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THE IMPLICATIONS OF RENEWABLE AND NON-RENEWABLE ENERGY CONSUMPTION FOR ECONOMIC GROWTH IN CAMEROON

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ABSTRACT

Energy is widely considered a propulsive force for economic activity and industrial development. In this context, this paper aims at investigating the implications of renewable and non-renewable energy consumption for economic growth in Cameroon. To achieve this objective, used is made of time series data spanning the period 1971 - 2016 and an error correction. We find a long-run relationship between gross domestic product, renewable energy consumption, non-renewable energy consumption, gross capital formation and government expenditure. We also find that with the exception of non-renewable energy, these variables register positive and significant long-run effects on economic growth. However, once the two energy sources are interacted, the observed substitution-effect between renewable and non-renewable energy utilization enhances the direct impact of each energy source on economic growth. This indicates that renewable energy is a major driver of economic growth in the short- and long-run in Cameroon. These findings suggest that increasing the exploitation and use of renewable energy sources have implications for overall prosperity in developing country settings.

Contribution/ Originality: The first contribution is that, unlike many previous studies, the paper disintegrates energy into renewable and non-renewable sources to account for their effects on economic growth. Secondly, the paper looks at how renewable energy modulates the effect of non-renewable energy on economic growth, which has typically been ignored in previous studies.

1. BACKGROUND OF THE STUDY

Energy is the backbone of all productive sectors within an economy and may either have positive or negative effects on the flow of economic activities. As an example, changes in the cost of energy have a direct influence on economic output and growth. That is, an increase in the cost of energy increases the cost of doing business, engendering a negative impact on economic growth in the short-run. Clean energy resources, in particular, can amplify the impact of technology and generate economic growth. High grade resources can act as supporter of technology, whereas lower grade resources can dampen the intensity of recent technology. Ojinnaka (1998) suggested that the consumption of energy is linked to the national product. Hence, the size of energy consumption per capita could also be a vital indicator of economic modernization. Normally, countries that have higher per capita energy consumption develop at a faster rate compared to their counterparts with lower levels of energy consumption (Onakoya, Onakoya, Jimi-Salami, & Odedairo, 2013).

Energy could be a key variable for economic competitiveness and rapid growth (Fotourechechi, 2017). Clean energy is one of the foremost vital components for producers to provide goods and services. Energy is, however, depleting given the increasing demand and restricted availability; it is inevitable that non-renewable energy needs to be supplemented. Moreover, non-renewable energy consumption has a lot of limitations linked to climate change, environmental degradation and heating, which is caused by the ever-increasing greenhouse gas emissions such as dioxides and the methane series. The IEA (2010) suggests that current trends in energy consumption are still environmentally, socially and economically unsustainable. This might be an indication that policy efforts ought to be leaning towards promoting renewable energy for a sustainable energy supply for the future. Our present endeavor investigates the differential implications of renewable and non-renewable energy consumption for economic growth in the long-run to produce needed information for policy debates and analyzes.

It is expected that energy demand will increase by 1.5% per year in the period 2015 – 2030, fossil fuel being regarded as a major source of energy supply (Apergis & Dănuleţiu, 2014). It is projected that due to the rise in primary energy demand, energy-related greenhouse gas emissions can probably double by 2050. Several countries facing, energy security and environmental challenges, are therefore, forced to look for alternatives or substitutes to fossil fuels. These challenges are befittingly being addressed by investments in clean renewable energy sources. In contrast to traditional energy, renewable energy is inexhaustible, safe and clean. Consequently, several countries are engaging huge investments on renewable energy so as to cut back their greenhouse emissions and increase the provision of secure energy. The drive towards renewable energy is growing around the world. For instance, demand for renewable energy is increasing (8% per year) in USA, China and Europe. Throughout 2011 renewable energy sources constituted 16.7% of worldwide final energy consumption, and world investment in renewable energy stood at 17% because of price advantage and technological advancements (REN21, 2012).

