Impact of Energy Consumption on Poverty Reduction in Africa

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This study investigates the impact of energy consumption on poverty reduction in a panel of 12 African countries over a period of 1981-2014. Using the Fully Modified Ordinary Least Square (FMOLS) method, the study shows that a long-run negative relationship exists between energy consumption and poverty level, which underscores the importance of energy in poverty reduction in the selected African countries. The result also indicates that other variables such as capital stock and political stability have significant effect on poverty implying that these factors play critical role in reducing poverty. Furthermore, the granger causality test shows that a short-run unidirectional causality runs from energy consumption to poverty. The findings clearly suggest that increasing energy consumption leads to a decline in poverty level. The study therefore recommends that the government in the selected countries should improve infrastructure and maintain political stability in order to maximize the effect of energy consumption on poverty reduction.

Keywords: Energy Consumption, Panel Causality, Panel Cointegration, Poverty level.
JEL Classification: I32; Q43.

1.0 Introduction

Undoubtedly, energy plays an important role in economic development especially in economies with high economic growth rate. Most scholars agreed with the position that increased energy consumption is a panacea to poverty and a tool for sustaining and enhancing economic growth particularly in developing nations (Abdur and Khorshed, 2010; Boardman and Kimani, 2014; Legros et al. 2009). Based on this premise, most policy makers tend to advocate for increased supply of energy and borrowing to meet the capital requirements, energy demand and aspirations of their citizens. The rate of investments in modern energy, especially in developing countries increased by 10 percent between 2010 and 2014 in a bit to increase the supply of energy, access rate to modern energy within the same period increased by 2 percent (World Bank, 2016). It is expected that, with such level of investments in energy, there will be a drastic increase in economic growth

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that will lead to decline in poverty level. However, despite the increased investment in energy and increased access to modern energy, about 1.7 billion people (18 percent of the world's population) still live below the World Bank's poverty line (World Bank, 2014). Unfortunately, most of the increase in poverty occurred in developing and emerging countries where investment in modern energy grew at 1.8 percent over the past 10 years, still leaving these economies with about 1.3 billion people in absolute poverty (World Bank, 2015). While many scholars tend to assume that energy consumption reduces poverty; on the contrary, increased energy consumption does not decrease poverty rate in Africa because energy consumption does not always translate to economic growth.

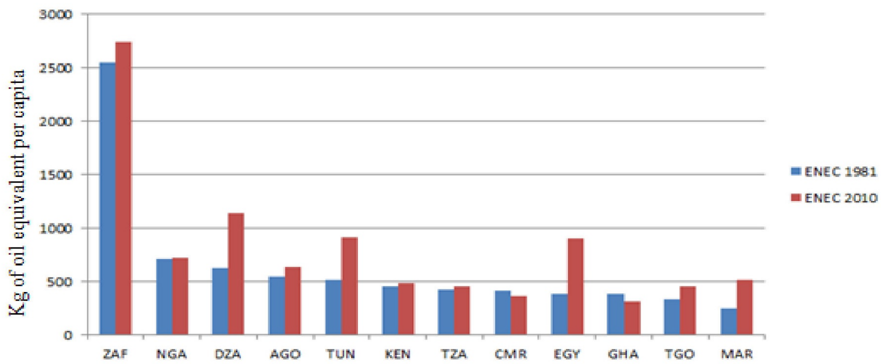
This paper argues that increased energy consumption is a necessary but not a sufficient condition in reducing poverty in developing countries. Certainly, energy such as electricity is needed in providing services that could enhance the living condition of the poor such as lighting, cooking and in providing power for some small scale industries, but it does not follow that even when such energy is made available, it will have a significant impact on the income of the poor. For such to happen, Gavin, Stefan and Michael (2013) argued that mechanism must be in place to transform energy into useful ventures. Such transformation is possible if constraints that inhibit the effective use of energy, such as lack of knowledge and skills, poor infrastructural facilities, political instability, inequality, poor business environment are removed. Neglecting these factors will not only affect the rate at which energy is transformed into economic activities but also affect gross domestic product (GDP)-energy relationship and consequently determine whether or not energy consumption will have sustainable impact on the citizens of a nation. There is, therefore, the need to pay close attention to factors that tend to affect energy-GDP relationship. This study paid attention to two of these factors-capital stock and political stability- which are issues of concern prevalent in most African countries.

In Africa the concept of energy-GDP nexus that explains the causal link between energy consumption and economic growth is better understood when extended to include the effect of this relationship on poverty level. Although many scholars seem to agree on the role of modern energy in human development, the disagreement on causal link between energy consumption and economic growth and by extension the role of energy in poverty reduction still remains. For instance, some scholars found a unidirectional causality between energy consumption and economic growth (Masih and Masih, 1997; Fatai, 2004; Wolde-Rufael, 2005). Others such as Morimoto and Hope (2004) and Lee and Lee (2010) found bidirectional causality between energy consumption and economic growth; while others argued that energy consumption has a neutral impact on economic growth (Ghali & El-Sakka, 2004; Lee and Chien, 2010). These disagreements on the place of energy consumption and economic growth in poverty reduction among scholars underscore the fact that policies to increase investment in energy in poverty reduction should be carefully designed and implemented.

This study examines the link between energy consumption, poverty level, political stability, capital stock and GDP across 12 African countries. The contribution of this study is in two folds: first, it examines the effects of energy consumption, capital stock, political stability and GDP on poverty across selected African countries. Capital stock in terms of infrastructures and political stability are essential for energy consumption to be translated to growth and poverty reduction (Lee & Chien, 2010; Tang & Abosedera, 2014). The fully modified OLS is used to establish this long-run relationship because it takes into account integration and cointegration properties of the variables, also correct the problem of serial correlation and heterogeneity that may arise from using panel data. Secondly, we ascertain whether energy consumption translate to poverty reduction among 12 selected African countries. Previous studies paid little attention to whether energy consumption translates to reduction in poverty. Taking insight from the work of Foster and Tre (2000) who studied the impact of energy intervention on the poor in Guatemala, the study assumed that poverty in most Africa countries could have indirect link with energy consumption. The panel VECM is therefore used to investigate the short-run and long-run causal effect of this relationship. The variance decomposition is used to ascertain the rate at which energy consumption translate to poverty reduction. The remainder of this study is as follows: section 2 provides some sylized facts while section 3 reviews theoretical and empirical literature, section 3 is a discussion on the methodology used, section 4 shows the empirical results and section 5 is the conclusion and policy implications.

2.0 Some Stylized Facts on Energy Consumption and Poverty in Selected African Countries

To give a clear understanding of the situation in the selected countries we describe the basic characteristics of economic growth, poverty rate and energy consumption. The countries were selected from five region of Africa. The 12 countries are Ghana, Nigeria, Tanzania, Egypt, Morocco, Togo, Tunisia, South-Africa, Algeria, Kenya, Cameroon and Angola. First, we compared the per capita energy consumption among the selected African countries for the period of 1981 and 2010. The bar charts of energy consumption of the two periods are depicted in Figure 1.



