Environmental Kuznets Curve: An Application of Heterogeneous Panel Methods Robust to Cross Sectional Dependence and Structural Breaks

Author: Iqra Mazhar,

Institution: Pakistan Institute of Development Economics

Abstract:

The present study aims to compare the estimates of different panel data estimation techniques by taking the example of Environmental Kuznets Curve (EKC). Plethora of research is available to determine relationship between environmental degradation and output. However in literature it is evident that when the assumptions of estimation technique change, coefficients also get changed (Stern 2003). Therefore; it is important to reinvestigate the EKC using several panel data techniques. The primary objective of this study is to estimate the heterogeneous parameters and finding the cross sectional dependence of the large sample panel data. For this purpose, the present study will not only rely on conventional panel data techniques but will also use 2^{nd} generation tests of cointegration. Further presence of structural breaks is also a phenomenon which cannot be ignored in presence of long panel data.

Introduction:

There is a plethora of research which provides the number of studies on the use of various estimation methodologies of panel data for various environmental related issues in the niche of economics. However; all the techniques have some advantages over other depending on the length and width of the panels. More specifically, panel data commonly uses four procedures. These are averaging group, aggregating estimates, pooling and cross-section regression.

We can also group data in two further categories, static and dynamic panel series. Pesaran (2006) illustrated in his study that pooling or aggregating dynamic heterogeneous panels can yield deceptive inferences. Furthermore, in dynamic models the frequently used hypothesis of homogeneity is too away from the reality. More clearly, most of the estimation techniques in the panel data econometrics assume that the slope parameters are homogenous among the cross sections. Therefore, the inferences cannot vary from cross sectional unit to unit. Moreover, when there is long panel data, where time series observations are large, then the problems of time series data also arise in the series. Hence, testing the stationarity is starting point in such series otherwise the results obtained are spurious and misleading. The tests designed for checking cross sectional dependence by the second generation techniques and the serially uncorrelated first generation methods are different. Also, some studies allow for structural breaks in presence of cross sectional dependence. But, there are number of flaws in these unit root tests. Although, some tests can be applied under the alternative hypothesis to liberate the restriction on the homogeneous coefficient, but using it might ensure limitations. Several tests of unit root were developed by Im et al. (2003) for the random coefficients in the model. The findings revealed that homogeneous constraints imposed on the auto regressive structure were being loosened. As, the so far formed tests of unit root for panel data are based on the individual unit root tests for time series data. So, we can deduce the outcomes from the panel unit root tests that: If the entire sample of countries reject the null hypothesis of the unit root test then it is not because the coefficients are stationary. Considering all the above arguments we considered dynamic heterogeneous panel data models and their techniques referring towards the work of Pesaran (2006). His work on multifactor error structure gave us a new approach of handling heterogeneous panels. Environmental Kuznets Curve (EKC) is considered as a postulated association among numerous variables of environmental degradation and economic growth. The concept of EKC was presented by Grossman and Krueger (1991) and promoted by the World Bank (Shafik and Bandyopadhyay). Researchers have explored a large variety of pollutants for validating the EKC hypothesis. Along with that, different studies have been experimented by using different econometric approaches. However, the debate remains open due to the differences in the sign, size, and significance. The controversy among the researches about the direction and the turning points of the curve motivates the researchers to further investigate the relationship between the carbon emission and the GDP. We are convinced that the sign, size and significance are really sensitive to the choice of the estimation methodology. Therefore, we need to compare the findings of the different methodologies to guide the policy makers on a right track. The present study is conducted in this way.

Objectives:

The main objectives of this study are:

- To reinvestigate the connection among the deprivation of environmental condition and output growth by econometric techniques using a panel data of large sample size, considering three different groups of countries, that is, lower, middle and higher income countries.
- To consider cross sectional dependence and slope heterogeneity, along with them, will also check the presence of structural breaks in the series.
- The study will compare the results of presence of Kuznets curve from many of the techniques of panel data to find the biasedness in the coefficients.

Literature Review:

The worldwide environmental alarms owing to antagonistic climatic changes on the planet earth have moved the world economies towards the usage of green energy along with substantial drop in CO2 emission. The EKC studies can be distributed into three categories i.e. time series, cross sectional data studies and the study of panel data estimation techniques.

The world understood that there was a dramatic increase in the earth average temperature which resulted in studying the hypothesis of environmental Kuznets curve in 1990's. The researchers from environmental economics theorized Environmental Kuznets curve in the same period, which got alarming attention hastily. Grossman and Krueger (1992) found at that time that greenhouse gases especially CO_2 emission had been caused by the economies due to industrialization. So, the relationship between CO_2 emission and economic development was the first to be formed. According to the hypothesis; the environmental condition gets poor with the initial increase in the income.

