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RENEWABLE ENERGY AND NONRENEWABLE ENERGY CONSUMPTION, CO2 EMISSIONS AND ECONOMIC EXPANSION NEXUS: FURTHER EVIDENCE FROM KENYA

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ABSTRACT

This research scrutinizes economic expansion, CO2 emissions and energy utilization relationship in Kenya by using FMOLS estimate. This study considers the causality matters among oil (Non renewable), electricity (Renewable) use, CO2 emissions, and GDP growth in Kenya by employing time series techniques and annual data for the period 1980–2017. The obtained empirical results from this study indicate that CO2 emissions and electricity effect negatively economic expansion while oil consumption affects it positively. The Granger-causality test conclude that there is no causal relationship running from economic expansion to CO2 emissions, which means that economic expansion can continue without escalating CO2 discharge. However, the study finds unidirectional causality running from economic expansion to oil, and electricity energy use, which implies that Kenya should make an effort to triumph over the constraint on oil and electricity utilization to achieve economic expansion.

Contribution/ Originality: Despite increased demand and utilization of oil products and electricity in Kenya, the rate of economic growth is still lower than the rate of energy consumption. To date, no study that focuses on the causality relationship between energy use, CO2 emissions, and real GDP with respect to Kenya has been carried out. Thus, the purpose of this study is filling the gap.

1. INTRODUCTION

The definitive objective of an economy is to achieve the preferred level of economic expansion. In maintaining at this level a country faces a number of impediments during the epoch of growth. One of the most significant of these is the damage on environment and inadequate energy supply (Reddy and Assenza, 2009). A great fraction of the world's power need is met through fossil fuels the reserve of which is rapidly running out. The gas emissions from these sources add to the amount of C02 which harms the green space as well as inflicting irrevocable damages on the atmosphere. Global warming and climate change have been one of the most decisive environmental problems in modern time for both developed and developing economies. Heavy use of energy and other natural resources, and waste cause environmental deterioration. According to Environmental Kuznets Curve (EKC) hypothesis, the income growth from industrialization will cause both income disparity and environmental injure in the initial stage of the economic expansion process but this tendency will be overturned in further phases when a definite income level is achieved.

Due to the fact that energy consumption is the vital source of the economic expansion and it directly pollutes the environment, the world could face an environmental calamity if precautions are not taken into consideration (Farhani, 2015). In this case, renewable energy (electricity) can potentially play a pivotal role to enhance energy supplies and to shrink emissions resulting from oil consumption (non renewable) (Apergis and Payne, 2010).

1.1. Past Economic Statistical Trends

Globally, the use of petroleum products has been rapidly increasing sustained by fast growing demand for road and air transport, particularly in the developing countries. In China for instance, the need for refined products surged by 12%. Asia accounted for 40% overall increase in use. In Latin America, consumption rose by 5.7%, while Middle East rose from 4.1% to 8%all in the 2013. This trend has been witnessed in Africa too where Nigeria recorded a whopping 10% increase in utilization in 2013. While Kenya and South Africa had 8%and 7.8% increase respectively. Similarly in Kenya, consumption of petroleum oil rose from 3530 barrels/day to 8050 barrels/ day from the year 1984 to 2014.

Energy use plays a vital role in economic growth and development. It should not be shocking to find that there is a close tie between GDP growth and energy (oil and electricity) supply. The Kenya's GDP is estimated to have lengthened by 6.0 per cent in 2016 compared to a 5.3 per cent growth in 2014. This expansion was mainly supported by a stable macroeconomic environment and enhancement in outputs of agriculture; infrastructure; devolution; construction; finance and insurance; and real estate (IMF, 2016).

Kenya is the fourth largest economy in sub-Saharan Africa, with an estimated nominal GDP of 55 billion USD in 2015. The story of Kenya's power sector is one of solid performance. For its population and per-capita GDP, Kenya is performing well in terms of power generated. Kenya's per-capita power consumption is 161 kWh (2014) compared to 126 kWh in Nigeria, which has a per-capita GDP nearly 3x higher. The contribution of energy sector to the overall tax revenue is about 20%, equivalent to 4% of GDP. The sector provides about direct and indirect employment to an estimated 24000 persons. Kenya's installed capacity in June 2016 was 2.3 GW, against a demand of 1.6 GW and is projected to grow to 2.6GW-3.6GW by 2020. Kenya's current electricity supply is 1.4 GW. Electricity supply is predominantly sourced from hydro and fossil fuel sources. This energy generation mix comprises 52.1% from hydro, 32% from fossil fuels, 13.2% from geothermal, 1.8% from biogas cogeneration and 0.4% from wind, respectively. However, hydro power has ranged 38-76% of the generation mix due to poor rainfall experienced in most Kenyan parts.

