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# ENERGY CONSUMPTION GOVERNMENT SPENDING ENERGY PRICE ON GROWTH IN GHANA: NONLINEAR ARDL APPROACH

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## ABSTRACT

This study employs a nonlinear autoregressive distributive lag model (NARDL) approach to investigate the asymmetric causality among energy consumption, government spending, energy price, and growth as well as long and short-run relationship. Time series data from 1980-2017 for Ghana sourced from world bank were employ. Unit root test based on ADF and PP and Zivot and Andrew establish the variables have mixed order of integration I(0) and I(1). The bound test determines the presence of cointegration. The positive shock of energy on growth is 1.25%, and negative shock is 0.34% in the long run. The short-run positive and adverse shocks are 0.61% and 0.17%, respectively. The outcome implies that positive shock impacted more on the growth than negative shock. The positive asymmetric causality supported the conservation hypothesis while the negative asymmetric causality backed feedback hypothesis. It highlighted the fact that no single package will solve the energy poverty in Ghana, but rather a highbred and dynamic approach is required. The policy implications are informed.

**Keywords:** Energy consumption, government spending, energy price, growth, asymmetric.

JEL classification: O40, O55, Q41, Q42, Q43

## 1. INTRODUCTION

The world economy depends primarily on energy consumption and has long been a question of great concern in a wide range of fields, even though no single sources of energy is sufficient to meet the need of economic growth. The developed nations combined different sources of energy from renewable to nonrenewable to cater for economic activities. Some studies construe energy as a fundamental source of economic growth and serve as an integral part of other factor inputs (see, for instance, Jamil and Ahmad, 2010; Ajlouni, 2015; Shahbaz *et al*., 2017; Emir and Bekun, 2019). Energy use has experienced unprecedented growth over the past 50 years, due to population explosion, advancement in technology, and industrial expansions. Developing countries and specifically, Ghana's economy struggle to sustain economic growth with impending energy poverty. Not only that, one of the action plans of Ghana is to achieve

  

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sustainable development goals of 2030. The discussion of this subject matter occurs at the material time when Ghanian economy is facing rising energy demand in analogous with a considerable energy scarcity (Appiah, 2018). Importantly, energy plays a vital role in current economic fortune in Ghana. The studies conducted in the recent past show how energy demand exceeds energy supply in Ghana (see, Gyam *et al*. 2018; Ghana Energy Commission (GEC) 2014; Asumadu *et al*. 2019).

In the past, many empirical studies steered on the energy growth nexus are (Kraft and Kraft 1978; Apergis and Payne 2010; Magazzino 2015; Shahbaz *et al*. 2017; Adams *et al*. 2018; Shahbaz *et al*. 2018; Emir & Bekun 2019). However, studies on energy and growth linkage found very intricate due to the possibility of four impact hypothesis, explicitly (Asumadu *et al*. 2019; Sarkodie and Adom 2018; Adams *et al*. 2018; Inglesi-Lotz and Pouris 2016) namely: neutrality, feedback, conservation and growth hypothesis. When unidirectional causal effect running from energy to growth occurs, growth hypothesis is supported. Secondly, the growth that triggers a one-directional causal impact on energy use backed conservation hypothesis. Thirdly, if there is mutual causal effect between energy and growth feedback hypothesis is supported. Finally, the neutrality hypothesis maintains that there is no causality between energy and growth. Energy use has been reported as the driving determinant of economic growth in many empirical work. Conversely, energy consumption produces a threat to environment in the form of greenhouse carbon emission ($CO_2$) which contributes to global warming. The studies that found the negative consequence of energy consumption on carbon emission (see, Appiah 2018; Behera and Dash 2017; Tang and Tan 2015).

Besides, previous empirical studies come up with different results, especially concerning their estimation techniques used, time-series data employed as well as model specifications, and these findings may not be appropriate to adopt in Ghana because of diverse economic situation. Likewise, most of the recommendations in the past provides by researches have primarily focused on one direction. That is if there is an increase in regressors, and the regressed will change. What if there is negative shock? What measures should be appropriate? The noble idea in this study is to unpack positive and negative shocks causality among energy consumption, government spending, energy price, and growth by applying nonlinear autoregressive distributive lag (NARDL) approach because to our knowledge preceding studies on energy and growth in Ghana rarely take into cognizance positive and negative shocks on energy against growth. The failure of considering current peculiarities will impair the impact of policies proposed by policymakers and government macroeconomic policies in energy-dependent economy like Ghana. Equally, the study will look into the long and short-run positive and negative shocks.

  

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The remaining part of the study is planned as follows, Section 2 empirical evidence of causal relationships. Section 3 methodology and data description while Section 4 deals with the empirical finding, and Section 5 concludes the study.

