Oluwatosin Mary Aderajo
Department of Economics, Osun State University, Osun State, Nigeria
oluwatosin.aderajo@uniosun.edu.ng

Temitope Sade Akintunde (Ph.D)
Department of Economics, Osun State University, Osun State, Nigeria
temitope.akintunde@uniosun.edu.ng

FINANCIAL DEVELOPMENT AND ENERGY CONSUMPTION IN NIGERIA

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Abstract

The study examined the effect of financial development on energy consumption in Nigeria from 1990 to 2020. The study made use of secondary data and the data was analyzed using the Non-linear Autoregressive Distributed Lag Model (NARDL). Domestic credit to the private sector was used to measure financial development, while fossil fuel energy and renewable energy consumption were used to measure non-renewable and renewable energy respectively. Other variables included Gross domestic product, interest rate, and inflation. The study revealed that domestic private credit had a significant and negative impact on non-renewable energy only in the short run while changes in domestic credit had a significant and positive impact on renewable energy in Nigeria. This shows that the efforts of the financial sector so far in Nigeria have encouraged the consumption of renewable energy which therefore translates that the financial sector in Nigeria has a significant role to play in achieving Goal 7 target agenda of affordable and clean energy of the sustainable development. The study, therefore, recommends proper mobilization of funds from the financial sector towards investment in renewable energy considering the growing need for alternative energy sources in Nigeria. Also, policies that will discourage the use of non-renewable energy sources but encourage the use and affordability of renewable energy in Nigeria should be considered so that a reduction in environmental pollution, as well as improved health status, can be achieved.

Keywords: *Renewable, non-renewable, financial development, Non-linear Autoregressive Distributed Lag Model*

JEL: G2, E5, Q2, Q3

1. INTRODUCTION

One of the major economic challenges in today's world is energy security. With increases in population and urbanization and economic growth, the use of energy necessary to sustain the standard of living tends to triple (Dash, 2013). This is because energy majorly contributes to the input of the manufacturing industry and also contributes to a huge percentage of household consumption (Stern, 2000). As economic activities continue to expand, more energy will be required to supplement growth. Hence energy is considered a major element in achieving economic growth and its demand in recent times has been on increase (Assi, Isiksal & Tursoy, 2021). According to Energy Information Administration (2019), the consumption of global energy is expected to increase by 50% from 2018 to 2050 and renewable energy is expected to be the leading source of primary energy consumption by 2050.

Energy sources are indispensable for survival and they can be in form of renewable or non-renewable. Renewable (clean energy) is useful energy that is collectible from natural sources and is constantly replenished. Five major renewable energy sources identified by the Energy Information Administration (EIA), include; Solar Energy (from the sun), Geothermal energy (from the heat inside the earth), Wind energy, Biomass (from plants), and Hydropower (from flowing water). Nonrenewable energy, on the other hand, is energy that cannot be replenished, and its sources include petroleum, hydrocarbon gas liquids, natural gas, coal, and nuclear energy. The growing concern for non-renewable energy, however, is that fossil fuels are finite and with an increasing population as well as the growing energy demand, the resources will eventually run out. A notable argument regarding this is Hubbert's (1956) peak theory whose hypothesis lays that for any given region, the fossil fuel production curve will follow a bell-shaped curve which firstly increases with the discovery of new resources, and peaks, then ultimately decline as the resources become depleted. In Nigeria for instance, most of the country's energy demand is met by non-renewable energy which is considered unclean and detrimental to health. However, with the limiting availability of fossil fuels, coupled with fluctuations in oil prices, higher energy consumption is likely to deteriorate the energy supply, and this may cause a risk to the country's energy security. Nigeria for a long time has continued to face energy issues that have crippled many businesses and industrial development of the country which has subsequently intensified unemployment in the country. The energy demand inefficiency continues to decrease the amplified competitiveness of the country's local industries in the global markets (Iwayemi, 2008).

These Lapses in the supply-demand balance are likely to produce severe economic problems, which may lead energy-dependent economies to adopt conservation policies to prevent the usage of energy consumption. Though non-renewable energy is usually inexpensive to use, they equally pose the problem of carbon emissions which are hazardous to the environment and the lives of people (Qi et al, 2020). Hence, amidst all these issues, it is imperative for countries that depend solely on non-renewable energy to seek out renewable sources of energy in other to create a balance between the demand and supply of energy. However. Renewable energy on the other hand is known to be expensive and almost not accessible to the poor. In Nigeria, the popular opinion on renewable energy is majorly focused on solar and occasionally on wind power. Solar energy has contributed greatly to rural and non-grid areas in Nigeria. Though small but growing, solar energy in Nigeria has delivered far greater stability in service than comparable interventions. Hydropower on the other hand has been at the core of Nigeria's grid electricity production since the 1960s, only two hydropower stations, the Kanji and Jebba Dams (1300MW) can account for half the capacity of Nigeria's stable power sources (Nwagbo, 2017). However, energy generated from renewable and nonrenewable sources has become an essential element in improving standards of living and also plays a crucial role in scientific and technological progress in many nations, (Uzokwe & Onyije, 2020).