In Kenya consumption of petroleum oil has been on an increasing but the rate on increase has been more than the proportionate increase in GDP growth, a clear sign that that there exists some ineffectiveness in the country. For example, in Kenya, the petroleum oil consumption in the year 2009 was 10% while the economy in the same period grew by 3%. It's paradoxical since it's expected more energy use is a good indicator of expected growth returns. Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacturer of cement. Though Kenya CO_2 emissions per capita fluctuated considerably in recent years, it tended to swell through 1996-2015 period ending at 0.33 metric tons in 2015.

1.2. Significance of the Study

Despite increased demand and utilization of petroleum products and electricity in Kenya, the rate of economic growth is still lower than the rate of energy consumption. To date, no study that focuses on the causality relationship between energy use, CO_2 emissions, and real GDP with respect to Kenya has been carried out. Thus, the purpose of this study is filling the gap. The current study will assist in policy formulation in energy consumption that should be adopted to accelerate economic growth. In recent years due to factors, such as increases in greenhouse and CO_2 emissions, global warming and climate changes has become a major threat for all countries. So in order to avert this increased environmental pollution and degradation CO_2 emissions must be reduced through increased use of electricity than oil.

2. LITERATURE REVIEW

The status of natural resources and environment in a country depends on several dynamics (Panayotou, 1999): The size of the economy, energy consumption, population, sectoral structure of economy, level of technology, environmental characteristics, impacts of environmental preservation and environmental spending. A larger economy (GDP) leads to rapid depletion of natural resources and a higher level of pollution. The mode and level of the depletion and pollution of resources also depends on the sectoral structure of economy. Countries that deeply depend on agriculture and basic industry are prone to suffer damages due to factors causing rapid depletion of resources such as soil erosion and low industrial pollution rates. Industrial countries that had the problem of depleting their rural resources have gradually become places that suffer from urban pollution and density.

Energy production and consumption, energy density, the status and price of energy all play a critical role in the development trend of CO_2 emission. In this sense, it acts as an engine of economic growth and development. Therefore, a country with heavy utilization of energy is thought to also have a high life standard. However, high energy use causes high carbon emission which has a reverse effect on the environment and economic activities (Alkhathlan and Javid, 2012). The constantly rising amount of CO_2 and its repression on the greenhouse effect shows the gravity of this problem. Scholars and policy-makers have a consensus on the necessity of reducing the emission of greenhouse gas to mitigate global warming (Zhang and Cheng, 2009). Emission of pollution factors tend to increase with the expansion of economic activities. On the other hand, clean technologies generate less pollution per unit and members of society can focus their demands on a healthier and more sustainable environment. In this case, the country can resort to implementing more strict environmental controls (Grossman and Krueger, 1991). According to EKC hypothesis, the connection between income per capita and pollutant emissions per capita is in the shape of an inverted-U curve. It shows that economic activities may benefit environmental quality after a certain point (Niu and Li, 2014). Therefore, environmental harm is inevitable at the first stages of economic growth and for this reason countries are obliged to endure it until the reversing effect (Figure 1) (Shahrin and Halim, 2007).

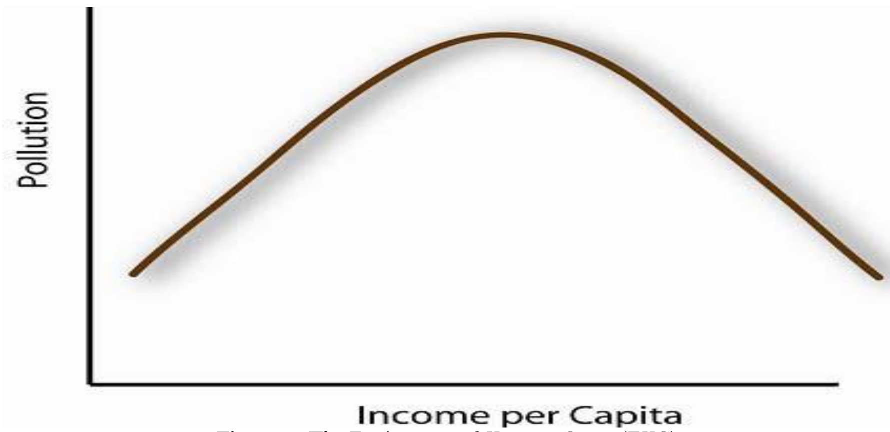

Figure-1. The Environmental Kuznets Curve (EKC)
Source: Shahrin and Halim (2007)

2.1. The Empirical Literature

Farhani (2015) employed panel co integration techniques to scrutinize the causal association between renewable energy utilization, economic growth and CO_2 emissions for 12 MENA countries covering the annual period 1975-2008. The Granger-causality results indicate that there is no causal association between these variables in short run except a unidirectional causality running from renewable energy consumption to CO_2 emissions. However, the study found unidirectional causality running from economic growth and CO_2 emissions to renewable energy use in long run. Panel FMOLS and DOLS estimates, found that only CO_2 emissions have an impact on renewable energy consumption.

