An Econometric Study of Effect of Renewable Energy Development On Carbon Emissions Reduction In Germany : The ARDL/bounds test approach

دراسة قياسية لأثر تطوير الطاقات المتجددة على تخفيض التدهور البيئي في: باستخدام نموذج الانحدار الذاتي للفجوات الزمنية الموزعة المتباطئة

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Abstract: This paper adopts the Autoregressive Distributed Lag (ARDL)/bounds test approach to study the dynamic effect of renewable and non-renewable energy consumption on Carbon Emissions Reduction in Germany , from 1990 to 2018.Our results indicate that a long-running equilibrium relationship exists between carbon emissions and its determinants. According to the variance decomposition of carbon dioxide emissions, the use of non-renewable energy consumption has a positive and notable influence on CO2 emissions, compared to other variables. On the other the results, we find that the use of renewable energy would remarkably reduce carbon emissions. The findings of our study will help policy makers develop energy-saving and emission-reduction policies.

Keywords: renewable energy; economic growth ; Carbon Emissions ; Germany ; ARDL/bounds test approach

Résumé : Cet article adopte de Autoregressive Distributed Lag (ARDL)/bounds test approach pour étudier l'effet dynamique de la consommation d'énergie renouvelable et non renouvelable sur la réduction des émissions de carbone en Allemagne, de 1990 à 2018.Nos résultats indiquent qu'il existe une relation d'équilibre à long terme entre les émissions de carbone et ses déterminants. Selon la décomposition de la variance des émissions de dioxyde de carbone, l'utilisation de la consommation d'énergie non renouvelable a une influence positive et notable sur les émissions de CO2, par rapport à d'autres variables. De l'autre, les résultats, nous constatons que l'utilisation des énergies renouvelables réduirait remarquablement les émissions de carbone. Les résultats de notre étude aideront les décideurs à élaborer des politiques d'économie d'énergie et de réduction des émissions.

Mots-clés: énergies renouvelables; croissance économique ; Émission de dioxyde de carbone ; Allemagne ; ARDL/bounds test approche

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ملخص: تعتمد هذه الورقة البحثية على استخدام منهجية الانحدار الذاتي للفجوات الزمنية الموزعة المتباطئة لدراسة التأثير الديناميكي لاستهلاك الطاقات المتجددة وغير المتجددة على خفض انبعاث ثاني أكسيد الكربون في دولة المانيا خلال الفترة من 1990 إلى 2018، ووفقا للنتائج تم التوصل إلى وجود علاقة توازن طويل الأجل بين متغير انبعاث الكربون ومحدداته، كما تم التوصل إلى أن متغير استهلاك الطاقة غير المتجددة له أثر ايجابي على انبعاث ثاني أكسيد الكربون في حين أن متغير استهلاك الطاقات المتجددة من شأنه أن يقلل بشكل كبير من انبعاث ثاني أكسيد الكربون في دولة المانيا. كما ستساعد نتائج دراستنا صناع السياسات على تطوير سياسات لتوفير الطاقة وخفض انبعاث الكربون.

الكلمات المفتاح : الطاقات المتجددة؛ النمو الاقتصادي؛ انبعاث الكربون؛ المانيا؛ منهجية Ardl/bound test

I- Introduction :

Nowadays, Energy strategy is of high priority in countries to face challenges for shortages of crude oil and increases its capabilities to meet the continuous increasing demand for energy, Non-renewable energy has fueled the world economic growth for many decades The depletion of non-renewable energy sources and the problem of global warming however, have recently attracted wide attention toward developing alternative energy sources Including investment in renewable energies. In this context, the primary production of renewable energy is witnessed to increase by an average growth rate of 4.3% and it is increased by 174% from 1990 to 2015 (IEA, 2015) . The exponential increase of energy consumption and the rapid growth of pollutant emissions is expected to have a noticeable effect on the global environment: rising of global temperatures, erratic climate and weather extremes and altered ecosystems and habitats ; All of these effects present increasing challenges for energy production and use and are increasingly playing a role in the design of future energy systems and energy policies.

Germany was chosen because it is the largest energy using country in the European Union (EU). Although Germany has increased in dependence on coal and imported petroleum products in recent years, it has started adding more renewable capacity in its energy mix. According to NRE (2017), Renewable energy in Germany is mainly based on wind, solar and biomass. Germany had the world's largest photovoltaic installed capacity until 2014, and as of 2016, it is third with 40 GW. It is also the federal government is working to increase renewable energy commercialization. and its edging ever closer to its national target of 65% renewable energy by 2030, market forces and Mother Nature have ensured that throughout 2018, renewable energy will cover at least 38% of Germany's total electricity consumption.

