IOSR Journal Of Humanities And Social Science (IOSR-JHSS)
Volume 23, Issue 2, Ver. 2 (February. 2018) PP 31-38
e-ISSN: 2279-0837, p-ISSN: 2279-0845.
www.iosrjournals.org

Energy used, economic growth and environmental quality in Malaysia: An Application of ARDL Quadratic Model

SulemanLawalGambo
Department of Economics, Umaru Musa Yar'adua University, P.M.B 2218, Katsina, Katsina State, Nigeria
Corresponding author: SulemanLawalGambo

Abstract: This paper studies the validation of the environment and energy: the environmental quality, growth, renewable and non-renewable energy used as well as FDI in Malaysia, using time series data for the periods of 1980–2014 with carbon dioxide emissions (CO_2) as an indicator for ecological dilapidation. The study employed Autoregressive distributed lag (ARDL) bounds testing method to co-integration is applied. The results of the study confirmed the presence of co-integration between the variables in the long-run path. Though, the diminishing negative effect of growth on the environment, in the long run, confirms the existence of environmental Kuznets curve (EKC's) is a postulated affiliation between the various indicator of ecological dilapidation and income per capita in Malaysia. Renewable energy and foreign direct investment were the major factors that reduce environmental degradation in Malaysia over the period of the study. The government should, therefore, 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. Another relevant recommendation is by forming industries that depend on slight energy consumption than with high level in productivity.

Keywords: ARDL, Energy Used, Environment quality and Economic growth, renewable energy and non-renewable energy

---

Date of Submission: 24-01-2018 Date of acceptance: 09-02-2018

I. INTRODUCTION

In the global context, we could not deny the fact that our environment is keeping regularly alteration. As per our physical environment vicissitudes commonly, hence does the need to become rapidly conscious of the problems such as a heavy or bulky in streaming of natural phenomenon, global warming and cooling periods, diverse kinds of weather conditions arrays and much more. Despite all, the government needs to be aware of what forms of ecological challenges our planet is fronting. All across the world, the government is experiencing a shortage of capital for financing new and existing environmental challenges every day. Roughly, some of them are small in nature and only affect a few environments, but others are extremely altering the landscape of what we previously know. In the context of Malaysia, we are increasingly aware of the impact of climate change, and various policy measures were instituted to mitigate the impact of climate change such as propagating the use of efficient energy and renewable energy into the 5-year Medium Term Malaysia Plan. In terms of climate and energy, Malaysia has scored 58.95 and ranked 89 out of 180 countries in 2015 (the year 2000: 32.2, 85; 2005: 27.3, 96; 2010: 28.0, 100), as reported in the Global Conservational (environmental) Performance Index, This indicates that Malaysia's EPI for climate and energy has improved its scoring for the past 5 to 10 years.

Over the past few decades, the correlation linking economic growth, as well as conservational contamination, has been the focus of the concentrated investigation. Thus, rare empirical research has proposed that there is an inverse-U-shaped association amongst economic activities (basically measured income per capita as an indicator of economic growth) and environmental quality. Thus, at the initial step of growth and ecological squalor also escalations as per capita income upsurges, however, environmental quality commences to diminution as per capita income increase passes beyond a rotating point. Therefore, this so-called Environmental Kuznets Curve (EKC's) and equivalent with the relationship between the level of income disparity and income per head measured by Kuznets.

Thus, many empirical studies on the influence of energy used and economic activities on the environment (for example, Jebli and Youssef (2015), Fodha and Zaghdoud (2010), Akbostanci et al. (2009); Jaunky (2011); and Narayan (2010)). Analysed the vigorous relationship between energy used, economic growth and environment using linear models, but in this paper, we used a linear quadratic model instead. Also, this paper employs the most suitable econometric techniques, Autoregressive distributed lag (ARDL) bounds testing method to cointegration in addition to the inverted-U shaped hypothesis of the Environmental Kuznets curve (EKC's) remains to analyzed economic growth. This paper offers new-fangled insights into energy consumption and economic growth literature, then the outcomes of the study offer an important course of action control tools for the government, international organizations and research institute towards an energy used, economic progression and ecological quality links.