Financial markets can impact the economy positively by increasing the efficiency of the country's economy and its financial system by diversifying financial funds from unproductive to productive uses. According to Demirguc-kunt and Leveine (2008), financial development is the process by which an economy improves its financial intermediaries, markets, instruments, and sectors. Financial development affects energy demand by making borrowing access easier for debtors (Sadorsky, 2010. Financial development has been argued to significantly increase energy consumption through the consumer effect, the business effect, and the wealth effect (Sadorsky, 2010).

Firstly, a developed financial system can help increase energy demand, by easing borrowing for households which increases confidence and wealth and encourages consumers to purchase durable consumer goods such as machinery, and automobiles which consume a lot of energy (Chang, 2015). This link is known as the consumer or direct effect. Here, development in the financial sector pumps funds into the economy leading to economic growth which increases energy consumption. Secondly, a developed financial system can promote businesses by reducing the cost of accessing financial capital for the business sector and making it easier to expand existing business activities which can influence the demand for energy via the use of plants, machinery, and labor activities (Oyinlola,2020) known as the business effect. Thirdly, increased stock market activity can create a wealth effect by boosting the confidence of businesses and firms which enables them to acquire an additional source of funding from the stock market. This in turn increases economic activity which translates to more energy consumption.

On the other hand, financial development may lead to a reduction in energy consumption by providing an opportunity for technological innovations for projects that are friendly to the environment of local firms (Shahbaz et al, 2017). It could also lead to better opportunities for renewable energy sectors, Kim and Park, (2016). Shahbaz et al (2017) assert that entrepreneurs are the key agents in a free-market system and the effect of financial sector development on energy consumption depends on the quality of labor, capital, technology, investment environment, and government sector policies and institutions. However, Nigeria's financial system activities continue to remain shallow as a relatively low level of credit is made available to the private sector when compared to the situation in other developing countries (Oluwole, 2014) Given this distinctiveness, of the role of financial development on energy consumption, the questions that readily come to mind are (i) does financial sector development affect energy consumption in Nigeria? If yes, what is the magnitude of this effect particularly on renewable energy in Nigeria? In answering these questions, this study, therefore, investigates the relationship between financial development and energy consumption in Nigeria.

The rest of the paper is divided into four sections study, section two presents the review of relevant literature, section three presents the methodology, section four discusses the results and section five concludes the study.

2. LITERATURE REVIEW

From the review of relevant literature, it has been observed that studies on the link between financial development, and energy consumption across various regions have been examined. Most of these studies have however been carried out in developed and emerging countries (Furuoka, 2015; Ji & Zhang; 2019), compared to developing countries (Odusanya et al., 2016; Oyinlola 2020) and have also focused more on financial development and total energy consumption.

2.1. Financial Development and Energy Consumption

Many studies have examined the direction of causality or the nature of interaction between financial development and energy consumption. However, the findings on the direction are rather mixed. For instance, Ouyang and Li (2018) employed the panel Granger causality test on three sub-group of Chinese provinces. This study showed that a bidirectional causality existed in the Eastern region, and unidirectional causality from energy consumption to financial development in the Central region while no causality was found in the Western region. In another study in South Asia by Akhtar, Sheikh, and Altaf (2016), a bidirectional causality was found between energy consumption and financial development in India, Pakistan, Bangladesh, and Sri Lanka.Also, Pradhan et al (2018) in a study on 35 Financial Action Task Force countries found the existence of a bi-directional relationship between financial development and energy consumption in the countries examined. While a study by Roubaud and Shahbaz (2018) used the VECM Granger causality and co-integration technique and found a bi-directional causality between electricity consumption and financial development in Pakistan. However, Furuoka (2015) using the heterogeneous panel causality test found a unidirectional causality from energy consumption to financial development in Asia. A study by Shahbaz, Desek, and Polemis (2018) also reported the existence of the unidirectional causality from clean energy consumption to CO2 emissions, from foreign direct investment and financial development to CO2 emissions in BRICS and the NEXT-11 countries examined.

Some evidence has also been established regarding the relationship between financial development and energy consumption. For example, Al-mulali and Lee (2013) investigated the effect of financial development on energy consumption in Gulf Cooperation Council (GCC) countries using the Pedroni co-integration test. The results revealed financial development as an important factor that increases energy consumption both in the short and long term. Also, Odusanya et al. (2016) employed the ARDL bounds cointegration technique in a study in Nigeria and the results showed the existence of a positive and significant relationship between financial development and energy use both in the short-run and long-run Meanwhile in a study by Ozdeser et al., (2021) on the impact of financial development on energy consumption with the use of ARDL bounds test reported evidence of a short-run relationship but no evidence of the long-run relationship in Nigeria. In the study conducted by Ji and Zhang (2019) in China, financial development was found to be important and contributed 42.4% to the variation of renewable energy growth in the country. While Quyang and Li (2018) examined the role of financial development in energy consumption by employing the panel structural VAR model and found that financial development aids the use of energy-efficient technology in the production process which in turn leads to a reduction in energy intensity.

