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Impact of Energy Used, Economic Growth on Environment: An Empirical Analysis of Malaysia

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Abstract: The study examines the environmental effect of renewable energy, renewable energy used and economic progression in Malaysia for the period 1980–2014 using autoregressive distributed lag approach. The results of the bound testing approach confirmed the existence of co-integration amongst the variables. The findings of the study show that in the long run economic progression and non-renewable energy exert strong positive relationship and significant effect on environment while renewable energy is not significant. Foreign direct investment has negative but insignificant impact on environment. The short run analysis shows that the error correction coefficient is string, and statistically significant indicating that about 74% eccentricity from the symmetry will be modified in the next coming years. As such, the government should double its effort to reduce the CO_2 carbon dioxide emissions, perhaps through regulatory intervention or mandatory application of renewable energy for certain household segments and industries. For instance, the manufacturing, iron & steel sectors should be given more emphasis to reduce their high consumption of the non-renewable energy to those which are renewable. The government should introduce some measures and campaign for environmental protection for the future generation as well as to introduce some taxes for the polluters. Other relevant recommendation is by instituting the economic activities to rely on slight energy consumption.

Keywords: Renewable Energy; Non-Renewable Energy; Gross Domestic product; Environment Degradation; ARDL.

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1. Introduction

The daily energy used is likely to amplify globally in the next coming generation (International Energy Agency, 2014). Human induced anomalies in the environment are evident globally and deteriorating at a rapid pace. Environmental abnormalities have significant influence on all aspects of life on earth (Bernhardt et al., 2017; Crist et al., 2017; Foley, 2017; Scheffer et al., 2001;). Equally our physical environment alterations frequently, so does the need to become rapidly aware of the problems such as a heavy or bulky in streaming of natural phenomenon, an upsurge in the normal temperature of the globe's air particularly a continued rise that roots global warming. Despite all, the government necessity to be conscious of what kind of ecological challenges our planet is facing. Globally, governments are facing new challenges related to environment conditions. Some of these problems are small in nature and only affect a little to the ecosystems, but others are drastically alteration the countryside (Faegri et al., 2013; Van Tilman and Clark, 2014; Tilman et al., 2001; Tongeren, 1991).

In the context of Malaysia, government have instituted various policy actions to mitigate the impact of climate change such as propagating the use of efficient energy and renewable energy into the 5-

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year Medium Term Malaysia Plan (Begum et al., 2015). Considering climate and energy requirement, Malaysia has scored 58.95 and ranked 89 out of 180 countries in 2015 (Year 2000: 32.2, 85; 2005: 27.3, 96; 2010: 28.0, 100), as reported in the Ecological Performance Index (EPI), World-wide Metrics for The Environment Hsu and Zomer (2016). This indicates that Malaysia's EPI for climate and energy has improved its scoring for the past 5 to 10 years.

The question remains whether Malaysia has instituted the necessary policy actions to alleviate the effect of environmental alteration in terms of energy efficiency and renewable energy policy. Historically, renewable energy in Malaysia is primarily sources from hydroelectric generation. However, lately Malaysian Government has embarked on supplementary kinds of renewable energy such as solar energy and biomass. In particular, the government has implemented the feed-in-tariff for the photovoltaic electricity generation which has been on electricity grid (Tang and Tan, 2013).

This study, therefore, aims at examining the impact of energy used on environment: Specifically, the paper measure the types of energy (non-renewable and renewable energy) that effects CO_2 emission in Malaysia; analyses, compare and estimate the gap between the two category of energy sources estimation in Malaysia.