Note: the abbreviations for the countries are; ZAF = South Africa, NGA = Nigeria, DZA = Algeria, AGO = Angola, TUN = Tunisia, KEN = Kenya, TZA = Tanzania, CMR = Cameroon, EGY = Egypt, GHA = Ghana, TGO = Togo and MAR = Morocco

Figure 1: Energy consumption in Selected African Countries, 1981 and 2010

As shown in Figure 1, energy consumption increased for the periods 1981 to 2010 in the selected countries except for Cameroon and Ghana where the per capita energy consumption decreased. The graph also shows that there is significant increase in per capital energy consumption in Algeria, Tunisia, Egypt and Morocco while South Africa, Nigeria Angola, Kenya, Tanzania and Togo have a moderate increase in energy consumption. The increase in energy consumption in almost all the countries suggests the importance placed on energy by these countries.

Despite the fact that energy consumption increased over the years in some of these countries, it is important to examine whether the increase in energy consumption translated to poverty reduction. This is because increased energy consumption may lead to economic growth but does not necessarily translate to reduction in poverty has is common in most African countries even though reducing poverty may constitute the main objective of most governments in Africa. Apart from the indirect effect of energy consumption on poverty rate, there are measures that have been taken among these countries that tend to link energy consumption directly to poverty reduction in the selected countries. For instance, the government in some of the countries subsidized the price of energy consumed and also ensures access to energy by citizens. We compare energy consumption and poverty rate among the selected countries using fitted line correlation for 1981 and 2010. The outcome is presented in the Figure 2 and 3.

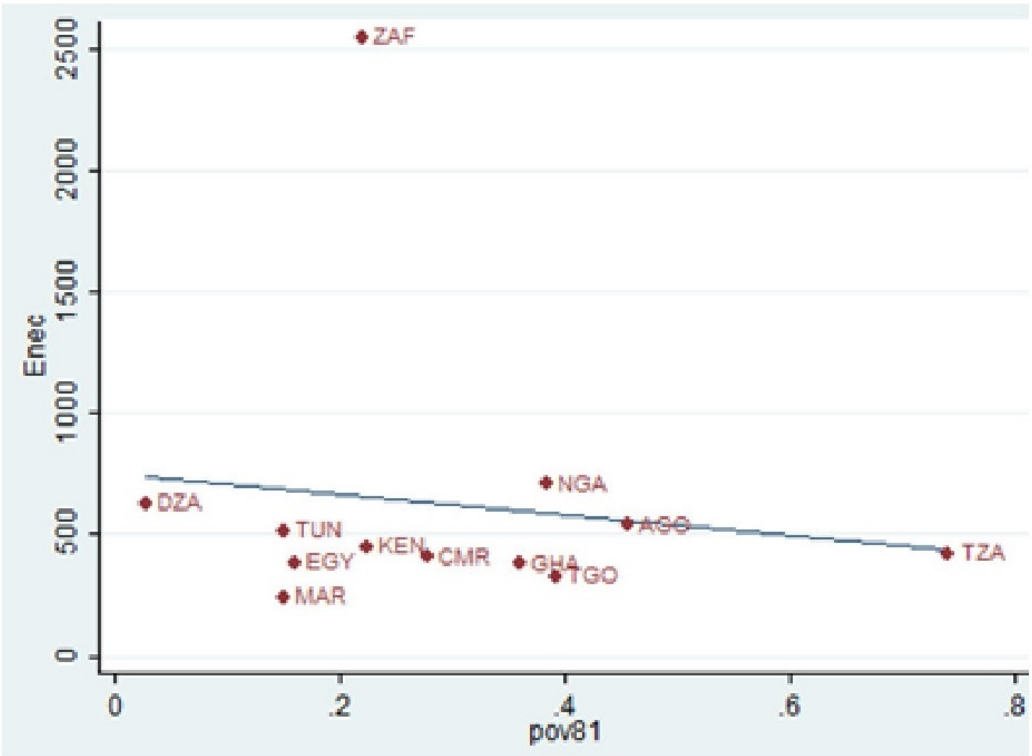


Figure 2: Energy Consumption and Poverty Rate,1981

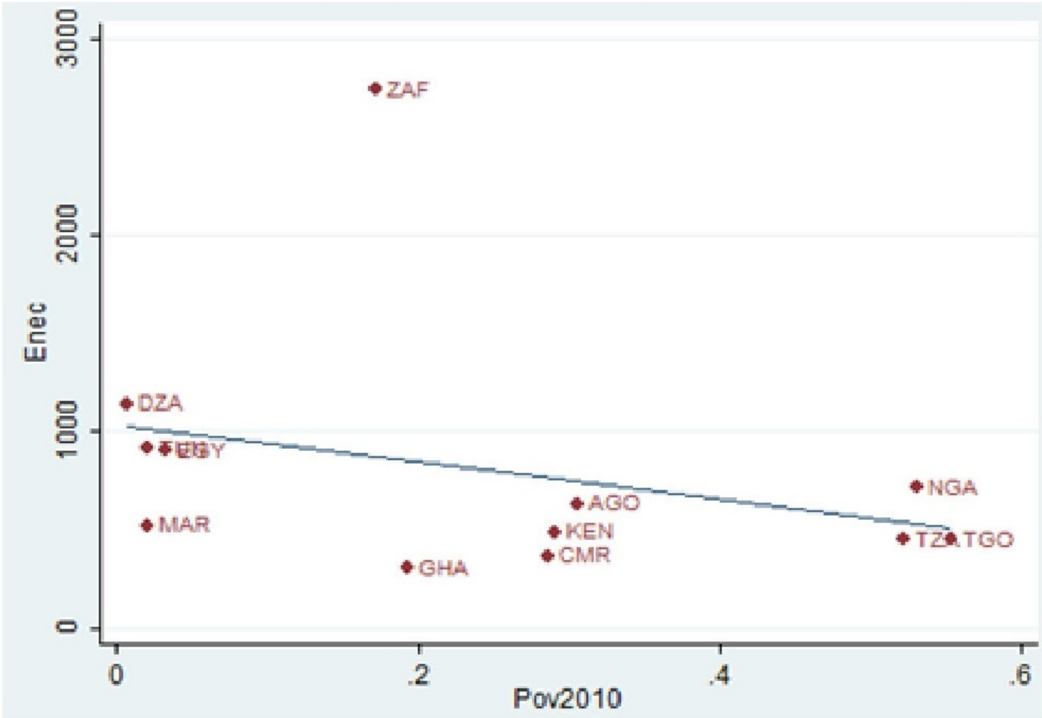


Figure 3: Energy Consumption and Poverty Rate,2010

Figures 2 and 3, as obtained from WorldBank Development Indicator (WDI) show the relationship between energy consumption and poverty in the selected countries for the period 1981 and 2010 respectively. Comparing the outcome from the two graphs suggest that countries that have increased energy consumption actually witness decrease in poverty rate - although this was not the case for countries like Nigeria and Togo that experienced an increase in poverty despite increase in energy consumption. Lastly on the stylized facts, we compare the average values of energy consumption, per capita income and poverty rate in these countries.

Table 1 shows the average values of energy consumption, real GDP and poverty rate of the countries base on their region. The results show that poverty rate is low among the North Africa countries. Unsurprisingly, the low level of poverty is associated with high GDP and energy consumption for the selected North African countries. The table also indicates that poverty rate is highest among West African countries. As expected, apart from Nigeria the energy consumption and income of these countries is quite low relative to those of the North African countries.

