**Growth Implications of Energy Use in Nigeria: Evidence from the Service Sector**

**ABSTRACT**

This study investigates the link between energy use and service sector growth in Nigeria. The time series data for each of the variables were obtained from secondary sources including the World Bank, International Energy Agency (IEA) and Organisation of Economic Cooperation and Development (OECD) National Data Accounts. This study utilized descriptive statistics, unit root test, cointegration and least squares estimation method alongside the post-estimation tests to analyze the datasets and evaluate the estimated autoregressive distributed lag (ARDL) model. The findings showed that fossil fuel use positively and significantly affects the service sector value added to GDP. As observed from the short-run results, the service sector value added increased by 11.026% following a percentage increase in fossil fuel energy use. At the same time, evidence of a positive and significant effect of renewable energy use on the service sector value added was established in both the short and long run. The results further showed that total electricity use has a positive and significant effect on the service sector value added in both the long and short run. In particular, the long-run results showed that the service sector value added increased by 1.83% as a result of a percentage increase in the total electricity usage by the firms in the sector. This finding suggests that the availability of electricity offers an opportunity for the growth of the service sector. On the other hand, the results showed that alternative energy use affected the service sector value added negatively in both the short and long run. Thus, it is recommended that governments at all levels should incentivize investments in renewable energy by providing tax breaks, grants, and subsidies for businesses that invest in renewable energy technologies to foster the long-term development of the service sector.

***Keywords***: Energy use, service sector, fossil fuel, renewable energy, electricity usage and Nigeria

**1. Introduction**

Globally, energy is acknowledged as a vital component of any nation's economic expansion. This is so because energy commodities support economic growth and development by increasing income and productivity and providing jobs for the world's growing population (Babatunde, 2016). Therefore, the goal of the efficient energy market is to supply energy commodities to power the agriculture, industrial and service sectors of the economy (Bernard and Oludare, 2016). The need for energy use has equally increased in Africa. This is because the continent's economic growth and development strategy still heavily relies on the development of the energy sector (Esso and Loesse, 2017). Notwithstanding the abundant renewable energy resources in Africa, the transition to modern and clean energy has been difficult considering the infrastructural deficits and financial constraints, among others (Ezekwe & Chidi, 2024).

Several issues, including an inconsistent energy supply, have plagued West Africa's energy sector over the years (Babatunde, 2013). On the other hand, the majority of the energy produced in the Central and Eastern regions of Africa comes from hydropower. In Nigeria, energy use has been considered a growth enabler for all sectors of the economy. According to Odularu and Okonkwo (2019), the reason for this is that energy is the foundation of wealth creation at the core of operations, facilitating the activities of other sectors of the Nigerian economy to spur economic growth. It is also argued in extant literature that energy use in Nigeria usually consolidates the activities of other sectors which often provide essential services to direct production activities in agriculture, manufacturing, mining and other sectors of the economy.

Despite the importance of reliable and adequate energy access, few studies document the relationship between energy use and service sector performance. This is worrisome given that an increase in energy use not backed by improved economic performance points to energy inefficiency. Thus, it becomes imperative to investigate how energy use has contributed to service sector value added to GDP in Nigeria. The study is organised into five sections. Following the introduction, Sections 2 and 3 provided the literature review and methodology respectively. Additionally, section 4 provides the results and discussion while section 5 concludes the paper.

**2. Related Literature**

**2.1 Theoretical Literature**

This study is anchored on the energy-led growth theory proposed by Mason (1955) and Sims (1972). The theory assumes that focus on the energy sector, from research to development and innovation and infrastructure development, can not just accelerate growth within the energy sector itself but can have beneficial spillover effects across the economy at large including the service sector. It suggests that a focus on the energy industry, including research, innovation, and infrastructure development, can not only drive growth within the energy sector itself but also have positive ripple effects throughout the broader economy. By improving energy efficiency, promoting renewable energy sources, and investing in sustainable energy practices, countries can not only meet their energy needs more effectively but also create new job opportunities, spur technological innovation, and reduce environmental impact.