Studies have also been conducted across countries to explore the energy–finance nexus. For example, Durusu-Ciftci et al (2018) examined the interrelationships between financial development, energy consumption, and economic growth with the use of Toda-Yamamoto causality and found that the structural shifts have an important effect on finance-to-energy, finance-growth, and energy-growth relations. A study on 53 countries by Chang (2015) revealed that an increase in stock market development reduces energy consumption in advanced economies with high income while increases in stock market-related financial development increase energy consumption in emerging markets and developing economies. Also, increased financial development in the banking sector leads to increased energy consumption for all. Paramati et al. (2016) employed the use of Panel ARDL on 20 emerging countries and reported that stock market development positively affects clean energy consumption. Similarly, a study in the European Union, the G20, and OECD countries by Kutan et al. (2017) with the Panel ARDL technique also showed that foreign direct investment and stock market capitalization intensify clean energy consumption. In a study by Salman and Atya (2014) on the relationship between financial development and energy consumption in Algeria, Egypt, and Tunisia. The study reported a positive relationship between energy consumption and financial development for Algeria and Tunisia whereas a negative relationship was reported for Egypt. Destek (2018) examined the influence of financial development on energy consumption using the common correlated effect (CCE). The results showed that the development of the banking sector and bond markets has a significantly negative effect on energy consumption.

2.2. Financial development and renewable energy

Studies have reported inconclusive results. For example, Pata (2018) examined the relationship between financial development and renewable energy consumption per capita in Turkey with the use of the Auto-Regressive Distribution Lag bounds testing technique, the Gregory–Hansen and Hatemi-J co-integration and reported the existence of a long-run co-integration between financial development and renewable energy consumption in Turkey. Similarly, Çetin and Bakırtaş (2018), in examining the G-7 countries reported a long-run relationship between Renewable energy and real GDP, oil prices, and financial development. Amri (2017) examined the relationship between economic growth and energy consumption under two categories- renewable and non-renewable energy consumption. The findings from the ARDL model supported a long-run relationship between economic growth and non-renewable energy consumption but no co-integration was found between renewable energy consumption and economic growth. The results posited bidirectional causality between non-renewable energy consumption and economic growth both in the short run and long run while a unidirectional causality was reported from renewable energy consumption to economic growth in the long run. Meanwhile, Khan et al (2020) employed the panel quintile regression method for 192 countries and found a positive relationship between financial development and renewable energy consumption.

2.3. Gaps in the literature

The motivation for this study stems from a few observed gaps in the literature. First, despite the numerous studies that have been carried out in this regard, there has been no consensus on the relationship among variables. The peculiarity of the countries of focus, variables, and the methodology used have resulted in mixed results. Secondly, there is a dearth of studies on the role of financial development on energy consumption in relation to renewable and non-renewable energy sources in Nigeria as most studies have focused on total energy (fossil fuel) consumption and estimated this relationship using the ARDL technique. With the growing demand for energy and the adverse effect it can pose on the economy alongside the focus of the Sustainable Development Goals in achieving a clean environment, the consideration for the role of financial development on both renewable and non-renewable sources of energy arises. This study will be a variant from other studies by testing for the long-run and short-run asymmetries in the variables using the NARDL technique to capture the effect of positive and negative changes.

3. METHODOLOGY

3.1. Theoretical Review

Theoretically, the role of financial development has been established in the literature. This dates back to the seminal work of Schumpeter (1911) who argued that a well-developed financial system solidifies technological innovations and growth by the provision of financial services and resources in the hands of entrepreneurs who can successfully generate growth through innovations, (Adusei, 2012). In his work, Schumpeter emphasized the allocation of savings and mobilization of funds into productive activities in the economy. In the literature, financial development has also been explained to firstly enhance economic growth which in turn can increase energy consumption (Shahbaz Chang 2015; Shahbaz et al, 2017). By implication, this means that energy consumption increases with growth.

Traditionally, several theories such as the Absolute income hypothesis, Keynes (1936), Relative income hypothesis, Duesenberry (1947), Life-cycle hypothesis, Modigliani (1954) and Permanent income hypothesis, Friedman (1957) have been used to explain consumption behavior in the literature. For example, the absolute income hypothesis by Keynes stipulates that as income increases consumption increases but not by as much as the increase in income.This non-proportional consumption function implies that in the short run average propensity to consume (APC) is greater than the MPC, this is because in the short run autonomous consumption does not change with income but over the long period horizon, as wealth and income increase, consumption also rises. However, the Relative income hypothesis states that the satisfaction an individual derives from a given consumption level depends on its relative magnitude in society rather than its absolute level. The life-cycle hypothesis on the other hand describes that individuals seek to smooth consumption throughout their lifetime by borrowing when income is low and saving when income is high while the permanent income hypothesis states that people will spend at a level consistent with their expected long-term average income. It is assumed that individuals will choose their demand for energy services as part of a consumption bundle that maximizes their utility subject to their budget, access to funds as well as information constraints (Durham et al 1998; Van de Bergh, 2008; Chang 2015).