I.1. To answer the main question, we ask the following sub-questions:

In this regard, this study will focus more on the CO2 emissions and renewable and non-renewable energy consumption. Accordingly, the following question is posed: What is the Effect of Renewable Energy Development On Carbon Emissions Reduction in Germany? and Is the development of renewable energy really limits CO2 emissions and boosts economic growth in Germany?

I. 2. The approach and objectives of the study:

This study followed a quantitative approach to test the existence of effects of renewable and non-renewable energy consumption and on CO2 emissions by using the Autoregressive distributed lag (ARDL) bounds approach for co- integration in order to test the long run relationship between the variables subject of study.

The rest of the paper is organized as follows. Section 2 provides a brief review of the literature. Section 3 explains the model specification, data and methodology. Section 4 discusses the empirical results. Section 5 concludes the paper.

II– Literature review

Many empirical studies have examined whether or not there exists a mutual relationship between CO2 emissions, economic growth, renewable and non-renewable energy consumption. Some empirical studies found a direct relationship that comes from renewable and non-renewable energy to stimulate the CO2 emissions of a country. Other studies viewed the relationship between these variables from another aspect; particularly that economic growth, renewable and non-renewable energy induces CO2 emissions growth. However, still other studies found inconclusive results about this relationship. This difference in results is due to different economic conditions of different countries in addition to the studied period and the used variables.

In the same line of research, (Shakouri & Soheila, 2018, pp. 121-127.) found a Granger causality results show that there is a unidirectional relationship from CO2 emissions to urbanization, and there is no causality between renewable energy consumption and CO2 emissions. as a result of their study conducted based on data in the period of 1992–2014 in the EU Countries Using panel data approach (DOLS and FMOLS) In the same research field, (Shakouri & Soheila, 2018, pp. 53-59.), The empirical results show that the findings do not support the environmental Kuznets curve between real GDP and CO2 emissions, as a result of their study conducted based on data in the period of 1995- 2014 in the Germany, Using autoregressive distributed lag (ARDL) approach. In another study by (Burhan & Özgür, 2015, pp. 2766-2777.) for the Turkey context, the relationship between economic growth and renewable energy consumption is examined for the period 1980–2013. Empirical evidence shows that, based on the Granger Causality Test, there is bi-directional Granger causality exists between economic growth and renewable energy consumption, results indicate that the renewable energy consumption cause real GDP, which can explain the role of renewable energy in stimulating economic growth in Turkey. (Yulong & et Al, 2019, pp. 208-216.) explore the relationship between RES consumption and GDP in China. Their analysis uses an econometric Based on the autoregressive distributed lag (ARDL) bounds testing approach and vector error correction model (VECM) Granger causality approach, Long-run results show that estimates show that increasing non-renewable energy and GDP increases CO2 emission, whereas renewable energy and foreign trade have a negatively impact on CO2 emissions.

(Nuno, 2014, pp. 393-397.), estimated a long run relationship between the economic growth, carbon dioxide emissions, renewable energy and globalization, that data used were annual covering the period 1970 to 2010, in Portuguese economy. they used a multivariate time series (OLS estimator, GMM, unit root test, and Granger causality) to estimate the long run relationship. they found a positive support for a long run association between variables, however, they also found that carbon dioxide emissions and renewable energy are positively correlated with economic growth. The econometric models also show that the overall index of globalization has a positive effect on growth. The Granger causality reports a unidirectional causality between renewable energy and economic growth. Also, The rise in the renewable energy consumption is the evidence of stabilization efforts initiated by the officials to encounter the escalating level CO_2 emissions.

(Shahbaz & et Al, 2017, pp. 09-25.), (Shafiei & Salim, 2014, pp. 07-25.), (Emeka & Aham, 2016, pp. 1-03.) These studies explore the determinants of CO_2 emissions,The empirical results show that non-renewable energy consumption increases CO_2 emissions, whereas renewable energy consumption decreases CO_2 emissions. (Syed & et Al, 2018, pp. 31619–31625) examine the relationship between renewable energy consumption and non-renewable energy consumption and CO_2 emissions for Pakistan by using auto-regressive distributive lag (ARDL) model of data from 1970 to 2016. The disaggregate analysis reveals that renewable energy consumption has an insignificant impact on CO_2 emission in Pakistan and that, in the non-renewable energy model, natural gas and coal are the main contributors to the level of pollution in Pakistan. Economic growth positively contributes to CO_2 emission in the renewable energy model but not in the non-renewable energy model.

