use is positive and significant at 1 percent. The coefficient of the GDP indicates that 1 percent increase in GDP results into 0.7 percent increase in energy consumption in the long-run. This is akin to the submission of Safaynikou and Shadmehri, 2014, p. 131; Mehrara and Musai, 2012, p. 98; Shahbaz and Lean, 2012, p. 478; Siddique and Majeed, 2015, p. 678.

Therefore, as the economy of Nigeria grows, the demand for energy tends to increase. Table 3 also reveals that the growth rate of population impact negatively and significantly on energy consumption in Nigeria. This is indeed contrary to theoretical expectation and to findings from earlier studies that have investigated the impact of population on energy consumption (see Islam et al., 2013, p. 441).

The short-run results are presented in Table 4. The result from the estimation of the short-run model indicate that financial development impact positively and significantly on energy consumption at 10 percent level. one percent growth in credit to the private sector by banks (i.e. financial development) results into 0.065 percent rise in energy use. Meanwhile, the rate of growth of the economy impact positively but insignificantly on energy consumption in the short-run.

Table 4. Statistical output for the short-run model

Dependent variable: $InEN_t$				
Variables	**Coefficient**	**Std. error**	**t-Statistics**	**p-value**
ΔFD_t	0.00114	0.00065	1.74860	0.092***
ΔGDP_t	0.00039	0.00037	1.06983	0.295
ΔPOP_t	-0.06261	0.02427	-2.57993	0.016**
ECT_{t-1}	-0.43752	0.08934	-4.89730	0.000*

The *,**,*** denote the rejection of the null hypothesis at 1%, 5% and 10% level of significance respectively.

On the other hand, population growth rate has negative and significant impact on energy consumption. Furthermore, the coefficient of the error correction term (ECT_{t-1}) is found to be negative and statistically significant and it relates the speed of adjustment from the short-run to the long-run.

With a coefficient of -0.44, it implies that deviation of energy consumption from short-run to the long-run is corrected by 44 percent each year. That is, for an initial error of 1percent, 44 percent of the error would be corrected in one year. A highly significant error correction term is also a further proof of a stable long-term relationship.

The results of the diagnostic tests are shown in Table 5. The table shows that the errors are normal. The model also passes both the Breusch-Pagan-Godfrey heteroskedasticity test and the autoregressive conditional heteroskedasticity (ARCH) test.

Table 5. Statistical output for Sensitivity test

Test	F-Statistics	Prob. Value
Normality test	1.300	0.521
ARCH test	0.717	0.403
Heteroskedasticity	0.833	0.617
Serial Correlation	2.703	0.087
Ramsey reset test	1.367	0.253

The serial correlation test reveals that the model have slight problem of autocorrelation. Meanwhile, the Ramsey reset test suggests that the model is well-specified.

6. Conclusion

The study investigated the nexus between financial development and energy consumption in Nigeria between 1971 and 2014, using the ARDL Bounds testing approach. A significant long-run relationship was confirmed between financial development and energy consumption in Nigeria. It was also deduced that the development of the financial sector exerted positively and significantly on energy demand in the Nigerian economy, both in the short-run and the long-run periods. This vividly implies that the development of the financial sector drives energy consumption by industrial and domestic users in the Nigerian economy. It also implies that policies aimed at developing the financial sector have implications for energy demand in Nigeria.

Therefore, the government and other stakeholders need to evolve policies that will enhance and engender the transmission of the developments in the Nigerian financial sector into level of consumption of energy in the economy.

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