## 2. EMPIRICAL EVIDENCE

The standing literature on energy economics that link energy-growth nexus establishes indefinite empirical evidence. For instance, Kraft and Kraft (1978) for the US examined the link between energy consumption and gross domestic products (GNP) and testified that energy consumption is a cause of GNP. Menyah and Wolde-Rufael (2010) for South Africa investigate the interrelationship amongst energy consumption and economic growth deploying data from 1965-2006. They reported that energy consumption accelerates growth, confirming growth hypothesis. Similarly, Sasana and Ghozali (2017) employed a fixed-effect model to study the effect of energy consumption on economic growth in BRICS countries and reported that energy use escalates the growth rate of the economy.

Shahbaz *et al*. (2013) used data from 1971-2011 and employed the ARDL approach found energy consumption to have a positive impact on growth in China. Elfaki, Poernomo, Anwar, and Ahmad (2018) applied the ARDL procedure and found unidirectional causality on energy growth nexus in Sudan. Appiah (2018) reported unidirectional causality from energy and growth in Ghana from 1960-2015 by adopting ARDL.

However, Akarca and Long (1980) examined the relationship between energy and GNP reported unbiased causality amongst energy and growth. Yu and Hwang (1984) revealed an autonomous relation between energy and growth. Similarly, studies conducted that reported neutrality among energy and growth (see, Akinlo, 2009, in Nigeria; Esso, 2010, in Nigeria, South Africa, Kenya, and Cameroon; Chiou-Wei *et al*., 2012, in China). Zerbo (2017) established the neutrality hypothesis in Congo, Ghana, Togo, Benin, Cote d'Ivoire, and South Africa from 1971 to 2013. Payne (2009) examined the linkage between aggregate energy and growth and identified that neither energy nor growth stimulates each other by adopting Toda Yamamoto causality test.

In contrast, Shahbaz *et al*. (2018) used a quantile-on-quantile approach to study energy on growth on major energy-consuming economies; they informed that growth led to energy use in China, India, Germany, and France, among others. This finding supported the conservation hypothesis. Besides, Jacques (2010) explored the linkage between energy and growth for seven selected African state by employing panel data from 1970-2007 and established that growth positively influence energy, thereby reinforcing the conservation hypothesis. The study conducted by Gökmenoğlu and Taspinar (2016) reported that economic growth accelerate the use of energy consumption in Turkey. Likewise, the study of Çetintaş (2016) in 17 countries revealed that economic growth causes more energy use.

  

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Inversely, Shakouri and Yazdi (2017) conducted a study in South Africa to find out the pivotal connection between renewable energy, trade openness on growth, the result shown significantly that energy and growth influenced each other. The empirical outcome indicates a resilient evidence of feedback effect between renewable energy and growth guides that renewable energy consumption is crucial for growth as well as economic growth boosts the use of renewable energy. Menegaki and Tugcu (2017) recognizes two-way causality between aggregate energy and growth in G7 economies.

Jamel and Charfeddine (2016) reported a bidirectional linkage among energy and growth for a panel of 8 Asian economies from 1991-2013; they employed VECM approach. Apergis and Payne (2014) conducted studies in Central America that involve Costa Rica, Guatemala, Nicaragua, El Salvador, Honduras, and Panama. They found a bidirectional link among nonrenewable electricity use and growth in both short and long run by the used of VECM. Ilhan and Acaravci (2010) investigate the causal connection between energy and growth for Albania, Hungary, and Romania for 1980-2006 reported bidirectional causality only in Hungary using ARDL approach.

More so, Karan and Li (2015) probed energy growth nexus for 160 countries for the year 1980-2010 and reported that in the long run, energy consumption and growth cointegrated, and dynamic feedback exists between the two variables. Peng and Sun obtained a similar result, posited a bidirectional causalities exist between GDP and energy use in the short and long run in China. Faisal *et al*. (2016) revisited the energy-growth nexus over the period from 1990-2011 the case of Russia. After establishing cointegration between the variables, the outcome shown feedback effect between energy and growth.

## 3. METHODOLOGY

### *3.1 Data*

The study employed twelve-monthly time-series data for 1980-2017. The variables used are economic growth (*GDP*) proxy by real GDP per capita calculated in constant of 2005 USD, energy consumption (*ECOI*) proxy by kg of oil equivalent per capita, government expenditure (*GEX*) is measured by real total spending total USD 2005, energy price (*PRI*) is proxy-based on consumer price index (2010=100), household expenditure (*HHE*) is proxy by final household consumption expenditure current of USD. These data sourced from the World Bank World Development indicator database (World Bank, 2018). Logarithmic process applied to all variables under consideration. The studies that used these variables in the recent past (see, Asumadu *et al*. 2019; Shahbaz *et al*. 2018; Toumi and Toumi 2019; Jami and Ahmad 2010; Mottaleb *et al*. 2017; Yong, 2002).