After the relationship being developed between emission of carbon dioxide and economic events like energy usage, growth and foreign trade, researchers revealed that there is causality between these factors and emission and found that its direction may be same or different in some means and ways. Diverse studies came forward on different individual countries and showed different results because of the dissimilarity in economic policies and features of each country. In time series data, the existence of EKC in short run for small sample could not be determined. In case of Pakistan; Ahmed (2012) made an empirical analysis for the period 1971-2008. The study used Auto Regressive Distributed Lag (ARDL) bounds test approach; it showed that the EKC phenomena existed in the case of Pakistan and more interestingly, population density along with all the other variables was also a source of deprivation in environmental condition in Pakistan. The study exposed about a short run relationship between environmental degradation and output. An inverted U shaped relationship was established between carbon dioxide emission and growth of economy in the long run studies. Furthermore, trade openness, energy usage and population density also affected environmental degradation. Therefore, the theory claimed about the EKC to be a long-run phenomenon for the case of Pakistan.

Sebri (2016) analyzed the relationship between water footprints and economic growth using the cross sectional data. The study examined about the variation in the per capita water footprints as a function of per capita income while staying within the framework of

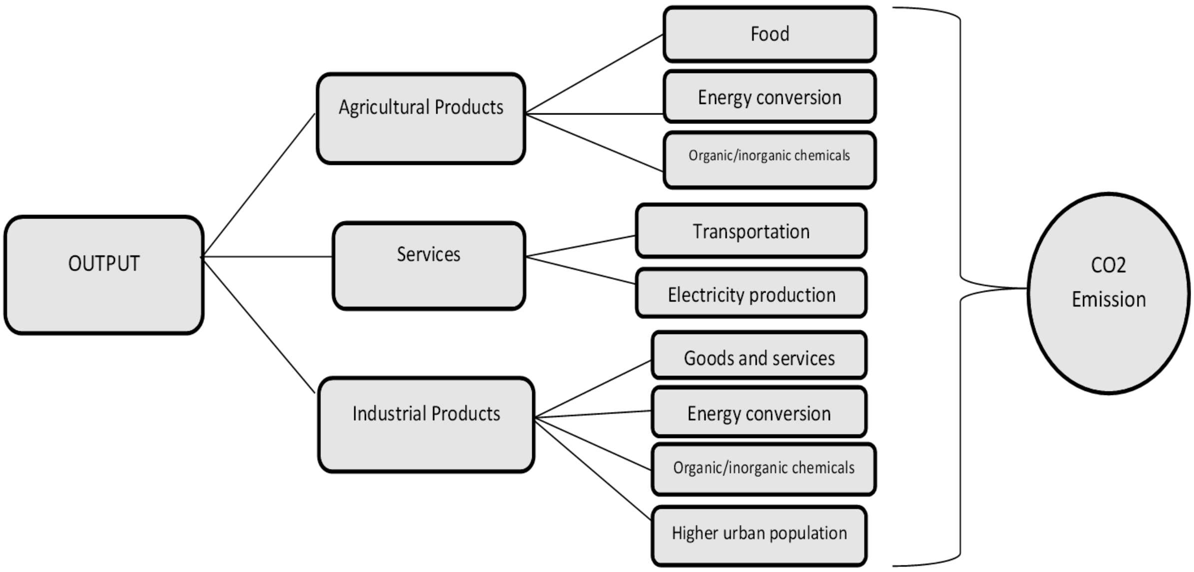
Environmental Kuznets curve. Moreover, the researcher also focused on the problem of the omitted variables by involving number of the controlled variables and found no evidence of an inverted u-shaped EKC. However, in many cases N-shaped relationship was evaluated which showed that; in the beginning there was a rise in the water footprints with an increase in income but then falls down with a very high increase in income.

Investigating the problems in estimating the environmental Kuznets curve, Wagner (2007) explained that the cloudy picture of EKC is due to the usage of bad econometric techniques. The key econometric problems were being discussed which had been ignored previously in the literature of environmental Kuznets curve (EKC). First was; in integrated regressors, usage of nonlinear transformation and in the second; the dependence of panel data cross-sectionally. He validated his claim by using different panel techniques of first generation in which the cross sectional dependence was ignored in the data and then the techniques of second generation which considered not only cross sectional dependence but also the slope heterogeneity within the data. Wagner (2007) found that such techniques were highly unsuitable for the usage of permanent cross-sectional dependence within the data.