Also, in accordance with the consumer behavior theory, the cost of using energy resources in production and business operations if compensated by positive economic impact can induce demand. Likewise, improvements in monetary transactions not only boost the economy and improves the living standard but can also trigger a set of innovative events on the part of business and relevant stakeholders that may lead to a lower incremental cost of energy production and hence increase energy consumption, (Lu et al., 2019). This means that though improved financial conditions can increase energy consumption, the cost of using energy is considered by consumers and businesses who may be less willing to pay more for energy consumption.

3.2. Model Specification

The study is hinged on the Absolute Income hypothesis of Keynes (1936) which assumes that consumption demand depends on income and the propensity to consume. Such that;

$$C = a + bY \quad (1)$$

Since the propensity to consume depends on various factors such as stock of wealth, interest rate, price level, and several subjective factors, this study, therefore, adopted the model of Pal and Mitra (2019)to examine the relationship between energy consumption and financial development in Nigeria. The model is specified as

EC_t=f(FD_t+GDP_t+INF_t+INT_t)--(2)

The functional and linear form Equation 1 is expressed as;

$EC_t = \alpha_0 + \alpha_1 FD_t + \alpha_2 GDP_t + \alpha_3 INF_t + \alpha_4 INT_t + \epsilon_t$---(3)

Where EC, FD_t GDP_t, INF, and INT represent energy consumption, financial development, GDP, Inflation, and Interest rate respectively, and ϵ_t denotes stochastic disturbance term at time t. The nonlinear ARDL is an asymmetric extension to the ARDL model of Pesaran and Shin (1999) and Pesaran et al. (2001) and is useful in explaining the asymmetric relationship that exists between variables.

The standard linear ARDL model of Equation 3 is specified as:

$$\Delta EC_t = \delta_0 + \sum_{j=0}^{p} \delta_1 \Delta FD_{t-j} + \sum_{j=0}^{p} \delta_2 \Delta GDP_{t-j} + \sum_{j=0}^{p} \delta_3 \Delta INF_{t-j} + \sum_{j=0}^{p} \delta_4 \Delta INT_{t-j} + \sum_{j=1}^{p} \delta_1 \Delta EC_{t-j} + \lambda_1 EC_{t-1} + \lambda_2 FD_{t-1} + \lambda_3 INF_{t-1} + \lambda_4 INT_{t-1} \epsilon_t \cdot \quad \text{-------(4)}$$

In addition, first difference operator is denoted byΔ , the coefficients of the short-run multiplier are signified byd_1-δ_4 while long-run multipliers are denoted by – and ϵ_t is the stochastic disturbance term.

This study adopts the nonlinear autoregressive distributed lag model (NARDL) technique by Shin et al (2014). The reason for adopting this technique lies in the fact that the bounds testing approach identifies asymmetries and also allows for regressors of mixed order as long as the variables are I(0) and I(1). The NARDL framework uses negative (decrease) and positive (increase) partial sum decomposition to model the asymmetric relationship between variables (Shin et al., 2014). Also, it is appropriate when the order of integration of the variable of interest does not exceed one (Raza, Shahzad, Tiwari, and Shahbaz, 2016). Lastly, it provides better estimates/results in the case of small sample sizes, Kocaarslan and Soytas (2019). In conformity with Shin et al. (2014) the nonlinear long-run model is specified as;

$$x_t = \Phi^+ z_{1t}^+ + \Phi^- z_{1t}^- + \Phi^+ z_{2t}^+ + \Phi^- z_{2t}^- + \Phi^+ z_{3t}^+ + \Phi^- z_{3t}^- + \Phi^+ z_{4t}^+ + \Phi^- z_{4t}^- + \epsilon_t \quad \text{------------(5)}$$

Where represents Energy Consumption (EC) and represents the independent variables respectively while and are the long run estimates is the vector of k* 1 exogenous variables expressed as

$$z_t = z_0 + z^{+}{}_{t} + z^{-}{}_{t} \quad \text{--}(6)$$

Financial development(*FD)*, GDP per capita (GDP), Inflation (INF), and Interest rate (INT)are apportioned into increase and decrease partial

sums s = s$\Delta\, InFD_t^{+} = \sum_{m=1}^{t} \Delta\, FD_m^{+} = \sum_{m=1}^{t} \max(\Delta\, FD_{m,}\ 0)$ and
$\Delta\, InFD_t^{-} = \sum_{m=1}^{t} \Delta\, FD_m^{-} = \sum_{m=1}^{t} \max(\Delta\, FD_{m,}\ 0)$--(7)

$\Delta\, InGDP_t^{+} = \sum_{m=1}^{t} \Delta\, GDP_m^{+} = \sum_{m=1}^{t} \max(\Delta\, GDP_{m,}\ 0)$ and $\Delta\, InGDP_t^{-} =$
$\sum_{m=1}^{t} \Delta\, GDP_m^{-} = \sum_{m=1}^{t} \max(\Delta\, GDP_{m,}\ 0)$ --(8)

$\Delta\, INT_t^{-} = \sum_{m=1}^{t} \Delta\, INT_m^{-} = \sum_{m=1}^{t} \max(\Delta\, INT_{m,}\ 0)\ and\ \Delta\, INT_t^{-} =$
$\sum_{m=1}^{t} \Delta\, INT_m^{-} = \sum_{m=1}^{t} \max(\Delta\, INT_{m,}\ 0)$ --(9)

$\Delta\, INF_t^{-} = \sum_{m=1}^{t} \Delta\, INF_m^{-} = \sum_{m=1}^{t} \max(\Delta\, INF_{m,}\ 0)\ and\ \Delta\, INF_t^{-} =$
$\sum_{m=1}^{t} \Delta\, INF_m^{-} = \sum_{m=1}^{t} \max(\Delta\, INF_{m,}\ 0)$ ---(10)

Energy Consumption (EC_t)as specified in equation (4) is decomposed into Non-renewable energy (FEC) and Renewable energy (REC).