In a study conducted by (Basak, 2016, pp. 600-604.), the determinants of Renewable Energy Consumption were investigated for Balkan countries (1998-2011). Hence, this was done using dynamic panel data analysis. Based on the analysis results it was found that there is a negative and statistically significant relationship between economic growth and renewable energy consumption. On the other hand, trade openness and natural gas rents are determined to have a positive effect on renewable energy consumption in the Balkans. On the other hand, in an analysis carried out by (Davoud & et Al, 2015, pp. 101-108) analyzed determinants of renewable energy consumption in Economic Cooperation Organization (ECO) countries, over the period 1992-2011and its drivers. The results indicate that the institutional circumstance variables are main determinant of renewable energy consumption in ECO countries and in contrast of last studies that have investigated the renewable energy consumption in developed countries, price of fossil energy, economic growth, FDI, carbon dioxide emission or financial development have not significant effect.

In Malaysia, (Haseeb & et Al, 2019, pp. 272-274) ; investigated the role of renewable energy in influencing economic well-being. The study utilized the sample of quarterly observation from the time frame of 1980 to 2016. By applying ARDLs methodology, the outcomes of the study established that renewable energy consumption is significant to influencing economic well-being advancements of Malaysia in long run. It is therefore recommended that the policymakers are required to focus on the green energy generation sector by increasing renewable energy production from the existing sources.

Table 01; present an overiew of empirical studies of hypothesis on the causality the relationship between CO_2 emissions (CO_2), renewable and non-renewable energy consumption (RE, NRE), real GDP. For some countries that are most analyzed in the literature.

Starting from all these facts, we will try through econometric modeling to verify if the development of renewable energy really limits CO_2 emissions and boosts economic growth in Germany. in Germany during the period 1990-2018.

III- Methods and Materials:

This study analyzes the EKC hypothesis in Germany by using an annual time series data over the period 1990-2018, The data is derived from International Energy Statistics, World Development Indicators (WDI) and Emissions Database for Global Atmospheric Research (EDGAR). for the and to investigate the causal linkages between per capita CO2 emissions (CO2), renewable and non-renewable energy consumption (RE, NRE), real GDP and international trade (TR).among others, we develop a model based on the Following the literature studies:

$$CO2 = \alpha_0 + \alpha_1 RE + \alpha_2 NRE + \alpha_3 GDP + \alpha_4 TR + \varepsilon_t \; .....(1)$$

To reduce the variation and induce stationary in the variance-covariance matrix, the natural logarithmic form (Ln) is applied to all the variables. The log linear EKC equation to examine the longrun relationship between variables is given as follow:

$$LnCO2 = \alpha_0 + \alpha_1 LnRE + \alpha_2 LnNRE + \alpha_3 LnGDP + \alpha_4 LnTR + \varepsilon_t \; .....(2)$$

To estimate equation (2) in the long run, we will use the ARDL model used by Pesaran and Shin (1999) and then extended by Pesaran et al. (2001), as the ARDL methodology does not require that the time series of the variables under study are not of the same rank, ie, both the I (0) and the I (1) Provided that the time series of the variables under study are not in the second difference I (2). The ARDL methodology is characterized by a set of characteristics that distinguish it from other standard methods., (Emeka & Aham, 2016, pp. 64-68) (Saed K & Michel, 2011, pp. 2-3.), (Dickey & Fuller, 1979, pp. 427-431)

- ✓ All variables of the model are assumed to be endogenous.
- ✓ Bounds test method for cointegration is being applied irrespectively the order of integration of the variable.
- ✓ There may be either integrated first order I(1) or I(0).
- ✓ The short-run and long-run coefficients of the model are estimated simultaneously. An ARDL representation of equation (1) is formulated as follows:

$$\Delta \mathrm{LNCO2}_t = c + \alpha_1 \mathrm{LNCO2}_{t-1} + \alpha_2 \mathrm{LNRE}_{t-1} + \alpha_3 \mathrm{LNNRE}_{t-1} + \alpha_4 \mathrm{LNGDP}_{t-1} + \alpha_5 \mathrm{LNTR}_{t-1} + \sum_{i=1}^{p} \beta_{1i}\, \Delta\mathrm{LNCO2}_{t-i} + \sum_{i=0}^{p} \beta_{2i}\, \Delta\mathrm{LNRE}_{t-i} + \sum_{i=0}^{p} \beta_{3i}\, \Delta\mathrm{LNNRE}_{t-i} + \sum_{i=0}^{p} \beta_{4i}\, \Delta\mathrm{LNGDP}_{t-i} + \sum_{i=0}^{p} \beta_{5i}\, \Delta\mathrm{LNTR}_{t-i} + break_t + \gamma_t + \varepsilon_t \; ..03$$

Where Δ denotes the first difference operator ; break is the dummy varaible that captures the regime change in the model, c is an intercept, t refers to time period in years from 1990 to 2018 and ε_t is the usual white noise residuals. The left hand side is the carbon dioxide emissions (CO2), the first until fourth expressions $(\alpha_1 - \alpha_5)$ on the right hand side correspond to the long run relationship. the remaining expressions with the summation sign $(\beta_1 - \beta_5)$ represent the short run dynamics of the model, to investigate the presence of long relationships among the (CO2, RE, NRE, GDP, TR), the lag (p) is determined using the VAR optimal model, which means that the lag minimizes the Akaicke (AIC), Schwarz (SIC) and Hannan-Quinn (HIC) information criteria.

