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# Disaggregated Energy Consumption and Sectoral Output in Nigerian Economy

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***Abstract:*** *It is obvious that energy is the engine that drives the economy of any nation. Fortunately, Nigeria has abundant natural energy resources that can bring her economy to the fore of development. This study therefore, evaluates the effect of energy consumption on Nigerian economy for the period of 1980-2017. Specifically, the objectives were to ascertain the impact of disaggregated energy consumption on industrial, agricultural and telecommunication sector contribution to Nigerian economy respectively. The study employed secondary data sourced from Central Bank of Nigeria (CBN) Statistical Bulletin between 1980 and 2017.The Secondary time series data were analyzed using Augmented Dickey Fuller unit root test and Ordinary Least Square techniques. The famous AK model of the endogenous growth theory was employed. The findings of the study showed that disaggregated energy consumption as was incorporated to modify the model used to achieve the specific objectives was simultaneously significant. The study therefore, concluded that any policy action lines taken to cause variations on energy consumption will have significant effect on Nigerian economy especially in the long run. The study recommended that adequate energy should be supplied to the industrial and agricultural sector so as to boost domestic production and at a reduced cost.*

***Keywords:*** *Energy consumption, Energy supply, Energy sources, Industrial output, agricultural output, telecommunication.*

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## I. Introduction

Nigeria is blessed with abundant energy resources and is currently known as the Africa's largest producer and exporter of petroleum and gas. The country's major energy resources include crude petroleum and gas, coal, bitumen, hydropower and fuel. Nevertheless, the increase in the world population with its' attendant increase in economic activities make the constant use of these energy sources inevitable. In Nigeria the total energy consumption was estimated at 4.4 quadrillion Btu (IEA, 2015). Nevertheless, 45 percent of all the energy generated are being used for heating, 10 percent used in industries, 15 percent for electric automobile and electronics and 30 percent for conveyance ( IEA, 2006).

However, Nigerian energy industry is probably one of the most inefficient in meeting the needs of its customers (Iwayemi, 2008). This is made manifest in the persistent disequilibrium in the markets for electricity and petroleum products, especially kerosene and diesel. This dismal energy service provision has invariably affected its consumption and the subsequent standards of living of Nigerians. As a matter of fact, this situation has exacerbated income and energy poverty in an economy where the majority of the people live below poverty line (less than two dollar per day) (Agbede, 2016).

It is worthy to note that, this Nigeria's persistent energy crisis has undermined the industrialisation processes, weakened agricultural productivity, lowered telecommunications performance and other efforts to achieve sustained economic growth. The Nigeria's chronic energy infrastructural gaps which have existed since the large scale inflows of oil income in the mid 1970s still worsened today despite huge amounts of public expenditure invested by government (Orazulike, 2012). It is imperative to state that the billion dollars of public investment into capacity expansion in the energy industry contrast sharply with the extremely poor supply outcomes measured by refinery output, rise in imported fuels and frequent power outages and voltage variation (Agbede, 2016). Every government, professionals and academic alike are concerned with the impact of energy supply and consumption on the Nigerian economy (Audu, 2013).

Meanwhile, the energy crisis in Nigeria for more than two decades has been enormous and has largely contributed to the incidence of paralyzing industrial, agricultural, telecommunication and commercial activities (Agbede, 2018). The council for Renewable Energy of Nigeria revealed that power outages brought a loss of 126 billion naira (US $984.38 million) annually (Udah, 2010). Apart from the huge income loss, it has also resulted to health hazards due to the exposure to carbon emissions caused by constant use of generators in different households and business enterprises, thus leading to a deterioration of living conditions. Increasing access to energy in Nigeria has proved not only to be a continuous challenge but also a pressing need by the international community. Neither manufacturing sector, agricultural sector, telecommunication sector, nor any enterprise in Nigeria can function productively without electricity or any regard to energy supply (Oyedepo, 2012).