II. LITERATURE REVIEW

Theoretical Literature

The most appropriate measure of the ecological or environmental impact on economic growth is the Environmental Kuznets curve (EKC's) hypothesis which looks at CO_2 emissions and economic growth that has an upturned U-shaped association. 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. 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.

Empirical Literatures

There are recent empirical studies that studied the causal relationship between carbon dioxide emissions (CO_2) and other variables from different countries. For example, Jebli and Youssef (2015) determine the Environmental Kuznets Curve (EKC) hypothesis and to demonstrate the presence of short-run unidirectional causation consecutively as of trade openness, GDP, CO_2 emissions and non-renewable energy to renewable energy. Thus, the long run appraisals demonstrate that the non-renewable energy plus trade openness have a positive influence on carbon dioxide emissions (CO_2), however renewable energy influences feebly as well as negatively to CO_2 emissions while the study using the model with export. Then, this effect is statistically insignificant while the model used with import. More so, empirical study for Tunisia, Fodha&Zaghdoud (2010), examines the interactions amongst the income per capita as an indicator of growth and impurity (CO_2, and SO_2 emissions), using time series data for cointegration investigation. Thus, the study demonstrates that the presence of an upturned U-shaped connection among the SO_2 radiations and the gross domestic products, hence a monotonically increasing the affiliation among the carbon dioxide (CO_2) emissions and gross domestic products (GDP). Therefore, both long and short run unidirectional causation consecutively as of gross domestic products to carbon dioxides and SO_2 emissions also exist.

Several other empirical studies examine the strength of the Environmental Kuznets curves hypothesis for a single country or more than country i.e. a balanced panel. Numerous of these studies investigate the vigorous association amongst economic growth and ecological quality such as; Akbostanci et al. (2009); Jaunky (2011); and Narayan (2010), while others studies amongst growth, energy used and environment see, Ang (2007 & 2008); Soytas et al. (2007); Sadorsky (2009); Apergis and Payne (2009); and Apergis et al. (2010). In addition some cluster of the empirical studies introduce foreign trade as a significant variable and assess its vigorous association with productivity, non-renewable energy used and impurity releases Jalil and Mahmud (2009); Halicioglu (2009); Jayanthakumaran et al. (2012); Shahbaz et al. (2013); and Sbia et al. (2014]). Ben Jebli et al. (2013) stated that renewable energy used as an essential variable of interest, the study examines vigorous connections amongst foreign and trade openness, output, non-renewable energy used and CO_2 emissions, for a panel of OECD nations.

Ang (2007) investigates the vigorous interactions between CO_2 emissions per capita, energy used and level of productivity for France. Thus, the study reveals that the presence of long-run causation consecutively as of economic progression to the growing of energy use as well as the growth of carbon dioxide emissions. Hence, the study also demonstrates that the unidirectional short-run causality running as of massive energy consumption due to increase in productivity, while the upturned U-shaped environmental Kuznets curve (EKC's) postulate is verified clearly and logically. Arouri et al. (2012) examine the interactions between per capita CO_2 emissions as an indicator of environmental quality, energy used and real GDP for the 12 North African and Middle East nations. The study demonstrates that energy used has a positive effect on per capita CO_2 emissions while real GDP shows a quadratic affiliation with CO_2 releases for the entire study area or regions. The long-run elasticity of income and it's genuine to fulfil the environmental Kuznets curve (EKC's) assumption in furthermost studied nations, however, is not satisfied for United Arab Emirates (UAE), Morocco and Tunisia.

Halicioglu (2009) argued that the vigorous fundamental connections amongst per capita CO_2 emissions, energy used, productivity and international trade in the situation of Turkey using ARDL bounds testing to cointegration techniques. Thus, the bounds test outcomes demonstrate the presence of cointegration in long run. The long-run connections show that carbon dioxide emissions (CO_2) are dogged by the massive energy used, income and international trade. Subsequently, the long run relations also show that country's income too, determined the country's CO_2 releases, energy used and international trade. In addition, income is the furthermost important variable in explaining CO_2 releases in Turkey, shadowed by energy used and international trade.

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 run association 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.