Worldwide commitments in renewable energy are set to reach 2.6 trillion USD from 2010 to 2019. According to the united nation environmental program (UNEP), solar energy alone is calculated to be answerable for half the investments. In 2018, twenty-nine countries individually invested more than one billion USD in renewable energy capability, as compared to twenty-five in 2017 and twenty-one in 2016. China has been the largest investor in renewable energy capability, investing 758 billion USD, American being second with 356 billion USD and Japan third with 202 billion USD. The 'Global Trends in Renewable Energy Investments (GTREI) report states that this investment registered quadrupled renewable energy capability (excluding massive hydro) from 414 gigawatt (GW) at the end of 2009 to well over 1,650 GW at the end of 2019. This supports GTREI (2019) which posited that the world switch to renewables should be accelerated to satisfy development goals and the international climate challenges.

The oil sector in Cameroon is controlled by the government oil company; the National Hydrocarbon Corporation (NHC), that operates in partnership with few cluster or International Oil corporations (IOCs). It is conjointly answerable for marketing the state-owned shares of oil output and holds a 20% stake in operations by Total, Pecten and Perenco. As per an announcement on April 11 2008, NHC signed a production sharing contract with Swiss-based Glencore and AFex Global limited to extract natural oil resources within the Matanda sector of the country's Douala-Kribi/Campo basin. The sector covers a distance of 1.187km^2 between the Wouri coastal waters and therefore the neighboring onshore space to the west and south of Douala - Central Africa's largest port. The National Hydrocarbon Corporation indicated that this contract was meant to activate exploration activities on this span of the mining domain in Cameroon, which for over a decade had registered no economic activities, meanwhile, its potential in gas and condensates is evidenced by the two wells drilled by Gulf Oil Corporation in the early Nineteen Eighties (IEA, 2010).

Hydroelectricity remains one of the most readily and available exploitable form of energy in Cameroon, which, together with the Democratic Republic of Congo, is considered to have the largest hydroelectric potential in Africa. Hydroelectric energy is produced mainly by two electrical stations on the Sanaga River. Almost 60% of the electricity generated from these stations goes to the aluminum smelting company in Edea. Around the 1980s this station was expanded by another complex on the Sanaga River (Song-Loulou) and a 72 megawatt generator (built with Chinese aid) on the Benue River. Electricity generation in Cameroon was evaluated at 5 billion kilowatt-hours in 2006 and rose to 5.6 billion kilowatt-hours in 2007. Consumption stood around 4.37 billion kilowatt-hours and 4.8 billion kilowatt-hours in 2006 and 2007, respectively. It should be noted that CO_2 emissions from the consumption of fossil fuels in Cameroon was evaluated at 7.48 million metric tons in 2007 and 8.06 million metric tons in 2008 (IEA, 2010).

In terms of volumes of oil reserves and natural gas, Cameroon is world widely ranked 47^{th} and has an estimated proven reserves of natural gas of 4.8 trillion cubic feet (4,800 bcm). Kribi-Campo basin and Ebome are the main oil fields (EIA, 2015). The total amount of oil produced has drastically reduced as reserves are depleting over time. Notably, between 2000 and 2015, the amount of natural gas and crude oil produced, dropped from 6,860 to 2,185 kilotons of oil equivalence, whereas the exploitation of wind and solar energy amounted to 6 kilotons of oil equivalence. The amount of renewable energy in the total final energy consumption (TFEC) reduced from 81.6 to 78.1% from 1990 to 2012. Primary biofuels form the largest part of renewable energy sources at 66.3% of TFEC in 2012, while the modern biofuels contributed 6.7% and hydro only 5.1%. Renewable energy sources contributed a share of about 73.0% of electricity generated (AFREC, 2015).

Cameroon's greatest desire is to carryout economic transformation and to achieve the status of an emergent country by 2035. As economic growth is linked to energy, so too is the future of every economy, including that of Cameroon. Alam (2006) argued that, "energy is the indispensable force driving all economic activities". It is very difficult to find anything consumed or produced in Cameroon that does not require energy as an input. It logically follows that changing oil prices or changing oil consumption patterns can have an effect on economic processes. In order to achieve sustained growth, increased production and productivity must be at the center of the economic recovery strategy. However, increasing production cannot take place without energy. Thus, to formulate policy measures for achieving sustained enhancement in production and rapid economic growth with the most efficient use of energy, relevant empirical knowledge on how the different sources of energy relate to growth in the short- and long-run is indispensable. It is on this premise that this paper seeks to answer the following questions: (1) What is the effect of renewable energy on economic growth in Cameroon? (2) To what extent does non-renewable energy influence economic growth in Cameroon? (3) How does renewable energy modulate the effect of non-renewable energy on economic growth in Cameroon?