Theoretical Model and Econometric Specification:

Economic growth depends on production of different sectors i.e. agriculture, industry and services, pollutants (Grossman; 1991, Panayotou; 1993, Jalil and Mahmud 2009, Farhani et al. 2014). Hence, economic degradation due to pollutants and output seems to be incompatible as whenever there will be economic growth, it will ruin the environment.

The following flow chart can explain a clearer picture.



In present study we are also taking the case of emission of CO_2. Similar to Begum et al. and Ahmed et al. (2016), we also assume that CO_2 is function of Y_t i.e. in production process different pollutants emit, which cause environmental degradation.

$$CO_2 = [F(Y_t)] \tag{3.1}$$

Following the seminal work of Stern (2004) the baseline equation for EKC is.

$$CO_2 = \beta_0 + \beta_1 Y_t + \beta_2 Y_t^2 \tag{3.2}$$

It is mentioned in the literature that during the initial growth stages of economy; due to economic expansion, pollution rises. While, the transformation of industrial economy to services economy is due to economic structure, the increase in pollution starts decreasing. But, usage of different types of economy and different keys of pollution give significantly varying results. Therefore, several relationships are offered; an inverted U shaped relationship, a linear relationship, an inverted L shaped and even an N shape, (Dinda, 2004; Kaika and Zervas, 2013) is also being proposed. Following Al- Mulali et al. (2015 a) we have also considered the role of trade in explaining the nexus of economic development and environmental degradation. The preceding papers for the individual countries made use of energy consumption for representing energy sector. Such as, Al-Mulali et al. (2015a) worked by using fossil fuels energy usage and renewable energy usage by considering them indicators of energy consumption for analyzing the case of Vietnam during the period of 1981 to 2011. The readings of Dina (2004), Shahbaz (2011) and formerly Panayotou (1997) designated population as one of the factors subsidizing towards the environmental degradation. Rate of economic development and population density are also important factors. The price of environment rises moderately with the growing economy and population.

Considering all these arguments, the econometric regression line can be written as:

$$LCO_{2it} = \beta_0 + \beta_1 LGDP_{it} + \beta_2 LGDP^2{}_{it} + \beta_3 LGDP^3{}_{it} + \beta_4 LRE_{it} + \beta_5 LTD_{it} + \beta_6 LUR_{it} + \beta_7 LFD_{it} + \mu_{it} \quad (3.3)$$

Where L CO_2 is the log of carbon dioxide emission depending upon the variables including log of gross domestic product (LGDP), the LRE; including log of geothermal, hydropower, solar, wind, tides, biomass, and biofuels, LTD is a log of trade openness which includes trade of goods log and services log as a degree of trade openness, LUR indicates log of urbanization and the cross domestic credit to the private sector log is used as sign of the financial progress dignified in millions of 2000 constant US dollars. βo is intercept, β_i denotes the slope coefficients where i varies from 1 to 6, and u_{it} represents Gaussian error term.

Estimation Methodology:

Estimation of Panel data is many times taken to be an efficient analytical approach in econometric data handling.

First generation panel unit root test:

First generation panel unit root tests considered cross sectional independence

Maddala and Wu (1999) test:

Maddala and Wu (1999) tried an improvisation till some level by giving a model that could also be used with panels in unbalance state to resolve the fallbacks of all former tests. Thinking that there are N unit-root tests, the MW is in the shape of

$$\Pi = -2\sum_{i=1}^{N} \ln \pi_i \tag{4.6}$$

Where Π_i is the probability limit value from regular DF (or ADF) unit-root tests for each cross-section i. Because -2$\ln(\Pi_i)$; has a x^2 distribution with 2 degrees of freedom, the Π statistic will follow a x^2 distribution with *2N* degrees of freedom as $T_i \to \infty$ for finite *N*. In order to consider the dependence between cross-sections, Maddala and Wu propose obtaining the Jr;-values by using bootstrap procedures by arguing that correlations between groups can induce significant size distortions for the tests.

So, to consider interdependence among the cross- sections within a data, Maddala and Wu proposed that attaining the values of πi by the method of bootstrapping through argument that the correlation among sets may be the cause of massive distortions in the size for the tests.