  

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### *3.2 Model specification*

The study aims to examine the asymmetric short and long-run effects of energy consumption on growth as well as asymmetric causality relation amongst *GDP*, *ECOI*, *GEX*, and *PRI* in Ghana by using NARDL model developed by (Shin *et al*. 2014). The model of the study formulated as follows

$$LGDP_t = \beta_{0t} + \beta_1 LECOI_t + \beta_2 LGEX_t + \beta_3 LPRI_t + \beta_4 LHHE_t + \varepsilon_t \qquad [1]$$

where $\beta_1$ ... $\beta_4$, stands as the coefficients of the independent variables of the time series while $\beta_{0t}$, $\varepsilon_t$ represent intercept and stochastic error term, respectively. The extension of Equation [1] to reflect the asymmetric model ($p$, $q$) shown below:

$$\Delta GDP_t = \beta_0 + \sum_{k=1}^{p} \beta_1 \, \Delta GDP_{t-k} + \sum_{k=0}^{q_1} \beta_2^* \, \Delta ECOI_{t-k}^* + \sum_{k=0}^{q_2} \beta_3 \, \Delta GEX_{t-1} + \sum_{k=0}^{q_3} \beta_4 \, \Delta PRI_{t-1} + \sum_{k=0}^{q_4} \beta_5 \, \Delta HHE_{t-k} + \beta_6 GDP_{t-k} + \beta_7^* ECOI_{t-1}^* + \beta_9 GEX_{t-1} + \beta_{10} PRI_{t-1} + \beta_{11} HHE_{t-1} + \varepsilon_t \qquad [2]$$

the $GDP_t$ is a k × 1 vector of multiple regressors described as $\beta_7^* ECOI_{t-1}^* = \beta_7^+ ECOI_{t-1}^+ + \beta_7^- ECOI_{t-1}^-$ is the autoregressive parameter, $\beta_j^+$ and $\beta_j^-$ represents the asymmetric distributed lag parameters. The $t$ = 1980 – 2017; $j$ = 1, …, $q$-1; Δ is the first operator, and the indicator (+) and (-) in the model means positive and negative shocks for the variables. *P* and *Q* justify the order for regressed and regressors, respectively. The Model 2 to test the asymmetric long-run cointegration is verified by equating the equality of the coefficient of positive and negative constraint in the variables $\beta_j^+ = \beta_j^-$ by using the Wald test. Thus, the long run asymmetry cointegration between variables $Z_t$ and $W_t$ necessitates the two variables should be integrated of the same order I(1). The asymmetric cointegration among the variables symbolises the following integration in Equation [3].

$$W_t = \beta^+ z_t^+ + \beta^- z_t^- + \varepsilon_t \qquad [3]$$

hence $z^+$ and $z^-$ implies the effects of positive and negative shocks in the selected variables, respectively.

Furthermore, the idea of categorising data into cumulative positive and negative begins in the work of Granger and Yoon (2002). The aggregate shocks of the function positive and negative in gross domestic products (*GDP*), energy consumption (*ECOI*), government expenditure (*GEX*),

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consumer price (*PRI*) and household consumption expenditure (*HHE*) are separately design as follows:

$$GDP^{+} = \sum_{j=1}^{t} \Delta\, GDP_j^{+} = \sum_{j=1}^{t} \max\left(\Delta GDP_j, 0\right);\ GDP^{-} = \sum_{j=1}^{t} \Delta GDP_j^{-} = \sum_{j=1}^{t} \min\left(\Delta GDP_j, 0\right) \qquad [4]$$

$$ECOI^{+} = \sum_{j=1}^{t} \Delta\, ECOI_j^{+} = \sum_{j=1}^{t} \max\left(\Delta ECOI_j, 0\right);\ ECOI^{-} = \sum_{j=1}^{t} \Delta ECOI_j^{-} = \sum_{j=1}^{t} \min\left(\Delta ECOI_j, 0\right) \qquad [5]$$

$$GEX^{+} = \sum_{j=1}^{t} \Delta\, GEX_j^{+} = \sum_{j=1}^{t} \max\left(\Delta GEX_j, 0\right);\ GEX^{-} = \sum_{j=1}^{t} \Delta GEX_j^{-} = \sum_{j=1}^{t} \min\left(\Delta GEX_j, 0\right) \qquad [6]$$

$$PRI^{+} = \sum_{j=1}^{t} \Delta\, PRI_j^{+} = \sum_{j=1}^{t} \max\left(\Delta PRI_j, 0\right);\ PRI^{-} = \sum_{j=1}^{t} \Delta PRI_j^{-} = \sum_{j=1}^{t} \min\left(\Delta PRI_j, 0\right) \qquad [7]$$

the long run asymmetry in the model is tested by $H_0\ : \rho = \beta_1^{+} = \beta_1^{-} = \beta_2^{+} = \beta_2^{-} = 0$ against the alternative hypothesis $H_1\ : \rho \neq \beta_1^{+} \neq \beta_1^{-} \neq \beta_2^{+} \neq \beta_2^{-} \neq 0$ Pesaran *et al.* (2001).