2. RESEARCH OBJECTIVES

2.1. Main Objective of the Study

- The main objective of this paper is to investigate the implications of renewable and non-renewable energy consumption for economic growth in Cameroon, while controlling for other correlates.

2.2. Specific Research Objectives

- To investigate the effect of renewable energy consumption on economic growth in Cameroon.
- To assess the implications of non-renewable energy consumption for economic growth in Cameroon.
- To examine the extent to which renewable energy modulates the implications of non-renewable energy for economic growth in Cameroon.

3. OUTLINE OF THE PAPER

This paper is divided into seven parts. Section 1 dwells on the background. Section II hosts the research objectives and Section III presents the outline of the paper. Section IV dwells on the literature review and Section **V** presents the methodology and data used. Section VI presents the findings and Section VII submits the conclusion and policy implications.

4. LITERATURE REVIEW AND KNOWLEDGE GAPS

4.1. Empirical Review

Molem and Ndifor (2016) investigated the effects of energy use on economic growth in Cameroon. Their study made use of secondary data spanning from 1980 to 2014 (35years) and the generalized method of moments to obtain the results. The study disclosed a positive and very significant relationship between oil consumption, electricity consumption, Gross domestic investment (GDI), population growth rate and economic growth. Their results indicated that gross domestic product (GDP), petroleum price and population growth rate, have a positive relationship with petroleum consumption. They counseled that the state ought to expand current sources, while and exploiting other sources of energy such as wind energy, thermal energy, solar energy so as to increase the consumption and production of clean energy that increases economic growth. They indicated that to take advantage of different sources of renewable energy, sound empirical knowledge is needed to elucidate their growth potentials. In this context, this paper proceeds through an empirical exercise to provide sound information on the relative importance of non-renewable and renewable energy sources in shaping the strength of the Cameroon economy. Our present endeavor is different from previous ones, in that, we look at how renewable energy modulates the effect of non-renewable energy on economic growth.

Luke (2016) examined the connection between renewable energy utilization and economic growth (GDP) in sub-Saharan Africa. The paper made use of secondary data spanning from 1990 -2011(22years) and used the Fully-Modified method of least squares (FMOLS). The results indicated the existence of a significant long-term relationship between real GDP and independent variables. The Granger causality tests indicated unidirectional relationship running from economic process to renewable energy consumption in the long-run. He therefore suggested that renewable energy technologies could help enhance energy access across sub-Saharan Africa.

Soytas and Sari (2003) investigated the connection between energy use and economic growth in G-7 Countries. The study made use of yearly time series data of energy consumption and gross domestic product and reexamined the relation relationship between the two series within the prime ten rising markets (excluding China) and G-7 countries. They found bi-directional relation in Argentina, relation running from gross domestic product to energy consumption in Italia and Korea, and from energy consumption to gross domestic product in Turkey, France, European nation and Japan. From their results, it is evident that energy conservation could have retarded economic progress in Turkey, France, European nation and Japan.

Dogan (2014) examined the relationship between energy utilization and economic growth in four low-income countries in Sub-Saharan Africa. In this endeavor use was made of time-series data spanning from 1971- 2011 (41years) and Johansen co-integration & Granger causality test to estimate the model. The Granger causality test indicated that there is a unidirectional relation running from energy use to economic growth in Kenya and no relationship between energy consumption and economic growth in Zimbabwe, Congo and Benin. This is indication that the causative relationship between energy use and economic growth is country-specific, and such information is still fragmented and unsettled for the economy of Cameroon.

Akinlo (2008) investigated the connection between energy consumption and economic growth in sub-Saharan Africa for eleven countries. Use was made of cross-sectional information and an autoregressive distributed lag (ARDL) bounds test and granger causality test to estimate the variables. The results disclosed that energy consumption is co-integrated with economic growth in Republic of Gambia, Cameroon, Senegal, Sudan, Zimbabwe, Ghana and cote d'Ivoire. Moreover, his study highlighted that energy consumption has a positive and statistically important impact on growth in Ghana, Kenya, Senegal and Sudan. Granger causality test supported by the vector error correction model (VECM) found a bi-directional relationship between energy consumption and economic growth for Senegal, Gambia and Ghana.