Second Generation Panel unit root tests:

Second generation panel techniques considered cross sectional dependence but without considering structural breaks within the series

Bai and Ng (2004) test:

Bai and Ng (2004) considered the possibility of unit root in the common factors. They are able to carry out separate unit root tests in the common and the idiosyncratic components. The specification used by Bai and Ng is given by the static factor model (assuming one factor for ease of comparison):

$$y_{it} = \alpha_{io} + \alpha_{i1}t + \gamma_i f_t + v_{it}$$

Where f_t is the common factor, γ_i the associated factor loadings, and v_{it} the idiosyncratic component assumed independently distributed of *ft*. The unit root properties of γ_{it} is determined by the maximum order of integration of the two series f_t and v_{it}. Hence, γ_{it} will be *I*(1) if either v_{it} or f_t contain a unit root. Averaging across *i* and letting *N*→∞, for each *t*, *v̄t*→0, if v_{it} is stationary, and $\overline{v_t} \rightarrow \infty$, where *c* is a fixed constant if v_{it} is *I* (1). Therefore, a unit root in f_t may be tested by testing the presence of a unit root in $\overline{\gamma_t}$ independently of whether the idiosyncratic components are *I* (0) or *I* (1).

Pesaran (2007) test:

Pesaran (2007) proposed a simple panel unit root test where the standard DF (or ADF) regressions are augmented with the cross section averages of lagged levels and first-differences of the individual seriesThe common factor has been introduced to model cross section dependence of the stationary components. As a result when testing Φ_i = 1, the order of integration of γ_{it} changes from being *I* (1) if f_t is stationary, to *I* (2) if f_t is *I* (1).

Panel Cointegration tests:

Second Generation Panel Cointegration tests

In the present we applied a panel cointegration test which considered cross sectional dependence along with the structural breaks within the series.

Westerlund and Edgerton (2008) test:

Westerlund and Edgerton (2008) panel cointegration test can be used. This test is based on the concept of considering not only the cross sectional dependence of the data but also the structural breaks within the data as well. Furthermore, Westerlund and Edgerton (2008) gave two statistics and the null hypothesis for both the statistics is "no cointegration".

Estimating Long Run and Short Run Elasticities:

Finally, we move towards estimating long term and short term Elasticities by CCEMG besides the PMG and MG estimators proposed by Pesaran (2006).

We tried to elaborate almost all the panel data techniques of first generation and second generation in this section and also mentioned the issues due to which the econometricians kept on proposing the new techniques. Therefore; considering the short comings of first generation panel techniques and the ignored factors, we applied second generation panel unit root and cointegration tests.

Data and Variables

This chapter has been organized to elaborate about the variables being used in our study and their significance and the other part explains about the type and source of data that why and from where the sample data has been collected.

The Country Sample:

We have considered the sample of lower, middle and higher income countries ranging from 1980-2016. By using the diversified sample, we will be able to check that whether the relationship whether U shape, L shape or N shape exist in all samples or vary in countries with different income levels.

Variables Construction:

For our case carbon dioxide emission is the key dependent variable and we took all the independent variables based on the assumptions.

CO_2 **Emission Per Capita:**

We are using CO_2 emission as our dependent variable, which is explained as stopping the scorching of fossil fuels and the cement production.

GDP Per Capita:

Gross Domestic Product (GDP) defines the worth of all the belongings and facilities that are manufactured in a country in a specific period. When GDP increases, after attaining a specific level the environmental situation starts getting better (Masih and Masih 1996; Wolde- Ruffel 2006; jalil and Mahumd 2009).

Trade:

CO_2 Emission, which is used as a proxy for environmental degradation, not only affected by GDP but there are some other arguments which may negatively affect the environment. For example; trade, energy emission and urbanization. Trade openness increases the scale of economy and through increase in scale pollution will increase. On the other hand, enhancement in trade will improve the techniques of production; which is known as technique effect; will improve the environmental situation (Ang 2009; Jalil and Mahmud 2009). Trade is defined as ratio of sum of imports and exports to GDP.

Urbanization:

Our study also analyses the impact of urbanization on CO2 emission. For urbanization, the number of people living in urban areas is being considered.

Energy:

Like the other indicators renewable energy also has a significant effect on carbon emission. EKC hypothesis was confirmed for five regions excluding Middle East, North Africa and Sub Saharan Africa because, in these areas renewable energy had no important impact on emitting carbon dioxide . So, this indicator will be considered as a factor of carbon emission for many regions in our study.

Financial development:

Plethora of literature is available which gives evidence about the strong influence of financial expansion on energy usage. Shahbaz et al. (2013b) gave empirical evidence and also indicated that financial development reduces CO_2 emissions. Considering the strong evidences about the effects on environment of financial development, we add broad money in percentage of GDP as a significant indicator in our analysis. The data of all these variables is collected from World Development Indicators (2016).

Estimation Results:

The empirical results of all the above discussion are present in this section.