After regression of Equation (03), the Wald test (F-statistic) was computed to differentiate the long-run relationship between the concerned variables, bound testing under Pesaran et al (2001) procedure is used , the bound testing procedure is based on the F test. The F test is actually a test of the hypothesis of on coinetegration among the variables against the existence or presence of cointegration among the variables denoted as : Ho: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = 0$, i.e., there is no cointegration among the variables Ha : $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq \alpha_5 \neq 0$, i.e., there is cointegration among these varibles. Therefore, if the computed F-statistic is smaller than the lower bound value, then the null hypothesis is not rejected and we conclude that there is no long-run relationship between. Conversely, if the computed F-statistic is greater than the upper bound value, then carbon dioxide emissions (CO2) and its determinants share a long-run level relationship. On the other hand, if the computed F-statistic falls between the lower and upper bound values, then the results are inconclusive.

Once the null hypothesis of no cointegration is rejected, and cointegration is established, in the second step, the conditional ARDL long-run model that captures the long-run dynamic may be estimated as (04) where the orders of the ARDL(q1,q2, q3, q4,q5) model are selected by using AIC.

$$\mathrm{LNCO2}_t = c + \sum_{i=1}^{q1} \alpha_{1i}\,\mathrm{LNCO2}_{t-i} + \sum_{i=0}^{q2} \alpha_{2i}\,\mathrm{LNRE}_{t-i} + \sum_{i=0}^{q3} \alpha_{3i}\,\mathrm{LNNRE}_{t-i} + \sum_{i=0}^{q4} \alpha_{4i}\,\mathrm{LNGDP}_{t-i} + \sum_{i=0}^{q5} \alpha_{5i}\,\mathrm{LNTR}_{t-i} + break_t + \gamma_t + \varepsilon_t \ldots\ldots\ldots (04)$$

Finally, the end step aims to estimate the error correction model for the short-run by using the ordinary least squares method and the AIC and SIC to select the order of the ARDL (p1, p2, p3, p4, p5). This model may be written as follows:

$$\Delta\mathrm{LNCO2}_t = c + \alpha_1 + \sum_{i=1}^{p1} \beta_{1i}\,\Delta\mathrm{LNCO2}_{t-i} + \sum_{i=0}^{p2} \beta_{2i}\,\Delta\mathrm{LNRE}_{t-i} + \sum_{i=0}^{p3} \beta_{3i}\,\Delta\mathrm{LNNRE}_{t-i} + \sum_{i=0}^{p4} \beta_{4i}\,\Delta\mathrm{LNGDP}_{t-i} + \sum_{i=0}^{p5} \beta_{5i}\,\Delta\mathrm{LNTR}_{t-i} + \Delta break_t + \gamma_t + \mu\mathrm{ECM}_{t-1} + \varepsilon_t \ldots\ldots\ldots (05)$$

In addition, the stability of the error correction model (eq.05) was checked by the Cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests (paul, 2010, pp. 1049-1053).

IV- Results and discussion :

The results of the analysis are organized in a sequential order as first some importante descriptive stats are presented second the test of Stationary is applied through (ADF) and (PP), we have to check for the lag selection criteria and in the end we examine the long-run relationship of the model through (ARDL) and short-run relationship of the variables through (ECM), and stability of the functions was also tested by CUSUM and CUSUMSQ.

The series for CO2 emissions, non-renewable energy consumption (NRE) and renewable energy consumption (ER), real GDP and international trade (TR) are presented in the figure1.in Appendix

4.1.Result of Descriptive Statistics :

Table 02 ; Shows the descriptive statistics of the variables used in our study, the mean of CO2 emissions is a amounted to 3.21 metric tons per capita with the standard deviation 81020.7 metric tons per capita over the period of 1990-2018, the CO2 emissions can achieve as high as 929973 metric tons per capita or as low as 719883 metric tons per capita throughout these 29 years. The statistic of Skewness reveals that carbon dioxide emissions (CO2), Renewable energy consumption (RE), trade openness (TR).are skewed to right while, GDP and non-renewable energy consumption (NRE) has the left side skewness. Furthermore the natural logarithmic form (Ln) is applied to all the variables to reduce the variation and induce stationarity in the variance covariance matrix.