Orhewere and Machame (2011) examined the effect of energy consumption on economic growth in Nigeria. They made use of secondary data from 1970-2005(36 years) and a vector error correction based granger causality test to estimate the variables. The results indicated a unidirectional relation from electricity consumption to GDP each within the short and long-run. Their study underlined a unidirectional relation from gas consumption to GDP in the short-run and a bi-directional relation between the variable in the long run. The study found a unidirectional relation from oil consumption to GDP in the long run. However, in the short run, they study found no causality in either direction between oil consumption and GDP.

Dantama, Abdullahi, and Inuwa (2012) examined the impact of energy consumption on economic growth in Nigeria from 1980-2010(31years). He made use of an autoregressive distributed lag (ARDL) approach. The results indicated a long run relationship between economic growth and energy consumption. Their results pointed that each fossil fuel consumption and electricity consumption square measure is statistically significant in boosting economic growth.

Esso (2010) investigated the relationship between energy consumption and economic growth in seven Sub-Saharan African countries. The study made use of secondary data from 1970–2007(38years) and the Gregory and Hansen test to threshold co-integration to estimate the results. The results showed that energy consumption is co-integrated with economic growth in Ghana, Nigeria, Cameroon, Cote d'Ivoire and South Africa. Their results also indicated that economic growth registered a statistically significant positive long run impact on energy consumption in these countries before 1988; and this impact became negative after 1988 in South Africa and Ghana. This study provides very important information but however fails to disintegrate energy into renewable and non-renewable, so as to isolate their differential effects on economic growth. This paper comes to fill this visible literature gap.

Odularu and Okonkwo (2009) examined the effect of energy consumption on economic growth in Nigerian. The study made use of time series data spanning from 1970-2005(36years) and a vector error correction based Granger causality test and co-integration technique. The results posited that there exists a positive relationship between energy consumption and economic growth. However, their study observed that with the exception of coal, the lagged values of those energy components are negatively associated with economic growth.

Adorn (2011) examined the relationship between energy use and growth in Seven African Countries using yearly statistic data spanning 1971 to 2008 and also the TodaYamamoto procedure to co-integration to conduct the causative relationship between electricity utilization and economic growth for Ghana. His findings uncovered the existence of a unidirectional causative relationship running from economic growth to electricity utilization.

Odularu and Okonkwo (2009) investigated the relationship between energy use and economic growth in Nigeria. They made use of time series data spanning from 1970 -2005(36years) and applying the co-integration technique to estimate the variables. The study found that there exists a long run positive relationship between energy consumption and GDP. With the exception of coal, a negative relationship was noted for lagged values of energy consumption and GDP. their study pointed out that with the exception of coal, the lagged values of these energy components are negatively related to economic growth.

Shiu and Lam (2004) applied the error-correction model to inform the relationship between electricity consumption and real gross domestic product for China in the period 1971–2000. Their estimation results indicated that real gross domestic product and electricity consumption for China are co-integrated. Used Nigeria annual statistic data from 1970-2005 to examine the relationship between energy consumption and GDP. The study made use of an Autoregressive Distributed lag (ARDL) procedure. In their study, energy consumption was more disaggregated into oil, gas and electricity consumption. The findings highlighted a unidirectional causative relationship between total energy consumption and GDP. In addition, their study showed that there is no causative relationship between electricity consumption and economic process.

Emily and Adjasi (2015) examined the linkages between renewable and non-renewable energy sources and economic growth in African countries. They made use of time series data spanning from 1971-2013(43years) and ARDL model. The result showed that causality runs from renewable energy to real gross domestic product however not the other way round, and supports a long term causality running from real gross domestic product to Non-renewable energy. The work of Emily and Adjasi (2015), like several others reviewed above have written on the effects of renewable and non-renewable energy consumption on economic growth, however these studies have all ignored to look at how renewable energy modulates the implications of non-renewable energy for economic growth. This paper tries to fill this empirical and policy gap using data on Cameroon.

5. METHODOLOGY AND DATA USED

5.1. Econometric Model

In order to achieve the objectives of this research paper, a linear multiple regression model would be formulated and an error correction model(ECM) estimation technique will be used to estimate the parameters of the variables. The model is stated as follows.