Unit Root Test without Structural Breaks:

The panel unit-root tests results are shown in Table 6.1

As the table shows that the p-values of most of the coefficients in both the tests (Maddala and Wu and Pesaran) are larger than the critical value therefore, the null hypothesis is not rejected that means the unit root problem exists. . The study checked the stationarity of the series at first difference and second difference level and found the series are non-stationary.

H_o =The series is non- stationary

H_1 =The series is stationary

Table 6.1Panel unit root tests without structural breaks: p-values are given with null hypothesis that series is I (1).

	Lag 0	Lag1	Lag2
Maddala and Wu (1999)			
CO2 emission	0.2816	0.7501	0.9272
output	0.3064	0.0547	0.3574
output square	0.2961	0.2865	0.6108
Energy	0.7026	0.9563	0.9623
Trade	0.0441	0.7068	0.7545
financial development	0.3574	0.7665	0.8130
urbanization	0.7540	0.3405	0.5115
Pesaran (2007)			
CO2 emission	0.0795	0.5728	0.2082
output	0.0150	0.8547	0.9648
output square	0.2718	0.1117	0.4259
Energy	0.6587	0.5426	0.6298
Trade	0.5495	0.3527	0.8826
financial development	0.9004	0.8329	0.4662
urbanization	0.9538	0.7601	0.7273

As the table shows that the p-values of most of the coefficients in both the tests (Maddala and Wu and Pesaran) are larger than the critical value therefore, the null hypothesis is not rejected that means the unit root problem exists. The study checked the stationarity of the series at first difference and second difference level and found the series are non-stationary. To eliminate this problem, the study used Pesaran (2007) panel unit root test which assume the cross section dependence.

Panel unit root tests with structural breaks:

The con of the Pesaran (2007) test is that it doesn't consider the structural breaks in the estimations. For this reason, the study is using Bai and Carrion-i-Silvestre (2009) panel unit root test as it considers the case of structural breaks and cross section dependence. The results obtained are presented in Table 6.2, which shows that including the structural breaks do not modify the result of panel series. If the p-values of all the lag coefficients at constant and trend, mean shift and trend shift are more than the critical value; therefore, we do not reject the null hypothesis: series is I(1) that is the series is non- stationary. At the first difference, if the variables are stationary, the resulting step will be the evaluation of the long run relationship between the variables by using the panel cointegration test.

Table 6.2 Panel unit root tests with structural breaks: p-values are given with null hypothesis that

	Lag 0	Lag1	Lag2
Constant and trend			
CO*2 *emission	0.3565	0.8654	0.8117
output	0.8504	0.5617	0.7706
output square	0.3455	0.8751	0.2580
Energy	0.1271	0.2793	0.6501
Trade	0.8200	0.1725	0.6293
financial development	0.5043	0.3187	0.1576
urbanization	0.7646	0.0341	0.2336

Mean shift			
CO2 emission	0.9586	0.7602	0.3299
output	0.4049	0.7266	0.9533
output square	0.8885	0.4676	0.8314
Energy	0.5482	0.5322	0.7595
Trade	0.5232	0.3817	0.2126
financial development	0.8311	0.0455	0.1016
urbanization	0.2798	0.4546	0.0563
Trend shift			
CO2 emission	0.5701	0.2240	0.6995
output	0.9740	0.8577	0.9531
output square	0.0135	0.4570	0.9287
Energy	0.4549	0.8218	0.4265
Trade	0.6270	0.2444	0.0672
financial development	0.1858	0.6321	0.9319
urbanization	0.3269	0.3797	0.4996

Slope heterogeneity test:

As compared to the normal time series and cross section data, the heterogeneity and the serial correlation problem is more controlled in panel data (Baltagi, 2005). Next, the study will check the condition of slope homogeneity and two tests are used for this purpose, the standard version of Swamy's test and adjusted version of the Swamy's test adjusted for the small sample properties. The results are shown in Table 6.3. The table shows the rejection of the null hypothesis of homogenous slope parameters, which indicates the use of long run estimates.

Table 6.3 Slope heterogeneity test.	
Swamy’s stats	8.113
Adjusted Swamy’s stats	7.9133

Panel Cointegration Test:

Now the long run relationship between the variables will be estimated by using Westerlund (2007) and Westerlund and Edgerton (2008) panel cointegration tests. Westerlund (2007) test is valid when the heterogeneous panel data and cross section dependence is present, but the structural breaks are not considered. Therefore, to encounter structural breaks, the study will use Westerlund and Edgerton (2008) panel cointegration tests. Westerlund proposed four normally distributed tests, Gt, Ga, Pt, and Pa. The results found from the Westerlund's tests are slightly varied. The Gα and Pα tests outcomes show the acceptance of the null that is no cointegration, while Gt and Pt tests, at 10% significance level, show panel cointegration. The estimated results of Westerlund (2007) panel cointegration test are shown in Table 6.4 and Westerlund and Edgerton (2008) are shown in Table 6.5. The results presented show the rejection of null hypothesis that is no cointegration.

