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Oil Consumption and Economic Growth Nexus in Tanzania Co integration and Causality Analysis

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Abstract
Over the years, there has been a radical increase in energy consumption in Tanzania. Oil is the most energy source which is highly consumed in the country. The country imports refined oil in bulky amount to support day-to-day economic activities. This oil importation has been associated with imported inflation, budget deficits and trade deficits. This challenge has motivated the researcher to pursue this study by analyzing the relationship between oil consumption and economic growth for the period 1972-2010. The purpose is to ensure sustainable growth by regulating excessive oil importation. The study used modern econometric techniques in pursuing time series analysis. All variables were non-stationary at level and they become stationary after the first difference i.e. I(1). Johansen Cointegration test revealed one cointegrating equation. Thus, the variables were cointegrated. Granger causality test suggested unidirectional causal relationship running from per capita oil consumption to oil prices and unidirectional causal relationship running from per capita real GDP to per capita oil consumption. The study supports conservation hypothesis. There will be no harm to the economy due to reduction of oil importation. Thus, it is very important for the country to accelerate oil exploration and extraction efforts and concurrently investing more in renewable technologies. This will ensure viable energy supply and hence sustainable growth and development in the country.
Keywords: Energy, Oil, Economic Growth, Cointegration, Causality.

Introduction

Over the years, energy has been thought to be the catalyst for growth and development of both developing and developed countries. The demand for energy has been increasing dramatically over time. According to the report by the British Petroleum (BP), the world primary energy consumption grew by 45% over the last 20 years and it is expected to rise by 39% in the next 20 years (BP, 2011). Also, the world population has increased by 1.6 billion over the last 20 years and it is also expected to increase by 1.4 billion over the next 20 years. Moreover, the real income in the world has increased by 87% over the past 20 years, and in the next 20 years it is projected to increase by 100% (BP, 2011). So, with more people in the world with more income, production and consumption of more energy become necessary.

Most of the energy consumed comes from the fossil fuels (coal, natural gas and crude oil). Despite of the rapid increase in energy demand, the reserves for fossil fuels decrease more rapidly over time. These fossil fuels are non- renewable in nature, and thus, they are exhaustible. Among the highly consumed and vital energy resources in the world, oil is on top of them. International Energy Agency (IEA) identified that in year 2012 oil accounted for about 33% of the global primary energy consumption. Despite that oil is exhaustible; over the decades, its demand has been increasing swiftly especially in the transportation sector. Unless there will be some structural changes in the way the world engineers her transportation sector, oil consumption is expected to grow continuously.

Oil plays as one of the essential inputs in the production activities in the economy. It complements labor and capital in the production process. Thus, oil has become crucial in the development and growth process of many economies (Cooper, 2003). Tanzania is among the less developed economies which are very rich in minerals and energy resources. However, the country remains among the poorest economies in the world due to uneconomical utilization of these resources. So far, the country excessively imports refined oil in order to support her daily economic activities. Transportation sector has been dominant in oil consumption in the economy.

The existing bulky importation of refined oil poses a great challenge to the economy by creating some imported energy inflation, persistent currency depreciation, and persistent budget and trade deficits (URT, 2011). Fluctuations in the oil prices in the world market have increased the cost of production and the cost of living the country. The country bears a cumbersome burden towards the use of many foreign currencies for importing oil. In addressing these challenges, the country is currently embarking on exploring gas and oil reserves which seem to be present in on-shore and off-shore areas. Tanzania Petroleum Development Corporation (TPDC), on the behalf of the government, is accountable in the supervision of all activities that involve exploration and production of oil in the country. The initial results seem to provide a great fortune in the near future despite that the actual extraction of oil is not yet.

This paper focuses on the causal relationship between energy consumption specifically oil consumption and the economic growth in Tanzania by using annual time series data 1972–2010. The aim is to address the above mentioned problems by controlling excessive oil importation while ensuring sustainable growth of the economy.

In regard to energy-growth nexus, Apergis and Payne (2009) pointed out four possible causal relationships between energy consumption and economic growth. There is a unidirectional causal link running from energy consumption to economic growth (growth hypothesis). This implies that more energy consumption will increase economic growth. The economy seem to depend much on energy consumption for growth, thus, any policy to reduce energy consumption will have an adverse impact on economic growth. Some of the studies supporting this hypothesis include Wolde-Rufael (2004) and Lee and Chang (2008).