$LGDP_t = \beta_0 + \beta 1LHYDROt + \beta 2LOILt + \beta_3LGCF_t + \beta_4LGGE_t + \mu_t$

$\beta_0>0,\ \beta_{1,2,3,4}>0,$

The equation above represents the economic growth equation. GDP (a proxy of economic growth) is expressed as a function of hydroelectric (proxy for renewable energy consumption) and oil consumption (proxy for non-renewable energy consumption), gross capital formation, and government expenditure. It is assumed theoretically that GDP is positively related to hydroelectricity consumption, oil consumption, gross capital formation, and government expenditure

5.1.1. Definition of Variables

HYDRO = Hydroelectric Consumption from hydroelectric sources:.

OIL = Electricity Produce from Oil Sources.

GDP = Gross Domestic Product.

GCF= Gross Capital Formation.

GGE= General Government Expenditure.

μ=Stochastic or Error Term.

L = It denotes natural logarithm.

t =time.

5.2. Estimation procedures

5.2.1. Model Estimation Procedures

The technique used to estimate the above equation is designed from a co-integration analysis and the error correction model (ECM) which is commonly used in the literature (Adam, 1992; Egwaikhide, 1999; Mafimisebi, 2002). The main idea behind this analytical framework is to evaluate the characteristics of the time series properties. Most significantly, to determine the level of integration and, therefore, the number of times a variable has to be differenced to arrive at a stationary process. The underlying principle behind estimation methodologies in economics is that the mean and variance computed from economic variables that are unit stationary would be unbiased estimates of the unknown population mean and variance. However, because of fluctuations within the World economy, non-stationarity has become an especially common development in macro-economic variables. The implication of non-stationarity in economic modeling is grave because it ends up in spurious regression. This usually manifest once the regression of unrelated non-stationary series indicate that the series are correlative (Adam, 1992). Egwaikhide (1999) argued that the utilization of one or additional non stationary series in the same equation might produce biased estimates, thereby leading to incorrect statistical inferences when such series are estimated at their levels, except in the case of a co integration relationship. Therefore, identification of the statistic properties of model variables assists in avoiding spurious estimates and encouraging reliable prediction.

According to Granger's illustration theorem (Engle & Granger, 1987) if it is established that variables are co-integrated, it follows that there are forces that tend to revive the equilibrium relationship between the variables every time it is broken. This means that to the system goes back to equilibrium through the method of a dynamic short term adjustment, which may be portrayed through an Error Correction Mechanism. However, this study used the two steps Engel and Granger Error Correction procedure to estimate the short and long term coefficients of the model.

5.3. Data Used

The study made use of secondary data, spanning from 1971 to 2016 and collected from the World Bank publications and African development indicators.

6. PRESENTATION OF THE FINDINGS

6.1. Test for Stationarity

Table-1. Augmented dickey fuller (ADF) unit root test of variables of interest.

Variable	Test statistic (Z)	1% Critical value	5% Critical value	10% Critical value	order of integration (I)
GDP	-3.583	-3.628	-2.950	-2.608	I(1)
	MacKinnon approximate p-value for Z(t) = 0.0061				
LOIL	-3.484	-3.668	-2.966	-2.616	I(1)
	MacKinnon approximate p-value for Z(t) = 0.0048				
HYRO	-4.583	-3.668	-2.966	-2.616	I(1)
	MacKinnon approximate p-value for Z(t) = 0.0001				
GCF	-3.624	-3.628	-2.950	-2.608	I(1)
	MacKinnon approximate p-value for Z(t) = 0.0079				
GGE	-4.599	-3.628	-2.950	-2.608	I(1)
	MacKinnon approximate p-value for Z(t) = 0.0001				

The null hypothesis for stationarity test states that the variable of interest is not stationary and the alternative holds that the variable is stationary. These hypotheses can be verified using either the critical value approach or the p-value approach (Mackinnon approximate p-value). For instance, taking LGDP, we can observe that the calculated Z statistic (-3.583) is greater than the 5% critical value (-2.950), rejecting the null hypothesis. The last column of Table 1 hosts the level of integration of each variable, indicating the level of stationarity as well. The variable, like lGDP, has the level of integration I(1) indicating that it has achieved stationarity at first difference. LOIL has the level of integration I(1) indicating that oil is stationary at first difference. More essentially, the Mackinnon approximate p-values are less than 5%, thus, we reject the null hypothesis of the presence of a unit root and conclude that the variable was generated by a stationary process.