Environmental Kuznets curve (EKC) hypothesis potentially describes the most appropriate measure of the environmental impact on economic growth (Dinda, 2004; Ozokcu and Ozdemir, 2017; Stern, 2017; Stern, 2004; Zoundi, 2017). It relates the economic growth and carbon dioxide emissions, showing U-shaped relationship (Apergis et al., 2009; Apergis et al., 2010; Jalil and Mahmud, 2009). On the one hand, the theory argues that at early stages of development, a country will strive to grow and this requires higher energy intensity consumption and higher CO_2 growth (Shahbaz et al., 2012; Shahbaz et al., 2013). On the other hand, as the country achieves its developed status the energy consumption falls with better technology and societal realization on conserving the environment. Grossman and Krueger (1995) claimed an optimistic and positive connection amongst economic growth and environmental quality. They anticipated that increasing incomes from trade openness would lead to severe conservational control. Trade openness would shield the environment. Beckerman (1992) described as "The sturdy relationship among incomes, and the magnitude to which ecological safety actions are implemented, the study also reveals that in the long run, the certain method to expand our environment is to become safe and rich".

Numerous empirical studies were carried out in the recent time the causal relationship amongst the CO_2 emissions as a dependent and other variables as an independent from different countries (Ajmi et al., 2015; Apergis and Payne. 2009a; Apergis and Payne. 2009b; Halicioglu, 2009; Isik et al., 2018; Jaunky, 2011; Salahuddin et al., 2015). As a benchmark, similar empirical study by Jebli et al. (2013) to conclude the Environmental Kuznets Curve (EKC) hypothesis reveal that the occurrence of an unidirectional causality running in short-run from trade openness, gross domestic product, carbon dioxides emission and non-renewable energy consumption to renewable energy used. The long-run estimates reveals that non-renewable energy used and trade openness is positively linked with the CO_2 emissions, although renewable energy used feebly and negatively linked with CO_2 emission using the model for exports and this impact is statistically insignificant using the model for imports (Sadorsky, 2009).

Saidi and Hammami, (2015) examine the impact of carbon dioxides emissions and economic growth energy used and study outcomes demonstrates that economic growth and energy used is positively correlated, moreover, CO_2 emissions also have a positive relationship with the energy used. López-Menéndez et al., (2014) confirmed that renewable energy play significant role in decreasing carbon dioxides emission as an experimental study for Tunisia. Fodha and Zaghdoud, (2010) investigate the associations amongst gross domestic product per capita and pollutant CO_2 emissions, using time series data and co integration analysis. The studies confirm the presence of an inverted U-shaped association amongst carbon dioxide (CO_2) emissions and gross domestic products (GDP), a monotonic growing relationship amongst CO_2 emissions and GDP. Furthermore, a long and short run unidirectional interconnection consecutively from gross domestic products to CO_2 emissions also occurs.

Studies in France showed dynamic causal associations amongst energy consumption, CO_2 emissions per capita and output (Ang, 2007; Ang, 2008). The study results confirm the presence of long-run connection consecutively from economic growth to the growing of energy used as well as growing of pollution. Henceforth, the outcomes moreover demonstrate a unidirectional causality running from energy consumption to output growth in short run, while the inverted U-shaped EKC hypothesis was verified vividly and logically. Arouri et al. (2012) studied data of the twelve (12) Middle East and North African (MENA) countries, described the connections amid energy used, CO_2 emissions per capita, and real gross domestic products (GDP). The outcomes express that in the long-run energy used has a positive effect on carbon dioxides emissions. Real GDP show a quadratic association by CO_2 emissions for the whole regions. Therefore, long-run income elasticity and its genuine satisfy the environmental Kuznets curve hypothesis in most studied nations, however is not satisfy for United Arab Emirates (UAE), Morocco and Tunisia.

Autoregressive distributed lag (ARDL) bounds testing to co-integration methods was used and reported that energy used, CO_2 emissions per capita, productivity and foreign trade are strongly inter-linked (Ahmed and Du, 2017; Akbostanci et al., 2009; Halicioglu, 2009). However, the bounds test outcomes confirm the presence of long-run relations amid the variables. Thus, long run associations designate that CO_2 emissions are strong minded in an energy ingesting, income and trade openness. The second procedure, longterm relations showed that income is roughly linked with the energy consumption, CO_2 emissions, and external trade. Furthermore, income is the most significant variable in clarifying CO_2 emissions in Turkey, followed by energy consumption and external trade.