The NARDL form of Equation 4 is specified as:

$$\begin{aligned}\Delta \mathrm{InFEC}_t = \delta_0 &+ \sum_{m=1}^{p} \psi_j \Delta \mathrm{InFEC}_{t-m} + \sum_{m=0}^{q}(\delta_m^{+}\, \Delta\, InFD_{t-sm}^{+} + \delta_m^{-} \Delta\, InFD_{t-m}^{-} + \\ &\delta_m^{+}\, \Delta\, InGDP_{t-m}^{+} + \delta_m^{-} \Delta\, InGDP_{t-m}^{-} + \delta_m^{+}\, \Delta\, INT_{t-m}^{+} + \delta_m^{-} \Delta\, INT_{t-m}^{-} + \\ &\delta_m^{+}\, \Delta\, INF_{t-m}^{+} + \delta_m^{-} \Delta\, INF_{t-m}^{-}) + \lambda \mathrm{InFEC}_{t-1} + \Phi_{fd}^{+} InFD_{t-j}^{+} + \Phi_{fd}^{-} InFD_{t-1}^{-} + \\ &\Phi_{gdp}^{+} IGDP_{t-j}^{+} + \Phi_{gdp}^{-} InGDP_{t-1}^{-} + \Phi_{int}^{+} INT_{t-j}^{+} + \Phi_{int}^{-} INT_{t-1}^{-} + \\ &\Phi_{inf}^{+} INF_{t-j}^{+} + \Phi_{inf}^{-} INF_{t-1}^{-} \epsilon_t \quad \text{--}(11)\end{aligned}$$

$$\begin{aligned}\Delta \mathrm{InREC}_t = \delta_0 &+ \sum_{m=1}^{p} \psi_j \Delta \mathrm{InREC}_{t-m} + \sum_{m=0}^{q}(\delta_m^{+}\, \Delta\, InFD_{t-m}^{+} + \delta_m^{-} \Delta\, InFD_{t-m}^{-} + \\ &\delta_m^{+}\, \Delta\, InGDP_{t-m}^{+} + \delta_m^{-} \Delta\, InGDP_{t-m}^{-} + \delta_m^{+}\, \Delta\, INT_{t-m}^{+} + \delta_m^{-} \Delta\, INT_{t-m}^{-} + \\ &\delta_m^{+}\, \Delta\, INF_{t-m}^{+} + \delta_m^{-} \Delta\, INF_{t-m}^{-}) + \lambda \mathrm{InREC}_{t-1} + \Phi_{fd}^{+} InFD_{t-j}^{+} + \Phi_{fd}^{-} InFD_{t-1}^{-} + \\ &\Phi_{gdp}^{+} IGDP_{t-j}^{+} + \Phi_{gdp}^{-} InGDP_{t-1}^{-} + \Phi_{int}^{+} INT_{t-j}^{+} + \Phi_{int}^{-} INT_{t-1}^{-} + \\ &\Phi_{inf}^{+} INF_{t-j}^{+} + \Phi_{inf}^{-} INF_{t-1}^{-} \epsilon_t \quad \text{--}(12)\end{aligned}$$

The increase and decrease partial sums decomposition of Equations 7 and 8 is represented by (+) and (–) in Equations 11 and 12. From Equation 11, and denotes the long-run asymmetry while the short-run asymmetry is represented byand.

3.3. Sources of Data

The variables used in this study are time-series secondary data from 1990–2020 obtained from the Central Bank of Nigeria (CBN) Statistical Bulletin and World Bank development index (WDI). For this study, Energy consumption (EC), is decomposed into 2 (two); FEC (fossil fuel energy consumption % of total energy) as a proxy for Non-renewable energy, and REC (renewable energy consumption % of total energy) as a proxy for renewable energy. Domestic credit to private sector is a proxy for Financial Development (FD) while GDP per capita, Inflation, on, and Interest rate are used as control variables.

4. EMPIRICAL FINDINGS AND DISCUSSION

The empirical result for this study is organized as follows: (i) Stage one focuses on descriptive statistics (ii) stage two concentrates on unit root tests using the Augmented Dickey-Fuller (ADF) and Phillip –Perron unit root test to check the order of integration of the series employed; (iii) stage three entails co-integration test, NARDL result, and diagnostics tests.