### *3.3 Unit root test*

This study employs the unit root procedure developed by Augmented Dickey-Fuller (ADF) and Phillips and Perron (1988) (PP) tests. Further, we expect the presence of break in the series, the application of unit root test with structural break developed by Zivot and Andrews (2002) is considered helpful to analyse the effects of break within the period of the study. However, if the integration orders of the variable under consideration evaluated, the best model is selected. The

  

ADF test that improved from an earlier version known has as DF test. Assume, for instance, a first-order autoregressive process of y:

$$Y_t = \propto_1 Y_{t-1} + \varepsilon_t \qquad [8]$$

where Y is the estimated coefficient, $\propto_1$ implies parameter and $\varepsilon_t$ stand for white noise error term. Y assume series is stationary in the absence of unit root. Describe the features of unit root procedures: $\propto_1 < 0 (\text{or } \rho < 1)$ and non-stationary if $\propto_1 = 1$ by subtracting from $Y_{t-1}$ from Equation [8], the necessary test is carried out by:

$$\Delta Y_t = \rho Y_{t-1} + \varepsilon_t \qquad [9]$$

$$Y_t = \propto_1 Y_{t-1} + \varepsilon_t \qquad [10]$$

$$Y_t - Y_{t-1} = \propto_1 Y_{t-1} - Y_{t-1} + \varepsilon_t \qquad [11]$$

$$\Delta Y_\epsilon = (\propto_1 - 1) Y_{t-1} + \varepsilon_t \qquad [12]$$

where, Δ represent difference operator, and the test comprises null hypothesis is $H_0$: ρ=0.

## 4. EMPIRICAL RESULT

### *4.1 Descriptive analysis*

Table 1 represents the descriptive statistic of Ghana, the average values of all variables are higher than their corresponding standard deviation but with the exception of energy price with an average of 2.30 and standard deviation of 2.34, respectively. The result shows that the variables are normally distributed. In addition, all the variables have a standard deviation of less than one which indicates less volatility over time. The variables gross domestic products, government expenditure, household consumption expenditure are positively skewness, while energy consumption and energy price are negatively trend, respectively. Table 2 indicates the correlation matrix between gross domestic products and energy consumption is negative -54% and statistically significant at 1 per cent. However, the correlation between growth and government spending, energy price as well as household expenditure are 95%, 94%, and 92% at 1 per cent level of significance, respectively. It implies that the relationship between the variables is strong.

  

**Table 1: Summary statistic**

| | *GDP* | *ECOI* | *GEX* | *PRI* | *HHE* |
|---|---|---|---|---|---|
| Mean | 23.6437 | 5.8125 | 20.7485 | 2.3008 | 22.8778 |
| Median | 23.5753 | 5.8213 | 20.5093 | 2.7669 | 22.4320 |
| Maximum | 24.6802 | 6.0298 | 22.4199 | 5.4478 | 24.4926 |
| Minimum | 22.8449 | 5.5952 | 19.2869 | -2.8058 | 22.0107 |
| Std. Dev. | 0.55337 | 0.1247 | 0.8900 | 2.3427 | 0.8899 |
| Skewness | 0.3523 | -0.1532 | 0.4672 | -0.4794 | 0.7399 |
| Kurtosis | 1.9522 | 1.8898 | 2.0817 | 2.0756 | 1.8021 |
| Jarque-Bera | 2.5242 | 2.1001 | 2.7174 | 2.8087 | 5.7393 |
| Probability | 0.2830 | 0.3499 | 0.2569 | 0.2455 | 0.0567 |
| Sum | 898.4617 | 220.8783 | 788.4458 | 87.4329 | 869.3585 |
| Sum Sq. Dev. | 11.3301 | 0.5757 | 29.3103 | 203.0679 | 29.3028 |
| Observations | 38 | 38 | 38 | 38 | 38 |

**Table 2: Pearson correlation estimates**

| Variables | *GDP* | *ECOI* | *GEX* | *PRI* | *HHE* |
|---|---|---|---|---|---|
| *GDP* | 1.0000 | | | | |
| | ----- | | | | |
| *ECOI* | -0.5435*** | 1.0000 | | | |
| | 0.0004 | ----- | | | |
| *GEX* | 0.9475*** | -0.4821*** | 1.0000 | | |
| | 0.0000 | 0.0022 | ----- | | |
| *PRI* | 0.9435*** | -0.5479*** | 0.8579*** | 1.0000 | |
| | 0.0000 | 0.0004 | 0.0000 | ----- | |
| *HHE* | 0.9204*** | -0.5610*** | 0.9593*** | 0.8172*** | 1.0000 |
| | 0.0000 | 0.0002 | 0.0000 | 0.0000 | ----- |

Note: *** represent 1% level of significance.