Jebli et al., (2013) usage panel co integration procedures to examine the causal associations amid CO_2 emissions per capita, non-renewable and renewable energy used and international trade for a panel of twenty five (25) OECD States. Therefore, long run Granger causality examinations express the presence of a unidirectional causality running from per capita output, renewable and non- renewable energy used, foreign trade and CO_2 emissions per capita. However, the long-run approximations recommend that renewable energy used per capita, trade openness have negative effects on CO_2 emissions per capita, while the inverted U-shaped EKC hypothesis is verified.

Chindo et al., (2015) examined the affiliation between energy used, CO_2 emissions and GDP in Nigeria. The study employing ARDL method to co-integration, the outcomes have shown that there is a long term association between energy used, CO_2 emissions and GDP. Thus, both in the short and long run CO_2 emissions has been found to have a substantial and positive effect on GDP, while energy used demonstrate a significant and negative effect on GDP in the short-run.

2. Methodology

2.1 Data and Variable Measurement

The Annual data is used in this study for the period 1980 to 2016 and it was obtained from Bank Negara Malaysia quarterly statistical bulletin, Department of statistics (DOS), and World Development Indicators (Mundial, 2014). The data were on the following variables: E represent CO_2 emission per capita (used as an endogenous variable and indicates environmental degradation), Y represents real GDP per capita, RE represents renewable energy consumption measured in metric tons per capita, NRE represents non-renewable energy consumption measured in metric tons per capita and FDI represents foreign direct investment.

2.2. Estimation Procedure and Model Specification

Initially, the unit root test is employed to check for the statistical stationarity of data (to avoid false regression). Therefore, stationarity is check for both 'trend' and 'difference' using an Augmented Dickey-Fuller unit root test. Then, an integrated stochastic process is used where the order of integration is taken [i.e., I(0) and I(1)] per the unit root test results. The outcomes of the unit root tests process provide a basis for using ARDL techniques. This process has been frequently stated in contemporary literature and is favored above the Johansen technique of co integration since it has the elasticity to modified lag lengths (which can amend and compute provisional adjustment in time series data), evade endogeneity and validate even minor sample sizes in order to attain healthier outcomes. The subsequent is the mathematical representation of Autoregressive distributed lag (ARDL) model:

Gt = f (Ct, Et) [1]

Thus, following the model based on EKC hypotheses by Ang, (2007), Holicioglu, (2009) and some modification by Jayanthakumaran et al. (2012):

$$C_t = \beta_0 + \beta_1 E_t + \beta_2 G_t + E_t \quad [2]$$

Whereas, C_t is the CO_2 emissions per capita (metric tons); E_t is commercial energy consumption per capita (measured in kilo grams of oil); G_t is per capita real income (measured in local currency i.e. Ringgits), E_t stand as the regression error term for the model. However, the parameters β_1 and β_2 are the springs of CO_2 emission with respect to energy use and real gross domestic products per capita. β_1 and β_2 are expected to be positive under the EKC hypothesis. Though, the study transformed our model by investigating variables in the logarithm linear of environmental Kuznets (EKC) equation in order to investigate the long run association among variables as stated below;

$$E_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 RE_t + \alpha_3 NRE_t + \alpha_4 FDI_t + \phi_t \quad [3]$$

In equation (4), E CO_2 emissions per capita (used as an endogenous variable and also indicates that environmental degradation with respect to rest of the explanatory variables) then, Y stands for real GDP per capita, RE represents renewable energy consumption in metric tons per capita, NRE stands for non-renewable energy consumption also in metric tons per capita, FDI stands for foreign direct investment (to proxy technology) and t represents time period. The next steps of the co-integration tests, there are several approaches accessible including Autoregressive Distribution Lags (ARDL) bounds testing approach (Pesaran et al., 2001), maximum-likelihood approach (Johansen and Juselius, 1990) and residual based approach described (Engle and Granger, 1987). In this study ARDL bounds testing approach is used as it avoids the problematic of endogeneity, produces more accurate results for the smaller data arrays and assistance to appraisal the coefficients in the long-run by using the following equations:

$$\begin{aligned}\Delta \ln E_t = \alpha_0 + \sum_{i=1}^{n}\alpha_{1i}\Delta \ln E_{t-i} + \sum_{i=0}^{n}\alpha_{2i}\Delta \ln Y_{t-i} + \sum_{i=0}^{n}\alpha_{3i}\Delta \ln RE_{t-i} + \sum_{i=0}^{n}\alpha_{4i}\Delta \ln NRE_{t-i} \\ + \sum_{i=0}^{n}\alpha_{5_i}\Delta \ln FDI_{t-i} + \hbar_1 \ln E_{t-1} + \hbar_2 \ln Y_{t-1} + \hbar_3 \ln RE_{t-1} + \hbar_4 \ln NRE_{t-1} + \hbar_5 \ln FDI_{t-1} + \phi_t\end{aligned} \quad [4]$$

Appraisals of short run connection amongst the variables of the study using the ARDL bounds testing method and Error Correction Model (ECM) is an appraised formula of Equation below:

$$\begin{aligned}\Delta \ln E_t = \alpha_0 + \sum_{i=1}^{n}\alpha_{1i}\Delta \ln E_{t-i} + \sum_{i=0}^{n}\alpha_{2i}\Delta \ln Y_{t-i} + \sum_{i=0}^{n}\alpha_{3i}\Delta \ln RE_{t-i} + \sum_{i=0}^{n}\alpha_{4i}\Delta \ln NRE_{t-i} + \sum_{i=0}^{n}\alpha_{5_i}\Delta \ln FDI_{t-i} \\ + ECM_{t-i} + \phi_t\end{aligned} \quad [5]$$

The equation (4) shows estimates of long run connection amongst the variables of study using the ARDL bounds testing method. The null hypothesis is verified by H_0: $\hbar_1 = \hbar_2 = \hbar_3 = \hbar_4 = \hbar_5 = 0$ to find out the study variables are co integrated in long-run as well to find relationship among the variables exist. However, the F-statistics with upper and lower bound limits I(1) and I(0) respectively, lead to the refusal of the null hypothesis. Then, if the values exceed the upper bound limit, therefore a choice can be made to reject the null hypothesis with co integration. The Diagnostic Tests with Lagrange multiplier tests and F-statistic tests are conducted to ensure validity of the fitted model, to check serial correlation, function form, normality and also heteroscedasticity. Last but not least, the stability test is proceeding through the CUSUM and CUSUMSQ offers investigation of stricture disparities. The CUSUM tests must be within the limits of 5% critical lines in order to guarantee steadiness. The same is valid in CUSUMSQ.

Table 1. Variable integration using Augmented Dickey-Fuller test statistic (ADF)

Variable	ADF				PP			
	Intercept and trend and intercept				Intercept and trend and intercept			
	Level		First Difference		Level		First Difference	
$lnCO_2$	-1.0491 (0.7236)	-	-6.3737 (0.0000)	***	-1.7577 (0.7020)	-	-6.3354 (0.0001)	***
lnY	-0.6686 (0.8410)	-	-4.8075 (0.0005)	***	-1.6342 (0.7571)	-	-4.7391 (0.0032)	***
lnNRE	-1.4621 (0.5399)	-	-4.7359 (0.0006)	***	-0.7525 (0.9600)	-	-4.8384 (0.0025)	***
lnRE	-3.2796 (0.0243)	**	-4.9133 (0.0004)	***	-3.4537 (0.0620)	*	-3.9975 (0.0202)	**
lnFDI	-0.0222 (0.9497	-	-4.9873 (0.0003)	***	-4.1299 (0.0169)	**	-4.9103 (0.0020)	***

Note: ***, **, * indicate significance level at 1%, 5% and 10% respectively. Values in parenthesis are probability values. $lnCO_2$, log carbon dioxide emissions; lnY, log gross domestic product; lnNRE, log non-renewable energy; lnRE, log renewable energy and lnFDI, log foreign direct investment.

3. Results and Discussion

Traditional unit tests Augmented Dickey-Fuller (ADF) was utilized to find out the order of co integration among the variables of the study (Table 1). The statistical values also suggest that all of the variables have a unit root problem level with intercept and trend. While, the first difference all of the variables are found to be stationary at I(1). This concept also to support progress that enumerates all of the numbers are co integrated at I(1). We also check that all of the variables are non-stationary at level in the presence of structural breaks. These structural breaks are present in the series of carbon dioxide emission, renewable and non-renewable energy used, economic growth and environment.