4.1. Descriptive Statistics

This section focuses on the preliminary analysis. From table 1, the mean and median values lie within the maximum and minimum values and are not too far from each other. This suggests that the distribution is nearly symmetrical. Specifically, renewable energy consumption exhibited the lowest variability in the series with a standard deviation of 1.531699, while GDP had the highest variability in the series with a value of 929.6981. This implies that GDP exhibited the highest level of fluctuation while renewable energy consumption exhibited the lowest level of fluctuation in the data set. All variables are positively skewed except for renewable energy and interest rate are negatively skewed, implying all variables except renewable energy and interest rate have their distribution as long right tails. For the kurtosis, except GDP which is platykurtic, all other variables are greater than 3, and hence leptokurtic implying that the series is greatly peaked relative to the normal distribution. Finally, the Jarque-Bera Statistics (which serves as a goodness of fit test to check whether the series are normally distributed) indicated that most of the variables are normally distributed except for INT and INF which are not normally distributed.

Table 1. Descriptive Statistics of the Variables

	FEC	REC	DMC	GDP	INT	INF
Mean	19.60028	86.5759	10.16841	1414.229	3.199465	17.88025
Median	19.08190	86.78124	8.909485	1268.383	5.790567	12.21778
Maximum	24.22590	89.78531	19.62560	3098.986	18.18000	72.8355
Minimum	15.85414	82.95602	4.957522	270.224	1.45257	5.17297
Std. Dev.	1.970779	1.531699	3.546446	929.6981	10.45916	16.76369
Skewness	0.540556	-0.393497	0.908566	0.257457	-1.369056	2.1062
Kurtosis	2.603709	2.976202	3.522256	1.550779	5.303467	6.335015
Jarque-Bera	1.712554	0.800737	4.617349	3.055282	16.53749	37.28607
Probability	0.424741	0.670073	0.099393	0.217047	0.000256	0.000000
Sum	607.6087	2683.855	315.2206	43841.09	99.18341	554.2878
Sum Sq. Dev.	116.5191	70.38304	377.3183	25930156	3281.820	8430.634

Source: Author's Computation

4.2. Correlation Matrix

Table 2 displays the result of the association among the variables. Taking FEC as the dependent variable, it is observed that all the variables are negatively correlated except Inflation which is positively correlated. Meanwhile, when REC is taken as the dependent variable, all the variables are positively correlated. The results suggest that the correlation coefficients between these three variables are moderate and can co-exist in the same model.

Table 2. Correlation Matrix

	FEC	DMC	GDP	INF	INT	REC
FEC	1					
DMC	-0.35236	1				
GDP	-0.13829	0.72368	1			
INF	0.07852	-0.30646	-0.44738	1		
INT	-0.14869	0.42131	0.41931	-0.82075	1	
REC	-0.23215	0.27408	0.26524	0.11003	0.02217	1

Source: Author's Computation

4.3. Unit Root (Stationarity) Test

An attempt was made to evaluate the time series properties of the series employed in this study using both unit root tests (Augmented Dickey and Fuller (ADF), Phillips, and Perron (P–P) as presented in Table 3. The result of the unit root test using the Augmented Dickey-Fuller (ADF), discloses that all the variables were stationary at first difference I (1). From the Phillips –Perron (PP) unit root test conducted; all series were stationary at I1 except for the INT series which was stationary at level I(0).

Table 3. Unit Root Test (Augmented Dickey-fuller and Phillip-Peron)

ADF Varia-bles	Levels	1st Difference	Re-marks	PP Varia-bles	Levels	1st Difference	Re-marks
FEC	-1.556353	-4.870189*** (0.0005)	I(1)	FEC	-2.083020	-4.867109*** (0.0005)	I(1)
REC	-2.083020	-5.470233*** (0.0001)	I(1)	REC	-2.190745	-5.702709*** (0.0001)	I(1)
DMC	-2.594958	-4.930827*** (0.0005)	I(1)	DMC	-1.8959180	-5.586151*** (0.0001)	I(1)
GDP	-3.750791	-5.750791* (0.0818)	I(1)	GDP	-0.634600	-6.346002* (0.0401)	1(1)
INF	-2.115343	-4.686257*** (0.0008)	I(1)	INF	-2.35432	-4.686257*** (0.0008)	I(1)
INT	-4.182253*** (0.0031)	None	I(0)	INT	-4.182253** (0.0251)	None	I(0)

Source: Author's Computation. Note: ***, ** and * represent 1%, 5% and 10% respectively

4.4. Cointegration test

Having established that the variables were integrated of order one and zero, the bounds test for co-integration was applied to the model. The result of the ARDL bounds test for co-integration is reported in Table 4. From the result, the associated F-statistics for FEC is 5. 243 which is greater than the lower and upper bound values at 5% level of significance. The study, therefore, concludes that the variables co-move and hence have long-run relationship. The associated F-statistic for REC is 3.412 which is lesser than the lower and upper bound values and hence the null hypothesis cannot be rejected. This shows that no long-run relationship exists among the variables.