Table 6.4 Westerlund error correction panel cointegration tests.			
Null hypothesis:			
No cointegration			
Statistic Value p-Value Robust			
	Stats	p-value	Robust p-value
Gt	-3.911761	0.071039	0.00811
Ga	-5.557583	0.016742	0.006527
Pt	-6.369853	0.029981	0.002954
Pa	-19.36467	0.035232	0.009894
Note: Gt and Ga are the groups mean statistics. Pt and Pa are panel mean statistics.			

Table 6.5 Panel cointegration test results with structural breaks and cross sectional dependence.				
Model	Gt	Ga	Pt	Pa
No Break	5.845105	0.003756	3.11682E+14	0.055431
Mean Shift	2.467817	0.001847	2.777421332	0.024376
Regime Shift	4.427497	0.009593	2.054666029	0.0741
Note: The test is implemented using the Campbell and Perron (1991) automatic procedure to select the lag length.				

The next task is to estimate the long run and short run Elasticities. Several estimators are used for estimating the cointegration vector in the literature based on the dynamics of data. For this purpose, we use MG, PMG and CCEMG estimators. The long run estimates of MG, PMG and CCEMG estimators are presented in Table 6.

Table 6.6: The long run effect of energy consumption on economic growth- high Income Countries											
Dependent variable is CO_2 emission											
Regressors	PMG	MG	CCMG		PMG	MG	CCMG		PMG	MG	CCMG
GDP	0.5997*	0.5465*	0.2356**		0.4568***	0.7748***	0.0998***		0.6773***	0.4503**	0.6652***
	(0.3253)	(0.3221)	(0.1033)		(0.1597)	(0.1570)	(0.0365)		(0.1878)	(0.1937)	(0.1565)
GDP square	-0.4848***	-0.8813*	-0.5850***		-0.8329***	-0.6292***	-0.1618*		-0.1305*	-0.2455***	-0.1734***
	(0.1060)	(0.4663)	(0.1927)		(0.2163)	(0.1221)	(0.0905)		(0.0685)	(0.0345)	(0.0670)
Energy	0.3803**	0.3208	0.6939***		0.2182**	0.4062***	0.2198**		0.6604***	0.2976***	0.6602***
	(0.1843)	(0.9775)	(0.0655)		(0.1037)	(0.1733)	(0.1045)		(0.1436)	(0.1083)	(0.1431)
Trade	NA	NA	NA		0.5472***	0.6056***	0.8321***		0.4678***	0.6580***	0.2241
	NA	NA	NA		(0.2341)	(0.1772)	(0.1466)		(0.0571)	(0.1233)	(0.1930)
Financial Development	NA	NA	NA		NA	NA	NA		0.7256***	0.6659***	0.6583***
	NA	NA	NA		NA	NA	NA		(0.1765)	(0.2823)	(0.1753)
Urbanization	NA	NA	NA		NA	NA	NA		0.0221	0.9339*	0.4172
	NA	NA	NA		NA	NA	NA		(0.8432)	(0.5502)	(0.3856)
Constant									0.2733**	0.4773***	0.0572**
									(0.1223)	(0.1495)	(0.0270)
Note: *, **, and *** indicate significance at 10%, 5% and 1%.											

The basic model for high income countries has been estimated using GDP per capita, squared GDP per capita and renewable energy, we can see the clear evidence of U-shaped relationship between income and environmental degradation, later by adding the variable of trade we see change in magnitude but the relation remains the same as we apply all the three estimators PMG, MG and CCEMG. And the shape of the curve remained the same as we added financial development and then urbanization. This means that initially with the increase in income the environmental condition decreases but latterly the environmental quality improves with the increase in income per capita. It is essential to elaborate here about taking structural breaks into account through CCEMG does not change the sign and significance of the key factors. We can see that all the estimators are consistent for high income, middle income and low income countries. Almost same picture can be seen for middle income countries as of high income countries. Again we obtained an inverted U-shaped relationship between carbon emission and income per capita and it remained the same as we add the other variables with income but we cannot see a significant change with increasing economy which may be due to that some middle income countries like China are not making prominent attempts to save the environment and are just focusing on increasing the economy which show robust picture. For the low income countries we see that the PMG estimator gives a positive relation even with the increase in income. Which means that some low income countries does not have any resources of increasing the economy and the environmental degradation level does not increases which causes robustness.