In addition, there is a unidirectional causal relationship running from economic growth to energy consumption (conservation hypothesis). This implies that an increase in income causes an increase in energy consumption. So, the energy conservation policies to reduce energy consumption will have no adverse effects on economic growth. This hypothesis goes in line with findings from Kraft and Kraft (1978) and Abosedra and Baghestani (1989).

Also, there is a bidirectional causal relationship between energy consumption and economic growth (feedback hypothesis). These variables complement one another. This implies that energy policies to affect energy consumption would adversely impact economic growth.

Some of the studies supporting this hypothesis include Soytas and Sari (2003) and Asafu-Adjaye (2000).

Lastly, there is no causal relationship between energy consumption and economic growth (neutrality hypothesis). This implies that any changes in any variable will have no impact on the other variable. This hypothesis goes in line with findings from Fatai et al, (2002) and Akarca and Long (1980).

Since the study findings have different policy implications, this will help the energy practitioners and energy policy makers to adjust the energy policy towards the changing energy needs. The rest of the paper is thus organized as follows: section two presents the literature review, section three presents the methodology and data sources, section four presents the discussion of the findings while section five presents the concluding remarks and the policy implications.

Literature Review

Many energy policy analysts and researchers have shown a great interest towards the energy-growth nexus. The relationship between energy consumption and economic growth has raised an unresolved debate so far. Over the different time periods, many past studies have used different econometric approaches for different countries; however, the findings regarding energy-growth nexus are still equivocal. Some of the studies used regression analysis while others used causality analysis which led to conflicting results. For instance, the pioneer study by Kraft and Kraft (1978) examined the causal connection between economic growth and energy consumption in United States over the period 1947-1974. The findings pinpointed that there is a unidirectional causal relationship running from economic growth to energy consumption.

Hatemi and Irandoust (2005) found causality from income to electricity consumption for Sweden. Belloumi (2009) used annual time series data for Tunisia (1971-2004) to examine causal relationship between energy consumption and economic growth. The results indicated that there was a bidirectional causal relationship between energy consumption and economic growth.

The study by Lee and Chang (2008) found a long run unidirectional causality running from energy consumption to economic growth. Cheng and Lai (1997) found causal relationship running from economic growth to energy consumption for Taiwan. The study by Ebohoh (1996) found causal relationship between energy consumption and economic growth for Tanzania and Nigeria.

Altinay and Karagol (2005) used time series data (1950-2000) for Turkey to examine causal relationship between income and energy consumption. The results suggested that there was a strong long-run causal relationship running from energy consumption to income. Empirical evidence showed that there was Wolde-Rufael (2004) provided the evidence on the unidirectional granger causality running from total energy consumption to real GDP

Abosedra and Baghestani (1989) found a unidirectional causal relationship from economic growth to energy consumption in United States. Soytas and Sari (2003) suggested that in Turkey there is a bidirectional relationship in the short run and a unidirectional causal relationship running from energy consumption to GDP per capita.

The study by Odhiambo (2009) used annual time series data (1971-2006) for Tanzania to examine the causal relationship between economic growth and per capita electricity consumption. The results suggested that per capita electricity consumption has significant impact on economic growth in Tanzania.

From the above discussion it can be seen that many studies have investigated the nexus between total energy consumption and economic growth and still we have a mixed bag of results. Also, they have ignored the fact that oil consumption has a unique effect in the economy. This paper has seen this as a loophole in the energy literature. Thus, this paper will focus directly on the link between oil consumption and economic growth by integrating also the oil prices in the same framework. The study will examine the existence of cointegration and causal relationship among these variables. To the best of author's knowledge, there are no previous studies that have been pursued in Tanzania to examine this specific nexus. Thus, this study expects to fill that gap in the literature of energy economics in Tanzania.

Econometric Methodology and Data

The paper adopted econometric time series analysis. Most of the time series variables are non-stationary in nature; however, they become stationary after taking the first difference. Thus, usually time series variables suffer from a unit root problem. So, the conventional regression analysis will produce spurious results. In understanding that situation, this study adopted cointegration and causality approach to examine the link between oil consumption, oil prices and economic growth in Tanzania.

To begin with, this study tested for unit root by using the Augmented Dickey-Fuller (ADF) test developed by Dickey and Fuller (1979) and Phillips-Perron (PP) test developed by Phillips and Perron (1988). The later test is quite similar to the former except it is non-parametric and it relaxes assumptions about autocorrelation and heteroscedasticity. However, both tests have the same asymptotic distribution. ADF estimates the following regression:

$$\Delta X_t = \theta_1 + \theta_2 t + \beta X_{t-1} + \sum_{i=1}^{k} \lambda_i \Delta X_{t-i} + \varpi_t \quad \text{.....................} (1)$$

Where ϖ_t is a pure white noise error term and $\Delta X_t = X_t - X_{t-1}$. ADF tests whether β is zero.