Lim *et al.* (2014) investigated the short- and long-run causality issues among oil use, CO_2 emissions, and GDP growth in the Philippines by using time series techniques and annual data for the period 1965–2012. The findings were presented as follows: First, there is bi-directional causality linking oil use and economic activities, which recommend that the economy should attempt to overcome the constraints on oil use to achieve growth. Second, bi-directional causality between oil use and CO_2 emissions is established, which implies that the country needs to improve efficiency in oil use in order to eliminate CO_2 emissions. Third, uni-directional causality originating from CO_2 emissions to economic growth is detected, which means that growth can persist without increasing CO_2 emissions.

Bozkurt and Akan (2014) in their study examined GDP growth, CO_2 emissions and energy use connection in Turkey by using co integration test using 1960-2010 data. The obtained empirical results from this paper indicated that CO_2 emissions effect negatively country growth while energy utilization affects it positively.

Melike (2013) investigated the relationship between electricity consumption and economic growth by using Autoregressive Distributed Lag (ARDL) bounds testing approach and vector error-correction models (VECM) in Cameroon, Cote D'Ivoire, Congo, Ethiopia, Gabon, Ghana, Guatemala, Kenya, Senegal, Togo and Zambia for period 1970-2010. The ARDL results show that there is cointegration relation between electricity consumption and economic growth in ten of the eleven countries. The causality analysis reports that growth hypothesis exists in Cameron, Congo Rep., Ethiopia, Kenya and Mozambique and the conservation hypothesis in Senegal and Zambia. For Gabon, Ghana and Guatemala, there exists the bidirectional causality between economic growth and electricity consumption.

Alam *et al.* (2012) researched into the presence of a dynamic causation between energy utilization, electricity use, carbon emission and economic activities in Bangladesh using the bivariate Johansen cointegration model and Granger causation tests. According to findings, there is a bidirectional long-term causation connection between electricity use and economic activities while there is a unidirectional causation relationship between energy consumption and growth both in the long and short terms yet there is no short term causation.

Menyah and Wolde-Rufael (2010) explore the causal association between CO_2 emissions, renewable and nuclear energy use and real GDP for the US for the period 1960-2007. The empirical study concludes unidirectional negative causality running from nuclear energy use to CO_2 emissions and proves that nuclear energy utilization can help to reduce CO_2 emissions. In contrast, they found no causality between renewable energy consumption to CO_2 emissions but they also found a unidirectional causality running from CO_2 emissions to renewable use.

2.2. Conceptual Framework

Figure 2 attempts to contextualize the theoretical framework to the objectives of the study, the hypotheses and how the procedures of data analysis relate to the problem of the study. The conceptual representation shows the explanatory variables which include carbon emission, oil and electricity energy, while dependent variable is the real GDP growth. In between the dependent and explanatory variables are the intervening variables which are not controlled for and comprise exchange rate instabilities, political instabilities and domestic policies.

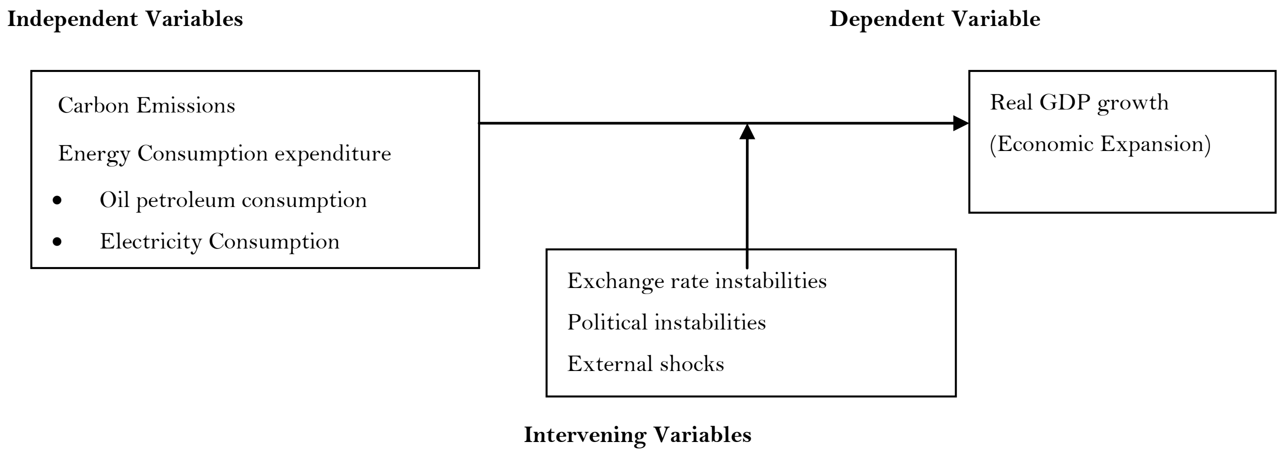

Figure-2. Conceptual Framework.