The significance that the country has placed on crude oil is relatively very high (Udah 2010). This over reliance on crude oil in Nigeria is a major challenge because it has failed to diversify its energy consumption to ensure an appropriate energy mix.

## II. Theory And Related Literature Review

The Nigerian energy production and consumption have received a considerable attention in the literature, and theories explaining this phenomenon abound. The most popular among the theories are the famous AK Model of the endogenous growth theory, the energy ladder theory, real business cycle theory, and the Solow growth model of long run (Solow, 1956).

The AK Model of economic growth is an endogenous growth model used in the theory of economic growth, a subfield of modern macroeconomics. The key property of AK endogenous growth model is the absence of diminishing returns to capital. In lieu of the diminishing returns of capital implied by the Cobb-Douglas production function, the AK model uses a linear model where output is a linear function of capital. Its' appearance in most essays is to introduce endogenous growth theory.

In a study on energy supply and industrial output growth in Nigeria, Agbede (2018), revealed that electricity generated and premium motor spirit have a positive impact on industrial output growth in Nigeria, though with high cost of production. The findings implied that the availability of liquefied natural gas in Nigeria has not contributed significantly to the industrial performance. In line with the findings, the study concluded that irregular electricity supply has been a major bane to output growth in the manufacturing sector. The findings are in line with Liew et al (2012); Tan Mohd and Tunku (2016). Liew *et al* (2012), critically analyzed the interdependent relationship between energy consumption and sectoral outputs in Pakistan for the period of 1980 to 2007. The co-integration estimate showed that energy consumption exhibited long-run relationship with agriculture as well as other services output. The study found no evidence of long-run relationship between energy consumption and industrial output. Tan, Mohd and Tunku (2016), examined the effect of electricity consumption on agriculture, services and manufacturing sector in Malaysia between 1975 and 2009. Their Vector error correction model showed a long-run relationship among electricity consumption, agriculture and manufacturing in Malaysia. It was observed that electricity consumption is found to contribute to a change in agriculture in Malaysia. The study therefore recommended adequate electricity supply to boost agriculture, service and industrial sector in Malaysia.

Similarly, Haruna & Saifullahi (2012), Bright and Machame (2011), revealed that petroleum, coal and electricity consumption lead to economic growth without feedback but a bidirectional relationship exist between gas consumption and economic growth. Their study made use of both the aggregated and the disaggregated data on energy consumption including coal, petroleum, gas and electricity. The implication of their findings is that energy conservation policy will retard the economic growth. They concluded that government should find possible ways of redressing low energy consumption prevailing in Nigeria so that the sector could play its role of enhancing economic performance.

Bright and Machame (2011) studied the impact of energy consumption and economic growth in Nigeria using the period of (1970 to 2005). The study found non-stationary and co-integrated series for both economic and energy variables in Nigeria. The study further recommended that a policy to reduce energy consumption aimed at reducing emission will have negative impact on the GDP in Nigeria.

Gbadebo and Chinedu (2009) used co-integration analysis to examine the impact of energy consumption in Nigerian economy during the period of 1970-2005. The dependent variable was real GDP and the independent variables were crude oil consumption, coal consumption and electricity consumption. The result showed a negative relationship between the lagged values of electricity consumption and economic growth. The research suggested that there should be an increase in electricity supply as to enhance energy infrastructure.

Nevertheless, Erbay Kal (2008) investigated the relationship between economic growth and electricity consumption from 1970-2003 periods in Turkey using the bounds test approach to co-integration. The study found that in the short run, both oil and electricity consumptions have positive significant effects on economic growth. In the long run however, oil consumption has positive but insignificant effect on economic growth. Molem and Ndifor (2016) examined the effect of energy consumption on economic growth in Cameroon during the period of 1980-2014. The result showed that Gross Domestic Product (GDP), population growth rate and petroleum prices have a positive relationship with petroleum consumption. It was recommended that the government should expand current energy sources and exploit other sources such as renewable so as to increase the production and consumption which will in turn boost economic growth

Audu, Nathan and Apere (2013) empirically analyzed the dynamics of demand and supply of electricity in Nigeria. The analysis revealed that electricity demand is price inelastic, while income is elastic.