Table 4. Bounds Test for Co-integration Relationship

Model	F-statistic		F-statistic
FEC	5.243112	**REC**	3.412345

Bounds Level	1(0) Bo-und	I(1) Bo-und	Bounds Level	1(0) Bo-und	I(1) Bo-und
1 % Critical Value	2.67	3.06	1 % Critical Value	3.76	5.28
5 % Critical Value	3.48	5.01	5 % Critical Value	3.62	4.37
10% Critical Value	2.64	3.95	10% Critical Value	3.39	4.48

Source: Author's Computation

4.5. NARDL Analysis

Table 5 reports the asymmetric result on financial development and non-renewable energy. The short-run estimation shows that the coefficient of the error correction term is both negative and statistically significant at 5%. The coefficient estimates of the ECM which is – 0.30 implies that the model corrects its short-run disequilibrium by about 30 % speed of adjustment to return to the long-run equilibrium.

Both short-run and long-run estimates reveal that positive and negative changes in DMC had a negative and insignificant impact on Fossil Fuel energy with coefficients -0.56 and -0.92 respectively. By implication, this shows that the availability of domestic credit by the financial sector is not effective in determining fossil fuel energy consumption. Having established this relationship between financial sector development and fossil fuel energy, it is safe to say that the financial sector development in Nigeria does not encourage the consumption of fossil fuel energy. This finding conforms with (Destek, 2018; Ozdeser et al 2021).

Similarly, Positive and negative changes in GDP have a positive and significant effect on fossil fuel energy consumption both in the short run and long run. By implication, this means that the demand for non-renewable energy consumption increases with GDP in Nigeria. This confirms that the increase in productive economic activity in Nigeria is majorly fueled by non-renewable energy. Also, positive and negative changes in INT was found to have a negative effect on non-renewable energy consumption both in the short run and in the long run, however, the effect was only significant in the short run. This could be because the changes in interest rate gives an indication for people to lower their consumption expenditure by increasing their savings in the short run. Meanwhile, positive and negative changes in INF on fossil fuel energy were negative but insignificant in the short run while the effect in the long run was found to be positive and significant. Meaning that changes in inflation will in the long run stimulate non-renewable energy in Nigeria.

Table 5. NARDL Result on Financial Development and Non-Renewable Energy

Dependent Variable: FEC				
Variables	Coefficient	Std. Error	t. statistics	Prob
Long run Estimate				
C	20.046631	1.608442	12.463387	0.0000
DMC^{+}	-0.569416	0.331024	-1.720166	0.0973
DMC^{-}	-0.926399	0.510152	-1.815925	0.0809
GDP^{+}	0.215643**	0.074347	2.900491	0.0124
GDP^{-}	0.142745**	0.065845	2.167906	0.0493
INF^{+}	0.197308***	0.042749	4.615553	0.0036
INF^{-}	0.161439***	0.038080	4.239521	0.0054
INT^{+}	-0.477606	0.359495	-1.328549	0.4080
INT^{-}	-0.045966	0.033278	-1.381288	0.2164
Short Run Estimate				
ΔDMC^{+}	-0.172953**	0.087913	-1.967308	0.0599
ΔDMC^{-}	-0.281381**	0.116456	-2.416206	0.0230
$\Delta GDP +$	0.775066***	0.319010	2.429597	0.0024
ΔGDP^{-}	0.515000***	0.194178	2.652213	0.0022
$\Delta INF +$	-0.091110	0.121193	-0.751778	0.5896
ΔINF^{-}	-0.283522	0.195799	-1.448026	0.3848
ΔINT^{+}	-0.086115	0.040564	-2.122942	0.0780
ΔINT^{-}	-0.174364**	0.065577	-2.658932	0.0229
ECM	-0.303737**	0.1489270	-2.039499	0.0517

Source: Author's Computation. ***,** and *represent 1%, 5% and 10% respectively

Table 6 reports the asymmetric result on financial development and renewable energy.

The result from the short run analysis shows that both positive and negative changes in DMC has a positive and significant effect on renewable energy. With coefficients 0.052 and 0.204 respectively, implying that a positive change in domestic credit in Nigeria will lead to a 5.2% increase in renewable energy while a negative change will lead to a 20 % decrease in fossil fuel consumption. This shows that domestic credit stimulates the consumption of renewable energy in Nigeria. Also, Positive and negative changes in GDP had a positive effect on renewable energy consumption in the short run, though this effect was insignificant. By implication, this means that the increases in GDP does not significantly stimulate renewable energy in Nigeria. This could be as a result of the heavy reliance on fossil fuel as a source of energy. Positive changes in inflation on renewable energy were negative and significant while negative changes were negative but insignificant. Likewise, positive changes in interest rate were found to have a negative and significant effect on renewable energy consumption in Nigeria while negative changes were insignificant.