Ben Jebli et al. (2013) the study employed panel cointegration techniques to find out the causal relations between per capita CO_2 emissions, renewable and non-renewable energy used and trade openness for a panel of twenty-five (25) OECD states. Meanwhile, in long run Granger causality checks demonstrate the presence of a unidirectional causation consecutively as of per capita output, renewable and non-renewable energy used, trade openness to per capita CO_2 emissions. However, the long run appraisals reveal that renewable energy used per capita and international trade have negative effects on per capita CO_2 emissions, and the upturned U-shaped environmental Kuznets curve (EKC's) assumption is verified.

III. METHODOLOGY

Data and Variable Measurement

Annual time series data were used in this study for the periods of 1980 to 2014 and it was sourced from Central Bank of Malaysia (Bank Negara Malaysia) statistical bulletin, Department of Statistics (DOS), and World Development Indicators (World Bank). The data were on the following variables: E,CO_2 emission per capita (and is used as an endogenous variable and also as an indicator of environmental degradation with respect to rest of the explanatory variables), Y represents real per capita GDP, RE represents renewable energy consumption measured in metric tons per capita, NRE represents non-renewable energy consumption also dignified in metric tons per capita, FDI represents foreign direct investment.

Estimation Procedure and Model Specification

Initially, the stationarity checks are employed to test for the unit roots of the data (to evade false regression). Therefore, the unit roots are checked for both 'trends' and 'first difference' using an Augmented Dickey-Fuller (ADF) stationarity test. Then, a combined of stochastic procedures are employed where the order of integration among the variable is engaged (that is at a level I(0) or at first difference I(1) per the unit root check outcomes). The outcomes of the unit root tests procedures provide a root for using an autoregressive distributed lag (ARDL) techniques. This procedure has stood frequently stated in current empirical literature and is favoured more than the Johansen technique of cointegration for the reason that it has an elasticity to change lags lengths or interval (which can amend and compute temporary adjustment in time series data). Therefore in order evade endogeneity and validate even with the lesser sample sizes in order to attain healthier outcomes. Hence, subsequent is the mathematical illustration of Autoregressive distributive lag (ARDL) model:

$$Gt = f(Ct, Et) \quad (1)$$

Following literature like Ang (2007), Holicioglu (2009) and Jayanthakumaran et al. (2012): the autoregressive distributive lags model can be used to investigate the impact energy used, economic growth and environmental quality in Malaysia as follows:

$$C_t = \beta_0 + \beta_1 E_t + \beta_2 G_t + \beta_3 G^2 + \varepsilon \quad (2)$$

Whereas ***C*** is the carbon dioxide emissions (calculated in metric tons per capita emissions); ***E*** is commercial energy consumption (dignified in kilograms of oil and gas used per capita); ***G***is a real income per capita (dignified in local currency i.e. Malaysian Ringgits),G^2 is square of per capita real income and ε is the regression error term.

The parameters $\alpha 1$, α2 and $\alpha 3$ are the long-run elasticities of carbon dioxide emissions with respect to energy used per capita real GDP and squared per capita real GDP, respectively, thus the symbol of $\alpha 1$ is expected to be positive, under the environmental Kuznets curve hypothesis $\alpha 2$ is expected to be positive whereas $\alpha 3$ sign is expected to be negative. The statistical insignificance of $\alpha 3$ suggests a monotonic increase in the relationship between pollutant emissions and income per capita.

$E_t = f(Y_t, Y_t^2, RE_t, NRE_t, O_t)$ (3)

However, the study also transmuted our research model by investigating variables in the quadratic environmental Kuznets equation to scrutinize the long run affiliation amongst the study variables as mentioned below;

$$E_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 Y_t^2 + \alpha_3 RE_t + \alpha_4 NRE_t + \alpha_5 FDI_t + \phi_t \quad (4)$$