6.2. Descriptive Statistics

Table 2 represents the descriptive statistics of the variables used in the paper. That is, their mean, maximum, minimum, and standard deviation.

Table-2. Descriptive statistics.

Variables	Obs	Mean	Std. Dev.	Min	Max
LGDP	46	23.5101	0.4396	22.5598	24.2801
LOIL	40	18.2222	1.0503	17.1828	20.9725
LHYRO	40	21.5819	0.4431	20.7682	22.1725
LGCF	46	22.0773	0.4946	21.121	22.9151
LGGE	46	21.1183	20.0248	20.0248	22.0914

Looking at the five variables under the study, we can observe that the mean of hydroelectric consumption, electricity produced from oil sources, gross capital formation and GDP are closest to their maximum values, indicating that they have improved over the time period under consideration.

6.3. Presentation of Regression Results

Worth recalling that the analyses were carried out using the Engle and Granger two stage estimation technique. In the first stage the long run estimations (with and without interactive variables) were conducted. The used of the interactive variable was intended to verify if there exists a complementarity effect between the use of renewable and non-renewable sources of energy. Complementarity effect implies that using the two simultaneously should increase economic growth. Thus, if this is the case then the sign of the interactive variable is expected to be positive. However, if it is negative, it means, an increase in the use of one energy source will result to a decrease proportionally to the other. In this case, the variables are competitive in demand even if not being perfect substitutes.

The results of the long run effects are presented in Table 3. Column one shows the result without the interactive term, while column two produces the modified results including the interactive variable.

Table-3. Long run regression results of the effects of energy used on economic growth.

Variables	Coefficient (Standard Error)	Coefficient (Standard Error)
LGCF	0.3226*** (0.0225)	0.2951*** (0.0227)
LOIL	0.0023 (0.0090)	1.8412*** (0.6451)
LHYRO	0.3725*** (0.0664)	1.8604*** (0.5254)
LGGE	0.2452*** (0.0727)	0.2765*** (0.0672)
INTERACTIVE (OIL*HYDRO)		-0.0834*** (0.0293)
Constant	3.0974*** (0.4030)	-29.7328* 11.5217
Number of observations	40	40
Goodness of fit test	F(4, 35) = 748.62 Prob > F = 0.0000	F(5, 34) = 722.49 Prob > F = 0.0000
R-squared	0.9884	0.9907
Adjusted R-squared	0.9871	0.9893

Note: *** = 1% level of significance, **= 5% level of significance, * = 10% level of significance.

The coefficient of electricity production from oil sources (proxy for non-renewable energy) is positive. This implies that an increase in electricity production from oil source will result to an increase in GDP. Specifically, a 1% increase in electricity production from oil sources will result to a 0.0023% increase in GDP. However, this result is insignificant. Thus, energy from non-renewable sources may not be very instrumental in improving economic growth. One key reason may be due to the low proportion of electricity supply from this source of energy.

The coefficient of hydroelectric production is positive. This means an increase in hydroelectric production will result to an improvement in GDP. Specifically, a 1% rise in hydroelectric production will result to a 0.373% increase in GDP. This result is significant at 1% level of significance. Thus, electricity supply from hydroelectric source is very important in enhancing economic growth in Cameroon. This result underlines the potent of renewable energy in boosting economic growth significantly in Cameroon.

The value of gross capital formation is positive. This means an increase in gross capital formation will result to an increase in GDP. Specifically, a 1% rise in gross capital formation will result to a 0.323% increase in GDP. With the introduction of the interactive variable, it is observed that gross capital formation is still significant.

Government general expenditure has a positive effect on GDP. This means an increase in government general expenditure will result to an increase in GDP. Specifically, a 1% increase in government general expenditure will result to a 0.245% increase in GDP. This result is significant at 1% level of significance.

The adjusted R-squared is 0.9907; this implies that 99% variation in GDP is explained by the independent variables in this model. The p-value of the F-statistics (0.0000) is less than 1%, this implies that the independent variables in the model are globally significant at 1% in underlying the dependent variable. Thus, the model has goodness of fit. Furthermore, it can be concluded that the results were reliable as the Breusch-Pagan test of heteroscedasticity reveals that the variance of the error term was constant over time, the VIF test show no multicolinearity among independent variables and Durbin-Watson d-statistic (DW)value is very close to 2 ($DW = 2\ when\ \alpha = 0\ for\ AR(1)$) indicating that there is no strong autocorrelation.