Table 6. NARDL Result on Financial Development and Renewable Energy

Dependent Variable: REC				
Variables	Coefficient	Std. Error	t. statistics	prob
Short Run Estimate				
ΔDMC^{+}	0.052034**	0.019462	2.673610	0.0501
ΔDMC^{-}	0.204910***	0.100919	2.030431	0.0083
ΔGDP^{+}	0.257437	0.432273	0.595543	0.5934
ΔGDP^{-}	0.532959	0.352633	1.511370	0.2279
ΔINF	-0.043153**	0.016608	-2.598320	0.0482
ΔINF^{+}	-0.227877	0.131680	-1.930534	0.0818
ΔINT^{+}	-0.133059***	0.118038	-2.035503	0.0074
ΔINT-	-0.042190	0.022871	-1.844652	0.0723
ECM	-0.362804**	0.178234	-2.035546	0.0530

Source: Author's Computation. ***, ** and * represent 1%, 5% and 10% respectively

The model's diagnosis tests in Table 7, show that the residual series is normally distributed as suggested by the Jarque–Bera statistics, while the Breusch–Godfrey LM test statistics showed that the models do not have significant serial correlation problem. Moreover, the ARCH test and the Ramsey RESET test respectively show that the residuals are homoscedastic, and the model has a correct functional form.

Table 7. Diagnostics Tests

DIAGNOSTICS TESTS	
Normality Test	0.614 6 (0.132)
Serial Correlation L.M. Test	Chi Square (2) = 5.4212 (0.3692)
ARCH Heteroskedasticity Test	Chi SQ (12) = 1.2322 (0.6613)
Heteroskedasticity Test	Chi Square (12) = 0.4021 (0.5810)
Functional Form (Ramsey RESET Test)	Chi SQ (1) = 1.6715 (0.126)

Source: Author's computation

5. CONCLUSION AND RECOMMENDATIONS

The study examined the effect of financial development on energy consumption in Nigeria from 1990 to 2020. The study in an attempt to fill the gap in the literature decomposed Energy Consumption into Renewable and Non-renewable Energy and estimated the relationship using the NARDL technique to account for the effect of positive and negative changes. From the bound test in relation to non-renewable energy, a long-run relationship was depicted among variables while only a short-run relationship existed among variables with respect to renewable energy. The study revealed that domestic private credit was only found to have a significant negative impact on non-renewable energy in the short run. This, therefore, means that access to domestic credit in Nigeria reduces non-renewable energy consumption. On the other hand, positive and negative shocks to domestic credit have a positive impact on renewable energy in Nigeria. This ascertains that the development of the financial sector in Nigeria encourages the consumption of renewable energy than non-renewable energy. This study, therefore concludes that access to domestic credit is crucial in stimulating the consumption of renewable energy in Nigeria. The Nigerian financial sector consequently has a significant role to play in achieving affordable and clean energy agenda of the sustainable development goal. Although both positive and negative shocks to GDP were found to stimulate fossil fuel energy consumption both in the short run and long run, increasing consumption of fossil fuel has been known to reduce environmental quality. This study, therefore, recommends the proper mobilization of funds from the financial sector towards investment in renewable energy as an alternative energy source in Nigeria. Since, increases in interest rate were also found to reduce the consumption of renewable energy, policies that will discourage the use of non-renewable energy sources but encourage the use and affordability of renewable energy should be considered in order to reduce environmental pollution and improve health status in Nigeria.

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Oluwatosin Mary Aderajo
Department of Economics, Osun State University, Osun State, Nigeria
oluwatosin.aderajo@uniosun.edu.ng

Temitope Sade Akintunde (Ph.D)
Department of Economics, Osun State University, Osun State, Nigeria
temitope.akintunde@uniosun.edu.ng

FINANCIJSKI RAZVOJ I POTROŠNJA ENERGIJE U NIGERIJI

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Prethodno priopćenje

Sažetak

Studija je ispitivala učinak financijskog razvoja na potrošnju energije u Nigeriji od 1990. do 2020. godine. Studija je koristila sekundarne podatke, a podaci su analizirani korištenjem nelinearnog autoregresivno distribuiranog lag modela (NARDL). Domaći krediti privatnom sektoru korišteni su za mjerenje financijskog razvoja, dok su energija fosilnih goriva i potrošnja obnovljive energije korišteni za mjerenje neobnovljive odnosno obnovljive energije. Ostale varijable uključivale su bruto domaći proizvod, kamatnu stopu i inflaciju. Studija je otkrila da su domaći privatni krediti imali značajan i negativan utjecaj na neobnovljivu energiju samo u kratkom roku, dok su promjene domaćih kredita imale značajan i pozitivan utjecaj na obnovljivu energiju u Nigeriji. To pokazuje da su dosadašnji napori financijskog sektora u Nigeriji potaknuli potrošnju obnovljive energije, što znači da financijski sektor u Nigeriji ima značajnu ulogu u postizanju cilja 7 agende pristupačne i čiste energije održivog razvoja. Studija stoga preporučuje odgovarajuću mobilizaciju sredstava iz financijskog sektora za ulaganja u obnovljivu energiju s obzirom na rastuću potrebu za alternativnim izvorima energije u Nigeriji. Također, trebalo bi razmotriti politike koje će obeshrabriti korištenje neobnovljivih izvora energije, ali poticati korištenje i pristupačnost obnovljive energije u Nigeriji kako bi se moglo postići smanjenje onečišćenja okoliša, kao i poboljšano zdravstveno stanje.

Ključne riječi: *obnovljivi, neobnovljivi, financijski razvoj, nelinearni autoregresivni distribuirani lag model*

JEL: G2, E5, Q2, Q3