There are many criticisms of energy-led growth theory. One major criticism is its limitation in accounting for the complex factors that contribute to economic growth. The theory tends to oversimplify the relationship between energy consumption and economic development, neglecting the multifaceted nature of growth processes. Additionally, critics argue that energy-led growth theory does not adequately consider the impact of technological advancements and innovation in shaping economic progress. The theory also faces challenges in addressing concerns related to environmental sustainability and the finite nature of energy resources. Furthermore, some scholars argue that a singular focus on energy may overlook other crucial factors influencing economic development, such as human capital, institutions, and policies.

**2.2 Empirical Literature**

Karanfil and Li (2015) investigated the short- and long-run effects of electricity consumption and economic activity in a selected sample of 160 countries from 1980 to 2010. The study's major goal was to determine the dynamic consequences of continental electricity dependence and how this level of dependence could assist in achieving the desired level of urbanisation and GDP growth. The study's findings established that the feedback hypothesis exists in the long run for the vast majority of the sample size. The study identified unidirectional causality in the short-run between economic growth and electricity consumption in the Pacific, East Asia, North Africa, the Middle East, and lower-middle-income countries. The neutrality hypothesis was also found in Sub-Saharan Africa, North America, and upper-middle-income nations, according to the study. They also discovered that there was no evidence of growth hypothesis in any of the examined strata. Their study's Granger causality finding revealed a range of outcomes in terms of urbanisation and electricity net import. The study revealed that in wealthy countries, the association between electricity consumption and economic growth has primarily short-term consequences, whereas in low-income economies, the relationship has long-term consequences.

Nwosa and Akinbobola (2012) considered the link between aggregate energy consumed and Nigerian sectoral output between the periods of 1980 and 2010. The method of data analysis involves a bi-variate vector auto-regressive (VAR) model. The result indicates a two-way causality between aggregate energy consumption and AGOP and a one-way causality running from the service sector to aggregated energy consumed. It concluded that the link between consumed energy and the output of respective sectors of the economy differs. Hence, energy policies that are targeted to individual sectors rather than a generalized policy was recommended. Conservative energy policies were seen to be injurious to productivity in agricultural and service sectors within the economy of Nigeria.

Mawejje and Mawejje (2016) examined the causal relationship between electricity consumption and sectoral output growth in Uganda. First, they used vector error correction techniques to estimate the long-run relationship between electricity consumption and GDP growth. Second, they applied Granger causality tests to determine the direction of this relationship. Third, they disaggregate GDP into its major sectors of agriculture, industry and services and test for Granger causality between sectoral output growth and electricity consumption. At the macro-level, results suggest long-run unidirectional causality running from electricity consumption to GDP. At the sectoral level, results indicate long-run causality running from electricity consumption to industry; a unidirectional short-run causality running from the services sector to electricity consumption; and neutrality in the agricultural sector. These results have important policy implications. In particular, policies that improve electricity generation and consumption will accelerate growth in Uganda by facilitating industrial sector growth.

Lukic (2016) looked at the specifics of energy efficiency's impact on the profitability of the service sector, with special insight into trade in Serbia. The theoretical and methodological presentations are illustrated by applying the comparative approach, to the original empirical data of the European Union and Serbia. To a certain extent, to thoroughly analyze the problem, the data from the surveys conducted in the United States of America, Canada and Russia were used. The results of empirical research show that energy efficiency in the service sector in Serbia is considerably lower than in the European Union and other countries with developed market economies. Given that, it is necessary to introduce appropriate measures to improve the energy efficiency of the service sector in Serbia in the future. These are: modern energy technologies, an increase of renewable energy shares in total final energy consumption, reduction of energy consumption throughout the entire supply chain, reduction of carbon dioxide emissions related to energy consumption, construction of energy-efficient office buildings and retail facilities, and improvement of the existing. The ultimate effect of this is to improve profitability in the service sector in Serbia.