Some countries like Angola and South Africa clearly negate the classical assumption that high energy consumption and GDP reduces poverty rate as posited in the literatures. What this implies is that the growth process in some of the African countries had not been pro-poor or in some cases the proper mechanism needed to transmit the growth process to poverty reduction has not been adequately put in place for energy-GDP process to be transmitted to poverty reduction in some of these countries. Rauniyar and Kanbur (2010) and Jaumotte, Lall and Papageorgiou (2008) for instance, argued that growth become inclusive when there is improved capital stock that will ensure equitable distribution of resources.

We acknowledge the facts that there are some reservations when it comes to linking the growth process of nations to poverty reduction. The reservations arise not just from the differences in the view points and discipline of scholars but also from the strength of institutions of countries and socio-cultural ideologies that tend to affect the will of some government to give proper attention to poverty reduction. Such idiosyncrasies that exist among these nations, although important, tend to affect policies necessary to provide the required nexus between energy consumption, GDP and poverty. In as much as we do not just want to assume this away, the study addresses this fact by accounting for the heterogeneity that exists among the countries.

Table 1: Energy Consumption and Poverty Rate, 2010

Region	Countries	Average Energy Consumption	Average Real GDP (in millions USD)	Average Poverty Rate
Central Africa	Cameroon	393.24	62,761.16	0.31
	Angola	538.45	247,960.15	0.47
East Africa	Kenya	452.18	116,519.81	0.26
	Tunisia	717.92	213,266.35	0.07
	Tanzania	407.44	48,551.20	0.69
North Africa	Egypt	662.73	409,492.8	0.08
	Algeria	931.91	972,343.96	0.03
	Morocco	359.68	443,367.27	0.08
South Africa	South-Africa	2698.48	924,832.89	0.26
West Africa	Ghana	341.21	43,874.9	0.33
	Nigeria	731.68	337,305.8	0.55
	Togo	392.95	13,763.62	0.52

Source: World Bank Indicator [WDI], (2016)

3.0 Literature Review

3.1 Theoretical Framework

Energy plays a very important role in the growth process of most economies (Fatih, 2007; Akinlo, 2008). This postulation is based on the theory of economic growth and natural resources propounded by Solow (1956). The theory argued that natural resources such as capital, labour and land are important factors of production and play significant roles in economic growth. Starting with the pioneering work of Kraft and Kraft (1978) who established the relationship between economic growth and energy consumption, energy is argued to be one of the main drivers of modern economy especially across countries that have witnessed rapid growth in recent years. Many other empirical studies have assessed the effect of energy consumption on economic growth (Asafu-Adjaye 2000; Wolde-Rufael, 2006). Most of the studies focused on the causality between energy consumption and economic growth (Asafu-Adjaye, 2000; Chontanawat, Hunt & Pierse, 2008; Apergis & Payne, 2010; Ozturk, Ashan & Kalyonau , 2010; Apergis & Payne, 2010; Aziz, 2011).

Recent theoretical conjectures have tried to link energy consumption with poverty. Among such studies are Foster and Tre (2000) and Barnes, Khandker and Samad (2010). The concept of linking energy consumption to poverty is anchored on the energy transition theory. The proponents of the energy transition theory such as Hosier and Dowd (1987) and Leach (1992) linked the nature of energy consumed to income. The theory explains that the type of energy consumed by a nation strongly depends on the level of per capita income. Drawing from consumer theory, the theory posits that as income increases, energy consumers tend to transit from traditional or inferior energy to modern energy due to ease of use and comfort. The theory holds that there is a direct link between level of income and energy consumption; high income countries tend to consume more quality energy than poor countries. This study, like previous studies, rests on the energy transition theory and which maintains that poor access to modern energy limits a nation's potentials to reduce poverty and ensure sustainable growth. This is because access to energy is central to any poverty reduction drive (Pachauri & Spreng, 2004) as energy deprivation inhibits production and limits level of economic activities (Kaygusuz, 2011 and Sovacool, 2012).

3.2 Empirical Literature

The empirical literature reviewed in this study are divided into two strands: the first strand of literature examines the relationship between energy consumption and economic growth. The second strand of literature focuses on whether energy consumption affects poverty and standard of living.

Many studies had attributed economic growth to increased energy demand (Mahadevan and Asafu-Adjaye, 2007); others argued that energy consumption increases growth. For instance, Chontanawat, Hunt and Pierse (2008) studied energy consumption and economic growth across 100 countries. Using Granger causality, they found that the proportion at which causality runs from energy to GDP is higher in developed countries than in developing countries. Ozturk, Ashan and Kalyonau (2010) studied the relationship between energy consumption and economic growth across 51 countries using panel causality. They group the nexus effect of energy-GDP relationships of countries based on their level of income. The study found a unidirectional causality that runs from GDP to energy consumption for low income countries while a bidirectional causality exist for middle income countries. Mahadevan and Asafu-Adjaye (2007) studied the relationship among energy consumption, economic growth and prices in 20 developed and developing countries. Using panel vector error correction model (VECM) the study found that, bidirectional causality exist between economic growth and energy consumption in developed economies both in the short and long run, while a unidirectional causality flows from energy consumption to economic growth in the short-run. Another interesting result of this study is that the elasticity response in terms of economic growth from an increase in energy consumption is larger in developed countries than in developing countries.

Similar studies conducted in some Africa of individual countries also found related results: Wolde-Rufael (2006) test the long-run and causal relationship between electricity consumption per capita and real gross domestic product (GDP) per capita for 17 African countries for the period 1971-2001. The study employed cointegration test proposed by Pesaran et al (2001) and the granger causality test proposed by Toda and Yamamoto (1995). The result of the study shows a long-run relationship between electricity consumption per capita and real GDP per capita for only 9 countries and Granger causality for only 12 countries. Study also found a unidirectional causality running from real GDP to electricity consumption for 6 countries. It found a unidirectional causality running from electricity consumption to GDP and bi-directional causality for the remaining 3 countries. Okafor (2012) examined the causal relationship between energy consumption and economic growth in Nigeria and South Africa. Employing the Hsiao's Granger causality approach, the study found that economic growth causes total energy consumption in South Africa while energy consumption causes economic growth in Nigeria. Similar study by Kahsai, et al. (2012) tested the relationship between energy consumption and economic growth in sub-Saharan Africa using a panel cointegration approach. Their findings showed that there is no causal relationship between GDP and energy consumption in low income countries in the short-run while a strong causal relationship running in both directions is found in the long-run.

Orhewere and Henry (2011) studied energy consumption and economic growth in Nigeria. They investigated the causality between GDP and energy consumption in Nigeria. Using the vector error correction techniques they found a unidirectional causality from electricity consumption to GDP both in the short-run and long-run. Abdur and Khorshed (2010) also studied the nexus between electricity generation and economic growth in Bangladesh using granger causality. They found a unidirectional causality that flows from electricity generation to economic growth. The results of these studies underscore the importance of energy in economic growth.

Ouedraogo (2013) studied energy consumption and economic growth among Economic Community of West African States (ECOWAS). The study tested the long-run relationship between energy consumption and economic growth rate across fifteen of the ECOWAS members from 1980 to 2008. Using the panel cointegration techniques and granger causality, the results of the study show that GDP and energy consumption move together in the long-run. The study also found a unidirectional causality that runs from energy consumption to GDP in the long-run and from GDP to energy consumption in the short-run.