In equation (4), ***E*** per capita CO_2 emission (as an endogenous variable as well as an indicator ecological dilapidation with respect to rest of the descriptive variables of the study), ***Y*** represents per capita real GDP, $\boldsymbol{Y^2}$ represents the quadratic form of the model, RE represents renewable energy used dignified in metric tons per capita, ***NRE*** represents non-renewable energy used also measured in metric tons per capita, FDI represents foreign direct investment and t represents time period. For the subsequent stages of the cointegration test, there are numerous approaches available for computing results and analysis. Henceforth, a residual centred method of Engle and Granger, 1987, maximum-likelihood method of Johansen and Juselius, 1990 and Autoregressive Distributed Lag (ARDL) bounds testing method by Pesaran et al., 2001. This investigation employed the ARDL bounds testing techniques because it evades the difficulties of endogeneity as well as the study produces healthier results for smaller data sets and also aids to assessment the coefficients, in the long run, using the following equations

$$\Delta \nu\lambda E_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta \nu\lambda E_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta \nu\lambda Y_{t-i} + \sum_{i=0}^{n} \alpha_{3i} \Delta \nu\lambda Y^2{}_{t-i} + \sum_{i=0}^{n} \alpha_{4i} \Delta \nu\lambda RE_{t-i}$$

$$+ \sum_{i=0}^{n} \alpha_{5\ i} \Delta \nu\lambda NRE_{t-i} + \sum_{i=0}^{n} \alpha_{6_i} \Delta \nu\lambda FDI_{t-i} + \pi_1 \ln E_{t-1} + \pi_2 \ln Y_{t-1} + \pi_3 \ln Y^2{}_{t-1} + \pi_4 \ln RE_{t-1} \quad (5)$$

$$+ \pi_5 \ln NRE_{t-1} + \pi_6 \ln FDI_{t-1} + \phi_t$$

The equation (5) shows appraisals in the long run connection amongst the variables of study using the ARDL bounds testing techniques. Thus, the null hypothesis is verified by H0: $\pi 1 = \pi 2 = \pi 3 = \pi 4 = \pi 5 = 0$. Subsequently, the model is check for Schwartz-Bayesian Criteria (SBC) and Akaike's Information Criteria (AIC), the Error Correction Model (ECM) is appraised in the form of Equation (6):

$$\Delta \nu\lambda E_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta \nu\lambda E_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta \nu\lambda Y_{t-i} + \sum_{i=0}^{n} \alpha_{3i} \Delta \nu\lambda Y^2{}_{t-i} + \sum_{i=0}^{n} \alpha_{4i} \Delta \nu\lambda RE_{t-i}$$

$$+ \sum_{i=0}^{n} \alpha_{5\ i} \Delta \nu\lambda NRE_{t-i} + \sum_{i=0}^{n} \alpha_{6_i} \Delta \nu\lambda FDI_{t-i} + \vartheta ECT_t + \phi_t \quad (6)$$

In addition, the Granger causality tests were functional to check the association among energy used i.e., renewable and non-renewable energy, per capita income gross domestic product as an indicator of growth, foreign direct investment. Ensuring this study, the constancy of the model was similarly checked through diagnostic tests (i.e., normality test for residual terms, ARCH test and LM test for serial correlation).

IV. EMPIRICAL RESULTS

Unit Root Tests

Before commencing the ARDL cointegration, a stationarity test is a necessity towards determining the degree of assimilation of each variable and confirmed through Augmented Dickey-Fuller test statistic (ADF) method. Refer to Table 1 for the results of unit root test.

Table 1: Unit Root Test

Variable	ADF				PP			
	Intercept and trend and intercept				**Intercept and trend and intercept**			
	Level		**First Difference**		**Level**		**First Difference**	
lnCO2	-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)	***

lnY^2	-2.7559 (0.0763)	*	-8.7640 (0.0000)	***	-4.0913 (0.0153)	**	-8.6421 (0.0000)	***
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.

The results of Augmented Dickey-Fuller test statistic (ADF) demonstrate that all variable within stationary at their level and first difference. As a result, all the variables are integrated into in a range of level I(0) and first difference I(1), then the next stage is the commencement of ARDL for the cointegration test of the model.

Co integration Results

In order to examine the cointegration within variables, the bound test has been commenced and the resulting base on the F-statistic. The result shows in table 2. From the value of Narayan (2005) table, the quadratic model shows the variables are cointegrated at 5% and 10% level of significance. From this, the study can clinch that there is cointegration between the variables. Refer to table 2 for Co-integration Bound test.