### *4.2 Unit root test*

The stationarity test conducted based on ADF and PP reports in Table 3, which exhibit the variables integrated of mixed order I(0) and I(1) at 1% and 5% level of significance, respectively. Hence, Perron (1989) state that there is a close association between unit root and structural breaks, because the traditional unit root test is subjected to "biased towards false unit root null when the data are trend stationary with a structural break." However, this research uses Vogelsang and Perron (1998) and Zivot and Andrews (2002) unit root with structural breaks.

Table 4 discloses the test of stationary based on structural break dates, and the simulation divulges mixed order of integration in accord with ADF and PP unit root tests in Table 3. The break dates in the variables reflect the sequence of information that required to be examined,

  

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such as the gradual changes in government policies as well as changes in the global commodity market overtime. Energy consumption experienced a break-in 2009 this relate to the subsidy in the sector and vague macroeconomic policies and poor economic state, and led the economy into huge indebted poor country in 2011. It reported that the Ghana public debt at the end of 2009 was considerable to USD9,304 million, equivalent to 37% of GDP. It further escalates to USD14,625 million, equal to 39% of GDP at the end of 2011. The conditions of the economy compelled household and industrial energy consumption expenditure to decline due to rise in electricity tariffs and prices of petroleum products while the take-home income remained stagnant energy sector management assistance program (ESMAP, 2006; Asumadu et al., 2019).

Further, economic growth indicated breakpoint in 2013, because, in 2013, Ghana's economic growth rate was dropped by 5.4%, against the target of 8.8% global economic performance (GEP, 2014). Likewise, government expenditure exhibit breakpoint in 2015, is due to debt servicing. Ghanian government spending is overburden with external debt and servicing of the debt (Obeng, 2017; IMF, 2015; Lucy et al. 2016).

Table 5 reported the long-run equilibrium and Akaike information criteria (AIC) is deploy. The cointegration test indicates the existence of long-run relationship amongst the variables under consideration. The F-statistic value of the models is above the critical value at 1% and 5% level of significance. However, established the basis for computing long and short-run relationship.

**Table 3: Unit root results**

| | ADF | | | | PP | | | |
|---|---|---|---|---|---|---|---|---|
| | Level | | First difference | | Leve | | First difference | |
| Variable | Intercept | Intercept + Trend | Intercept | Intercept + Trend | Intercept | Intercept + Trend | Intercept | Intercept + Trend |
| *LGDP* | 3.08 | -2.45 | -3.44** | -3.79** | 3.08 | -3.10 | -3.26** | -3.57** |
| *LECOI* | -1.29 | -2.05 | -5.17*** | -5.10*** | -1.46 | -2.00 | -5.18*** | -5.11*** |
| *LGEX* | -0.14 | -2.60 | -4.97*** | -4.92** | 0.07 | -2.75 | -5.30*** | -5.33*** |
| *LPRI* | -3.58** | -1.77 | -5.08*** | -7.09*** | -5.12*** | -3.17 | -5.70*** | -10.81*** |
| *LHHE* | 0.23 | -1.60 | -5.08*** | -5.13** | 0.23 | -1.60 | -5.08*** | -5.14** |

Note: ***, ** represent 1% and 5% level of significant.

  

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**Table 4: Break point unit root tests**

| Variables | ZA | *p*-value | Lag | Break date | Critical value (1%) | (5%) |
|---|---|---|---|---|---|---|
| Level | | | | | | |
| *LGDP* | 0.1440 | >0.99 | 4 | 2008 | -4.9991 | -4.4436 |
| *LECOI* | -3.7489 | 0.2589 | 0 | 2000 | -4.9991 | -4.4436 |
| *LGEX* | -2.6424 | 0.8534 | 0 | 2003 | -4.9991 | -4.4436 |
| *LPRI* | -6.1253 | <0.01 | 4 | 1995 | -4.9991 | -4.4436 |
| *LHHE* | -4.8254 | 0.0165 | 0 | 2006 | -4.9991 | -4.4436 |
| First difference | | | | | | |
| *LGDP* | -8.7443 | <0.01 | 2 | 2013 | -4.9991 | -4.4436 |
| *LECOI* | -5.3371 | <0.01 | 0 | 2013 | -4.9991 | -4.4436 |
| *LGEX* | -6.1107 | <0.01 | 0 | 2015 | -4.9991 | -4.4436 |
| *LPRI* | -7.6904 | <0.01 | 2 | 2004 | -4.9991 | -4.4436 |
| *LHHE* | -6.2916 | <0.01 | 0 | 2007 | -4.9991 | -4.4436 |

Note: ADF test statistics present in the above table. Lag is based on system selection using *F*-test. The simulation is built on-trend and intercept selection. Determination for break date only applies to the intercept model, and the break type selected is innovation outlier.