4.2.Result of Unit Root Test :

We start by applying the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) unit root tests to each individual series, in order to conclude whether the series are stationarity or not.

Appendix (3a, 3b) of the list of Appendices; presents the results of the ADF and PP unit root tests for the Five variables both at level and first difference of the natural log values. Interestingly, all the variables in ADF test are nonstationarity at level except for GDP and RE . The variables turn into stationary when they are first differenced at 1% significance level while RE is the only variable significant at 5% level. Besides, PP test produces results similar to ADF test. Only GDP and RE achieves stationarity at level while other variables such as TR, NRE, CO2 emissions become stationary at first difference with 5% significance level. As all the variables are found to have the order of I(0) and I(1), we choose to employ ARDL bound test in order to determine the long-run cointegration between GDP, RE, NRE, TR, with CO2 emissions in Germany.

4.3.Result of ARDL Bound Test

The second step was the estimation of a basic ARDL model that explains carbon dioxide emissions (CO2) and its determinants. To determine the lag structure for the regressors in the model, the ARDL(1.0.1.1.0) model is chosen that minimizes the Schwarz criterion (SC). (Table 04, figure 02); shows the estimates of the selected parsimonious ARDL model specification. It is important to have statistically desirable parameter estimates for the further steps of the analysis. For this purpose, a number of diagnostic tests were performed for the modem. The diagnostic tests results are provided in the bottom panel of table 04; The selected ARDL(1.0.1.1.0) model passes the reported diagnostic tests (JB normality test, ARCH test, Breusch–Godfrey serial correlation LM).

In the third step, the estimated ARDL(1.0.1.1.0) model was used as basis for applying the bounds test to examine the lon-run cointegration relationship among carbon dioxide emissions (CO2) and its determinats. The results of the bounds test are presented in Table 05 in Appendix.

In Table 05 ; the results of the bounds cointegration test demonstrate that the null hypothesis of against its alternative is easily rejected at the 5% significance level, the computed F-statistic of 7.35 is greater than the lower critical bound value of 2.56 thus indicationg the existence of a steady state long-run relationship among carbon dioxide emissions (CO2) and its determinats.

4.4..Result of Long and short-Run relationship

In the fourth step. The long run results of ARDL method of estimation is displayed In Table 06 the long-term relationship among the variables is estimated through the OLS the coefficients obtained from the model are all significant and shows the long-run relationship of the variables. Also, Long-run results show that estimates show that increasing non-renewable energy consumption, and GDP increases CO2 emission, whereas renewable energy consumption and foreign trade have a negatively impact on CO2 emissions. This result is consistent with the finding of Yulonget al (2019) and Yazdi and Shakouri (2018) and Mirza et al. (2018).

Renewable Energy consumption is found to be negatively related to CO2 emission in the long run. The CO2 emission is diminished by 1.78% with one percent increase in Renewable Energy consumption. The result indicates that renewable energy really limits CO2 emissions and boosts economic growth in Germany. it does not promote the consumption of renewable electricity in Malaysia. This finding is in line with the result reported by (Shahbaz and Al, 2017), (Sahar and Ruhul, 2014), (João-Paulo and Victor, 2016). Show that, in the long term, GDP and non-nenewable Energy consumption have impact on CO2 emissions. The first variable has a positive impact and the second a positive one.

The short run results of ARDL method of estimation is displayed in Table 06. The findings displayed a valid short run relationship between carbon dioxide emissions (CO2) and its determinats in Germany. the coefficient of error term is displaying the value of around -0.63 propose that around 63% of instability is adjusted in the present year. Results also error correction coefficient (ECTt-1), is negative and significant at 5%, the coefficient indicates the adjustment speed to restore equilibrium in the dynamic model, that is the effect of a shock will be corrected by 63% with a year.

4.5.Result of Stability Test

The results of the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) of the standardized recursive residuals are used to check the stability of the ARDL error-correction model as proposed by (Brown & Evans, 1975, pp. 149-192). The plots of both CUSUM and CUSUMSQ statistics are provided in Figure 03. As it is clear from Figure. 03, the plots of both the CUSUM and CUSUM square within the boundaries and hence these statistics confirm the stability of the long run coefficients of regressors.

V- Conclusion:

This paper has estimated the impact of the renewable energy and non-renewable on the CO2 emissions of Germany by using time series data from 1990-2018 by employing ARDL and bounds test approach. The analysis demonstrates that in the long-run, show that estimates show that increasing non-renewable energy, consumption growth, and GDP increases CO2 emission, whereas renewable energy and foreign trade have a negatively impact on CO2 emissions. The short run results show tha relationship between carbon dioxide emissions (CO2) and its determinats in

Germany. The findings of our study will help policy makers develop energy-saving and emission-reduction policies.