Table 2: Co-integration Bound test

F-Statistics (K=4, n=32)	95% Lower Bound	95% Upper Bound
10.9206	2.62	3.79
	90% Lower Bound	90% Upper Bound
	2.26	3.35

However, the study outcomes which have been confirmed in this research objectives have adequate features to demonstrate that there exists in co-integration as our study has stated in Table 2. The F-statistics for the model are clearly demonstrated that greater than the upper bound of the bound test critical values by Narayan (2005), thus, if the variables are not co-integrated definitely the null hypothesis was rejected at some at 1%, some at 5% while others at 10% level of significance. In addition, the model can be used to appraisal short and long-run parameters. Refer to table 3 for the long run elasticity of ARDL quadratic model.

Table 3: The Long-run Elasticity of ARDL Quadratic Model

Variable	Long Run			
	Coefficient	Std.Error	T-Ratio	Prob
lnGDP	0.049	0.328	0.151	0.881
$lnGDP^2$	-0.001	0.010	-0.055	0.956
lnNRE	0.284	0.175	1.621	0.118
lnRE	-0.017	0.017	-1.009	0.323
lnFDI	-0.049	0.049	-1.001	0.327
C	-0.001	0.024	-0.047	0.963

First of all, one important thing to note is that although all the variables are statistically insignificant individually with more than 10% p-value, jointly they are significant as a model. The results for the quadratic model shows that in the long run, the coefficient for ***lnGDP*** and ***lnNRE*** have a smaller positive coefficient as compared with coefficient in the short run and this is consistent with the theory of EKC. This indicates that a 1% increase in ***lnGDP*** will escalation CO_2 releases by 0.0496%, whilst a 1% upsurge of ***lnNRE*** will raise the CO_2 releases by 0.2839%. In addition, as expected the coefficients of ***lnRE*** and ***lnFDI*** are negatively correlated with CO_2. This provides evidence that the renewable energy sub-sector can decrease the CO_2 emissions by -0.0169% in Malaysia. Refer to table 4 for the Short-run elasticity of ARDL quadratic model.

Table 4: The Short-run Elasticity of ARDL Quadratic Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D (lnGDP)	0.129	0.539	0.239	0.812
D($lnGDP^2$)	-0.001	0.024	-0.055	0.956
D(lnNRE)	0.696	0.418	1.663	0.109
D(lnRE)	-0.041	0.040	-1.029	0.314
D(lnFDI)	-0.119	0.119	-0.998	0.328
CointEq(-1)	-2.450	0.178	-13.722	7.420

As we explained earlier for the long-run elasticity, the model is statistically significant jointly. The results for quadratic model demonstrates that the in short run, a coefficient for ***D(lnGDP)*** and ***D(lnNRE)*** are of bigger positive than in the long run. Similar with the long run elasticity, as expected the coefficient for ***D(lnRE)*** and ***D(lnFDI)*** are negatively correlated with CO_2 emissions.

In summary, in order to capture the impact of renewable energy on CO_2 emission, perhaps it is more precise and appropriate to use the quadratic model which is more capable of capturing the relationship amongst the economic growth and the use of newer technology (renewable) with CO_2 emissions are clearly diminished.

Diagnostic Tests Results

The summarized outcomes of the diagnostic checks are as stated in Table 5. Outcomes from the diagnostic test are found satisfactory in all aspects of serial correlation, functional form, normality, and heteroscedasticity thus supporting the validity of the estimates. The LM Test shows P. value for serial correlation and Heteroscedasticity are greater than 5% critical value, while P. value for functional form and significant at 1%. We may assume that we accept H0= No Serial Correlation= No Functional Form = No Heteroscedasticity. Refer to table 5 for the diagnostic tests.