However, Table 6 shows the estimated coefficients of both the long and short run. The long-run results explain that the negative shock by one per cent in *LECOI* will improve the *LGDP* by 1.25 per cent in the same direction and statistically significance at 1 per cent. This finding is similar to the results of Nyasha *et al*. (2018) for Ethiopia, Shahbaz *et al*. (2018) for Europe, Mutascu (2016) for G7 countries, and Bloch *et al*. (2015) for China. Conversely, the negative shock in *LECOI* on economic growth experiences a decrease of 0.34 per cent compared with positive shock at 1 per cent level of significance, and the finding is in line with the study conducted by Toumi and Toumi (2019) for Kingdom of Saudi Arabia. Confirm the asymmetric behaviour of energy on growth and implies the economy depends on energy importation as the primary source of growth.

The positive shock coefficient of 0.61. It means that a positive shock on *LECOI* enhances the *LGDP* by 0.61 per cent, and establishes the fact that energy consumption is one of the major drivers of economic growth in the short run. The result is accord with the studies of Toumi and Toumi (2019) for Saudi Arabia, Apergis and Tang (2013) for selected African countries and Yildirim *et al*. (2014) for ASEAN countries. Unlike the positive shock, the negative shock coefficient of -0.17 per cent explains that the negative shock on *LECOI* adversely reduces

  

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growth by 0.17 per cent at 1 per cent level of significance. The finding is in line with the studies made by Shahbaz *et al*. (2018) for ten energy-consuming countries and Kassi *et al*. (2019) for sub-Saharan African countries. The reported error correction term $ECT_{t-1}$ is -0.48, a weak adjustment parameter, and statistically significance at 1 per cent. The coefficient of $ECT_{t-1}$ implies that if the economy is at disequilibrium overtime can adjust itself to the correct position by the speed of adjustment of 0.48 per cent within one year. Finally, Ghana, as one of the oil exporting and energy consumer, clearly indicate how positive and negative shocks affect the economy. Asumadu *et al*. (2019), in a study conducted, confirmed the asymmetric behaviour of energy consumption towards economic growth.

**Table 5: Bound cointegration test**

| Dependent variable | *F*-Statistic | Lag | Critical Values Sig. Level | I(0) | I(1) |
|---|---|---|---|---|---|
| Gross domestic products | 9.592*** | 7 | 1% | 3.31 | 4.10 |
| Energy consumption | 5.174*** | 7 | 5% | 2.69 | 3.83 |
| Government expenditure | 4.842** | 7 | 10% | 2.38 | 3.45 |
| Energy price | 8.221** | 7 | | | |
| Household consumption expenditure | 4.619*** | 7 | | | |

Note: *** and** signify significance at 1% and 5% levels, respectively.

Table 7 exhibit the results of asymmetric causality. By examine the asymmetric causality direction amongst *LGDP*, *LECOI*, *LGEX*, and *LPRI*, and the study employs the Wald test to confirm the asymmetric relation. Besides, the causality of the positive and negative elements of energy consumption ($LECOI^{+}$, $LECO^{-}$) to *LGDP*, the asymmetric positive shock is unidirectional from *LGDP* to *LECOI***.** The finding confirmed the conservation hypothesis, where energy conservation policies suggested without impairing the economic growth. The result is in line with the studies of  Gorus and Aydin (2019) for MENA countries, Nyasha *et al*. (2018) for Ethiopia and Kayicki and Bildirici (2015) for GCC and MENA countries. Conversely, the negative shock of *LECOI* to *LGDP* is bidirectional causality. However, it implies that there is mutual dependence between energy and growth. The result is similar to the research showed by Toumi and Toumi (2019), Bildirici and Gökmenoğlu (2017) for G7 and Rafindadi (2016) for Nigeria.

  

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**Table 6: NARDL estimation result dependent variable: Gross domestic products**

| Variable | Coefficient | *t*-Statistic | Probability |
|---|---|---|---|
| Long-run | | | |
| $LECOI^{+}$ | 1.255*** | 7.870 | 0.000 |
| *LECOI-* | -0.347*** | -5.936 | 0.000 |
| *LGEX* | 0.126*** | 5.202 | 0.000 |
| *LPRI* | 0.032*** | 2.920 | 0.009 |
| *LHHE* | 0.045** | 2.449 | 0.024 |
| C | 9.536*** | 58.091 | 0.000 |
| Short-run | | | |
| $\Delta(LECOI^{+})$ | 0.615*** | 7.565 | 0.000 |
| $\Delta\ (LECOI^{-})$ | -0.170*** | -5.813 | 0.000 |
| Δ *(LGEX)* | 0.076*** | 7.215 | 0.000 |
| Δ *(LPRI)* | 0.000 | 0.041 | 0.967 |
| Δ *(LPRI (-1))* | 0.075*** | 4.974 | 0.000 |
| Δ *(LHHE)* | -0.010 | -0.768 | 0.452 |
| Δ *(LHHE (-1))* | -0.035** | -2.720 | 0.014 |
| $ECT_{t-1}$ | -0.489*** | -9.506 | 0.000 |

Note: Δ represents difference operator, and (+, -) signify the positive and negative shocks while, ***, ** denote 1% and 5% level of significance, respectively.

