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Financial Development and Energy Consumption Nexus in Nigeria: An Application of Autoregressive Distributed Lag Bound Testing Approach

Hamisu Sadi Ali[1]*, Zulkornain Bin Yusop[2], Law Siong Hook[3]

[1]Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia, [2]Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia, [3]Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia. *Email: hamisusadi@gmail.com

ABSTRACT

Using autoregressive distributed lag bound test framework, the dynamics of financial development, economic growth, energy prices and energy consumption was investigated in Nigeria for the period of 1972Q1-2011Q4. The finding signifies that variables were cointegrated as null hypothesis was rejected at 1% level of significance. In the short-run financial development has significant negative impact on fossil fuel consumption, economic growth also shows the same relationship. However, energy prices have positive and significant influence on the consumption of fossil fuel. In the long-run however, financial development has insignificant negative impact on energy consumption, and economic growth has negative but significant impact on energy consumption, while energy prices has positive and significant impact on fossil fuel consumption. The policy recommendation remains that Nigerian authority should try to explore other alternative sources of energy in order to curb the adverse effect of fossil fuel consumption on the financial market and overall economic growth. Exploring the potentials of green energy is paramount in Nigeria which is more eco-friendly and contain less carbon emissions.

Keywords: Financial Development, Energy Consumption, Oil Prices
JEL Classifications: Q43

1. INTRODUCTION

The correlation between energy consumption, financial market performance and growth of the economy is still getting momentum among academicians, researchers, and policy makers. Consumption of energy is among the factors that determine economic performances because it affects both the volume and efficiency of productivity in global economy. Its importance in economic dealings can never be ignored considering its diverse functions for both households and firms. The growing of the emerging economies faster than anticipated couple with increase in human population necessitated more demand for energy therefore its consumption remain upsurge. Despite the 2009 global recession due to 2007/2008 global financial crisis, the consumption of energy remains unaffected, for example highest energy consumers in Asia (China and India) still needs substantial amount for their various economic dealings. Various empirical evidences indicated that development of the financial market can lead to a reduction of energy consumption by improving energy efficiency. The purpose of the study is to examine the nexus between energy consumption, financial development, energy prices and economic performance for the period under investigation in Nigeria. The motivation for the study includes among others that Nigeria is blessed with abundant natural and human resources thereby becomes the highest producer and consumer of energy in Africa. Investigating the linkages between energy uses and financial market performance in Nigeria is an important issue because the country consumed high amount of energy therefore to observe its impact on financial market performance as well as other control variables is eminent.

2. LITERATURE REVIEW

Various empirical studies documented the links between consumption of energy, financial development, economic growth as well as the cost of energy in the global economy. For example a study by Oh and Lee (2004) examined the connection between economic growth and energy consumption using Granger-causality and vector error correction model (VECM) approach in Korea over the period of 1981Q1-2000Q4. The empirical finding suggests no causality between the variables in the short-run and in the long-run there is unidirectional causality running from economic growth to energy consumption. Hye and Riaz (2008) use Pakistan data and examined the nexus between economic growth and energy consumption for the period of 1971-2007 based on autoregressive distributed lag (ARDL) form of Granger-causality. In the short-run the causality test shows bi-directional relationship between the variables, and one way causality running from economic growth to energy consumption in the long-run. Energy consumption do not influence economic growth in the long-run because higher prices of energy may induce the cost doing business to upsurge which will lead energy uses to affect economic growth negatively. Using ARDL bound testing technique Odhiambo (2009) examined the association between energy uses and economic growth in Tanzania during 1971-2006. The result shows variables were cointegrated which means they have long-run relationship. The causality test however shows one-way running from total energy consumption to economic growth. Al-Mulali and Sab (2012a) study the effect of energy consumption, CO_2 emissions on economic growth and financial market advancement across 30 sub-Saharan African economies for the time frame of 1980-2008. The finding exhibited that energy consumption significantly enhance economic growth and financial development albeit higher rate of environmental pollution.