3. RESEARCH METHODOLOGIES

3.1. Research Area

This study used quantitative research design to scrutinize the link between energy utilization, carbon emissions and economic growth in Kenya for the period 1980 and 2017. The study will use time series annual data. The chosen research design is appropriate to the proposed study as it will capture the trends of involved variables. This study was carried out in Kenya. This is because in the last decade, there has been a significant improvement in energy utilization and policy. Further, the preceding studies have pointed out that we cannot generalize results from panel and cross sectional studies to a particular country such as Kenya.

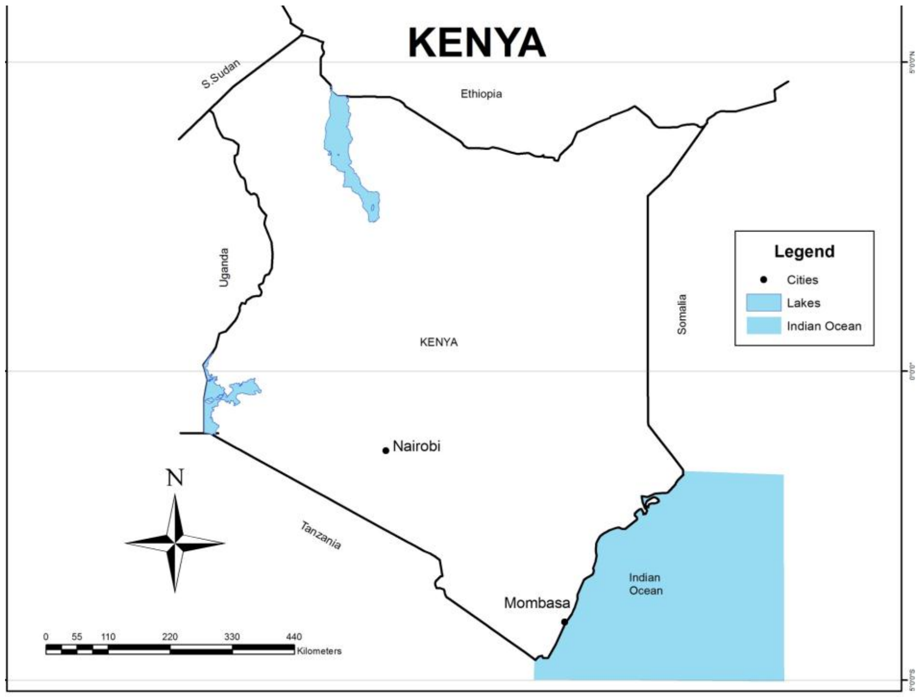

Figure-3. Map of Kenya.

Source: Kenyan Open Data Project (2012).

3.2. Data

The variables used in this study are Energy Consumption which is measured in kg of oil equivalent per capita and billion Kilowatts, CO_2 emissions measured in metric tons per capita and Real GDP growth measured in constant US$. These variables come from the World Bank sources. The annual data are selected to cover the period from 1980 to 2017.

3.3. Econometric Modeling

The study utilizes Augmented Dickey-Fuller (ADF) unit root test to examine for the stationary of variables. The regression models of the ADF unit root test are below: The null hypothesis is that each individual time series contains a unit root against the alternative that each time series is stationary. The model is specified as;

$$\Delta Y_t = \mu_i + \rho Y_{t-1} + \sum_{l=1}^{pi} \theta_{iL} \Delta Y_{it-L} + \alpha_{mi} d_{mt} + \varepsilon_{it} \qquad m=1,2,3 \qquad (3.1)$$

The unit root test evaluates the null hypothesis of H_0: $\rho = 0$, for all i, against the alternative hypothesis H_1: $\rho < 0$ for all i. The lag order ρi is anonymous and is allowed to vary across individuals. The unit root test is implemented as follows; the ADF regressions are run for each individual *i*. The orthogonalized residuals are then generated and normalized. Model (3.2) below was estimated;

$$\Delta Y_t = \rho Y_{t-1} + \sum_{L=1}^{pi} \theta_{iL} \Delta Y_{it-L} + \alpha_{mi} \partial_{mt} + \varepsilon_{it} \qquad (3.2)$$

where ρi represents selected lag orders.

The two orthogonalized residuals are generated by the subsequent two auxiliary regressions;

$$\Delta Y_{it} = \sum_{L=1}^{pi} \theta_{iL} \Delta Y_{it-L} + \alpha_{mi} \partial_{mt} + \mu_{it} \qquad (3.3)$$

$$\Delta Y_{it-1} = \sum_{L=1}^{pi} \theta_{iL} \Delta Y_{it-L} + \alpha_{mi} \partial_{mt} + W_{it-1} \qquad (3.4)$$

When the difference operator is incorporated it becomes;

$$\Delta Y_t = \varphi Y_{t-1} + \mu_t \qquad (3.5)$$

The residuals are saved as $\tilde{u}_{it}$ and $\acute{w}_{it-1}$ respectively. To remove the heteroscedasticity, the residuals $\tilde{u}_{it}$ and $\acute{w}_{it-1}$ are normalized by the regression standard error from the ADF regression.