According to Samuel and Lionel (2013) in Nigeria efforts should be made to improve electricity generation technology which should encourage capital formation to reduce power loss and improve electricity supply.

Simon (2012) examined the impact of electricity crisis on the manufacturing productivity growth in Nigeria from 1980 to 2008, using ordinary least square multiple regression to analyze the time series data. The result showed a positive relationship between capacity utilization, exchange rate and the index of manufacturing productivity, while electricity generation and government capital expenditure produced negative relationship with manufacturing productivity index as dependent variable.

Ozun and Cifter (2007) used a wave let analysis as a semi parametric model test for multi scale causality between electricity consumption and economic growth from 1968-2002 periods. The study found that in the short run, there is a feedback relationship between GNP and energy consumption, while in the long run, GNP leads to energy consumption.

## III. Theoretical Framework

The methodological framework of this study is based on AK model of the endogenous growth theory. The AK model of production function is a special case of a Cobb-Douglas production function with constant return to scale. Since the key property of AK endogenous growth model is the absence of diminishing returns to capital. In lieu of a Cobb-Douglas production function, the AK model uses a linear model where output is a linear function of capital. Its appearance on most essay is to introduce endogenous growth theory.

Thus;

$Y = AK^{\alpha}L^{1-\alpha}$ ………………….. (1)

Where Y represents the total production in an economy, A represents total factor productivity, K is capital, L is labour, the parameter $\alpha$ measures the output elasticity of capital. Following equation (1), Nnaji, Chukwu and Uzoma (2013) developed the following model: $Y = f$ (K, L, E) ....................... (2)

Where, output is a function of capital, labour and energy consumption.

Following the discussions in the theoretical framework, the study adopts with modifications the AK model (1980) based on further development by Nnaji, et al (2013). Therefore, in line with objectives of the study, we specified our models functionally as follows taken GDP as output to be a function of energy consumption which will always have a constant return to scale. However, we consider main energy consumption in Nigeria and they include petroleum, electricity, gas and fossil fuel. We hence consider three major sectors that contribute to Nigeria Gross Domestic Product. These sectors include manufacturing sector, agricultural sector and telecommunication sector. Therefore, splitting energy into four while incorporating the challenge of $Co_2$ emission, then our model could be restated as follows:

**Model ………… (1)**

IND = $f$ ( K, L, PT, EC, FF, $Co_2$) ………………. (3)

However, equation 3 can be expressed in econometric model. In doing this, we take the common log of both sides of the equation.

$LogIND = \beta_0 + \beta_1 logK + \beta_2 logL + \beta_3 logPT + \beta_4 logEC + \beta_5 \log FF + \beta 6 LogCo_2 + \mu t$....…….(4)

**Model ............. (2)**

AGDP = $f$ (K, L, PT, EC, FF, $Co_2$)……… (5)

Hence, econometrically the equation 5 can be transformed in log linear form

$LogAGDP = \alpha_0 + \alpha_1 logK + \alpha_2 logL + \alpha_3 logPT + \alpha_4 logEC + \alpha_5 \log FF + \alpha_6 \log Co_2\ Vt$....…….(6)

**Model ......... (3)**

TEL = $f$ (K, L, EC, FF, GS, $Co_2$)………… (7)

We still express equation 7 in econometric model and hence, log both sides of the equation.