Al-Mulali and Sab (2012b) conducted an investigation on the impact of energy uses on economic growth and financial development across a sample of 19 countries for the period of 1980-2008. The finding shows that energy uses significantly influences development of financial market as well as the overall performance of the economy. It is however affected environmental quality negatively because it increases the rate of CO_2 emissions in the economies. Using ARDL bound testing approach Chaudhry et al. (2012) examine the nexus between energy consumption and economic growth in Pakistan for the period of 1972-2012. The result shows that when oil is used to measure energy consumption it negatively affect economic growth. The causal relationship of energy consumption and economic growth was investigated by Abid and Sebri (2011) for the time frame of 1980-2007 using VECM approach in Tunisia. The empirical finding shows that in overall economic perspective energy consumption lead to higher economic performance, while in sectoral level energy uses negatively affect economic growth. Using VECM technique Islam et al. (2013) examine the impact of financial market growth, population and economic performance on energy consumption in Malaysia. The finding reveals that energy consumption affect financial development and economic growth in the short and long-run as well, while its nexus with the growth of population exist only in the short-run.

Shahbaz et al. (2013a) investigated the relationship between energy consumption and economic growth by incorporating financial development and trade variables for the period of 1971-2011 in China using ARDL framework. The empirical finding suggests that energy consumption, financial development and trade have positive relationship with economic growth. Shahbaz et al. (2013b) examine the connection between economic growth, energy consumption, financial development, trade openness and CO_2 emission in Indonesia for the period of 1975Q1-2011Q2 and applied ARDL bound testing procedure. The result shows that increase in gross domestic product (GDP) and energy use leads to an increase in CO_2 emissions, whereas financial development and liberalization compressed it. However, the VECM causality analysis indicated feedback hypothesis among energy use and CO_2 emissions, bidirectional causality between economic growth and CO_2 emission exist and unidirectional causality exist running from financial development to CO_2 emission. Çoban and Topcu (2013) applied system-generalized method of moments approach and examined the impact of financial development on energy consumption across European Union (EU) member countries for the period of 1990-2011. The finding indicated that development of the financial system has significant impact on energy consumption among old EU member countries irrespective of the financial indicator used. Conversely, on the new member countries the effects relies on the type of financial development variable used. When bank index is applied the effect signifies an inverted U-shape whereas it shows no significant relationship when stock market index in used.

Mahalik and Mallick (2014) based on Indian data investigated the nexus between energy consumption, economic growth and financial development covered 1971-2009 timeframe using ARDL bound testing approach. The finding shows that consumption of energy is positive and significantly affecting the ratio of urban population, whereas it negatively influenced financial market advancement and economic growth significantly. The result also suggested that urban population growth negatively affect economic growth, while energy uses positively affects it. The nexus between renewable and non-renewable energy and performance of the economy was analysed by Uçan et al. (2014) across fifteen members of EU economies over the period of 1990-2011. The panel cointegration shows that variables were cointegrated. However, Granger-causality test reveal unidirectional causality running from non-renewable energy uses to economic growth. Osigwe and Aramowo (2015) examined the causal nexus between energy uses, oil price and economic growth in Nigeria using Granger-causality approach. The finding shows bidirectional causality between total energy consumption and economic growth. When electricity is used as a proxy for energy uses bidirectional causality also exist between consumption of energy and economic growth as well as among price of electricity and its consumption, whereas no causality exist between kerosene consumption, its price and economic growth. Chang (2015) applied Sadorsky (2010) to examine non-linear impacts of financial market performance on energy consumption and income across 53 countries for the period of 1999-2008 using various indicators of financial development. The consumption of energy is increasing with an increase in income for the case of emerging market and developing countries,

whereas in advanced economies it only increases with income temporarily up to a certain threshold level of income. In low income countries energy uses increase with financial development when the private and domestic credits are used as financial development measures. While, when stock market indexes are used as a measure of financial development, energy consumption decline marginally with the development of the financial market in advanced economies whereas it increases in the higher income countries of emerging market and developing countries.