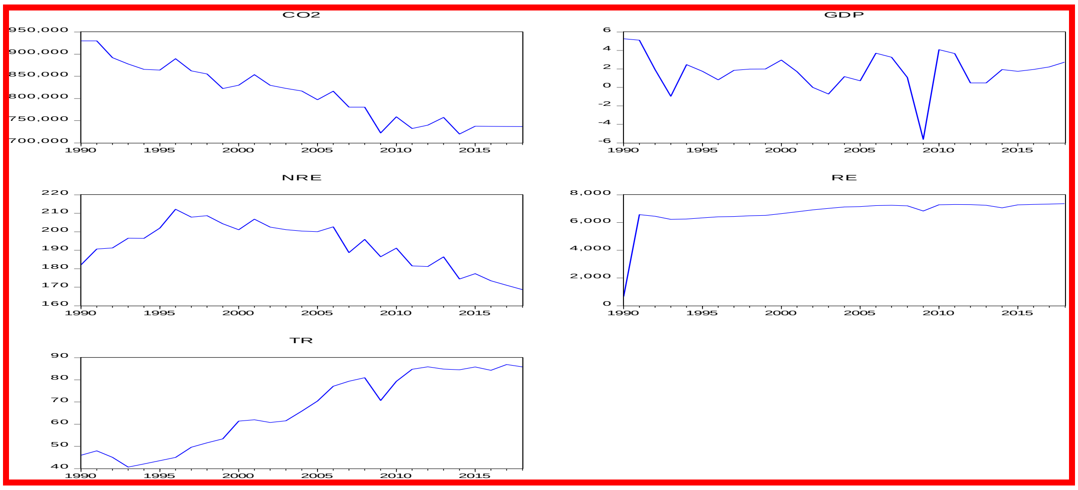
VI- Appendices:

Table (1) . Overview of selected studies

Study	Countries	Period	Methodology	Results
Bahram and Yazdi	EU Countries	1992–2014	A panel data	Co2 --- REC
Burhan and Ozgur	Turkey	1980–2013	Granger Causality Test	REC → GDP
Bahram and Yazdi	Germany	1995- 2014	The ARDL bounds test approach	No evidence of EKC hypothesis
Chen, et Al	China	1980–2014	The ARDL bounds test approach	EKC hypothesis exist
Nuno Carlos Leitão	Portuguese	1970- 2010	Granger causality for VEC model	REC ↔ GDP REC → CO2
Basak Gul Akar	Balkan	1998-2011	Dynamic panel data method	REC → GDP
Mehrara et Al	OECD countries	1992-2011	Averaging and Weighted-Average Least Square	REC ↔ GDP REC → CO2
Haseeb, et Al	Malaysia	1980-2016	The ARDL bounds test approach	REC → GDP REC → CO2
Shahbaz et Al, 2017	Indian	1960-2015	The ARDL bounds test approach	NREC → GDP
Sahar and Ruhul	OECD countries	1980-2011	STIRPAT model	REC → GDP REC → CO2 NREC → GDP EKC hypothesis exist
João-Paulo and Victor	Italy	1960-2011	The ARDL bounds test approach	REC → CO2
Faisal et al	Pakistan	1970-2016	The ARDL bounds test approach	REC → CO2 NREC → CO2

Note: x → y - causality runs from x to y.
x ↔ y - bi-directional causality exists between x and y.
x---y - no causality exists between x and y

Figure (1):. Presents a schematic overview of the variables of this study



The source : Eviews 09 output

Table (2) : Descriptive Statistics

test	**CO2**	**GDP**	**NRE**	**RE**	**TR**
Mean	810203.7	1.714483	192.5114	6685.818	66.09759
Maximum	929973.0	5.260000	212.1600	7361.860	86.90000
Minimum	719883.0	-5.620000	168.6600	664.9600	40.64000
Std. Dev.	64253.53	2.060032	12.28850	1219.889	16.67533
Skewness	0.180740	-1.327507	-0.369401	4.323496	0.140684
Kurtosis	1.882906	6.893833	2.032142	21.97713	1.463051

The source : Eviews 09 output

Table (3) 3a Unit root test;(ADF)