Despite studies that shows GDP-energy relationship, most energy economists have not yet agreed on the relationship between energy and economic growth. In general, studies have found three forms of energy-GDP relationship: first, a unidirectional causality that flows from energy to GDP which implies that energy is vital for economic development (Fatai, Oxley and Scrimgeour, 2004; Morimoto and Hope, 2004; Yoo, 2006). The second is a unidirectional causality that flows from GDP to energy, which means that energy is only needed for economic activities (Oh and Lee, 2004; Soytas and Sari, 2003). Thirdly, is the possibility of no causality between energy and GDP, which implies that energy does not have any impact on economic activities (Masih and Masih, 1997; Asafu-Adjaye, 2000). Overall, since the relationship between energy consumption and GDP affects policy options; the transmission mechanism to which energy consumption affects the poor and its interaction with other factors should be understood in the context of individual country's or regional economic structure.

The second strand of literatures found their basis in the endogenous growth theory which posits that other factors apart from capital, labour and energy are needed to enhance GDP growth of a nation. The proponents of the endogenous theory (such as Romer, 1986; Lucas, 1988; Baro, 1990) seek to explain the causes of growth that is left unexplained by the traditional concept of production. The theory laid emphasis on human capital development, infrastructure and research. The theory maintained that the government can improve efficient allocation of resources if there is increased investment in human capital, build a knowledge based institutions, provide environment that is conducive for local and foreign investment.

Just like energy-GDP relationship, the study of energy and poverty is becoming a paramount issue among energy economist because energy poverty could be a catalyst for unrest and instability (Basilian and Yumkella, 2015). According to Pachauri, et al. (2004) high level of poverty affects the pattern of energy consumption in terms of the quantity and quality of energy. The poor are always prone to the use of traditional and inefficient energy sources such as wood and coal which are unlikely to increase economic growth. Few studies have assessed the effect of energy consumption on poverty (Gertler, et al. 2011) most of the studies focused on theoretical relationship between energy and poverty (Short, 2002). Only few examine the magnitude of the impact of energy consumption on poverty. Meikle and Bannister (2003) for instance, studied the linkages between energy and poverty in poor urban households in Indonesia, Ghana and China. The study found that the poor are more vulnerable to shocks in the energy market.

Gertler, et al. (2011) studied the nexus between poverty, growth and the demand for energy. Using a panel analysis, they found that the demand for energy increases among countries that are pro-poor than among countries that are not.

They argued that not taking into consideration the pro-poor growth could grossly underestimate future energy use. When households' incomes go up, so is their demand for energy because they buy energy using assets. The speed at which households come out of poverty affects their purchase decisions. Improving the income of the poor increases their demand for energy. Filho and Hussein (2012) examine the link between energy availability and improvement in the standard of living. They found that the living standard is likely to improve with increased availability of modern energy. They pointed out that rural area stands to benefit more with increased availability of renewable energy technologies. The study used a comparative analysis, which tends to be subjectively bias. In this study we however, employed a more statistical method of analysis by employing the VECM method to assess the causal link between energy and poverty.

Darby (2011) argued that energy should not just be viewed as a commodity or an ecological resource but also a social necessity capable of increasing the social and economic wellbeing of people. According to the author, adequate energy supply to some extent affect economic growth and in some cases may determine the level of development, socio-cultural and economic ideology governing a nation. Fatih (2007) also pointed out that strong political will in the improvement of the general welfare of citizens is the main strategy to reducing poverty but not neglecting energy supply. Such improvement in the welfare of the citizens comes via increase in public and private investment in infrastructures and human capital, which serves as a prerequisite to efficient energy use. In this regard, Stern (2003) argued that innovation and energy efficiency, energy quality and shift in the composition of energy input are intervening factors affecting the relationship between energy and economic growth. According to Hodgson (2000), institutional factors play a big difference between developed and developing economy. Countries with strong institutions tend to have strong infrastructural base, provide reliable economic and political environment necessary for economic growth. Although other factors apart from energy may account for the differences in the impact of energy consumption on poverty reduction, this study tend to examine two of these factors by assessing the link between energy consumption, poverty, political stability, capital stock and GDP across 12 African countries.

Apart from institutional factors, studies have tried to identify channels through which economic growth affects poverty rate. Fields (2001) for instance, pointed out that growth can translate to poverty reduction when there is adequate physical capital, increase human capital, rule of law, competitive markets, openness to trade and investment, low inequality and increased agricultural activities. Kraay (2006) pointed out that the pattern to which growth can affect the poor is specific to countries but in generic terms economic growth can only reduce poverty when growth is pro-poor. They pointed out that in Africa one main channel to transmitting growth to the poor is improving the agricultural system. Agriculture still remain the highest employer of labour especially the poor. Juzhong et al (2009) categorized the channels to which growth affect poverty reduction into three main channels: direct channels which involves expenditure on education and infrastructures; the market through labour and finance; and government policy through trade openness and government subsidies.

Past studies contribute to our understanding of the relationship between energy consumption and economic growth, but less attention has been on whether energy consumption translates into poverty reduction. Earlier studies by Foster and Tre (2000) and Barnes, Khandker and Samad (2010) linked energy consumption to poverty in Guatemala and Bangladesh respectively. This study contributes to knowledge by examining the effect of energy consumption on poverty rate within selected African countries. This study intends to push this argument further by assessing the impact of variables such as capital stock and political stability so as to determine the place of energy consumption in poverty reduction especially among African countries. As indicated in the literature, addition to GDP we included two variables in the estimation of the energy poverty relationship as control variables. In this paper we argue that if energy consumption does not affect poverty level in some countries then policies towards increasing investment on energy supply to reduce poverty will only achieve infinitesimal success. Rather, such investments and policies should be redirected into projects and programs that will provide solid economic structures that will enhance sustainable economic development. As argued by Acemolu (2011) it is only when we understand the fundamental causes of the differences in development across countries can we then avoid platitude recommendations such as government should increase energy supply so has to reduce poverty.

4.0 Methodology

This study focuses on the relationship among GDP, energy consumption, poverty level, and political stability. Data used for this analysis were collected from (World Bank Indicator [WDI], 2016). The variables used for this analysis are annual data on energy consumption (kg of oil equivalent per capita), GDP at constant 2011 national prices (in million 2011 US$), political stability (measured by the perception that government will be destabilized by domestic violence or terrorism). The World Bank indicator measures political stability using the stability index consisting of factors like mass civil protest, politically motivated aggression, instability within political regime and instability of political regime. The political stability of a country is weak if the stability index is close to -2.5 and strong if the index is close to 2.5. The economic variable for growth is measured by the growth in the real GDP. Poverty is proxied by the head count of people living below the international poverty line of US$1.25 a day. This follows the application of poverty rate as a variable in the work of Dollar and Kraay (2002) and Anyanwa and Erhijakpor (2010). Data on capital stock is the capital stock at constant 2011 national prices (in million 2011 US$). The data cover the period 1981-2014 when data on all the variables of concern are available for the selected countries. The period is considerably long enough for energy consumption to have the required impact on poverty in the chosen countries.