Despite the role of the country in the global energy sector studies that investigated the impacts of financial development on energy consumption are very scanty in the literature. Our study also filled the literature gap of applying ARDL technique to examine this crucial issue that touch almost every economic spheres in Nigeria.

In their study Ozturk and Acaravci (2013) examine the long-run relationship between energy, growth, openness and financial sector development in Turkey for the period of 1960-2007. The F-test bound result reveal the present of long-run relationship among the variables as well as square of real income per-capita. The result also indicated that when GDP ratio of foreign trade increase, the level of per-capita carbon emission also increases while financial development has no significant effect on per-capita carbon emission in the long-run. The finding therefore confirmed environmental kuznet curve (EKC) in Turkish economy.

3. OVERVIEW OF NIGERIAN ECONOMY

As the largest economy in Africa and the most populous black nation in the world with over 150 million people, Nigeria is blessed with ample natural and human resources therefore requires substantial amount of energy for various economic purposes. Nigeria is Africa's giant in terms of production and consumption of energy. It is the continent's most productive oil producing nation, Libya and Nigeria control one third of Africa's crude oil reserves. In terms of gas deposit only Algeria is ahead of Nigeria in Africa (Sambo, 2008), and is the world's sixth largest producer of crude oil with an estimated reserve of 36.2 billion barrels. Based on Energy Information Administration[1] report energy consumption was about 4.4 quadrillion Btu (111,000 kt of oil equivalent) in 2010, out of the proportion traditional biomass and waste constituted for 82% of overall energy uses.

4. DATA AND METHODOLOGY

The data for the study was obtained from World Bank data base via world development indicators (WDI CD ROM, 2015) and West Texas intermediate for the period of 1972Q1-2011Q4. Energy consumption is proxied by fossil fuel which composed of coal, oil, petroleum, and natural gas products, financial development is proxied by domestic credit to private sector as a percentage of GDP, economic growth is proxied by real per-capita GDP and energy prices is proxied by the oil prices.

1 For more details about EIA check: http://www.eoearth.org/view/article/152513/

Following Khan et al. (2005) and Fosu and Magnus (2006) the ARDL form of VECM can be specified below;

$$\begin{aligned}\Delta \ln EC_t &= \beta_0 + \beta_1 \ln EC_{(t-1)} + \beta_2 \ln FD_{(t-1)} \\ &+ \beta_3 \ln EG_{(t-1)} + \beta_4 \ln EP_{(t-1)} + \sum_i^p \gamma_i \Delta \ln EC_{(t-1)} \\ &+ \sum_j^q \delta_j \Delta \ln FD_{(t-j)} + \sum_l^p \varphi_l \Delta \ln EG_{(t-l)} + \sum_m^q \eta_m \Delta \ln EP_{(t-m)} + \varepsilon_t\end{aligned} \quad (1)$$

Where; $\ln EC_t$ refers to the log of energy consumption, $\ln FD$ is the log of financial development, $\ln EG_t$ is the log of economic growth and $\ln OP_t$ is the log of oil price while subscript t denote time period. We will initially use ordinary least squares in order to estimate Equation (1) and proceed to conduct Wald test of F-test with the aim of testing joint significance of the coefficients of lagged variables to see if there exist long-run relationship between energy consumption, financial development, energy prices and economic growth in Nigeria. The next line of action is to test the null hypothesis $H_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ which stated that there is no cointegration between the variable against the alternate hypothesis $H_a \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$ which stated there is long-run relationship between the variables.