Table 5: Diagnostic Tests

LM Test Statistics	Results Quadratic Model	P-value
Serial Correlation :CHSQ(1)	0.303431	0.741
Functional Form: CHSQ(1)	0.031520	0.860
Normality: CHSQ(2)	0.215152	0.162
Heteroscedasticity: CHSQ(1)	1.194768	0.3430

CUSUM and CUSUMSQ Test of Stability

For incorporate stability, the short run dynamics for the constancy of long-run parameter CUSUM and CUSUMSQ tests confirmation is applied as both plots stayed within the critical bound. The result is as a graphical presentation of these two tests is provided in Figures below:

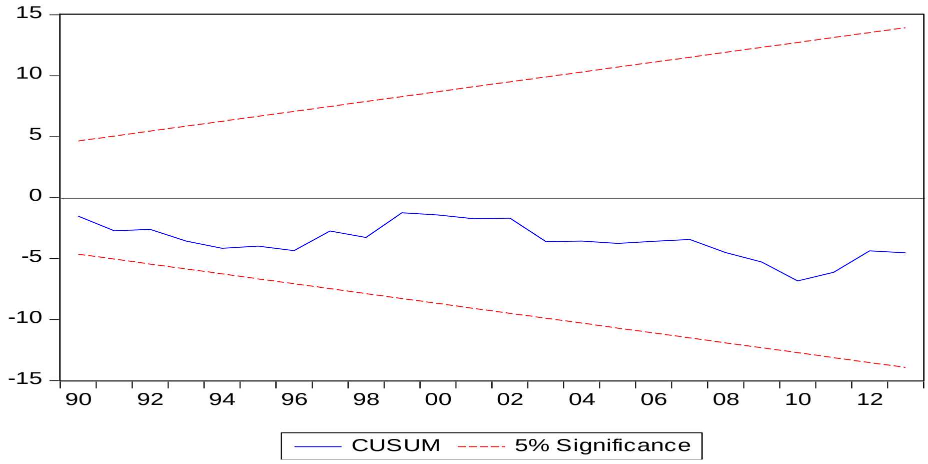

Figure 1. Cumulative Sum of Squares of Recursive Residuals

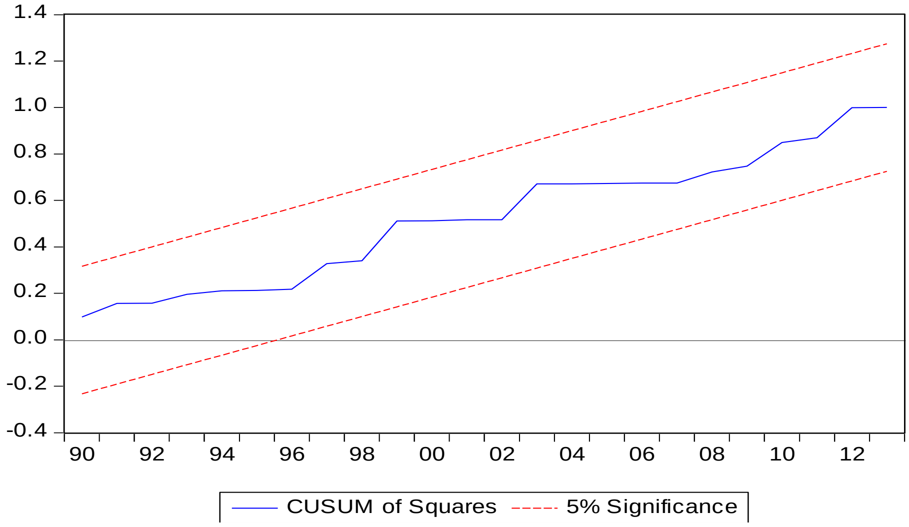

Figure 2. Plot of the cumulative sum of squares recursive residuals (CUSUMsq)

V. CONCLUSIONS AND POLICY RECOMMENDATIONS

This study explores the relationship between energy consumption and the economic growth as well as environmental degradation link using foreign direct investment as the added explanatory variables. Therefore, the study employed the ARDL bounds check approach to cointegration to examine the presence of the EKC's hypothesis. The quadratic model which is widely used for EKC theory, in our case indicates that it is insignificant as individual variables but jointly they are significant. As such we can still use the model as a guide. In terms of relationship, the short run and long-run elasticity are consistent whereby the GDP and non-renewable energy are positively correlated (coefficient) with the CO_2 emission. We also noticed that the coefficient for both variables became smaller in the long run as compared to the short run which may reflect the EKC theory. Furthermore, the renewable and FDI have a negative relationship with CO_2 emission as expected and also a larger negative coefficient in the long run as compared with the short run. As such, we can see that the quadratic model is more precise and appropriate in measuring the impact of the level of economic development and the renewable energy impact on the CO_2 emissions.