When variables are non-stationary still we can investigate the relationship among them using the cointegration test. According to Engle and Granger (1987), even if the two variables are non-stationary individually, it may happen that the linear combination of the two variables is stationary, then these variables are said to be cointegrated, provided that they are integrated of the same order (unit root). Johansen (1988) and Johansen and Juselius (1990) came up with the better version of testing cointegration when there is more than two series in the framework. This test uses the likelihood ratio test to determine the number of cointegrating equations in the regression.

Whenever there is a long run relationship between the variable (cointegration), Error Correction Model (ECM) is said to exist. Error Correction Model (ECM) tends to bring together the short-run and long-run economic behavior of variables. ECM combines the short run and the long run relationships of the variables in one equation. It also ensures that all variables in the estimated equation to be stationary. It allows us to study the short-run dynamics in the relationship between variables. The analysis of short-run dynamics is often done by differencing the data so as to eliminate trends. So, if there exists a long-run relationship between the variables, ECM will confirm this relationship (Maddala, 1992). The ECM estimates the following regression:

$$\Delta X_t = \beta_1 + \beta_2 \Delta Y_t + \beta_3 \mu_{t-1} + \phi_t \quad \text{..................} (2)$$

Where $\mu_{t-1} = X_{t-1} - \alpha_0 - \alpha_1 Y_{t-1}$ and φ_t is the stochastic error term.

Moreover, whenever there is at least one cointegrating equation, it is possible for one variable to granger cause the other. Granger (1969) developed granger causality test to examine the long run causal relationship between the variables. Granger causality analysis is nothing but examining if the lags of one variable significantly predict the other variable. If variable X granger cause variable Y then X has useful information in describing Y. In this causality test we have unidirectional causal relationship, bidirectional causal relationship (feedback system) and no causal relationship (neutral system). Consider the regression models below:

$$X_t = \sum_{i=1}^{n} \alpha_i Y_{t-i} + \sum_{j=1}^{n} \beta_j X_{t-j} + \xi_t \quad \text{.............................} (3)$$

$$Y_t = \sum_{i=1}^{n} \lambda_i Y_{t-i} + \sum_{j=1}^{n} \theta_j X_{t-j} + \psi_t \quad \text{............................} (4)$$

The error terms ψ_t and ξ_t are not correlated. There will be unidirectional causality running from Y to X in case $\Sigma\alpha_i \neq 0$ and $\Sigma\theta_j = 0$. Also, there will be a unidirectional causality running from X to Y in case of $\Sigma\alpha_i = 0$ and $\Sigma\theta_j \neq 0$. Furthermore, when the coefficients are statistically different from zero in both regressions there will be bidirectional causality between the variables. The variables will be said not related if the coefficients are not statistically different from zero in both regressions. For more details about these diagnostic tests and estimation techniques one can review them from Gujarati (2009). In order to support these diagnostic tests and estimation techniques, econometrics package, EVIEWS 6.0 was used.

This empirical study used annual time series data for per capita real GDP (in Tanzania Shillings), international oil prices (in U.S dollars) and per capita oil consumption (in metric tonnes) for the period (1972-2010) in Tanzania. These data were obtained from the Ministry of Energy and Minerals (MEM), Bank of Tanzania (BOT), and British Petroleum (BP). All variables used were changed into logarithmic scale so as to improve their distributions.

Discussion of Empirical Results

In this section we present the study findings. Initially, the study used ADF and PP unit root test to examine whether the variables are stationary. The tested null hypothesis was that the variable is a non-stationary against the alternative hypothesis that the variable is stationary. The regression model takes into account the constant term and a linear trend. The lag length selected was based on Schwartz Information Criterion (SIC). In EVIEWS 6.0, this criterion chooses the lag length automatically. Consider table 1 below:

Table 1:
Unit Root Test Results

	ADF Test Statistic		PP Test Statistic		
Variables	Level	First Difference	Level	First Difference	Remarks
LnOIL	-1.1084	-4.0250**	-1.2454	-5.6058***	I(1)
LnP	-2.9309	-5.9053***	-2.9730	-5.9023***	I(1)
LnY	0.1072	-3.9868**	1.1873	-3.8888**	I(1)

** and *** indicate statistical significance at 5% and 1% respectively

Table 1 above presents the unit root test results by ADF and PP at level and at first difference. The results indicated that all variables are non-stationary at their levels, however, they become stationary after first difference. Thus, this implies that all variables are integrated of order one i.e. I(1).