The estimated F-statistics will then be compared with tabulated critical value as suggested by Pesaran et al. (2001), if the value of F-statistics is above the upper critical value the null hypothesis of no cointegration is rejected which implies that variables were cointegrated. However, if F-statistics is less than the lower critical value the null hypothesis cannot be rejected which suggests no long-run relationship, while if the value of F-statistics falls between lower and upper bounds the result becomes inconclusive (Pesaran and Pesaran, 1997). The next stage is to test long-run coefficients of ARDL based on Equation (2) below;

$$\begin{aligned}\ln EC_t &= \beta_{(0)} + \sum_{(i=1)}^p \gamma_i \ln EC_{(t-1)} + \sum_{(j=0)}^{q1} \delta_j \ln FD_{(t-j)} \\ &+ \sum_{(i=0)}^{q2} \varphi_l \ln EG_{(t-l)} + \sum_{(m=0)}^{q3} \eta_m \ln EP_{(t-m)} + \varepsilon_t\end{aligned} \quad (2)$$

We select Schwarz Bayesian criterion lag selection criteria to choose lag length of the model, and we applied error correction model in order to determine the dynamics of the variables in the short-run;

$$\begin{aligned}\Delta \ln EC_t &= \beta_{(0)} + \sum_i^p \gamma_i \Delta \ln EC_{(t-1)} + \sum_j^q \delta_j \Delta \ln FD_{(t-j)} \\ &+ \sum_i^q \varphi_l \Delta \ln EG_{(t-l)} + \sum_m^q \eta_m \Delta \ln EP_{(t-m)} + \vartheta ecm_{(t-1)} + \varepsilon_t\end{aligned} \quad (3)$$

The next step is to test for stability of the long-run coefficients as well as the dynamics of the short-run following Pesaran (1997) that is cumulative sum of recursive residuals and cumulative sum of squares of recursive residuals i.e., cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) respectively.

5. RESULTS AND DISCUSSIONS

5.1. Unit-Root Test

When the analysis is time series based it is essential to test the stationarity of the variables so as to identify the order of integration

Table 1: ADF and PP unit root tests estimation result from 1972Q1 to 2011Q4

Variables	Level			
	ADF		PP	
	Constant without trend	Constant with trend	Constant without trend	Constant with trend
$\ln EC_t$	−3.136	−2.873	−5.019*	−3.616*
$\ln FD_t$	−3.340*	−3.446*	−2.398	−2.355
$\ln EG_t$	0.947	−0.884	1.896	0.035
$\ln EP_t$	−2.226	−2.773	−1.863	−2.144
First difference				
$\ln EC_t$	−3.250*	−3.369***	−3.848*	−4.080*
$\ln FD_t$	−2.641***	−2.750	−4.364*	−4.378*
$\ln EG_t$	−2.361	−3.192***	−4.043*	−4.129*
$\ln EP_t$	−4.013*	−4.038*	−4.807*	−4.805*

The ADF and PP test equations include both constant and trend terms. We used Schwarz information criterion to select the optimal lag order in the ADF test equation. The values in brackets are corresponding *P* values significance level at is shown by *1%, **5%, and ***10% respectively. ADF: Augmented Dickey Fuller PP: Phillips-Perron

Table 2: ARDL bound test estimation result

Model for estimation	Lag length	*F*-statistics	Significance level (%)	Critical bound *F*-statistics	
				I (0)	I (1)
$F_{EC}^{(FD\|EG\|EP)}$	4	8.212	1	3.65	4.66
			5	2.79	3.67
			10	2.37	3.20

Asymptotic critical value bounds are obtained from table *F*-statistic in appendix CI, Case II: Intercept and no trend for *k*=3 (Pesaran et al., 2001. p. 300). We use * to represent 1%, ** 5% and *** 10% for hypothesis rejection respectively, ARDL: Autoregressive distributed lag

Table 3: Long-run coefficients estimation based on SBC

Dependent variable ($\Delta \ln EC_t$)		
Regressors	**Coefficients**	***T*-ratio (*P*-values)**
Constant	17.331	3.080 (0.002)*
$\ln FD_t$	−0.334	−1.518 (0.131)
$\ln EG_t$	−0.534	−2.674 (0.008)*
$\ln EP_t$	0.502	3.355 (0.001)*