Malaysia has adopted some drastic measures to addressing the increasing environmental protections and concerns along with continued economic structural changes and reforms to support the economy growing with fewer impacts on environmental degradation or challenges. Malaysia passed the country Environmental Protection and Quality Act 1974, which aimed to protect biodiversity, safeguard the environmental quality as well as to reduce carbon dioxide emissions, and also promote the sustainable development practices within the country. Similar Efforts were already reported from Singapore (Tan et al., 2014). The act was revived and implemented with the emphasis on the recent years. However, during this time, indicators of economic growth also showed promising direction and significant improvement. Moreover economic reforms implemented in the late nineties lead to a high level of inflow and economic growth in early 2000s. The results of Augmented Dickey-Fuller (ADF) test statistic show that all variable within stationary at their level and first difference. Therefore, as a result of that, all the variables are integrated into a range of I(0) and I(1) then the next stage is the commencement of ARDL for the co-integration tests of the study model.

Results of the co-integration tests (Table 2) indicated that the lag mixture of the models was appraised grounded on the Akaike information criterion (AIC) and Schwarz Bayesian criterion (SBC). The outcomes of the study were picked base on the best model. Energy used, economic growth and environment, CO_2 emissions from manufacturing and construction sectors, and CO_2 emissions per capita were estimated based on AIC. While economic growth and CO_2 emissions from other sector of the economy was assessed based on SBC, responsible for the vital outcome for these models. The AIC achieves comparatively well when the model size is minor associated to a large sample scope (Onumah and Acquah, 2010; Sbia et al., 2014). Meanwhile, the SBC enacts more limits on the amount of parameters assessed, associated to AIC; consequently, the SBC (Schwarz Bayesian criterion) is stingier in lag length assortment and decreases loss of amount of liberty Ito (2009).

The outcomes of the bound test for co-integration in Table 2 the model estimated their optimal lags, and F-statistics. The outcomes recommend that co-integration occurs among the variables as such, the study accept the alternative hypothesis and reject the null hypothesis of means no co-integration among the variable.

Table 2. Bound Test

F-Statistics (K=4, n=32)	95% Lower Bound	95% Upper Bound
3.9970	2.86	4.01
	90% Lower Bound	90% Upper Bound
	2.45	3.52

Table 3. The Long-run ARDL Model

Variables	Coefficient	Std.Error	T-Ratio	Prob
lnY	0.977154	0.474895	2.057622	0.0506
lnNRE	0.682332	0.271559	2.512651	0.0191
lnRE	0.043841	0.064558	0.679097	0.5036
lnFDI	-0.166619	0.108378	-1.53739	0.1373
C	-7.231947	4.384165	-1.64956	0.1121

lnY, log gross domestic product; lnNRE, log non-renewable energy; lnRE, log renewable energy and lnFDI, log foreign direct investment.

Table 4. The Short Run ARDL Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(lnY)	0.723161	0.387392	1.866743	0.0742
D(lnNRE)	0.504973	0.188724	2.675727	0.0132
D(lnRE)	0.032445	0.045870	0.707336	0.4862
D(lnFDI)	-0.023740	0.103350	-0.229706	0.8203
D(lnFDI(-1))	0.195684	0.079556	2.459718	0.0215
CointEq(-1)	-0.740069	0.158374	-4.672925	0.0001

D(lnY), Change log gross domestic product; D(lnNRE), change log non-renewable energy; D(lnRE), change log renewable energy; D(lnFDI), change log foreign direct investment.