Table 6.7: The long run effect of energy consumption on economic growth: Middle Income Countries												
Regress	PMG	MG	CCMG		PMG	MG	CCMG		PMG	MG	CCMG
GDP	0.3266	0.7877	0.4030		0.9001	0.4137	0.5998		0.7933	0.5075	0.1042
	(0.1679)	(0.3408)	(0.1886)		(0.0418)	(0.1747)	(0.3507)		(0.0272)	(0.1370)	(0.0445)
GDP Square	-0.4755	-0.3713	-0.3675		-0.1171	-0.6669	-0.2619		-0.3234	-0.9586	-0.1296
	(0.1074)	(0.0337)	(0.1755)		(0.0173)	(0.2356)	(0.0448)		(0.1380)	(0.3661)	(0.0639)
energy	0.9050	0.6188	0.5648		0.6620	0.9927	0.3643		0.8567	0.9741	0.6495
	(0.2851)	(0.3411)	(0.2763)		(0.3895)	(0.7610)	(0.1528)		(0.4217)	(0.4723)	(0.7338)
trade	*NA*	*NA*	*NA*		0.6735	0.8305	0.9147		0.2921	0.3556	0.9368
	NA	*NA*	*NA*		(0.3377)	(0.3176)	(0.3216)		(0.0526)	(0.1463)	(0.3801)
Financial Development	*NA*	*NA*	*NA*		*NA*	*NA*	*NA*		0.5018	0.5399	0.4407
	NA	*NA*	*NA*		*NA*	*NA*	*NA*		(0.1891)	(0.1550)	(0.1888)
urbanization	*NA*	*NA*	*NA*		*NA*	*NA*	*NA*		0.7369	0.9422	0.1285
	NA	*NA*	*NA*		*NA*	*NA*	*NA*		(0.2806)	(0.5899)	(0.0523)
Constant	0.8101	0.3721	0.5321		0.7165	0.5469	0.3441		0.9871	0.6615	0.6307
	(0.1026)	(0.2335)	(0.2141)		(0.1952)	(0.1791)	(0.1801)		(0.5695)	(0.1483)	(0.4238)
Note: *, **, and *** indicate significance at 10%, 5% and 1%.											

Table 6.8: The long run effect of energy consumption on economic growth. Low Income Countries											
Regress	PMG	MG	CCMG		PMG	MG	CCMG		PMG	MG	CCMG
GDP	0.4689	0.6191	0.4389		0.1284	0.9857	0.2914		0.9558	0.6164	0.6572
	(0.1670)	(0.1987)	(0.0341)		(0.9231)	(0.2734)	(0.1150)		(0.5142)	(0.1767)	(0.0603)
GDP Square	0.3252	0.5738	-0.8407		0.4320	-0.3672	-0.2824		0.4504	-0.4459	-0.7544
	(0.1462)	(0.1987)	(0.1721)		(0.8873)	(0.1318)	(0.0970)		(0.1587)	(0.0961)	(0.1929)
Energy	0.6265	0.4303	0.1608		0.9032	0.4654	0.4079		0.7258	0.3112	0.5923
	(0.1778)	(0.0967)	(0.0741)		(0.9838)	(0.5382)	(0.9439)		(0.1238)	(0.1758)	(0.1904)
Trade	*NA*	*NA*	*NA*		0.4898	0.9999	0.0092		0.6241	0.5632	0.5468
	NA	*NA*	*NA*		(0.3258)	(0.2185)	(0.4072)		(0.0735)	(0.3032)	(0.2767)
Financial Development	*NA*	*NA*	*NA*		*NA*	*NA*	*NA*		0.0904	0.3882	0.3235
	NA	*NA*	*NA*		*NA*	*NA*	*NA*		(0.0336)	(0.1115)	(0.2351)
Urbanization	*NA*	*NA*	*NA*		*NA*	*NA*	*NA*		0.3406	0.5590	0.1918
	NA	*NA*	*NA*		*NA*	*NA*	*NA*		(0.1398)	(0.1746)	(0.2994)
Constant	0.9879	0.1891	0.8031		0.0221	0.6797	0.6893		0.8382	0.9520	0.3351
	(0.1672)	(0.6401)	(0.5433)		(0.4381)	(0.0275)	(0.5835)		(0.2379)	(0.3509)	(0.1498)
Note: *, **, and *** indicate significance at 10%, 5% and 1%.											