*Represent 1%, **5%, and ***10% significance for hypothesis rejection, SBC: Schwarz Bayesian criterion

as shown by the augmented Dickey–Fuller and Phillips–Perron unit root tests;

The result of unit root test in Table 1 indicated that energy consumption and financial development are stationary at level this implies that they are I(0), while economic growth and oil prices are non-stationary at level but stationary at first difference means they are I(1). Since the unit root result shows that two variables are I(0) and the other two are I(1) ARDL is suitable method to apply (Pesaran et al., 2001) in order to identify whether there exist long-run relationship between the variables using ARDL bound testing procedure.

5.2. Cointegration Test

Table 2 shows cointegration result which reveals that variables have long-run relationship as the calculated *F*-statistics value (8.212) is greater than the upper bound critical values for all the significance levels. Based on the result null hypothesis of no cointegration was rejected $H_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ and accepted alternate hypothesis $H_a \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$ at 1% significance level. Since the variables were cointegrated, we then move on to estimate our Equation (2) so as to obtain the long-run coefficients, the result is tabulated in Table 3.

The result shows that financial development is negative and statistically insignificant, more precisely 1% increase in energy consumption could lead to a decline of financial development by 0.3%, impliedly this suggest that higher consumption of energy does not stimulate financial sector development in Nigeria in the long-run, this support the finding of Chang (2015) who claimed that energy consumption decline marginally with financial development in advanced economies more especially in high income countries. Salman and Atya (2014) also found negative relationship between energy use and financial development in Egypt. Zeren and Koc (2013) also documented negative shocks of financial development on energy consumption in Malaysia, Mexico and Philippines. Furthermore, this might be connected with the level of financial exclusion in Nigeria, in the sense that majority of those that consumes fossil fuel are financially excluded therefore their consumption may not influence financial intermediation. Economic growth is also negative but significant at 1% which means that increase in the consumption of energy by 1% leads to a decline of economic growth by 0.5 that means more consumption of energy is a detriment to the growth of the Nigerian economy in the long-run. This finding also substantiated the results of Hye and Riaz (2008); Abid and Sebri (2011); Chaudhry et al. (2012) and Uçan et al. (2014) that energy consumption adversely affected economic growth. For example Chaudhry et al. (2012) argues that oil is highly imported in Pakistan which may increase other prices and hence increase the cost of doing businesses, this may negatively affect growth (Hye and Riaz, 2008). Energy price is positive and significant at 1% which means 1% increase in energy consumption could trigger prices of energy to increase by 0.5%, therefore an increase in fossil fuel consumption leads to an increase in cost of energy in Nigeria in the long-run.

The estimation of the short-run result presented in Table 4 indicated that both financial development and economic growth have significant negative impact on energy consumption, this implies that increase in the consumption of fossil fuel could lead to a decline in the financial development and overall economic performance in Nigeria in the short-run. However, energy prices have significant positive impact on the consumption of fossil fuel in Nigeria. This implies that an increase in fossil fuel consumption could upsurge the prices of energy which is consistent with the theory of demand and supply. The error correction term is less than one, negative and significant as expected, Banerjee et al. (1998) reported that the ECM value confirms the integrity of long-run relationship. This ratifies the above long-run nexus among the variables which implies that energy consumption is corrected from the short-run towards reaching long-run equilibrium at 2.4% every quarter.