Provided that all variables are integrated of the same order, then we can go further to check if they are cointegrated over the sample period. Cointegration suggests that the individual variables may be non-stationary, however, their linear combination will be stationary. This paper used Johansen-Juselius cointegration procedure to examine if the variables have a long run relationship. The test depends on two test statistics, namely, the Trace Statistic and Maximum-Eigenvalue Statistic. One lag length in first differences was select based on Schwartz Information Criterion (SIC) and Hannan-Quinn Information Criterion (HQIC). Consider table 2 below:

Table 2:
Maximum Likelihood Johansen Cointegration Test Results

	Trace Test		Max-Eigen Test	
Number of Cointegrating Eqns (r)	Statistic	5% Critical Value	Statistic	5% Critical Value
r=0	38.07476*	29.68	25.11684*	20.97
r=<1	12.95792	15.41	11.90423	14.07

(*) denotes rejection of the null hypothesis at the 5% significance level

Table 2 above indicates that both the Trace test and Maximum Eigenvalue test suggested one cointegrating equation at the 5% level of significance. It can be seen that the null hypothesis of no cointegration (r=0) has been rejected since the test statistic is greater than the 5% critical value. However, both tests did not reject the null hypothesis i.e r=<1 since both statistics are below the 5% critical value. Thus, the variables (i.e. per capital oil consumption, oil prices and economic growth) are cointegrated at 5% level of significance.

Since the variables are cointegrated, then the Error Correction Model (ECM) can been used to confirm this long run relationship between variables. ECM is applied when the model directly estimates the rate at which the changes in dependent variable return to equilibrium after a change in independent variable(s). Consider the ECM below:

$$\Delta L\,n\,OIL_t = \alpha_0 + \alpha_1 \Delta \mathrm{LnP_t} + \alpha_2 \Delta \mathrm{LnY_t} + \Theta[Ln\mathrm{OIL}_{t-1} - \beta - \alpha_3 Ln\mathrm{P}_{t-1} - \alpha_4 LnY_{t-1}] + v_t \quad \text{………. (5)}$$

Where, Θ indicates the coefficient of adjustment. It measures the rate at which the model re-equilibrates. Also, it tells us the proportion of disequilibrium which is corrected in every year. The equation expresses the dependent variable as a function of changes of all independent variables, the one period lagged value of the dependent variable and the one period lagged values of the independent variables. The coefficient of the lagged dependent variable is the coefficient in the error correction mechanism. This coefficient should be negative, significant and less than the absolute value of one to indicate convergence towards equilibrium. The term in the square brackets, indicates the disequlibrium error in the previous period. Consider table 3 below:

Table 3:
Error Correction Model Results

Dep Var: $\Delta LnOIL_t$	Coefficient	Std. Error	t-Statistic	Prob.
ΔLnP_t	-0.026321	0.089649	-0.293594	0.7710
ΔLnY_t	1.039985	1.094345	0.950326	0.3491
$LnOIL_{t-1}$	-0.430497	0.187328	-2.298088	0.0282
LnP_{t-1}	-0.005708	0.048528	-0.117616	0.9071
LnY_{t-1}	0.720226	0.319397	2.254959	0.0311
C	-5.458655	3.426906	-1.592881	0.1210

R-squared	0.248113	Mean dependent var	0.025426
Adjusted R-squared	0.130631	S.D. dependent var	0.151432
S.E. of regression	0.141196	Akaike info criterion	-0.933403
Sum squared resid	0.637958	Schwarz criterion	-0.674837
Log likelihood	23.73465	Hannan-Quinn criter.	-0.841407
F-statistic	2.111916	Durbin-Watson stat	1.649046
Prob(F-statistic)	0.089517		

The table 3 above provides the results of the Error Correction Model. The first differenced per capita oil consumption was regressed on the first differenced oil prices and per capita real GDP, the one period lagged value of the per capita oil consumption, one period lagged value of oil prices and one period lagged value of per capita real GDP. The coefficient of the one period lagged value of the per capita oil consumption is negative and statistically significant at 5% level of significance. It indicates that 0.43 of the deviation from the long-run equilibrium is corrected in each year. It is the speed of adjustment of the dependent variable towards its long run equilibrium. The coefficient is less than the absolute value of one and greater than zero, indicating that the model is convergent.