Empirical analysis is performed by using co integration test, error correction model (ECM) and Engle-Granger causality test. There are two major procedures to assess for the presence of cointegration, namely, the Engle-Granger (EG) two step procedures and the Johansen Maximum Likelihood Estimation procedure. The EG approach is used to investigate whether cointegration relations exist between these variables. However, this approach can only be applied if there exists just one cointegrating relation. Thus, we start by inspection whether the time series are pair wise co integrated. If the variables are co-integrated, they cannot move far away from each other. Having established the presence of a long-run relationship, one may proceed to specify the short-run dynamic relation for the economic aggregates hence VECM. Thus the Vector Error Correction Model (VECM) is tested. This indicates short-run dynamics of the model. The ECM combines the short and long- term relations between analyzed variable.

Granger causality is a test of whether lagged values of one variable help to forecast changes in another. Hence, a variable I (component of Independent variables) is said to granger cause another variable, real GDP growth, y ($I \rightarrow y$) if past values I can predict present values of y. If causality is in one direction from I to y we have a unidirection causality while if I granger causes y and y granger causes I, we have bi-directional causality($(y \leftrightarrow I)$. The test for Granger causality is performed by estimating equations of the following form.

$$\Delta \ln y_t = \beta_0 + \sum_{i=1}^{p} \beta_1, i\Delta \ln y_{t-i} + \sum_{i=0}^{p} \beta_{2,i} \Delta \ln I_{t-i} + \mu ECM_{t=1} + \varepsilon_t + \mu_i \quad (3.5)$$

$$\Delta \ln I_t = \delta_0 + \sum_{i=1}^{p} \delta_1, i\Delta \ln I_{t-i} + \sum_{i=0}^{p} \delta_{2,i} \Delta \ln y_{t-i} + \eta ECM_{t=1} + v_t \ \mu_i \quad (3.6)$$

Where ε_t, μ_i and v_t are white noise disturbance terms (independent and normally distributed), p are the number of lags crucial to stimulate a white noise in the residuals, and the ECM_{t-1} is the error correction term from the long-run relationship. I_t is said to granger cause y_t if one or more $\beta_{2,i}(i = 1,...p)$ and μ are statistically significant different from zero and vice versa.. Bi-directional causality is said to exist if at least $\beta_{2,i}$ and $\delta_{2,i}(i = 1,...p)$ or μ and η are significantly different from zero.

To carry out tests on the Co integrated vectors, it is consequently necessary to use methods of effective estimation. Various techniques exist, such as Fully Modified (FM-OLS) or Ordinary Least Squares (OLS). The collected data will be estimated by FM-OLS. This approach has one advantage over dynamic specification, in that it remains valid if the condition of weak exogeneity fails. In this research, the long-run association between nonrenewable, renewable energy, GDP and CO2 emissions will be given by the following equation:

$$Y_t = \beta lnC_t + \gamma ln\, E_t + v_t + \varepsilon_t$$

Where:

Y_t - is the dependent variable.

C_t - carbon emission

E_t – is the energy (oil and electricity) consumption.

β and γ - are parameters to be estimated

v_t – time fixed effects

$\varepsilon_{i,t}$ – is the error term

3.4. Econometrics Diagnostic Tests

Post-estimation econometrics diagnostic tests were carried out during the study. Normality test, Heteroscedasticity and Autocorrelation were tested for the above models before estimation and corrected accordingly.

4. EMPIRICAL RESULTS

4.1. Dickey-Fuller Unit Root Test

To test for unit-root in the variables, there are a number of approaches. However, the most recommended methods are the ADF and Phillip-Peron test. In this research, ADF was used. When using the ADF, one has to ensure that the error terms are identically and independently distributed (ii) and have constant variance. Further, this test takes into account the less restrictive nature of the error process.

Table-1. ADF Results

Variables in Logs	ADF at Level		Order	ADF at First difference		Order
	T Statistics	P value		T Statistics	P value	
lnGDP	-3.217	-0.01	I(0)	_	_	_
lnC	-2.623	-0.09	I(1)	-6.0	-0.00	I(0)
lnO	0.173	1.1	I(1)	-5.9	-0.00	I(0)
lnE	-0.004	1.9	I(1)	-4.7	-0.00	I(0)

All at 5 % level of significance (critical value: -2.966)

The results from Table 1 divulge that all the variables in the study except the real GDP growth were non-stationary at level using ADF test. The variables were then differenced once and they became stationary, meaning that the variables are integrated of order one.