However, the choice of the countries selected from each region was based on the availability of the data required for this study. Consequently, only South Africa was selected from the Southern region while Cameroon and Angola were selected from the central region. Three countries were selected each from the other three regions.

The study assesses the impact of energy consumption, capital stock, GDP and political stability on poverty level through the multivariate panel model specified as follows:

$$LNPOV_{i,t} = \delta_i + \gamma_t + \alpha_1 LNENC_{i,t} + \alpha_2 LNGDP_{i,t} + \alpha_3 LNKSTK_{i,t} + \alpha_4 POL_{i,t} + \varepsilon_{i,t} \tag{1}$$

where δ_i and γ_t are the country-specific fixed effects and deterministic trends respectively; LNGDP = log of GDP per capita; LNENC = log of per capita energy consumption; LNPOV = log of poverty level; LNKSTK = log of capital stock and POL = political stability. Panel data analysis of this nature provides more information and gives a high degree of freedom than cross-sectional data or times series data. Apart from POL that contains negative values, all the other variables were transformed to harmonize the units of measurement of the variables using the natural logarithm.

Recent developments in panel data analysis encouraged preliminary test for cross section dependence and slope homogeneity of variables (Baltagi & Pesaran, 2007). This is necessary because turbulence in one country can easily be transmitted to other countries either through international trade or regional integration (Nazlioglu, Lebe & Kayhan, 2011; Pesaran, 2006).

Thus, Breusch and Pagan (1980) and Pesaran (2004) test the possibility of cross sectional correlation through ε_{i_t} in equation 1. The null hypothesis assumed ε_{i_t} to be cross sectional independent while the alternative hypothesis assumes ε_{i_t} to be correlated across sections. Breusch and Pagan (1980) therefore proposed the following Lagrange Multiplier statistics:

$$LM = T \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{i,j}^2 \tag{2}$$

where $\hat{\rho}_{i,j}$ is the sample estimate of the pair wise correlation of the residuals expressed as:

$$\hat{\rho}_{i,j} = \hat{\rho}_{j,i} = \frac{\sum_{t=1}^{T} \hat{\varepsilon}_{i,t} \hat{\varepsilon}_{j,t}}{\left(\sum_{t=1}^{T} \hat{\varepsilon}_{i,t}^2 \right)^{1/2} \left(\sum_{t=1}^{T} \hat{\varepsilon}_{j,t}^2 \right)^{1/2}} \tag{3}$$

The Lagrange Multiplier (LM) is an asymptotical distribution chi-square with $N(N-1)/2$ degree of freedom. The Breusch and Pagan (1980) cross sectional dependence test is suitable for panel analysis with small N and large T. For analysis with large N and T, Pesaran (2004) proposed cross sectional dependence (CD) test that is based on the pair-wise correlation coefficients expressed thus:

$$CD = \sqrt{\frac{2T}{N(N-1)}}(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{i,j}) \tag{4}$$

Baltagi, Feng and Kao (2012) [BFK henceforth] also proposed a scaled LM test statistics that is suitable for both small and large N and T. BFK cross sectional dependence test is specified thus:

$$LM = \sqrt{\frac{1}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}(T_{i,j}\hat{\rho}_{i,j}^{2}-1) - \frac{N}{2(T-1)} \tag{5}$$

Both the BFK and Pesaran (2004) statistics are chi-square with asymptotic normal distribution. The Breusch and Pagan (1980), Pesaran (2004) and the Baltagi, Feng and Kao (2012) tests are used to test the cross section dependence of each of the variables. The test for cross section dependence is important because its presence distort the usual panel unit root test and helps to determine the appropriate panel unit root that addresses the problem. We conduct the cross section dependence tests and found that cross sectional dependence exist in all the variables. The presence of cross sectional dependence in the variables invalidates the first generation panel unit root tests that assume cross sectional independence. The study therefore adopts the panel unit root test as proposed by Choi (2002) and Pesaran (2007) which take into account cross sectional dependence by assuming that one or more common unobserved factors are present in the variables. A common factor can be represented in a variable as:

$$y_{it} = \rho_i\theta_t + \varepsilon_{it} \tag{6}$$

here $i = 1, 2, 3, \ldots, N$ is the country index;$t = 1, 2, 3, \ldots, T$ is the time index; y is the specific variables of concern (in this case GDP, energy consumption, poverty rate, capital stock and political stability); θ_t captures the unobserved factors.ε_{it} is the error term.

Just like the panel unit root test, not all panel cointegration tests are suitable to test for the existence of cointegration when the series exhibit cross sectional dependence. In this study, we use the Westerlund (2007) cointegration test because it is robust against heterogeneity and cross sectional dependence in panel. The aim of the co-integration test is to determine whether there exists a long-run relationship among the variables used in this study. The Westerlund (2007) cointegration test checks for the existence of error correction for series that are I(1) in the individual group and for panel by using four cointegration test statistics: the group-mean tests and the panel tests. The two group-mean test statistics (Gt and Ga) test the alternative hypothesis that at least one element in the panel is cointegrated while the panel test statistics (Pt and Pa) test the alternative hypothesis that the panel is cointegrated as a whole. In addition, the bootstrap test can be applied to the Westerlund (2007) cointegration test so as to reduce the distortions that may arise from the asymptotic test. The Westerlund's cointegration test is performed as follows:

$$\Delta POV_{it} = \alpha_{1i} + \sum_{i=1}^{q} \beta_i \Delta POV_{i,t-i} + \sum_{i=1}^{q} \varphi_i \Delta X_{i,t-i} + \gamma_i ECM_{i,t-i} + \varepsilon_{it} \quad (7)$$

where X = the vector of independent variables which include GDP, ENC, KSTK and POL; γ_i is the value of the speed of adjustment of the error term. If $\gamma_i = 0$ then there is no error correction and the variables are not cointegrated; if $\gamma_i < 0$ it means that there is error correction and the variables are cointegrated.

Once the cointegration relationship is established, the long-run parameters is then estimated using the panel fully modified ordinary least squares (FMOLS) as developed by Phillips and Hansen (1990) and (Saikkonen, 1991 and Stock and Watson, 1993) respectively. The panel FMOLS as modified by Pedroni (2000) is not only essential in estimating cointegrating regression but also useful in addressing the problem of cross section dependence and heterogeneity. The long-run relationship for each of the country is estimated as specified in equation (1).