$LogTEL = \lambda_0 + \lambda_1 \log K + \lambda_2 \log L + \lambda_3 \log EC + \lambda_4 \log FF + \lambda_5 \log GS + \lambda_6 \log Co_2 +$ Wt..... (8)

Where

L = Labour ratio

K = Capital ratio

TEL = Telecommunication contribution to GDP

IND = Industrial output

AGDP = Agricultural Gross Domestic Product (output)

PT = Petroleum

EC = Electricity consumption

GC = Gas consumption

FF = Fossil fuel consumption
I = Natural logarithm transformation
Co2 = Carbon dioxide emission
$\alpha_0$, $\beta_0$, and $\lambda_0$ are the intercept terms
$\alpha_{1-6}$, $\beta_{1-6}$, and $\lambda_{0-6}$ are the parameters to be estimated respectively.

## IV. Presentation of Results

### 4.1 Unit Root Test

Given that the unbiasedness property of the time series parameters would not be achieved if the underlying data values are nonstationary, the unit root test is therefore necessary to check for the stationarity of the variables.

**Table 4.1 Summary of Augmented Dickey-Fuller unit root test result**

| Variables | ADF statistics | Order of Integration | Remarks |
|---|---|---|---|
| AGDP | -5.939317 | 1(1) | Stationary at first difference |
| $CO_2$ | -5.894554 | 1(1) | Stationary at first difference |
| EC | -8.940731 | 1(1) | Stationary at first difference |
| FF | -6.097811 | 1(1) | Stationary at first difference |
| GC | -4.920748 | 1(1) | Stationary at first difference |
| IND | -5.463626 | 1(1) | Stationary at first difference |
| K | -5.399792 | 1(1) | Stationary at first difference |
| L | -9.954258 | 1(1) | Stationary at first difference |
| PT | -7.387996 | 1(1) | Stationary at first difference |
| TEL | -5.496144 | 1(1) | Stationary at first difference |
| MODEL 1 ECM | -5.157898 | 1(0) | Stationary in level |
| MODEL 2 ECM | -5.835858 | 1(0) | Stationary in level |
| MODEL 3 ECM | -6.014325 | 1(0) | Stationary in level |

**Source:** Researcher's computation using Eview 9 (2019).

As seen on table 4.1, all the variables were stationary at first difference while the ECM for the three models was stationary in level. Given this, the Autoregressive Distributed Lag modelling technique will not be applied since all the variables were integrated of same order.

### 4.2 Regression Results

**Table 4.2: Summary of the regression result: Dependent Variable- Industry (IND)**

**SHORT RUN MODEL**

| Variables | Coefficient | Std. Error | t-statistic | Prob. |
|---|---|---|---|---|
| C | 0.012650 | 0.005172 | 2.446097 | 0.0207 |
| K | 0.092899 | 0.050881 | 1.825796 | 0.0782 |
| L | 0.013128 | 0.026011 | 0.504723 | 0.6176 |
| PT | -0.358420 | 0.142378 | -2.517380 | 0.0176 |
| EC | -0.029422 | 0.088284 | -0.333269 | 0.7413 |
| FF | 0.525908 | 0.206036 | 2.552510 | 0.0162 |
| $CO_2$ | 0.077315 | 0.077453 | 0.998218 | 0.3264 |
| ECM(-1) | -0.097156 | 0.119944 | -0.810014 | 0.4245 |
| $R^2$= 0.299212 | F stat= 1.768855 | $R^2$Adj= 0.130056 | F prob.=0.13211 | |

**Source:** Researcher's compilation using E-view 9(2019)

**Table 4.3: Summary of the regression result: Dependent Variable- Industry**

**LONG RUN MODEL**

| Variables | Coefficient | Std. Error | t-statistic | Prob. |
|---|---|---|---|---|
| C | 1.202028 | 0.735141 | 1.635099 | 0.1121 |
| K | 0.073409 | 0.053088 | 1.382779 | 0.1766 |
| L | 0.139257 | 0.054723 | 2.544779 | 0.0161 |
| PT | 0.143697 | 0.125391 | 2.145995 | 0.0206 |
| EC | 0.469572 | 0.121130 | 3.876591 | 0.0005 |
| FF | 0.214827 | 0.301235 | 2.713154 | 0.0311 |
| $CO_2$ | -0.013575 | 0.078754 | -0.172375 | 0.8643 |
| $R^2$= 0.830167 | F stat= 25.25529 | $R^2$Adj= 0.797296 | F prob.=0.00000 | |