The appropriateness of the prescribed model is further certified through a diagnostic test to ensure the estimated results are free from bias inference. More importantly, Table 8 established that the null hypothesis of no serial correlation, homoscedasticity, and normality of the distribution of the residuals should not be rejected. The Durbin Watson (DW) test is 2.218 re-established the absence of autocorrelation. Ramsey reset test result of the functional form indicates that is well designed. It is noted that *LECOI*, *LGEX*, *LPRI,* and *LHHE* explained 99 per cent ($R^2$ =0.99) of the economic growth model while 1 per cent deviation explain by error term. Further, earlier in the study, structural break in the series were established, and Figure 1 reaffirm the breakpoint by CUSUMQ. Taking the breakpoint into consideration the CUSUM and the CUSUMQ are stable in the model for proper policymaking.

  

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**Table 7: Asymmetric causality results**

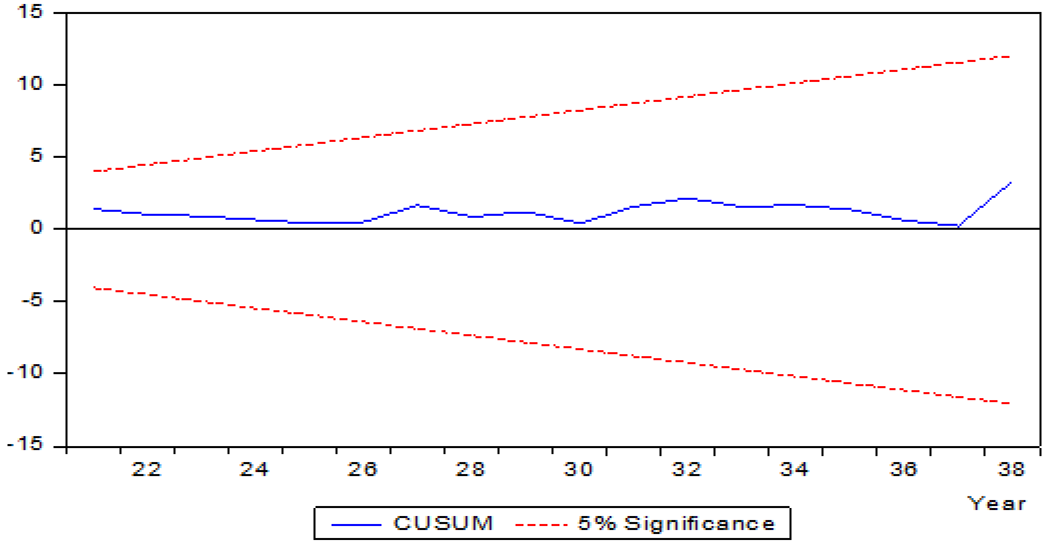
| Causality | F-Statistics | Probability | Decision |
|---|---|---|---|
| $ECOI^+ \neq> GDP$ | 1.10440 | 0.3445 | Unidirectional |
| $GDP \neq> ECOI^+$ | 11.1405 | 0.0002*** | Causality |
| $ECOI^- \neq> GDP$ | 4.27923 | 0.0232** | Bidirectional |
| $GDP \neq> ECOI^-$ | 7.28764 | 0.0026** | Causality |
| $GEX \neq> GDP$ | 0.97567 | 0.3882 | Unidirectional |
| $GDP \neq> GEX$ | 3.60303 | 0.0392** | Causality |
| $PRI \neq> GDP$ | 2.28102 | 0.1191 | Unidirectional |
| $GDP \neq> PRI$ | 8.87645 | 0.0009*** | Causality |
| $HHE \neq> GDP$ | 0.31809 | 0.7299 | Zero |
| $GDP \neq> HHE$ | 1.63875 | 0.2106 | Causality |
| $ECOI^+ \neq> ECOI^-$ | 2.09930 | 0.1402 | Zero |
| $ECOI^+ \neq> ECOI^-$ | 1.84645 | 0.1753 | Causality |

Note: ***, ** represent 1% and 5% significance level, respectively. A $\neq>$B means variable A does not cause variable. (+, -) stands for positive and negative causality.