**3. Methodology**

**3.1 Model Specification**

The model for this study is patterned after the work of Agbanike Nwani and Uwazie (2019) with an improvement following the recognition of heterogeneous energy supply sources to enhance production activities in different segments of the real sector. The model is specified in a functional form as:

SSV = f (FEU, REU, AEU, TOU) (1)

Where: SSV = service sector value added, FEU = fossil fuel energy use, REU = renewable energy use, AEU = alternative energy use and TOU = total electricity use

Specifically, the autoregressive distributed lag (ARDL) model is specified below:

$SSV\_{t}$ = α0 + $\sum\_{i=1}^{p}α\_{1}ΔSSV\_{t-1}$+$\sum\_{i=1}^{q}α\_{2}ΔFEU\_{t-1}+\sum\_{i=1}^{q}α\_{3}ΔREU\_{t-1}+\sum\_{i=1}^{q}α\_{4}ΔAEU\_{t-1}+$ $\sum\_{i=1}^{q}α\_{5}ΔTOU\_{t-1}$+$β\_{1}SSV\_{t-1}+β\_{2}FEU\_{t-1}+β\_{3}REU\_{t-1}+β\_{4}AEU\_{t-1}+β\_{5}TOU\_{t-1}+ε\_{t}$ (2)

Where: α0 = constant parameter to be estimated, α1 – α5 = short-run parameters to be estimated, $β\_{1}$ - $β\_{5}$ = long-run multipliers, p = optimal lag operator for each of the dependent variables, q = optimal lag operator of the independent variables, = first difference operator, $ε\_{t}$ = error terms

**3.2 Data and Variable Description**

Service sector growth defines thevalue added in wholesale and retail trade, transport, government, financial, telecommunication, education and health care services. It is arrived at after adding up all outputs and subtracting intermediate inputs. It was measured as a percentage of GDP. The energy use is measured by fossil fuel energy use, renewable energy use, alternative energy use and total electricity use. Annual time series data was utilized in this study. Specifically, the data on service sector value added were obtained from the World Bank and Central Bank of Nigeria Statistical Bulletin. Similarly, data on the energy use indicators were obtained from the World Bank, International Energy Agency (IEA) and Organisation of Economic Cooperation and Development (OECD) National Data Accounts. The datasets spanned from 1990 to 2023.

**3.3 Data Analysis Techniques**

The least squares approach was used in this study to estimate the ARDL models. Notably, the ARDL is distinct from the error correction mechanism (ECM) which is based on the proposition of Engel and Granger (1987). Hassler and Wolters (2006) contend that the popularity of the ARDL in econometrics literature is a result of the fact that the cointegration of nonstationary variables is equivalent to an error correction process. Furthermore, the variables must display a structure of I(0), I(1), or a combination of I(0) and I(1) for the ARDL to be estimated. As a result, determining the order of integration of each series using a unit root test is one of the ARDL model's antecedents. The purpose of this is to make sure that none of the series are I(2) to prevent the procedure from being void. The data analysis techniques also include descriptive statistics which covered the mean distribution, standard deviations and normal distribution of each of the variables over the study period. The augmented Dickey-Fuller (ADF) test proposed by Dickey and Fuller (1981) was also used for the unit root test in addition to the bounds cointegration test.

**4. Results and Discussion**

**4.1 Unit Root Test**

The results of the ADF unit root test are presented in Table 1

**Table 1: ADF Unit Root Test Result**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable  | ADF stat. at levels | ADF stat. at 1st diff. | Critical Value at 5% | Order of Integration |
| SSV | -1.8180 | -4.2113\*\*\* | -2.9604 | I(1) |
| FEU | -2.7280 | -5.8578\*\*\* | -2.9604 | I(1) |
| REU | -1.7160 | -5.6900\*\*\* | -2.9604 | I(1) |
| AEU | -2.4903 | -8.1275\*\*\* | -2.9604 | I(1) |
| TOU | -2.9633\*\* | - | -2.9604 | I(0) |