**Source:** Researcher's computation using E-view 9(2019)

From tables 4.2 and 4.3, the estimated coefficients of 0.092899 in the short run and 0.073409 in the long run for capital formation show that a unit increase in capital formation will subsequently increase industrial output in Nigeria by about 0.09 units and 0.07 units in the short and long run periods respectively. In addition, the estimated coefficients of 0.013128 in the short run and 0.139257 in the long run for labour force show that a unit increase in total labour force will lead to a 0.01 increase in industrial output in the short and long run periods respectively. Similarly, the coefficients of -0.358420 in the short run and 0.143697 in the long run for petroleum consumption indicate that a unit increase in petroleum consumption will decrease industrial output by about 0.35 units in the short run but will increase industrial output by about 0.14 units in the long run. This variation in effect can be explained by the fact that in the short run period when the firms are starting up, further expenditure above revenue will definitely affect the output of the firm but in the long run when these firms must have expanded, such increase in expenditure above revenue will not affect the firm since the firm must have developed other means of revenue and have also gained a significant share of the market. Furthermore, the coefficient of -0.029422 in the short run and 0.469572 in the long run for electricity consumption shows that a unit increase in electricity consumption will decrease industrial output by about 0.02 units in the short run but will increase industrial output by about 0.46 in the long run periods. The reason for such variation in effect can also be drawn from same reason as given above. In addition, the coefficient 0.525908 in the short run and 0.214827 in the long run for fossil fuel consumption show that a unit change in fossil fuel consumption will yield 0.52 units and 0.21 units increase in industrial output in the short and long run periods respectively. The coefficient of 0.077315 in the short run and -0.013575 in the long run for carbon dioxide ($CO_{2)}$ emissions shows that a unit increase in carbon dioxide emissions will lead to a 0.07 units increase in industrial output in the short run and a 0.01 unit decrease in industrial output in the long run. Finally, the negative coefficient for the ECM shows that in the previous period, the long run component of the ECM model (i.e., $\boldsymbol{\varepsilon_{t-1}}$) had a value that was > 0 which goes to mean that the value of the regressand in the previous period was above its equilibrium value, hence, the ECM short run component (i.e., $\boldsymbol{\alpha}$) needed to take a negative value to restore the value of the regressand back to equilibrium in the long run. Therefore, from the result, the coefficient value of -0.097158 for the ECM shows that about 9% of the disequilibrium/discrepancies in the previous period were corrected in the present period. This shows a low speed of adjustment.

The coefficient of determination, $R^2$, helps to measure the overall goodness of fit of the entire regression. The values of the R-squared were 0.299212 and 0.830167 in the short run and long run periods respectively. This indicates that the independent variables accounts for about 29% and 83% of the total variations in the Nigerian industrial output, in the short and long run periods respectively.

From the regression results, the values of the F-statistics were 1.768855 and 25.25529 with respective P-values of 0.13211 and 0.00000 in the short and long run periods. However, given that long run models are the models used for policy purposes, we will ignore the F-statistics for the short run period. We conclude from that of the long run period, that the independent variables and the overall regression are statistically significant hence, the regression is very robust with a high predictive power.

From the short and long run regression results, it can be deduced that the different sources of energy exerted various degrees of effects on industrial sector productivity. While petroleum and electricity consumption exerted negative effects on industrial sector productivity in the short run, others like fossil fuel consumption, labour, capital, Co2, exerted positive effect. In the long run, except Co2, other disaggregated energy consumptions exerted positive effects on industrial sector productivity. Following from the long run model, we conclude that disaggregate energy consumption has positive effects on industrial sector productivity in Nigeria. This finding is line with that of Agbede (2018).