Once it is determined that the variables are cointegrated, a panel-base vector error correction is used to examine the short-run and long-run causality. The VECM captures both the long-run and short-run relationship among variables. The VECM can identify the sources of causation and also distinguish between the long-run and short-run among the series (Oh & Lee, 2004). The study employed the two-step Granger causality test proposed by Engle and Granger (1987). To do this, first, the long-run model is estimated so as to obtain the estimated residuals ε_{it} (from which error correction term is derived). The residuals tell us the extent to which the observed values deviate from the long-run equilibrium in the short-run. The second step is to estimate the Granger causality model with a vector error correction model. It is expected that since the variables are cointegrated all deviation in a particular period should be forced back to the long-run equilibrium through the error correction mechanism. The following vector error correction model is stated for this analysis:

$$\Delta LNGDP_{it} = \alpha_{1i} + \sum_{i=1}^{q} \beta_{11} \Delta LNGDP_{i,t-i} + \sum_{i=1}^{q} \beta_{12} \Delta LNENC_{i,t-i} + \sum_{i=1}^{q} \beta_{13} \Delta LNPOV_{i,t-i} + \sum_{i=1}^{q} \beta_{14} \Delta POL_{i,t-i} + \sum_{i=1}^{q} \beta_{15} \Delta LNKSTK_{i,t-i} + \gamma_{1i} ECM_{i,t-i} + \varepsilon_{i,t}^{GDP} \quad (8)$$

$$\Delta LNENC_{it} = \alpha_{2i} + \sum_{i=1}^{q} \beta_{21} \Delta LNGDP_{i,t-i} + \sum_{i=1}^{q} \beta_{22} \Delta LNENC_{i,t-i} + \sum_{i=1}^{q} \beta_{23} \Delta LNPOV_{i,t-i} + \sum_{i=1}^{q} \beta_{24} \Delta POL_{i,t-i} + \sum_{i=1}^{q} \beta_{25} \Delta LNKSTK_{i,t-i} + \gamma_{2i} ECM_{i,t-i} + \varepsilon_{i,t}^{ENC} \quad (9)$$

$$\Delta LNPOV_{it} = \alpha_{3i} + \sum_{i=1}^{q} \beta_{31} \Delta LNGDP_{i,t-i} + \sum_{i=1}^{q} \beta_{32} \Delta LNENC_{i,t-i} + \sum_{i=1}^{q} \beta_{33} \Delta LNPOV_{i,t-i} + \sum_{i=1}^{q} \beta_{34} \Delta POL_{i,t-i} + \sum_{i=1}^{q} \beta_{35} \Delta LNKSTK_{i,t-i} + \gamma_{3i} ECM_{i,t-i} + \varepsilon_{i,t}^{POV} \quad (10)$$

$$\Delta POL_{it} = \alpha_{4i} + \sum_{i=1}^{q} \beta_{41} \Delta LNGDP_{i,t-i} + \sum_{i=1}^{q} \beta_{42} \Delta LNENC_{i,t-i}$$
$$+ \sum_{i=1}^{q} \beta_{43} \Delta LNPOV_{i,t-i} + \sum_{i=1}^{q} \beta_{44} \Delta POL_{i,t-i} + \sum_{i=1}^{q} \beta_{45} \Delta LNKSTK_{i,t-i}$$
$$+ \gamma_{4i} ECM_{i,t-i} + \varepsilon_{i,t}^{POL} \tag{11}$$

$$\Delta LNKSTK_{it} = \alpha_{5i} + \sum_{i=1}^{q} \beta_{51} \Delta LNGDP_{i,t-i} + \sum_{i=1}^{q} \beta_{52} \Delta LNENC_{i,t-i}$$
$$+ \sum_{i=1}^{q} \beta_{53} \Delta LNPOV_{i,t-i} + \sum_{i=1}^{q} \beta_{54} \Delta POL_{i,t-i} + \sum_{i=1}^{q} \beta_{55} \Delta LNKSTK_{i,t-i}$$
$$+ \gamma_{5i} ECM_{i,t-i} + \varepsilon_{i,t}^{KSTK} \tag{12}$$

where Δ is the first difference operator; $\alpha_{1i}, \ldots, \alpha_{1i}$ are the cross-sectional mean value of each fixed effect model, β parameters shows the short-run, q is the optimal lag length, γ_i is the parameter that tells the speed of adjustment to equilibrium after a shock. According to Granger (1969), there is Granger-causality from x to y if including the past values of x improves the prediction of the current value of y. x does not predict y if including the past values of x does not improve the prediction of the current value of y. Equations 8 to 12 enables us to determine the short and long-run causality between the variables.

To identify the source of causality, we test the significance of all coefficients in each of the equation. For the short-run causality, we test the short-run causality from energy consumption, poverty level, political stability and capital stock to GDP based on $H_0 : \theta_{12ik} = 0$ for every ik, $H_0 : \theta_{13ik} = 0$, for every ik, $H_0 : \theta_{14ik} = 0$ for every ik, $H_0 : \theta_{15ik} = 0$ for every ik in equation 8. The significance of any of coefficient means there is short-run causality from that variable to GDP. In equation 9, the short-run causality from GDP, poverty level, political stability and capital stock to energy consumption are tested respectively based on $H_0 : \theta_{21ik} = 0$ for every ik, $H_0 : \theta_{23ik} = 0$, for every ik, $H_0 : \theta_{24ik} = 0$ for every ik, $H_0 : \theta_{25ik} = 0$

for every ik in equation 8. Equation 10 is the short-run causality from GDP, energy consumption, political stability and capital stock to poverty rate are tested respectively based on $H_0 : \theta_{31ik} = 0$ for every ik, $H_0 : \theta_{32ik} = 0$, for every ik, $H_0 : \theta_{34ik} = 0$ for every ik, $H_0 : \theta_{35ik} = 0$ for every ik in equation 8. In equation 11, the short-run causality from GDP, energy consumption, poverty rate and capital stock to political stability are tested respectively based on $H_0 : \theta_{41ik} = 0$ for every ik, $H_0 : \theta_{42ik} = 0$, for every ik, $H_0 : \theta_{43ik} = 0$ for every ik, $H_0 : \theta_{45ik} = 0$ for every ik in equation 8. Lastly, in equation 12, the short-run causality from GDP, energy consumption, poverty rate and political stability to capital stock are tested respectively based on $H_0 : \theta_{51ik} = 0$ for every ik, $H_0 : \theta_{52ik} = 0$, for every ik, $H_0 : \theta_{53ik} = 0$ for every ik, $H_0 : \theta_{54ik} = 0$ for every ik in equation 8. The long-run causality is then tested by looking at the significance of the coefficients of the error correction term λ in equation 8 to 12. The null hypothesis $H_0 : \lambda_{1i} = 0$ for every i is tested against the alternative hypothesis $H_1 : \lambda_{1i} \neq 0$ for every i. The significance of λ determines whether the movement along the long-run equilibrium is permanent and deviation in such a case is temporal. The magnitude of λ determines the speed of adjustment after such deviation.

5.0 Discussion of Empirical Results

We checked for the cross section dependence among the variables as well as the residual of the fixed effects regression using the Breusch-Pagan LM, Pesaran (2004) and the Baltagi, Feng and Kao (2012) [BFK hence forth] cross section dependence test.

Table 2: Cross Section Dependence Test

Variable	Breusch-Pagan LM	BFK	Pesaran CD	Decision
POV	507.32***	37.18***	5.07***	Cross section dependent
GDP	1983.96***	165.71***	44.46***	Cross section dependent
ENC	969.14***	77.38***	12.64***	Cross section dependent
KSTK	1759.66***	146.18***	41.7***	Cross section dependent
POL	808.51***	63.40***	0.39	Cross section dependent
Resid $_{\text{Fixed Effect}}$	488.96***	35.58***	9.52***	Cross section dependent

Note: Null hypothesis states that there is no cross section dependence or correlation. *** indicates rejection of the null hypothesis at 1 percent level of significance. The Breusch-Pagan LM, follows a chi-square distribution, BFK and Pesaran CD follow standard normal distribution.