Conclusion:

In our study, the stationarity of the data with the conventional panel data approach is checked using unit root tests and also used the cointegration tests of 2nd generation panel data focusing on the backdrops. Not just the cross sectional dependence and slope heterogeneity is being considered but the presence of structural breaks is also being analyzed in the series. We found the long run Elasticities with the data by using MG, PMG and CCMG estimators by considering the techniques of dynamic heterogeneous panel data models, referred to work of Pesaran (2006). The EKC hypothesis was applied to check the dependence of environmental deprivation close to economic growth. It has been illuminated in the study that the facts of EKC hypothesis have no evidence of existence for individual countries; however it occurs from the general representation. The EKC concept finds a statistical connection of pollution emissions and GDP between many countries either at a single point at a time or between numerous countries at different level of times. Then, it concludes from this dynamic correlation; time advancement for general pollution routes that are depending on the GDP. Focusing on the results shown in chapter 6, if the countries typology has been looked once regarding per capita GDP, it is seen that the countries with higher income can be qualified as environmentalists, since they have decreasing emission tracks, the countries with middle income can be considered either as environmentalists or polluters and show horizontal emission trends and lastly, the countries with lower income are just considered as polluters, as their per capita CO_2 emissions is continuously increasing. Making the point more concrete, ponder as a last image which provides CO_2 emission drifts regarding to GDP in few countries with different levels of progress. The literature shows that the income levels changes with the correlation of the carbon emission and income per capita changes. More divergent development paths have been suggested since, the states with lower income showed the greater changeability in emission per capita than the high income states. The inference that it may be problematic to forecast the emission levels for low-income countries forthcoming, the turning point. Coherently, the larger part of the EKC work is about; correlation between these air pollutant and per capita income do not display a "U - inverted" shape. Carbon dioxide increases when per capita income increases. Nitrogen dioxide, instead, shows an "N - shape" pattern (Falco, 2001). So, by considering the traditional panel techniques and applying the 2nd generation methods we can examine the shape of the EKC curve for large panel and different income level of countries. We also tried to capture the structural breaks in the data of the income categories and checked the robustness in the parameters, which was yet the most ignored part of the 2nd generation panel data models.

Policy Recommendations:

Environmental pollution is one of the top category problems in the present era. Many countries have serious focus in this regard but as per the results of our study reveal that yet, more work should be done to improve avoid the carbon emission which is a factor of environmental pollution.

References

1. Al-Mulali, U., Ozturk, I., & Lean, H. H. (2015). The influence of economic growth, urbanization, trade openness, financial development, and renewable energy on pollution in Europe. *Natural Hazards*, *79*(1), 621-644.
2. Anderson, T. W., & Hsiao, C. (1981). Estimation of dynamic models with error components. *Journal of the American statistical Association*, *76*(375), 598-606.
3. Anderson, T. W., & Hsiao, C. (1982). Formulation and estimation of dynamic models using panel data. *Journal of econometrics*, *18*(1), 47-82.
4. Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The review of economic studies*, *58*(2), 277-297.
5. Bai, J., Kao, C., & Ng, S. (2009). Panel cointegration with global stochastic trends. Journal of Econometrics, 149(1), 82-99.
6. Dinda, S. (2005). A theoretical basis for the environmental Kuznets curve. *Ecological Economics*, *53*(3), 403-413.
7. Farhani, S., Mrizak, S., Chaibi, A., & Rault, C. (2014). The environmental Kuznets curve and sustainability: A panel data analysis. *Energy Policy*, *71*, 189-198.
8. Grossman, G. M., & Krueger, A. B. (1991). *Environmental impacts of a North American free trade agreement* (No. w3914). National Bureau of Economic Research.
9. Hausman, J. A. (1978). Specification tests in econometrics. *Econometrica: Journal of the Econometric Society*, 1251-1271.
10. Jalil, A., & Mahmud, S. F. (2009). Environment Kuznets curve for CO 2 emissions: a cointegration analysis for China. *Energy Policy*, *37*(12), 5167-517.

11. Maddala, G. S., & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and statistics*, *61*(S1), 631-652.

12. Pesaran, M. H. (2006). Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica*, *74*(4), 967-1012.

13. Stern, D. I. (2004). The rise and fall of the environmental Kuznets curve. *World development*, *32*(8), 1419-1439.

14. Wagner, M. (2008). The carbon Kuznets curve: a cloudy picture emitted by bad econometrics?. *Resource and Energy Economics*, *30*(3), 388-408.

15. Wagner, M. (2015). The environmental Kuznets curve, cointegration and nonlinearity. *Journal of Applied Econometrics*, *30*(6), 948-967.