The result in column two has the interactive variable (renewable*non-renewable). The sign of the coefficients of the independent variables found in column one remain the same. It is however observed that the coefficient of electricity production from oil source becomes significant at the 1% level of significance. It is also observed that both the magnitudes of the coefficients of both energy sources have sharply improved.

Worthy of note, the interactive variable of the two energy sources, that is the joint effect of electricity production from oil sources and hydroelectricity, is negative. The result specifically shows that, when electricity production from oil sources interacts with electricity production from hydroelectricity, economic growth decreases by 0.083%. This result is significant at 1% level of significance. The main implication of the result is that, both energy sources are not complementing each other, that is the complementarity effect is absent. However, the two energy sources are competitive to each other, meaning that, the increase production and use of one can only be done at the detriment of the other.

From the long run results, the residual was predicted and tested for presence of stationarity so as to permit the estimation of the short run model, using first differences. The result of the test for stationarity is presented in Tables 4 and 5:

Table-4. Stationarity Test for Residual without Interactive Variable.

Augmented	Dickey-Fuller test for unit root		Number of observations =	38
	Interpolated Dickey-Fuller			
	Test	1% Critical	5% Critical	10% Critical
	Statistic	Value	Value	Value
Z(t)	-4.350	-3.662	-2.964	-2.614
MacKinnon	approximate p-value for Z(t) = 0.0004			

It is observed that the test for stationarity of the two residuals (that is, for the model with and without the interactive variable) is statistically significant at the 1% level of significance. Thus, there is a long run relationship. Hence, following the Engle and Granger Error Correction model, the short run estimation can be performed.

The short run results are presented on Table 6. The estimations for various specifications with and without the interactive variable are presented in different columns. Column one presents the basic model without interactive term, while column two and four presents the basic model with interactive term. Column three and four extend the basic model by incorporating the lags of the key independent variables (non-renewable and renewable energy). The interactive variable is included only in column four.

Table-5. Stationarity Test for Residual with Interactive Variable.

Augmented	Dickey-Fuller test for unit root		Number of obs =	38
	Interpolated Dickey-Fuller			
	Test	1% Critical	5% Critical	10% Critical
	Statistic	Value	Value	Value
Z(t)	-5.061	-3.662	-2.964	-2.614
MacKinnon	approximate p-value for Z(t) = 0.0000			

Table-6. Short run results following Engle and Granger.

D.LGDP	Coefficient Standard Error	Coefficient Standard Error	Coefficient Standard Error	Coefficient Standard Error
D.LGCF	0.2795*** (0.0373)	0.2612*** (0.0371)	0.2806*** (0.0370)	0.2597*** (0.0370)
D. LOIL	0.0035 (0.0195)	0.7534 (1.1519)	-0.0030 (0.0200)	0.0064 (0.0215)
D.LHYRO	0.2553*** (0.0866)	0.8611 (0.9599)	0.2595*** (0.0855)	0.2452*** (0.0858
D.LGGE	0.01695 (0.0720)	0.0620 (0.0747)	0.0040 (0.0721)	0.0518 (0.0745)
LD. LGDP	0.253** (0.0983)	0.2218*** (0.0998)	0.3130** (0.1056)	0.2895** (0.1063)
LD. LOIT			0.0138 (0.0201)	0.0104 (0.0230)
LD.LHYRO			-0.1287 (0.0924)	-0.1427 (0.0941)
D.INTERACTIVE		-0.0342 (0.0528)		-0.0001 (0.0002)
L.RES	-0.5056*** (0.1288)	-0.5640 (0.1426)	-0.5318 (0.1302)	-0.5939 (0.1492)
Constant	0.0083 (0.0070)	0.0076 (0.0070)	0.0104 (0.0073)	0.0650 (0.0927)
Number of observation	38	38	37	37
Goodness of fit test	F(6, 31) = 17.06 Prob. > F = 0.0000	F(7, 31) = 11.92 Prob. > F = 0.0000	F(8, 29) = 13.50 Prob. > F = 0.0000	F(10, 26) = 10.71 Prob. > F = 0.0000
R-squared	0.7676	0.7930	0.7884	0.8046
Adjusted R-squared	0.7226	0.7265	0.7300	0.7294

Note: *** = 1 percent level of significance; ** = 5 percent level of significance; * = 10 percent level of significance.