**Table 4.4: Summary of the regression result: Dependent Variable- Agriculture (AGDP)**

**SHORT RUN MODEL**

| Variables | Coefficient | Std. Error | t-statistic | Prob. |
|---|---|---|---|---|
| C | 0.023268 | 0.005240 | 4.440644 | 0.0001 |
| D(K) | 0.150097 | 0.050679 | 2.961718 | 0.0060 |
| D(L) | 0.021197 | 0.025357 | 0.835945 | 0.4100 |
| D(PT) | -0.151710 | 0.144622 | -1.049009 | 0.3028 |
| D(EC) | 0.303375 | 0.091337 | 3.321489 | 0.0024 |
| D(FF) | 0.006554 | 0.210276 | 0.031168 | 0.9753 |
| D($CO_2$) | -0.106068 | 0.081907 | -1.294974 | 0.2055 |
| ECM(-1) | -0.119985 | 0.083541 | -1.436250 | 0.1616 |
| $R^2$= 0.375383 | F stat= 2.489778 | $R^2$Adj= 0.224613 | F prob.=0.039336 | |

**Source:** Researcher's computation using E-view 9(2019)

**Table 4.5: Summary of the regression result: Dependent Variable- AGDP**

**LONG RUN MODEL**

| Variables | Coefficient | Std. Error | t-statistic | Prob. |
|---|---|---|---|---|
| C | -1.464072 | 1.089597 | -1.343682 | 0.1888 |
| K | 0.067860 | 0.078685 | 0.862425 | 0.3951 |
| L | 0.191447 | 0.081108 | 2.360407 | 0.0247 |
| PT | 0.587243 | 0.185849 | 3.159786 | 0.0035 |
| EC | 1.145730 | 0.179534 | 6.381678 | 0.0000 |
| FF | -1.407377 | 0.446479 | -3.152172 | 0.0036 |
| $CO_2$ | -0.250530 | 0.116727 | -2.146292 | 0.0398 |
| $R^2$= 0.939079 | F stat= 79.64284 | $R^2$Adj= 0.927288 | F prob.=0.00000 | |

**Source:** Researcher's computation using E-view 9(2019)

From tables 4.4 and 4.5, the estimated coefficients of 0.150097 in the short run and 0.067860 in the long run for capital formation imply that a unit increase in capital formation will subsequently increase agricultural output in Nigeria by about 0.15 units and 0.07 units in the short and long run periods respectively. In addition, the estimated coefficients of 0.021197 in the short run and 0.191447 in the long run for total labour force show that a unit increase in total labour force will increase agricultural output in Nigeria by about 0.02 units and 0.19 units in the short and long run periods respectively. Similarly, the coefficients of -0.151710 in the short run and 0.587243 in the long run for petroleum consumption indicate that a unit increase in petroleum consumption will increase agricultural output in the long run by about 0.59 units but will decrease agricultural output in the short run by about 0.15 units. The coefficient of 0.303375 in the short run and 1.145730 in the long run for electricity consumption show that a unit increase in electricity consumption will increase agricultural output by about 0.30 units and 1.14 units in the short and long run periods respectively. The coefficient of 0.006554 in the short run and -1.407377 in the long run for fossil fuel consumption indicate that a unit increase in fossil fuel consumption will increase industrial output by about 0.01 units in the short run but will decrease agricultural output by about approximately 1.40 units in the long run. The coefficient of -0.106068 in the short run and -0.250530 in the long run for carbon dioxide emissions imply that a unit increase in $CO_2$emissions will decrease agricultural output by about 0.10 and 0.25 units in the short and long run periods respectively. Finally, the negative coefficient of the ECM (-0.119985) shows that in the previous period, the long run component of the ECM model (i.e., $\boldsymbol{\varepsilon_{t-1}}$) had a value that was > 0 which goes to mean that the value of the regressand in the previous period was above its equilibrium value, hence, the ECM short run component (i.e., $\boldsymbol{\alpha}$) needed to take a negative value to push up the value of the regressand to equilibrium in the long run. Therefore, from the result, the coefficient value of -0.119985 for the ECM shows that about 11% of the disequilibrium/discrepancies in the previous period were corrected in the present period. This shows a low speed of adjustment.