Engel and Granger (1987) has shown that if two series y_t and x_t are cointegrated of order *d, b*, that is, $y_t \sim CI\ (d, b)$, then the series have a long-run equilibrium relationship and any deviation from this equilibrium is temporal and will eventually be corrected and long-run equilibrium restored. For this to happen, however, two conditions must hold. First, all the components of y_t must be *I(d)* such that differencing them generates series that are integrated of a lower order. Second, there must exist a vector ***b*** such that, $zt = {}_b y_t \sim I\ (d\text{-}b)$. If for instance y_t is integrated of order one ($y_t \sim$ I (1)), then its first difference would be integrated of order zero (stationary) that is, $y_t \sim$ I (0), in which case y_t and x_t are co-integrated. Estimation of co integrating relationship requires that all time series variables in the model to be integrated order of one. But from the findings, the dependant variable real GDP is already stationary I (0) while the rest of the variables are of order (1), hence they are not of the same integration. This therefore implies there was no co- integration since the variables are of different integration.

The dependent variable "gdp" is stationary at levels and therefore we will definitely perform a VAR regression with the default lag length of 0 or 1. The selection of the model is based on the Schwartz-Bayesian Criterion (SBC) or Akaike Information Criterion (AIC). The AIC (Akaike Information Criteria) suggests a lag of 1 while SBIC (Schwarz-Bayesian Information) Criteria and HBIC select a lag length of 0. So we go with 1.

Table-2. Selection Order Criteria

Selection- order criteria
Sample: 1984 - 2017 Number of obs = 34

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-77.7459				.00144	4.80858	4.86982*	4.98816*
1	-61.0225	33.447	16	0.006	.001392*	4.76603*	5.07222	5.66389
2	-53.7837	14.478	16	0.563	.002433	5.2814	5.83255	6.89754
3	-29.044	49.479*	16	0.000	.001628	4.7673	5.56341	7.10173

Endogenous: gdp diff_c diff_ o diff_ e
Exogenous: _cons

4.2. Estimation Data Diagnostic Test

The Durbin Watson statistic (DWS) is used to test the presence of autocorrelation between the variables. DWS is close to 1.6; implying serial correlation is not a problem. This is because the closer the DWS value is to 2, the better the confirmation of the absence of autocorrelation (Table 3).

The F-test statistics findings demonstrate that the coefficients are simultaneously non-zero and hence the independent variables have explanatory power on the dependent variable at 10% level of significance. The adjusted coefficient of determination (adjusted R_2) test is used to show the total variation of the real GDP that can be explained by the independent variables. The adjusted R_2 is equal to 0.5, which entails that 50% of the variations in real Gross Domestic Product are explained by the changes in explanatory variables in the model within the phase under review.

Different post estimation diagnostic tests were carried out. The study used Breusch-Godfrey test for autocorrelation in data. Serial correlation causes the standard errors of the coefficients to be smaller than they actually are and higher R-squared. The null is no autocorrelation (0.252). From Table 3 result, the p-value is greater than 0.05, the study fails to reject the null hypothesis and conclude that the data does not have first-order autocorrelation. Heteroskedasticity occurs when the variance of the disturbance term is not constant. Hence, the t-values for the estimated coefficients cannot be trusted. A Breusch-Pagan test was carried out to test for heteroskedasticity and the result presented in table 4.2 the null is homoskedasticity (or constant variance). From above result (0.296) the null hypothesis is accepted hence no heteroskedasticity. The p-value is above 0.05 and as such it is not significant hence revealing that heteroscedasticity is not a problem. Normality test was tested using Jarque Berra to test whether the data is well modeled by a normal distribution. The p-value is greater than 0.05 (0.602) and therefore not significant at one % level of significance. From the test the model is normally distributed.

4.3. Econometrics Estimation Results

Estimation process of the role of C02 emission and Energy utilization starts by disaggregating energy further into Electricity and Oil use. The justification for doing so is that one strand of the economic expansion literature shows that the input of electricity and oil to growth and CO2 emission differs. Thus, the model to be estimated was specified in logarithm structure as:

$$lnY_t = \beta lnC_t + \gamma ln\, E_t + v_t + \varepsilon_t$$

Table-3. Empirical Results

Variable	Coefficient	Standard error	t- Statistics	p –Value
Constant	-5.11	2.45	-2.09	0.0448
lnC	-0.91	0.90	-1.01	0.3231
lnO	3.6	0.55	2.31	0.0273
lnE	-1.8	1.07	-1.77	0.0845
Goodness of Fit Test	R2 = 0.6	Adjusted R2 = 0.5		
F = 3.61	P-value(F) =0.022	D.Watson = 1.6		
Wooldridge Test	F(1,2) = 12.991	Prob > F = 0.0691		
Breusch-Godfrey Test	χ^2 (33) = 1.35	Prob> χ^2 = 0.252		
Breusch-Pagan Test	χ^2 (3) = 3.70	Pr = 0.296		
Jarque Berra	χ^2 (8) = 6.403	Pr = 0.602		

The obtained empirical results from this estimation indicated that CO2 emissions and electricity affect negatively economic expansion while oil use affects positively it at 5% level of significance. 1% increases in oil utilization raises economic escalation of about 4%. At the same time 1% increases CO2 emissions and electricity usage reduces GDP expansion of about 1% and 2% respectively.