From the results, the coefficient of gross capital formation has a positive. This means a rise in gross capital formation will result to a rise in GDP. Specifically, a 1% rise in gross capital formation will result to a 0.28% rise in GDP. This result is significant at 1% level of significance.

The coefficient of electricity production from oil sources is positive. This indicates that an increase in electricity production from oil sources will result to an increase in GDP. Specifically, a 1% increase in electricity production from oil sources will result to a 0.0035% increase in GDP. However, this result is not statistically significant.

The coefficient of hydroelectricity production is positive. This indicates that an increase in hydroelectric production will result to an increase in GDP. Specifically, a 1% increase in hydroelectricity production will result to a 0.255% increase in GDP. This result is significant at the 1% level of significance.

Government general expenditure has a positive relationship with GDP as the coefficient is positive. This implies an increase in government general expenditure will result to an increase in GDP. Specifically, a 1% increase in government general expenditure will result to a 0.017% increase in GDP. This result is not statistically significant.

The lag residual which shows the speed of adjustment is negative as expected and significant at the 1% level of significance. The result of the lag residual precisely shows that any shock in the system is adjusted at the rate of about 50 to 60 percent per year.

Other results from column one show that the short run adjusted R-squared is 0.793; this implies that 79% variation in GDP is explained by the independent variables in this model. The independent variables explain greater variation in the GDP in the long run than in the short run. The p-value of the F-statistics (0.0000) is less than 1%, this implies the independent variables in the model are globally significant at 1% level of significance. Furthermore, it can be concluded that the results were reliable as the Breusch-Pagan test of heteroscedasticity reveals that the variance of the error term was constant over time, the VIF test show no multicolinearity among independent variables and Durbin-Watson d-statistic (DW)value is very close to 2 ($DW = 2 \; when \; \alpha = 0 \; for \; AR(1)$) indicating that there is no strong autocorrelation since is closer to 2.

With the introduction of the interactive variable in column two it is observed that the signs of the other variables remain the same, though there are changes in the magnitude. It is also noted the effect of electricity supply from hydroelectric sources though still positive is now statistically insignificant at the 10% level of significance.

The interactive variable is negative indicating that in the short run the complementarity effect is also absent as was the case in the long run. This means that the two energy sources are competitive, that is, one can only be increase at the expense of the other. This effect is statistically insignificant at the 10 percent level of significance.

Column three and four introduce additional lag variables of the key independent variables. The sign of the variables remains the same though there are changes in the magnitude of the different variables. The key difference in the result in column three and four is that the short run result for hydroelectricity is statistically significant. Thus, hydroelectricity is a major source of energy that influences economic growth.

This finding is in accordance with the endogenous growth theory which forms a major theoretical base of this research. The results of this research are also in line with the findings of other researchers such as: Molem and Ndifor (2016) who investigated the effects of energy consumption on economic growth in Cameroon, Dantama et al. (2012) who examined the impact of energy consumption on economic process in Nigeria and Odularu and Okonkwo (2009) who examined the relationship between energy consumption and economic growth in Nigerian.

7. CONCLUSION AND POLICY IMPLICATIONS

Since the potentials of any economy to spur economic growth and development largely depend on energy consumption, this paper attempted to provide theoretical and empirical evidence by investigating the implications of renewable and non-renewable energy consumption for economic growth in Cameroon. In particular, used was made of time series data spanning the period 1971 - 2016 and an error correction model to investigate the long- and short-run effects of renewable and non-renewable energy utilization on economic growth in Cameroon.

We found a long-run relationship between gross domestic product, renewable energy consumption, non-renewable energy consumption, gross capital formation and government expenditure. We also found that with the exception of non-renewable energy, these variables register positive and significant long-run effects on economic growth. Interacting the two energy sources, we observed a substitution-effect between renewable and non-renewable energy utilization that enhanced the direct effect of each energy source on economic growth. The indication was that renewable energy is a major driver of economic growth in both the short- and long-run in

Cameroon. These findings suggest that increasing the exploitation and use of renewable energy sources would boost the effects of all energy sources on overall prosperity in a developing country setting.

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