Table 2 shows the results of the Breusch-Pagan LM, BFK and Pesaran (2004) cross section dependence test. The test indicated that there is cross section dependence in all the variables among the countries. This implies that a shock in one of the selected country tends to be transmitted to other countries. The summary of the panel unit root test for the variables used is presented in Table 3.

Table 3: Panel Unit Root Test Results

Variables ➔	GDP	ENC	POV	POL	KSTK
Level					
Pesaran	4.16	2.18	0.21	0.18	5.46
Choi	8.35	0.55	-1.23	-0.002	5.42
First Difference					
Pesaran	-6.63***	-9.24***	-8.73***	-7.81***	-5.03***
Choi	-2.84***	-7.34***	-7.67***	-9.19***	-4.75***

Notes: *** the null hypothesis of a unit root is rejected at 1% significant level. H_0: individual unit root process.

Table 3 depicts the panel unit roots test of the five variables in level and first difference for individual effect and trend. The table shows that the variables are not stationary at level. However, after taking the first difference, the series became stationary as the null of a unit root process is strongly rejected at 1 percent significance level. The result implies that all the variables are non-stationary and are integrated of order one. To account for the cross section dependence, we apply the Westerlund (2007) error correction based panel cointegration tests with bootstrapped P-values. The result of the cointegration test is shown in Table 4.

Table 4: Westerlund Panel Cointegration test Results

Statistics	Value	Z-value	P-value	Robust P-value
Gt	-2.687	-2.385	0.009	0.000
Ga	-6.322	1.732	0.958	0.630
Pt	-38.542	-26.002	0.000	0.000
Pa	-25.578	-9.222	0.000	0.007

Note: The P-values are for test that follows the normal distribution while the robust P-values are for test that follows the bootstrapped distribution.

Table 4 shows the Westerlund (2007) cointegration test result. Considering the outcome of the p-value and the robust p-value, all the statistics apart from Ga strongly reject the null hypothesis of no cointegration at 1 percent level of significance. The none rejection of the null hypothesis of the Ga statistics is not surprising because according to Westerlund (2007), the Ga works better in cases of small samples of less than 10 countries. The overall result implies that we can conclude that there exists a long run relationship among the variables.

The study used the fully modified OLS (FMOLS) techniques for heterogeneous cointegrated panel as proposed by Pedroni (2000) to estimate the long run impact of energy consumption, real GDP, capital stock and political instability as shown in Table 5. The coefficients of LENC, GDP and POL are negative and statistically significant at 1 percent level of significant respectively, while the coefficient of LKSTK is positive and significant at 1 percent. Poverty level (LPOV), GDP (LGDP), capital stock (LKSTK) and energy consumption (LENC) are expressed in natural logarithms. The result of the FMOLS suggests that an increase in energy consumption and GDP by one percent causes poverty level to decrease by 1.42 and 0.17 percent respectively. Also, an increase in capital stock by one percent increases poverty level by 0.26 percent. Increasing the political stability index by unit is shown to decrease poverty level of the selected African countries by 0.1 percent.

Table 5: Fully Modified Ordinary Least Square (FMOLS) estimates

Dependent variable: LNPOV	FMOLS	$FGLS_{SUR}$
LNENC	-1.42***	-1.31***
	(-99.47)	(-25.62)
LNGDP	-0.17***	-0.16***
	(-22.27)	(-7.03)
LNKSTK	0.26***	0.24***
	(25.73)	(10.23)
POL	-0.10***	-0.049***
	(-5.28)	(-3.95)
C	-	22.85***
		(62.64)
R^2	0.74	0.75
Observations	408	408
Wald test X_4^2	17041.71***	1440.81***

Notes: t-values in parenthesis. *** Significant at 1% respectively.

The FMOLS outputs in Table 5 provide an interesting result; first, the result of the long-run impact of energy consumption on poverty is quite similar to the findings in earlier studies such as Karezi et al. (2001) and Foster and Tre (2014) who in their various country specific study observed that improved energy consumption reduces poverty in Guatemala and Kenya respectively. According to Foster and Tre (2014) in the study of energy –poverty relationship, it is important to look at the entire portfolio of energy sources rather than just the energy source from electricity: thus, improving the energy source tends to improve the entire welfare of the society. The result of the GDP and political stability are also significant in reducing poverty among the countries. The result of the capital stock does not meet our a priori expectation, its significance connotes that capital stock of the selected countries is not tailored towards poverty reduction. To ensure the robustness of the estimates, the Wald test statistics shows that the model is significant. Furthermore, the Panel Feasible General least Square (FGLS) SUR that also addresses the problem of cross section dependence yielded almost similar result.

Owing to the differences and coupled with the fact that the selected countries cut across different region in Africa, we examine FMOLS result for the individual countries so as to examine the effect of energy consumption on poverty level in the respective countries. The estimates of the effects of energy consumption, political stability, capital stock and GDP on poverty in individual countries are depicted in Table 6.

Table 6: FMOLS Result for 12 Selected African Countries: Poverty as Dependent Variable

Countries/ Variables	Ghana (1)	Nigeria (2)	Tanzania (3)	Egypt (4)	Morocco (5)	Togo (6)	Tunisia (7)	South Africa (8)	Kenya (9)	Cameroon (10)	Angola (11)	Algeria (12)
LNENC	-0.39	2.01	0.63	2.83	1.38	1.03	-3.91**	-0.94	-4.52***	-3.05**	-0.15	-5.04***
	(-0.90)	(0.49)	(0.11)	(1.23)	(0.56)	(1.10)	(2.46)	(-0.89)	(-7.89)	(-2.63)	(-0.06)	(-3.31)
POL	-0.342	-0.78*	-1.16	0.084	0.92	0.22	2.72***	-1.34**	-1.36***	-0.45**	-0.52	2.14***
	(-1.11)	(-2.03)	(-0.53)	(0.13)	(0.50)	(0.29)	(3.49)	(-2.49)	(-21.48)	(2.71)	(-0.58)	(5.53)
LNKSTK	-1.11***	0.93***	2.372***	-2.44	-4.51*	0.83	-2.85	2.40***	1.41***	-2.57***	-0.49	-4.23***
	(-7.51)	(3.00)	(3.05)	(-1.17)	(-1.78)	(0.71)	(-0.67)	(3.20)	(3.87)	(-10.35)	(-0.39)	(-5.64)
LNGDP	0.79***	-1.36***	-2.66	0.87	0.974	0.057	1.81	-0.92**	-0.72***	1.64***	0.91	3.08***
	(3.31)	(-3.39)	(-1.43)	(0.47)	(0.66)	(0.07)	(0.92)	(-2.22)	(-3.23)	(10.15)	(1.30)	(5.32)
C	22.29***	8.64	13.19	16.7	47.02**	0.86	48.47***	4.71	34.74***	41.84***	9.66	62.22***
	(13.09)	(.324)	(0.69)	(1.05)	(2.61)	(0.15)	(3.16)	(0.38)	(14.23)	(4.84)	(0.49)	(9.94)
Adj R^2	0.94	0.69	0.93	0.30	0.39	0.80	0.95	0.87	0.98	96	0.65	0.95

Notes: t-values in parenthesis. *, ** and *** Significant at 10%, 5% and 1% respectively.