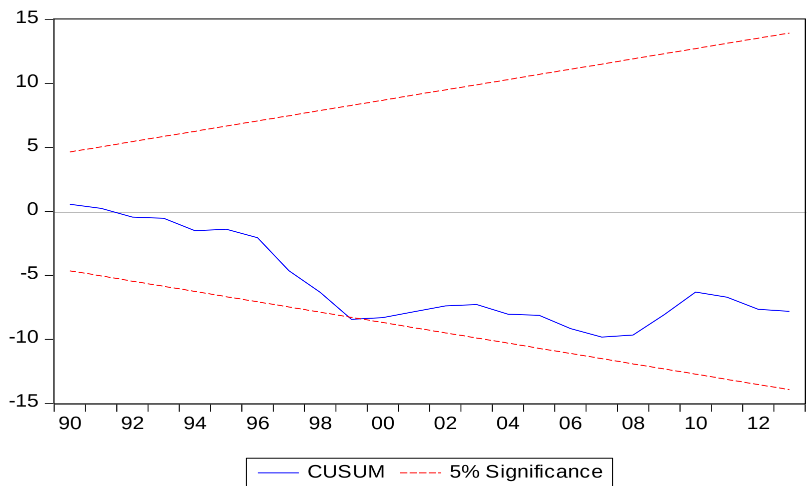

Fig. 1 Cumulative Sum of Recursive Residuals CUSUM

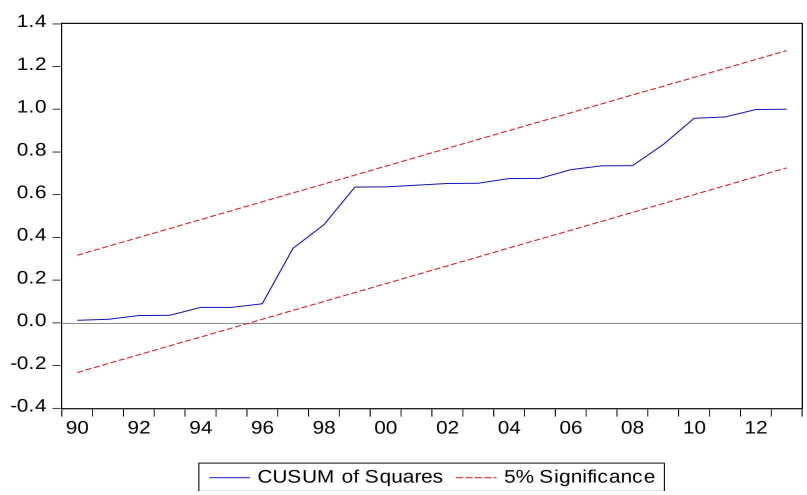

Fig. 2. Cumulative Sum of Squares of Recursive Residuals CUSUMSQ

The presence of co-integration is defensible by the upper values of the F-statistics over their upper-bound critical values (Narayan and Narayan 2010; Narayan, 2005) and at conventional 10% level of significance. For instance, the F-statistic value for CO_2 emission model is 3.99, which is lower than the upper bound 4.01 at 10% level of significance. Therefore, the null hypothesis set earlier as H_0: $\hbar_1 = \hbar_2 = \hbar_3 = \hbar_4 = \hbar_5 = 0$ can be rejected.

Endogeneity difficult is a condition where the descriptive variable of a model is interrelated with the error term is speak to in these models with the aid of padded dependent variables of each model. The existence of padded dependent variable confirms that independent variables are jointly limited from the error term.

Variables are co integrated at 10% level (Narayan, 2005) of significant then; the study concluded that there is co-integration relationship amongst variables for the models (Table 2). In the next step the appraisal and investigation of the short-run and long-run outcomes were performed producing the same lag interval assortment principles with the co-integration tests. In Table 3, presents the assessed long-run results.

Outcomes of the long run model indicated that the coefficient for lnGDP, lnNRE and lnRE are robustly positive than short run estimation (Table 3). An increase of 1% in lnGDP will lead to an increase of CO_2 emissions by 0.977154%, whilst a 1% increase of lnNRE and lnRE, will increase the CO_2 emissions by 0.682332% and 0.043841% respectively. In addition, the coefficient of lnFDI (technology) is negative. The results may suggests that the model is either unable to capture the negative relationship between renewable energy and CO_2 emission (i.e. spurious) or that the the mixture of renewable energy (those which still emits emission such as bio-gas, biomass, biodiesel vs a non-emitting ones such as hydro-electric and solar energy) is insufficient to decrease the CO_2 emissions in Malaysia.