UNIT ROOT TEST TABLE (ADF)						
	At Level					
		LNCO2	LNGDP	LNNRE	LNRE	LNTR
With Constant	t-Statistic	-1.6132	-4.2361	0.5714	-39.7075	-0.7133
	Prob.	*0.4624*	*0.0032*	*0.9861*	*0.0001*	*0.8274*
		n0	***	n0	***	n0
With Constant & Trend	t-Statistic	-3.9803	-4.5154	-2.5097	-85.2804	-1.8403
	Prob.	*0.0215*	*0.0131*	*0.3212*	*0.0000*	*0.6578*
		**	**	n0	***	n0
Without Constant & Trend	t-Statistic	-2.6048	-2.7473	-1.0035	0.7854	1.9315
	Prob.	*0.0113*	*0.0080*	*0.2753*	*0.8771*	*0.9848*
		**	***	n0	n0	n0
	At First Difference					
		d(LNCO2)	d(LNGDP)	d(LNNRE)	d(LNRE)	d(LNTR)
With Constant	t-Statistic	-8.9941	-5.9814	-8.2024	-107.1826	-4.6427
	Prob.	*0.0000*	*0.0001*	*0.0000*	*0.0001*	*0.0010*
		***	***	***	***	***

With Constant & Trend	t-Statistic	-9.1095	-5.9394	-10.3484	-99.3763	-4.5498
	Prob.	*0.0000*	*0.0003*	*0.0000*	*0.0000*	*0.0062*
		***	***	***	***	***
Without Constant & Trend	t-Statistic	-7.7961	-6.1189	-8.1472	-108.0655	-4.2566
	Prob.	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0001*
		***	***	***	***	***

The source : Eviews 09 output

Table (3) 3b Unit root test;(PP)

UNIT ROOT TEST TABLE (PP)						
	At Level					
		LNCO2	LNGDP	LNNRE	LNRE	LNTR
With Constant	t-Statistic	-1.4592	-5.4682	-0.5008	-20.7582	-0.6845
	Prob.	*0.5390*	*0.0001*	*0.8768*	*0.0001*	*0.8349*
		n0	***	n0	***	n0
With Constant & Trend	t-Statistic	-3.9803	-5.0851	-2.9759	-51.2265	-1.8403
	Prob.	*0.0215*	*0.0019*	*0.1561*	*0.0000*	*0.6578*
		**	***	n0	***	n0
Without Constant & Trend	t-Statistic	-4.3165	-2.6745	-0.5318	0.7949	2.0816
	Prob.	*0.0001*	*0.0096*	*0.4774*	*0.8788*	*0.9890*
		***	***	n0	n0	n0
	At First Difference					
		d(LNCO2)	d(LNGDP)	d(LNNRE)	d(LNRE)	d(LNTR)
With Constant	t-Statistic	-9.0380	-9.4432	-7.8810	-147.9893	-4.6333
	Prob.	*0.0000*	*0.0000*	*0.0000*	*0.0001*	*0.0010*
		***	***	***	***	***
With Constant & Trend	t-Statistic	-9.4057	-11.9687	-11.1773	-138.1671	-4.5373
	Prob.	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0064*
		***	***	***	***	***
Without Constant & Trend	t-Statistic	-7.5581	-9.8172	-7.7766	-115.7562	-4.2566
	Prob.	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0001*
		***	***	***	***	***

The source : Eviews 09 output

Table (4):. The estimates of the ARDL(1.0.1.1.0) model.

Selected Model: ARDL(1, 0, 1, 1, 0)
Note: final equation sample is larger than selection sample

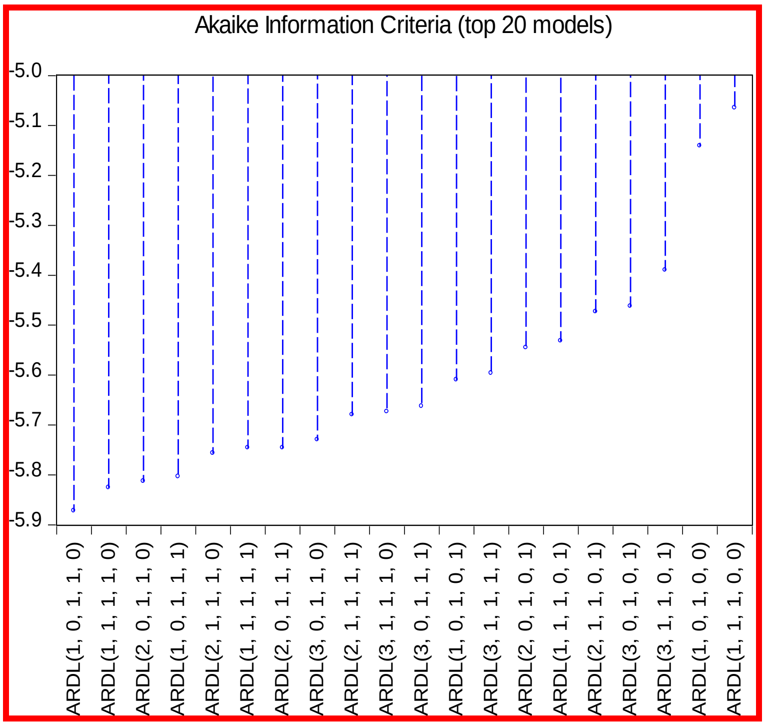
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LnCO2(-1)	0.671525	0.148843	4.511644	0.0002
LnGDP	0.004608	0.005677	0.811764	0.4270
LnNRE	0.788567	0.141562	5.570454	0.0000
LnNRE(-1)	0.650732	0.162747	3.998434	0.0008
LnRE	-0.261029	0.233330	-1.118714	0.2772
LnRE(-1)	-0.004014	0.011139	-0.360312	0.7226
LnTR	-0.077200	0.072387	-1.066487	0.2996