The Table 6 shows that energy consumption is significant in reducing poverty in four of the countries. Political stability affects poverty in six of the countries. Capital stock significantly affects poverty in nine of the selected countries, while GDP affect five of the countries. Contrary to the general FMOLS results, the results in Table 6 show that capital stock and political stability are important in reducing the level of poverty in at least nine and six of the selected countries respectively. This implies that capital stock and political stability are important variables in the reducing poverty in the selected countries.

The long run causality test is determined based on the statistical significance of the respective error term in the each of the equation while the short run Granger causality test is conducted by testing the significance of the lagged values of the first difference of the respective variables. The source of causation is identified if coefficients of a lag variable in an equation are significant.

Table 7 shows the results of the short-run and long-run causality among the variables. The values of short run causality are result of the chi-square test and the associated probability values using the Wald test. This is done by testing the significance of the coefficient of first difference of lagged variables in the respective equation (that is equation 8 to 12). Equation 8 indicates that poverty level has a significant impact on GDP in the short-run while energy consumption, political stability and capital stock are insignificant. In equation 9, all the variables are insignificant in the short-run. Equation 10 shows that real GDP, energy consumption and capital stock are significant while political stability is not. The results of equation 8 and 10 show that there is a short-run bidirectional causality between real GDP and poverty level. Equation 11 indicates that none of the variables are significant, thus there is no short run or long-run causal effect. Lastly, in equation 12, real GDP and political stability have a significant impact on capital stock in the short-run. Equation 10 and 12 also shows evidence of unidirectional short-run Granger causality between poverty level and capital stock.

The significance of ECM in equation 12 implies that there is unidirectional causality that flows from political stability and real GDP to capital stock. The relationship between political stability and capital stock suggests that reducing the risk of internal unrest could improve capital accumulation both in the long-run and short-run. The ECM in the equation 10 is also significant and shows a unidirectional causality that flows from energy consumption, real GDP and capital stock to poverty. The result implies that energy is important in reducing poverty in the region as it has been buttressed in others studies (Bazellian and Yumkella, 2015; Eggoh, Bangake and Rault, 2011). This means energy is important in the short-run among these countries as the error correction term suggests that poverty level responds to the deviations from the long-run equilibrium.

Table 7: Results of Panel Causality Test

Dependent Variable	Sources of Causation (Independent Variables)						
	Short-run						Long-run
	Equation	$\Delta LNGDP$	$\Delta LNENC$	$\Delta LNPOV$	ΔPOL	$\Delta LNKSTK$	ECM
$\Delta LNGDP$	(8)	-	1.748	22.072***	3.843	2.11	-0.0006
			(0.417)	(0.000)	(0.146)	(0.348)	(0.864)
$\Delta LNENC$	(9)	0.733	-	0.41	3.73	0.25	0.000*
		(0.693)		(0.81)	(0.15)	(0.88)	(0.084)
$\Delta LNPOV$	(10)	12.00***	5.79*	-	3.97	57.3***	-0.114***
		(0.002)	(0.055)		(0.131)	(0.00)	(0.002)
ΔPOL	(11)	3.76	0.63	1.26	-	0.69	0.0004
		(0.15)	(0.72)	(0.53)		(0.71)	(0.667)
$\Delta LNKSTK$	(12)	20.52***	0.85	3.80	12.05***	-	-0.067*
		(0.00)	(0.65)	(0.15)	(0.00)		(0.09)

Notes: Probability values in parenthesis. * and *** means the coefficient is significant at 10% and 1%.

Table 8: Variance Decomposition of Variables

Panel B:		Variance Decomposition of LPOV:				
Period	S.E.	LENC	LPOV	LKSTK	LGDP	POL__STAB
1	0.808440	0.028950	99.97105	0.000000	0.000000	0.000000
2	0.903323	0.746835	86.45814	10.33455	2.193727	0.266752
3	0.962701	1.336219	84.98587	11.22965	2.136304	0.311950
4	1.054986	1.296203	84.15762	12.22930	2.055251	0.261628
7	1.221775	1.524849	79.65161	16.42402	2.124075	0.275444
8	1.267282	1.552430	78.60348	17.43677	2.126822	0.280494
9	1.308716	1.569449	77.78139	18.24478	2.120476	0.283907
10	1.347363	1.576882	77.05650	18.95819	2.121176	0.287257

In addition to the Granger causality test, we examine the response of poverty to GDP, energy consumption, capital stock and political stability using the variance decomposition analysis. The results of the variance decomposition are depicted in Table 8. The study is particularly interested on the response of poverty level to all the variables of concern. Panel B shows that the response of the poverty level is more to capital stock, than to real GDP and very little to energy consumption and political instability. The result suggests that although there is unidirectional causality that flows from energy consumption to poverty; poverty tends to respond quickly to capital stock across the selected countries. Thus, despite the importance of energy to national development policies to increase energy supply will yield little impact in the reduction of poverty in the long-run if the necessary infrastructures are not in place. This implies that energy supply without creating the necessary environment could lead to energy waste and loss in the selected African countries.

6.0 Conclusion and Policy Implications

The attention of most policy makers among Africa countries is on increasing energy supply with the hope of meeting the energy needs and ensuring sustainable development. Although this is a veritable way in reducing poverty, however, most African countries are faced with problems such as poor infrastructural facilities, political instability, income inequality and other macroeconomic instabilities that tend to inhibit the efficacy of energy-GDP relationship on poverty level. This study contributes to existing literature by examining the nexus between energy consumption, real GDP, poverty level, political stability and capital stock across 12 African countries. The results of the long-run relationship reveal that energy consumption, and real GDP have a negative and significant impact on poverty in the selected African countries. However, long run impact for the individual shows that capital stock and political stability have significant impact in most of the countries. The implication is that capital stock and political stability have significant impact on poverty reduction across these countries. As such policies geared at poverty reduction and increased energy supply should include increasing capital stock as well as providing a stable environment.

The study also found a unidirectional causality that runs from energy consumption, real GDP and capital stock to poverty level in the selected African countries. The poverty level across the countries is also found to respond to the long run equilibrium after a shock. The variance decomposition shows that poverty responds more to capital and GDP than to energy consumption whenever there is a change in any of the variables. This implies that there is no strong link between poverty and energy consumption both in the short-run and long-run across these countries. Thus, increasing energy consumption may have no impact on poverty reduction except there is deliberate effort in building strong institutions that will encourage the distribution and use of energy.

On the basis of the short-run and long-run relationship between energy consumption, poverty level and real GDP, this paper pointed out that although energy plays an important role on economic growth, its role in reducing poverty rate is secondary, thus, the hypothesis of increasing energy supply so as to reduce poverty should be treated with caution in the selected countries. This is particularly important because for GDP-energy relationship to be sustainable, policy makers must ensure that the problems of poor infrastructure and violence in these countries must be addressed. Thus, the study suggests that effort should be made in ensuring a stable political climate as this will create and enhance efficient energy consumption. Furthermore, in addition to providing stable and efficient energy, the government in the selected African countries can reduce poverty rate by embarking on policies geared toward providing basic infrastructure, increasing income equality and ensuring increased access to modern energy at a subsidized rate.

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