The diagnostic tests are carried out as tabulated in the Table 5 in order to show the consistency and efficiency of the model. Our

Table 4: Estimated short-run coefficients from ECM based on SBC

Dependent variable ($\Delta \ln EC_t$)		
Regressors	**Coefficients**	***T*-ratio (*P*-values)**
$\Delta \ln EC_{t-1}$	0.691	12.916 (0.000)*
$\Delta \ln FD_t$	−0.094	−3.763 (0.000)*
$\Delta \ln FD_{t-1}$	0.072	2.967 (0.004)*
$\Delta \ln EG_t$	−0.013	−2.027 (0.044)***
$\Delta \ln EP_t$	0.012	2.505 (0.013)***
ECM(−1)	−0.024	−3.327 (0.001)*

NB: *Represent 1%, **5%, and ***10% significance for hypothesis rejection, SBC: Schwarz Bayesian Criterion, ECM: Error correction model

Table 5: ARDL diagnostic tests results

Test statistics	LM version	*F*-version
Serial correlation[1]	CHSQ (4)=5.535 (0.237)	*F* (4, 140)=1.304 (0.271)
Functional form[2]	CHSQ (1)=8.392 (0.004)*	*F* (1, 143)=8.242 (0.005)*
Normality[3]	CHSQ (2)=260.1 (0.000)*	N/A
Heteroscedasticity[4]	CHSQ (1)=0.088 (0.766)	*F* (1, 152)=0.087 (0.768)

*1%, **5%, and ***10% are used to test the significance level for hypothesis rejection, ARDL: Autoregressive distributed lag. [1]Langrange multiplier test of residual serial correlation, [2]Ramsey's misspecification test using squarer of the fitted values, [3]Jacque-Bera test for normality, [4]Autoregressive conditional heteroskedasticity test

Figure 1: Plot of cumulative sum of recursive residuals

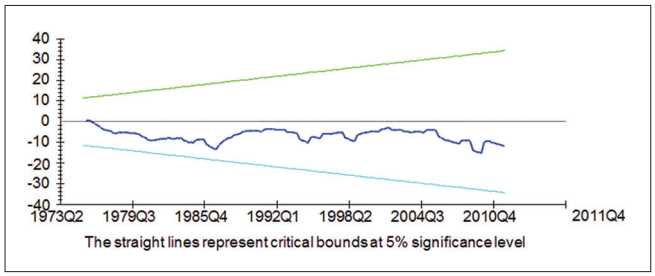
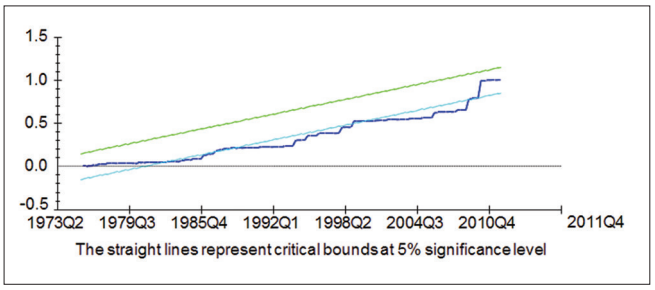


Figure 2: Plot of cumulative sum of squares of recursive residuals



model is normal and homoscedastic because it passed both serial correlation and heteroskedasticity tests which are the acute time series problems as their null hypothesis cannot be rejected. The stability of the model is shown by CUSUM of recursive residuals and CUSUMSQ of squares of recursive residuals in Figures 1 and 2 respectively.

6. CONCLUSION AND POLICY RECOMMENDATIONS

The present study applied ARDL bound testing technique and examine the impact of financial development, economic growth and energy prices on energy consumption in Nigeria. The finding shows that the variables were cointegrated which means have long-run relationship as null hypothesis of no cointegration is rejected at 1% significance level. The short-run dynamics exhibited that financial development and economic growth have negative significant effects on energy consumptions, whereas energy prices have significant positive effect on energy consumptions in Nigeria. In the long-run however, advancement of the financial sector has insignificant adverse effect on energy consumption, while economic growth has significant negative influence on energy consumption, and energy prices positively affected energy consumption in Nigeria. The policy recommendation based on these findings is that Nigerian public authority should strive to explore alternative sources of energy for example green energy because fossil fuel consumption apart from destroying natural environment is adversely affected financial development and economic growth, while energy prices increases with an increase in the consumption of energy in both short-run as well as long-run in Nigeria.

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