The values of the R-squared were observed to be 0.224613 and 0.927288 in the short run and long run periods respectively. This indicates that the independent variables accounts for about 22% and 93% of the total variations in the dependent variable in the short and long run periods respectively.

From the regression results, the values of the F-statistics were 2.489778 and 79.64284 with their respective P-values of 0.039336 and 0.000000 in the short and long run periods. Since the regressors are simultaneously significant and the overall regression model statistically significant we conclude that the regression is very robust with a high predictive power.

From the short and long run regression results, it can be deduced that the different sources of energy exerted various degrees of effects on agricultural output. While labour, fossil fuel and electricity consumption exerted positive effects on agricultural output in the short run, Co2 and petroleum consumption exerted a negative effect. In the long run, while petroleum consumption and electricity consumption contributed positively to agricultural output, Co2 and fossil fuel consumption contributed to decline in agricultural output. From the long run model, we therefore, conclude that disaggregated energy consumption can either have a positive or a negative effect on agricultural output in Nigeria.

**Table 4.6: Regression result: Dependent Variable- Telecommunications (TEL)**

**SHORT RUN MODEL**

| Variables | Coefficient | Std. Error | t-statistic | Prob. |
|---|---|---|---|---|
| C | 0.045514 | 0.027942 | 1.628887 | 0.1142 |
| K | 0.926656 | 0.274952 | 3.370248 | 0.0021 |
| L | 0.188937 | 0.131074 | 1.441455 | 0.1602 |
| EC | 0.959510 | 0.482618 | 1.988134 | 0.0563 |
| FF | -1.109053 | 0.988694 | -1.121735 | 0.2712 |
| GC | 0.668765 | 0.563803 | 1.186169 | 0.2452 |

| | | | | |
|---|---|---|---|---|
| $CO_2$ | -0.788693 | 0.489990 | 1.609609 | 0.1183 |
| ECM(-1) | -0.683258 | 0.189349 | -3.608449 | 0.0011 |
| $R^2$= 0.413359 | F stat= 2.919135 | $R^2$Adj= 0.271755 | F proby=0.00193 | |

**Source:** Researcher's computation using E-view 9(2019)

**Table 4.7: Regression result: Dependent Variable- Telecommunications (TEL)**

**LONG RUN MODEL**

| Variables | Coefficient | Std. Error | t-statistic | Prob. |
|---|---|---|---|---|
| C | -21.39390 | 2.641695 | -8.098553 | 0.0000 |
| K | 0.969428 | 0.175045 | 5.538174 | 0.0000 |
| L | 0.326882 | 0.198780 | 1.644438 | 0.1102 |
| EC | 1.990101 | 0.570360 | 3.489203 | 0.0015 |
| FF | -3.837463 | 1.073399 | -3.575057 | 0.0012 |
| GC | 2.062411 | 0.432983 | 4.763258 | 0.0000 |
| $CO_2$ | -1.604863 | 0.305905 | 5.246275 | 0.0000 |
| $R^2$= 0.871203 | F stat= 174.2521 | $R^2$Adj= 0.865630 | F proby=0.00000 | |