**Source: Computed from E-views Software**

**Note: \*, \*\* and \*\*\* denote Significant at 10%, 5% and 1% levels respectively**

The results show Total electricity use is stationary at levels given that the ADF statistics at levels are greater than the corresponding critical value at the 5% level. Consequently, the null hypothesis of the unit root is rejected at the 5% critical value. This result implies that total electricity use is integrated into order zero I (0). On the other hand, the results show that the other variables are non-stationary at levels given that their ADF statistics at levels are less than the associated critical value at the 5% significance level. However, they were found to be stationary at first difference, indicating that they are integrated of order one (1). The evidence of mixed integration in the series provided the statistical requirement for the application of the bounds cointegration test.

**4.2 Cointegration Test**

The bounds cointegration test results for each of the models are presented in Table 2.

**Table 2: Bounds cointegration test results**

|  |
| --- |
| SSV FEU REU AEU TOU |
| F-Bounds Test | Null Hypothesis: No levels of relationship |
| Test Statistic | Value | Signif. | I(0) | I(1) |
| F-statistic |   3.682 | 10% | 2.2 | 3.09 |
| K | 4 | 5% | 2.56 | 3.49 |
|  |  | 2.5% | 2.88 | 3.87 |
|  |  | 1% | 3.29 | 4.37 |

**Source: E-views Software 12**

The result shows that the computed F- statistics (3.682) is greater than the upper bound critical value (3.49) at the 5% significance level. This necessitates the rejection of the null hypothesis of no long-run relationships among the variables at the 5% significance level. Hence, service sector value added has a long-run relationship with the energy use indicators. This finding equally aligns with the result of Samuel *et al.* (2021) and Alam, (2015) who found evidence to justify the claim that there is a long-run relationship between the service sector and energy use in developing economies.

**4.1 Model Estimation**

**Model Estimation**

The least squares method was employed to estimate the ARDL models. The results are presented in Table 3.

**Table 3: Summary of ARDL results**

|  |  |  |
| --- | --- | --- |
| Dependent Variable: SSV |  |  |
| Selected Model: ARDL(1, 1, 0, 1, 1) |  |
| Short run results |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| D(FEU) | 1.7688\*\*\* | 0.708098 | 2.498074 | 0.0197 |
| D(REU) | 1.8708\*\*\* | 0.585739 | 3.193978 | 0.0039 |
| D(AEU) | -46.5229\*\*\* | 14.057853 | -3.309390 | 0.0029 |
| D(TOU) | 0.24446 | 0.177540 | 1.376964 | 0.1812 |
| CointEq(-1) | -0.26429\*\* | 0.109832 | -2.406332 | 0.0242 |
| Long run results |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| FEU | 11.0262\*\* | 4.976909 | 2.215475 | 0.0365 |
| REU | 7.07865\*\* | 3.224294 | 2.195411 | 0.0380 |
| AEU | -269.4716\*\* | 113.528061 | -2.373612 | 0.0260 |
| TOU | 1.83162\*\*\* | 0.700676 | 2.614079 | 0.0152 |
| C | -755.746\*\* | 358.221917 | -2.109716 | 0.0455 |
| Adjusted R-squared | 0.84962 |  | Prob(F-statistic) | 0.0000 |

**Source: E-views Output (2024)**

**Note: \*\*\*, \*\* and \* denote significant at 1%, 5% and 10% levels respectively**

The findings showed that fossil fuel use positively and significantly affects the service sector value added to GDP. This finding aligns with the theoretical expectation which predicts that fossil fuels are an important energy source for the service sector. The positive contribution of fossil fuel usage to service sector value added to GDP agrees with the findings of Kwakwa, Adu and Osei-Fosu (2018) who reported that fossil fuels significantly enhanced the growth of the service. This finding is not surprising following the increasing dependence of the service sector, especially transportation as an important source of energy in developing economies including Nigeria. This goes forth to explain how the transportation of goods and services in Nigeria largely depends on fossil fuels including premium motor spirit and diesel.