Based on the quadratic model, this study concludes that there are favourable impacts of renewable energy and FDI on the reduction of CO_2 emissions. 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. Another relevant recommendation is by inaugurating the industries that rely on slight energy consumption but high in output similar to the ones adopted by the China and Asian Tigers.

REFERENCES

[1]. Akbostanci E, Türüt-Asik S, Tunç GI. The relationship between income andenvironment in Turkey: is there an environmental Kuznets curve? EnergyPolicy2009; 37:861–7.
[2]. Ang JB. CO2emissions, energy consumption, and output in France. EnergyPolicy2007; 35:4772–8.
[3]. Apergis N, Payne JE. Energy consumption and economic growth in CentralAmerica: evidence from a panel cointegration and error correction model.Energy Econ 2009; 31:211–6.
[4]. Apergis N, Payne JE, Menyah K, Wolde-Rufael Y. On the causal dynamicsbetween emissions, nuclear energy, renewable energy, and economic growth.Ecol Econ 2010; 69:2255–60.
[5]. ArouriMEH,BenYoussefA,M'henniH,RaultC.Energyconsumption,economic growth and CO2emissions in Middle East and North Africancountries. Energy Policy 2012; 45:342–9.
[6]. Ben Jebli, M, Ben Youssef, S, Ozturk, I. The environmental Kuznets curve: the role of renewable and non-Renewable energy consumption and trade open- ness. MPRA paper 51672, University Library of Munich, Germany; 2013.

[7]. Chindo, S., Abdulrahim, A., Waziri, S. I., Huong, W. M., & Ahmad, A. A. (2015). EnergyConsumption, CO2 emissions and GDP in Nigeria. GeoJournal, 80(3), 315-322.
[8]. Fodha M, Zaghdoud O. Economic growth and pollutant emissions in Tunisia: an empirical analysis ofthe environmental Kuznetscurve. Energy Policy2010; 38:1150–6.
[9]. Halicioglu F. An econometric study of CO2emissions, energy consumption,income and foreign trade in Turkey. Energy Policy 2009; 37:1156–64.
[10]. Jalil A, Mahmud SF. Environment Kuznets curve for CO2emissions: A cointegration analysis for China. Energy Policy 2009; 37:5167–72.
[11]. Jayanthakumaran K, Verma R, Liu Y. CO2emissions, energy consumption, tradeand income: a comparative analysis of China and India. Energy Policy2012; 42:450–60.
[12]. Jaunky VC. The CO2emissions-income nexus: evidence from rich countries.Energy Policy 2011; 39:1228–40.
[13]. Narayan PK, Narayan S. Carbon dioxide emissions and economicgrowth:panel data evidence from developing countries. Energy Policy 2010; 38:661–6.
[14]. Sadorsky P. Renewable energy consumption, CO2emissions and oil prices inthe G7 countries. Energy Econ2009; 31:456–62.
[15]. Sbia R, Shahbaz M, Hamdi H. A contribution of foreign direct investment, cleanenergy, trade openness, carbon emissions and economic growth to energydemand in UAE. Econ Model 2014; 36:191–7.
[16]. Shahbaz M, Lean HH, Shabbir MS. Environmental Kuznets curve hypothesis inPakistan: cointegration and Granger causality. Renewable Sustainable EnergyRev 2012; 16:2947–53.
[17]. Shahbaz, M., Ozturk, I., Afza, T., & Ali, A. (2013). Revisiting the environmental Kuznets curve in a global economy. Renewable and Sustainable Energy Reviews, 25, 494-502.

SulemanLawalGambo "Energy used, economic growth and environmental quality in Malaysia: An Application of ARDL Quadratic Model." IOSR Journal of Humanities And Social Science (IOSR-JHSS). vol. 23 no. 2, 2018, pp. 31-38.