The findings obtained show that oil use has an upbeat effect on GDP growth while electricity and carbon secretion has a negative effect. The finding agrees with Bozkurt and Akan (2014) in their study Turkey. The result contradicts the study by Melike (2013) that concluded that the income elasticity of electricity demand has a positive sign and statistically significant in the long run for Gabon, Guatemala and Senegal but negative sign for Zambia. As the economy grows, it is likely that environmental degradation and climate change will have damaging effects on the natural order, people, economies, and infrastructure. In Kenya consumption of electricity has been on an increasing but its effect on economic expansion is negative, a clear indication that that there exists some inefficiency in the economy. The findings supports ECK hypothesis, environmental damage is inevitable at the first stages of economic advancement and for this reason economies are expected to endure it until the reversing effect phase (Shahrin and Halim, 2007). This conclusion is similar to those reached by Zeshan and Ahmed (2013). Economic augmentation and development inevitably lead to depletion of natural resources and degradation of the ecosystem despite increasing life standards and life quality. In this sense, it must be the ultimate goal to achieve a sustainable economy by less CO2 emission and consuming less energy.

4.4. Granger Causality test

In the empirical literature the direction of causality between economic expansion and energy utilization is highly debatable. Some studies have found a bi-directional causality while others find a uni-direction causality running from economic enlargement to energy utilization or verse versa while others find no causality. In this study granger causality analysis is conducted to check the direction of causality between variables and the results are presented in Table 4 below.

Table-4. Granger Causality Result

Direction	Chi 2	P-Value	Conclusion
$\ln gdp \rightarrow \ln e$	1.17	0.556	Uni-directional Causality running from electricity utilization to economic expansion
$\ln e \rightarrow \ln gdp$	9.42	0.009	
$\ln gdp \rightarrow \ln o$	5.13	0.093	Uni-directional Causality running from oil utilization to economic expansion
$\ln o \rightarrow \ln gdp$	1.98	0.371	
$\ln gdp \rightarrow \ln c$	0.06	0.970	No causality from carbon emission to economic expansion
$\ln c \rightarrow \ln gdp$	0.04	0.979	

This conclusions show that there exist a uni-directional causality running from both electricity and oil utilization to economic increase in Kenya. Electricity and Oil plays a vital role in economic expansion and development. It should not be unanticipated to find that there is a close tie between GDP growth and energy use. For example from the findings, uni-directional causality running from economic expansion to electricity/oil use was detected in Kenya. That is, people are more likely to demand oil as the economy develops. However, electricity demand will increase with increase in GDP. On the other hand, the reverse causality does not exist, which means demand-side management of oil could be adopted since the less use of oil does not hold back economic expansion in Kenya. An increase in oil nad electricity utilization could push economic expansion in both cases. Deficiency of oil and electricity supply infrastructure can hinder economic increase. Governments whose country has these cases should deal with rising demand for oil and electricity. The study is in agreement with findings conducted in Taiwan by Yang (2000). This finding are also consistent with those of Alam *et al.* (2012) and Bloch *et al.* (2012) who found energy use causes economic expansion regardless of the measure of energy utilization. However the conclusion of this research contrast studies by Menyah and Wolde-Rufael (2010) who found that economic expansion does not Granger cause energy utilization. The Granger-causality results indicate that there is no causal association running from CO2 emissions to GDP growth. This finding is in agreement to previous studies like Farhani (2015) and Lim *et al.* (2014).

4.5. Impulse Response Analysis

Granger causality may not tell us absolute chronicle about the interactions between the variables of the system. In applied work, it is important to know the response of one variable to an impulse in another variable in a system that involves a number of further variables as well. Studying this causality involves tracing out the effect of an exogenous shock of innovation in one of the variables on other variables. An impulse response function traces the effect of a onetime shock or innovations on current and future values of the endogenous variables. From the research, response of GDP growth has little effect on Carbon emission and energy utilization in Kenya.