The existence of one cointegrating equation based on the Johansen Cointegration test indicated that there exists a long run relationship among the variables. Therefore, at least in one direction, there will be granger causality among them. This study applied pair wise granger causality technique to determine the direction of causality between per capita oil consumption, oil prices and per capita real GDP. Consider table 4 below:

Table 4:
Pairwise Granger Causality Test Results

Null Hypothesis:	Obs	F-Statistic	P-value
LnP does not Granger Cause LnOIL	36	1.35470	0.27615
LnOIL does not Granger Cause LnP		3.09935	0.04208
LnY does not Granger Cause LnOIL	36	3.88936	0.01884
LnOIL does not Granger Cause LnY		0.39571	0.75704
LnY does not Granger Cause LnP	36	3.06491	0.04361
LnP does not Granger Cause LnY		2.17780	0.11207

Table 4 above shown that there is unidirectional causal relationship running from per capita oil consumption to oil prices. Also, the results suggested that there is unidirectional causal relationship running from per capita real GDP to per capita oil consumption. This implies that energy policy to reduce oil importation will not have detrimental impact to the economy. Moreover, we found a unidirectional causal relationship running from per capita real GDP to oil prices. The results are more realistic in the sense that the increased demand for oil resulted into higher oil prices. In addition, results show that oil consumption does not granger cause economic growth and also oil prices do not granger cause economic growth. The results supports conservation hypothesis that economic growth influences energy consumption. Thus, changes in oil supply will not have a negative effect in the economy.

Conclusion and Policy Implication

Tanzania has experienced a rapid increase in energy consumption over time. Many studies have suggested that there is a connection between energy consumption and economic growth. However, most of them obtain vague results on whether more energy consumption leads to economic growth or economic growth leads to more energy consumption. This unconcluded debate motivated the researcher to pursue this study by applying modern econometric procedures to analyze the relationship between oil consumption and economic growth in Tanzania. In understanding a unique contribution of every kind of energy to the economy, this study opted to use specifically oil consumption as a proxy for total energy consumption. The country has been relying heavily on importing refined oil to support day-to-day economic activities. This bulky importation has created imported inflation, persistent trade deficits and persistent budget deficits. The study examined the existence of cointegration and causality between oil consumption, oil prices and economic growth. This nexus has received little attention to many researchers in the country.

The study used annual time series data for the period 1972-2010. In time series analysis, most of the macroeconomic variables tend to be non-stationary. Thus, this study used Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test to check for unit root. The results found out that all variables were non-stationary at level but they become stationary after the first difference. Thus, this implied that all variables were integrated of order one i.e. I(1). Since the variables were integrated of the same order, Johansen-Juselius cointegration technique was applied to see whether there exists a long run relationship between these variables. The results suggested one cointegrating equation and thus, the variables were cointegrated. Error

Correction model (ECM) was used to confirm this relationship and the model seem to be convergent towards the long-run equilibrium.

Since we succeeded to establish cointegration between oil consumption, oil prices and economic growth then a pair-wise granger causality test was adopted to analyze the existence of long-run causal link between these variables. The findings indicated a unidirectional causal relationship running from per capita real GDP to oil prices; unidirectional causal relationship running from per capita oil consumption to oil prices; and unidirectional causal relationship running from per capita real GDP to per capita oil consumption. The findings have a strong support on the conservation hypothesis which implies reducing energy consumption will not have adverse impact on economic growth. Thus, in our case the results suggest that if the country reduces her excessive oil importation it will not harm the economy.

Therefore, from these empirical results this paper recommended that it is very important for the government to expedite her efforts in exploration and then extraction of the oil and gas from the discovered reserves. The use of domestically extracted oil and gas will spare the foreign currencies which were used in importing oil. Also, with our own oil and gas, the cost of living and production will be relieved, thus, promoting the people's welfare.

Also, there is a need for the government to invest in research and development so to promote innovations and use of renewable energy technologies and thus making renewable energy sources to be more plausible and reduce environmental degradation and heavy dependence on the importation of oil which has caused unstable prices in the domestic market. Renewable energy technologies provide employment opportunities and generate incomes. Renewable resources are non-exhaustive and environmentally friendly. So, they have an indirect effect on poverty alleviation and create sustainable environment. The government should offer a tax exempt on all imported renewable energy equipments and components. This will encourage the investors in the energy sector. There is also a need to create a legal framework that is conducive for growth and sustainable renewable energy utilization in the country.

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