Short run estimation of the ARDL model is presented in the Table 4. The coefficient for D(lnY), D(lnNRE) and D(lnFDI(-1)) are of smaller positive than long run as well as statistically significant to CO_2 emissions. A comparison between long run and short run elasticity shows that coefficient increases over long run analysis whilst ignoring the negative impact of renewable energy on CO_2 emission positive but not significant. However, the result of error correction term is negative as well as statistically significant which indicated that about 74% speed of adjustment and deviation from equilibrium will be corrected in one year.

3.1. CUSUM and CUSUMSQ Test of Stability

Monthly For incorporate stability, the short run analysis for the constancy of long run parameter CUSUM and CUSUMSQ tests (Fig. 1, 2) confirmation is applied as both plots stayed within the critical bound. The result here is presented graphically of these two tests below.

4. Conclusion

The study explores the relationship amongst energy consumption. Economic growth and environmental degradation nexus using ARDL bounds tests approach to co integration. The findings shows that the GDP, the renewable energy used as well as the non-renewable energy used are significantly positive as well as it has impact on the CO_2 emission in the long run as compared with the short run estimation. Meanwhile, the FDI indicates a positive coefficient in relation to CO_2 emission in short run and is statistically significant. However, in long run estimation it indicates a negative coefficient in relation to CO_2 emission but it is not statistically significant and this findings also consistent with that of Jebli and Youssef (2015). As such, government should double its effort to reduce the CO_2 carbon dioxide emissions, perhaps through regulatory intervention or mandatory application of renewable energy for certain household segments and industries. For instance, the manufacturing, iron and steel sectors should be given more emphasis to reduce their high consumption of the non-renewable energy to those which are renewable. The government should introduce some measures and campaign for environmental protection for the future generation as well as to introduce some taxes for the polluters. Other relevant recommendation is via instituting the economic activities to rely on slight energy consumption but high in productivity similar to the ones adopted by the developed countries.

5. Policy Implication

The policy insinuations of our outcomes is that energy used has not fully advanced to a level that will bring about supportable economic progression and development; hence, supplementary energy used is mandatory to boost energy consumption to a stage where it can moderate CO_2 emissions and improve conservational quality. Additionally, technological transfer and its dispersion can make energy used to be more unstable to be controlled by the policy makers. The insinuation of this is that energy used will continue to increase economic growth and environment quality. Though, since trade openness which is less instable compared to energy used has proved evidence of mitigating CO_2 emissions, this present study endorse that policy makers should pay consideration to quality of energy supply rather than the quantity, particularly the energy used as one of the sources of $CO_{2.}$

The outcomes of the study had also shown that energy used have positive impact CO_2 emissions as well as energy consumption can mitigate CO_2 emissions in the industrial and construction sector. Hence, giving more care to the reduction technology who's consuming much renewable energy to further decrease radiations from the industrial sector for sustainable economic progression and improvement. Though, CO_2 emissions from transportation sector exceed CO_2 emissions mitigations from the industrial and construction sectors. Supplementary indicates that energy used will linger to raise CO_2 emissions, till appropriate modification policies are set in place in the transportation sector. Furthermore, the optimistic connection among the level of energy used and CO_2 emissions from other sectors of the economy may recommend the prospect of higher $CO_{2.}$ The government most proceeds active degree to cut CO_2 embodied from other sectors of the economy.

Energy used consistently remained important in both the short-run and long-run models, it indicates that it has vital contribution in CO_2 emission as an economic progression needs energy as its substance. Though, the regulator of energy used can be less explosive associated to environment quality. Henceforth, we added commend to energy preservation procedures by policy makers to improve effectiveness in the consumption of energy.

List of abbreviations: ADF, Augmented Dickey-Fuller; AIC, Akaike information criterion; ARDL, autoregressive distributed lag; CUSUM, Cumulative Sum of Recursive Residuals; CUSUMSQ, Cumulative Sum of Squares of Recursive Residuals; FDI, foreign direct investment; GDP, Gross domestic product; SBC, Schwarz Bayesian criterion.

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