**Source:** Researcher's computation using E-view 9(2019)

From tables 4.6 and 4.7, the estimated coefficients of 0.926656 in the short run and 0.969428 in the long run for capital formation shows that a unit increase in capital formation will subsequently increase the performance of the telecommunications sector in Nigeria by about 0.92 units and 0.96 units in the short and long run periods respectively. This goes to show the importance of capital assets in the growth of the telecommunications sector. In addition, the estimated coefficients of 0.188937 in the short run and 0.326882 in the long run for total labour force show that a unit increase in total labour force will increase the growth of the telecommunications sector by about 0.18 units and 0.32 units in the short and long run periods respectively. Similarly, the coefficients of 0.959510 in the short run and 1.990101 in the long run for electricity consumption indicate that a unit increase in electricity consumption will help improve the telecommunications sector by about 0.95 units and 1.99 units in the short and long run periods respectively. The coefficient of -1.109053 in the short run and -3.837463 in the long run for fossil fuel consumption show that a unit increase in fossil fuel consumption will decrease the performance of the telecommunications sector by about 1.11 units and 3.84 units in the short and long run periods respectively. The coefficient of 0.668765 in the short run and 2.062411 in the long run for gas consumption indicates that a unit increase in gas consumption will boost the performance of the telecommunications sector by about 0.67 units and 2.06 units in the short and long run periods respectively. Furthermore, the coefficient of -0.788693 in the short run and -1.604863 in the long run for $CO_2$ emissions show that a unit increase in $CO_2$ emissions will deteriorate the performance of the telecommunications sector by about 0.78 units and 1.60 units in the short run and long run periods respectively. Finally, the negative coefficient for the ECM shows that in the previous period, the long run component of the ECM model (i.e., $\boldsymbol{\varepsilon_{t-1}}$) had a value that was > 0 which goes to mean that the value of the regressand in the previous period was above its equilibrium value, hence, the ECM short run component (i.e., $\boldsymbol{\alpha}$) needed to take a negative value to restore the value of the regressand to equilibrium in the long run. Therefore, from the result, the coefficient value of -0.683258 for the ECM shows that about 68% of the disequilibrium/discrepancies in the previous period were corrected in the present period. This therefore shows a high speed of adjustment to long run equilibrium.

The values of the R-squared were observed to be 0.413359 and 0.871203 in the short run and long run periods respectively. This indicates that the independent variables accounts for about 41% and 87% of the total variations in the telecommunications sector, in the short and long run periods respectively**.**

From the regression results, the values of the F-statistics are2.919135 and 174.2521 with respective P-values of 0.0019369 and 0.00000 in the short and long run periods respectively. Hence, we conclude that the regressors are significant and the overall regression model is statistically significant and as such, the regression is very robust with a high predictive power.

From the short and long run regression results, it can be deduced that the different sources of energy also exerted various degrees of effects on Nigeria's telecommunications sector. While Co2 and fossil fuel consumption exerted a negative effect on Nigeria's telecommunications sector in the short run, labour, capital, electricity and gas consumption exerted positive effects. In the long run, while electricity and gas consumption exerted positive effects on Nigeria's telecommunications sector, C02 and fossil fuel consumption exerted negative effect. Following from the long run model, we therefore conclude that disaggregate energy consumption can either positively or negatively affect Nigeria's telecommunications sector

## 5. Conclusion and Recommendation

The study focused on energy consumption and Nigerian economy between 1980 and 2017. Three main sectors were considered, among which were; industrial sector, agricultural sector and telecommunications sector. The objectives were to examine the disaggregated energy consumption on industrial, agricultural and telecommunications sector output. Findings of the study show that the three identified economic sector (industry, agriculture and telecommunications) depend highly on the level of energy consumption in Nigeria. Empirical investigation reveals that energy consumption is still underutilized. We therefore conclude that any policy action lines taken to enhance energy consumption will have significant effect on economic growth in Nigeria especially in the long run. As we observed a strong relationship between energy consumption and agricultural productivity, we therefore recommend that energy price and tax policy should be kept low. This policy effect will help to boost agricultural output if commercial farm producers can afford petroleum products and other energy sources. We also recommend manpower updating programmes for the power sector as to boast alternative energy for electricity consumption. This will in the long run contribute to telecommunication sector output, as energy requirements of telecommunications sector were usually electricity which can be substituted by the use of alternative/renewable energy.

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