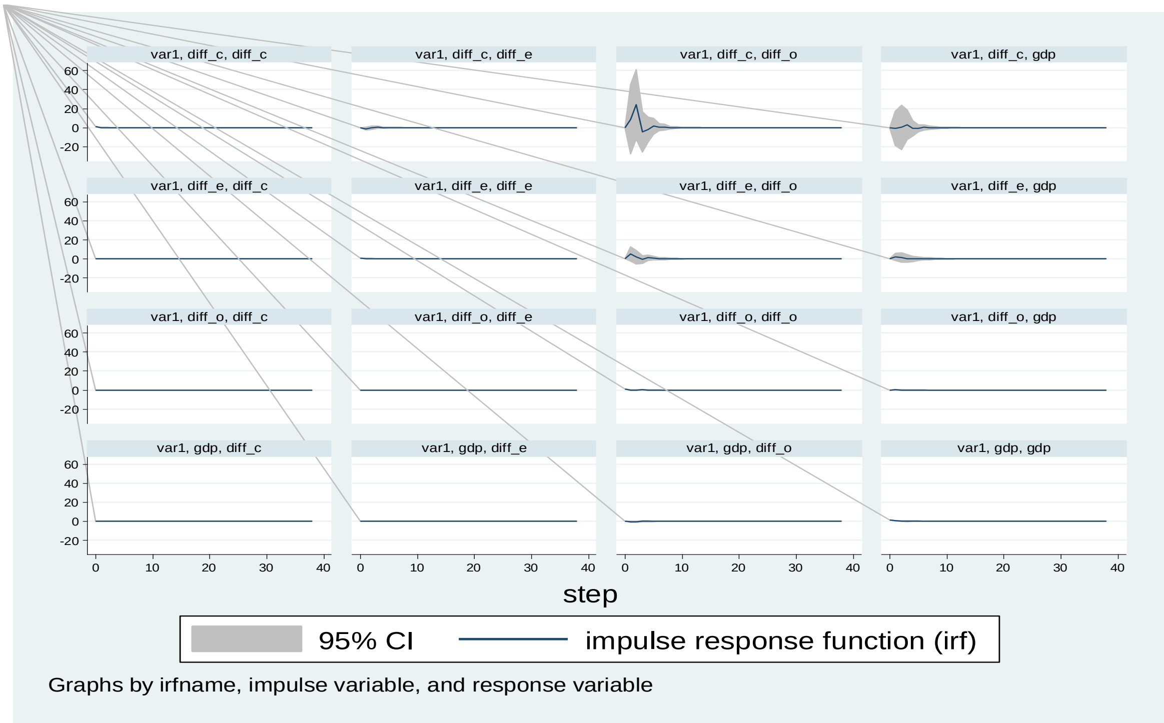

Figure-3. Impulse Response Analyses

5. CONCLUSION AND RECOMMENDATIONS

To study the causal association between these variables, the study employed Engel and Granger (1987)'s test which examines the dynamic relationship. In sum, empirical results show that there is uni directional causal relationship between economic growth, and oil and electricity utilization. This study supports to the argument that energy utilization stimulates economic expansion with or without feedback effect. In order not to unfavorably affect economic activities, efforts must be made to encourage public and private sector to increase oil and electricity use. Besides, one could reasonably expect that economic expansion enhances oil and electricity consumption.

Furthermore, there is a no causality running from CO_2 emissions to economic increase. Increasing CO_2 emissions is linked to inducing more economic activities. This means that the economic progress of the Kenyan is dependent on CO_2 emissions. Thus, implementing the policies of mitigating CO_2 emissions may adversely affect economic activities. The Kenya needs to reduce domestic CO_2 emissions minimizing their effect on its economy, and to maintain its existing industrial structure, which is not very energy-intensive, and highlight the development of renewable energy sources. Moreover, for the idea of reducing CO_2 emissions, energy requires to be used more efficiently and directed toward using more clean energy source in order not to produce the consequent deteriorating economic side effects. The policymakers should then take into consideration the degree of economic expansion in Kenya when renewable energy utilization policy is formulated.

Economic expansion and development inevitably lead to depletion of natural resources and degradation of the ecosystem despite increasing life standards and life quality. In this sense, it must be the ultimate goal to achieve a sustainable economy by less CO_2 emission and consuming less energy. This can be done by more effective and efficient use of resources and utilization of renewable energy sources. Implementation of renewable energy by making investments at once in this area is necessitated by the fact that a large portion of energy is supplied through coal, petroleum and their derivatives which are rapidly being depleted and have adverse effects on environment and that forests are destroyed or swept away with deforestation. Because it takes long years to remedy the damages inflicted on the environment and bring back its old condition, which is often impossible. All segments of society must act with responsibility and show due sensibility in order to pass on a cleaner environment and living space to future generations. The increased demand for energy in Kenya's growth and development process requires that the path must be cleared for clean and renewable energy sources like wind farms, solar power, and natural gas with long-term investments on technology despite their serious economic cost. The regulations to be arranged and policies to be implemented must aim to reduce our dependency on foreign energy sources and eliminate it over time in a way to avoid slowing down the economy.

5.1. Areas of Further Research

For future research, studies can focus on the inclusion of the population growth, trade openness and the index of globalization in order to attain a comprehensive effect of economic growth, energy and CO2 emissions which will provide new insights to policy makers in controlling environmental degradation.

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