**Table 8: NARDL diagnostic test results**

| Detail | *F*-Statistic | Probability |
|---|---|---|
| Normality | 0.353 | 0.837 |
| Serial Correlation | 1.532 | 0.246 |
| Heteroscedasticity | 0.661 | 0.800 |
| Ramsey | 0.859 | 0.366 |
| Durbin Watson | 2.218 | |
| Adj. $R^2$ | 0.999 | |
| $R^2$ | 0.999 | |



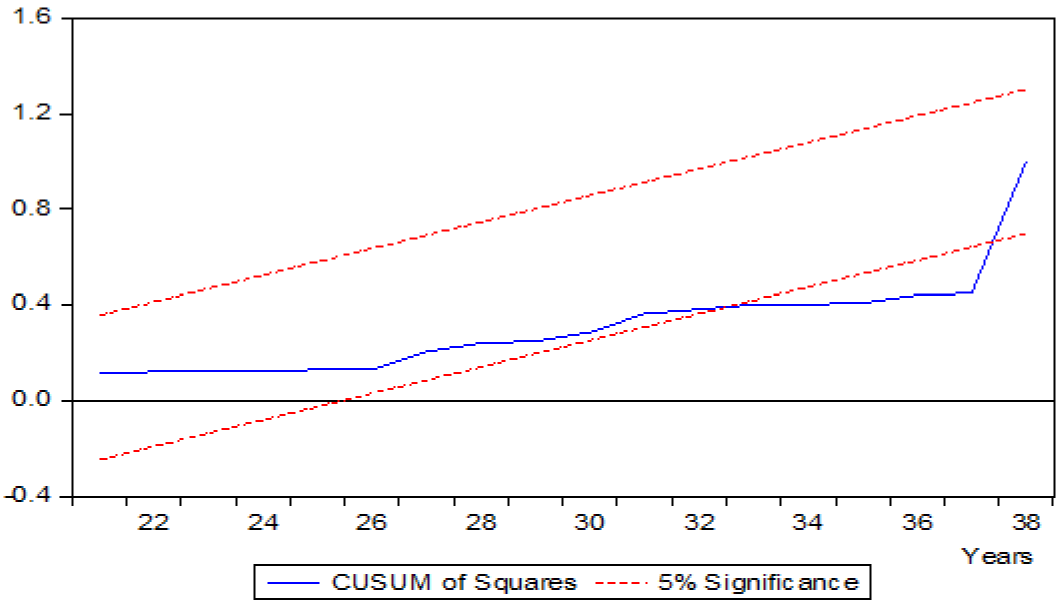




**Figure 1: CUSUM and CUSUMQ test with 95% confidence intervals**

## 5. CONCLUSION

This study scrutinised the asymmetric causality amongst energy consumption, government spending, energy price, and growth by applying NARDL approach and as thoroughly analysed the short and long-run positive and negative shocks of energy consumption on economic growth in Ghana. Time series data sourced from world bank from 1980-2017. Using ADF and PP for the unit root test conducted considered structural break, and without break regime, all the results

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indicate the variables are integrated in mixed order I(0) and I(1). However, breakpoint establishes in the series, and the model estimation takes into consideration the breakpoint.

The bound test shows that the variables are cointegrated. The long-run positive energy consumption shock of 1.25 per cent implies the escalating effect of energy towards growth. While the negative shock of energy use identifies a diminishing impact on growth by 0.34 per cent, thereby confirm the asymmetric relation among the variables. Government spending, in the long run, influence the growth of the economy by 0.12 per cent, indicating the vital role of government share in the growth of the economy. Similarly, energy price drives growth by 0.03 per cent; the impact is not enormous but favourable.

In the short run, the positive shock of energy on growth exhibit the magnitude of 0.61 per cent increase. The adverse shock of energy on growth indicates a decline in economic growth by 0.17 per cent. Hence, government spending influences the growth by 0.07 per cent. The energy price does not affect the growth of the economy. The error correction mechanism is 0.48 per cent. The speed of adjustment is fair to correct the economy back to equilibrium when there are unfavourable shocks.

The asymmetric causal relationship of positive shock is unidirectional from GDP to energy consumption, thereby supporting conservation hypothesis. The negative shock is bidirectional between energy and growth, this backed feedback hypothesis. The joint shocks of positive and negative is unobservable. Therefore, unidirectional causality from GDP to government spending and to energy price found, respectively. Summarily, the results of this study highlighted that a single package approach would not solve the energy needs of Ghana, and a dynamic plan is necessary. The contributions of this present study has provided additional evidence concerning the influence of positive and negative shocks of energy use in Ghana and a growing body on energy literature.

In the phase of policy implication, it is evident that energy demand supersedes energy supply that led to energy poverty in Ghana. The proportional impact of energy on growth is very encouraging. Ghana is facing two competing energy policy to pursue in two regimes. The favourable shock regime, there is the need to conserve energy because it will not affect growth. Under this condition diversification in the economy is necessary inform of competing investment, local and foreign direct investment. The negative shock regime, energy and growth are complementary. The policymakers must strike a balance between energy and growth. Investment in diverse energy sources to complement the present source of energy like renewable energy is deemed necessary. The economy should be more open in terms of macroeconomic policies to accommodate new venture capital and investment in infrastructure i.e. energy sector. For Ghana to meet up with sustainable development goal of 2030 energy supply must be

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sufficient. Finally, the major shortcoming of this study is a single country time series which is vulnerable to missing information, and the other possible extension to this may include disaggregate energy consumption (by sector), panel data approach and sociodemographic indicators.

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