Similarly, the results showed evidence of a positive and significant effect of renewable energy use on the service sector value added in both the short and long run. This finding is in tandem with the a priori expectation and highlights the growth benefits of renewable in the service sector. It further explains that energy transition is beneficial to the growth of the service sector. The significant positive contribution of renewable energy use to service sector value added agrees with the findings of Strielkowski *et al.* (2021) and Opeyemi (2021) who reported that renewable energy is essential for the growth of the service sector including the electric power sector development. The results further showed that total electricity use has a positive and significant effect on the service sector value added in both the long and short run. This finding follows the results of Olanrele *et al.* (2020), Kirikkaleli, Güngör and Adebayo (2022) and Lukić (2016) who reported that electricity consumption is significant in driving long-term growth in the service sector. The implication of this finding is that access to stable and affordable electricity to service firms has the potential to promote sustainable development in the sector. However, the results showed that alternative energy use affected the service sector value added negatively in both the short and long run. This finding could be linked to the large dependence of transportation, communication and entertainment services on fossil fuels as key energy sources. This finding is contrary to the results of Iqbal, Hassan and Arshed (2023) and Oh, Pang and Chua (2010) who reported that alternative energy plays a moderating role in boosting the growth of the service sector.

**Table 4.: Post-estimation test results**

|  |  |  |
| --- | --- | --- |
| Test Type | Test Statistic | Probability value |
| Breusch-Godfrey Serial Correlation LM Test | 2.4675 | 0.4812 |
| White heteroskedasticity test | 8.7531 | 0.3635 |
| Ramsey RESET | 0.5367 | 0.6622 |

**Source: E-views Output (2024)**

As observed from the post-estimation test results, there is no serial correlation in the model at the 5% level. This is based on the fact that the probability value (0.4812) of the Breusch-Godfrey serial correlation LM test result is greater than 0.05. Thus, the null hypothesis of no serial correlation is accepted at the 5% level. The results further showed that the variance of the residuals is constant over the study period given that White heteroskedasticity test result is associated with a probability value of 0.3635. In addition, there is no problem of functional misspecification in the model at the 5% significance level given that the probability value (0.6622) of the Ramsey RESET result is greater than 0.05. In this regard, the null hypothesis of no functional misspecification in the model is accepted. These findings are impressive as they provide enough evidence for the reliability of the estimated ARDL model.



**Figure 1: Cumulative sum (CUSUM) graph for model 4**

In this study, the stability of the estimated ARDL model was determined using the CUSUM graph. The results show that, at the 5% significance level, the CUSUM graph falls between the two critical bound lines. This suggests that during the study period, the estimated parameters remain constant. In sum, the post-estimation test result further confirms the estimated ARDL model is reliable.

**5. Concluding Remarks**

The role of energy in service sector development has continued to attract the attention of policymakers, researchers and stakeholders in the energy sector. This has triggered several researches to provide insights into the contribution of the value added of the service sector. Findings showed that the long-term effect of fossil fuel usage on service sectors value added is positive. This finding could be linked to the large dependence of the service sector on fossil fuels, especially diesel for an increased service delivery and value addition to GDP. The results further showed that the effect of renewable energy use on service sector value added is positive and significant. This finding is impressive as explains that access to renewable energy is imperative for the improved performance of the service sector. However, it was found from the results that alternative energy use contributed negatively to the service sector value added. On the contrary, the long-term effect of total electricity use on service sector value added is positive. Given the findings, this study concludes that the use of clean and modern energy in the forms of renewable energy, alternative energy and electricity is important for the growth of the service sector. Hence, it is recommended that governments at all levels should incentivize investments in renewable energy by providing tax breaks, grants, and subsidies for businesses that invest in renewable energy technologies to foster the long-term development of the sevice sector.

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