C	1.784986	2.231251	0.799993	0.4336

R-squared	0.970089	Mean dependent var	13.59580
Adjusted R-squared	0.959069	S.D. dependent var	0.076844
S.E. of regression	0.015547	Akaike info criterion	-5.248753
Sum squared resid	0.004592	Schwarz criterion	-4.864801
Log likelihood	78.85816	Hannan-Quinn criter.	-5.134584
F-statistic	88.03028	Durbin-Watson stat	1.632154
Prob(F-statistic)	0.000000		

The source : Eviews 09 output

Figure (2):.. The lag order selection by Akaike criteria



The source : Eviews 09 output

Table (5). The results of the ARDL/bounds test.

Test Statistic	Value	k
F-statistic	7.355378	4

Critical Value Bounds

Significance	I_0 Bound	I_1 Bound
10%	2.2	3.09
5%	2.56	3.49

2.5%	2.88	3.87
1%	3.29	4.37

The source : Eviews 09 output

Table (6). Results using ARDL Approach (Long and short-Run relationship)

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LnGDP)	0.002949	0.003562	0.828052	0.4179
D(LnNRE)	0.766951	0.094527	8.113553	0.0000
D(LnRE)	-1.241799	0.047733	-5.065631	0.0001
D(LnTR)	-0.026056	0.045043	-0.578458	0.5697
CointEq(-1)	-0.307791	0.056459	-5.451588	0.0000

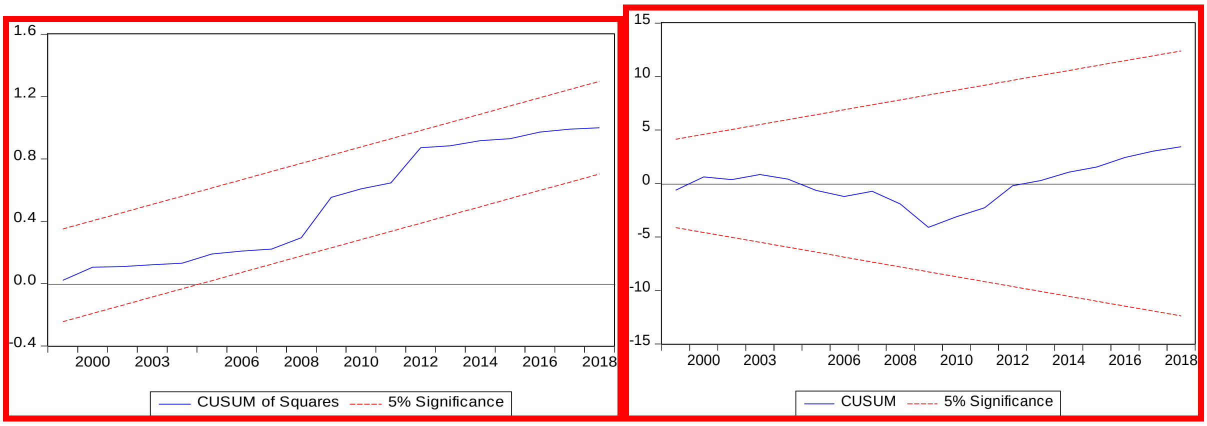
Cointeq = LNCO2 - (0.0140*LNGDP + 0.4196*LNNRE - 0.7825*LNRE -0.2350*LNTR + 5.4342)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LnGDP	0.014029	0.019369	0.724313	0.4777
LnNRE	0.419620	0.212075	1.978645	0.0625
LnRE	-1.782451	0.688770	-1.136012	0.0701
LnTR	-0.235024	0.165181	-1.422831	0.0010
C	5.434152	5.635120	0.964337	0.0070

The source : Eviews 09 output

Figure (3): Plot of cumulative sum (CUSUM) and CUSUM of squares tests for the equation of CO2 emission



The source : Eviews 09 output

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