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Testing for Environmental Kuznets Curve and Pollution Haven Hypothesis: A Continental Analysis

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Abstract

Environmental pollution and sustainable development have become major concerns for policy makers as both may not be achieved simultaneously. On one hand, economic growth and foreign direct investments (FDI) are necessary for the countries to prosper. On the other hand, economic growth and FDI are related with environmental pollution which affects atmosphere at global level and poses threat to all those who share common environment. To address this concern, this study tests the validly of environmental Kuznets curve (EKC) and pollution haven hypothesis (PHH) for CO_2 emission. The study uses cross-sectional as well as panel data for a sample of 42 countries from three continents (Asia, Africa and Europe) and covers the period from 1990 to 2014. The study applies ordinary least square, pooled OLS, fixed effect model, random effect and two-stage least square techniques to estimate the models. The study finds that energy use and globalization positively impact pollution when estimated for full sample. Moreover, the study suggests that EKC holds for full sample, Asia, and Europe while results do not confirm EKC for Africa continent. Besides, the study finds that PHH does not sustain in any of the three continents. The study suggests that use of cleaner energy should be promoted to mitigate CO_2 emission. Therefore, the policy makers should design alternative policies for Africa to reduce global environmental degradation.

Keywords: *Environmental Kuznets Curve, Pollution Haven Hypothesis, CO_2 emission, Economic growth, foreign direct investment*

Testing for Environmental Kuznets Curve and Pollution Haven Hypothesis: A Continental Analysis

1. Introduction

The world is facing global environmental changes in the form of greenhouse gases (GHGs), environmental pollution and climate change. These environmental changes are dangerous for all those species which live under and share the common atmosphere. Moreover, these changes have become main concern of today, since environmental changes make air much polluted and weather warmer than before. Whereas, extreme rainfall, floods, droughts, rising ocean levels and melting of glaciers are some of the consequences of these climatic changes which adversely affects the survival of human beings. Likewise, melting of glaciers is another threat to agriculture, hydropower and sanitation of people. Therefore, one critical challenge for countries and human beings is to deal with these environmental changes without giving up sustainable development (Chowdhury and Moran, 2012).

Sustainable development of any country needs economic production, which in turn requires consumption of energy as well as burning of fossil fuels. This phenomenon makes environment warmer than before by releasing massive amount of emissions (Kang *et al*., 2016). Therefore, economic growth cost a lot in term of environmental degradation. This relationship between economic growth and environmental degradation can be explained with the help of Environmental Kuznets Curve (EKC) introduced by Grossman and Kruger (1991). The concept of environmental Kuznets curve explains the relationship between economic growth and environmental pollution as inverted U-shaped curve. The EKC hypothesis posits that quality of environment

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tends to degrade as per-capita GDP rises, but after achieving a certain level of per-capita GDP, quality of environment tends to improve (Dinda, 2004; Sapkota and Bastola, 2017).

A country needs foreign direct investment (FDI) to meet the desired goals of sustainable development. For developing countries FDI inflows are the most important source of development, employment and income growth. Therefore, FDI inflows are warmly welcomed by all countries (Blanco *et al.*, 2013). However, with increasing rate of FDI, emission of pollution also tends to increase and deteriorates the environment (Bokpin, 2017). Alongside, environmental policies are strong in developed countries and correspondingly regulatory costs are often higher for polluting activities in these countries. Therefore, developed countries physically invest in developing countries to experience comparative advantage because of lower environmental standards and weak enforcement cost in host developing countries. This is known as Pollution Haven Hypothesis (PHH) and it is studied by Copeland and Taylor (1994).

The existence of PHH is closely linked with the presence of EKC as FDI inflows have impact on economic growth as well as on the quality of environment. Whereas, the relationship between economic growth and quality of environment explains the presence of EKC while the relationship between FDI and quality of environment explains the existence of PHH. Cole (2004) examines the linkages between PHH and EKC and finds that trade contributes to the EKC relationship through pollution haven effects. Similarly, Lau *et al*. (2014) concludes that FDI tends to promote economic growth however, leads to environmental degradation (Acharyya, 2009). This discussion suggests that the relationship between EKC and PHH is interlinked and therefore it is usually focused together (Solarin *et al*., 2017; Sapkota and Bastola, 2017).

Although there are many factors which are responsible for environmental degradation, however, air pollution particularly degrades environment. Most frequently emitted gases in the environment are carbon dioxide (CO_2), methane (CH_4) and Nitrous oxide (N_2O). Carbon dioxide is released from the burning of fossil fuels while methane is emitted when gas, oil and coal are produced or transported whereas, Nitrous oxide (N_2O) is released by agriculture and industrial activities. Fluorinated gases which are also known as high global warming potential gases are emitted from the industrial processes (UNEP, 2014).

Although, the validity of the EKC hypothesis has been tested widely yet the evidence of existence of EKC has been questioned from several corners (Dinda, 2004; Stern, 2015). Similarly, several authors have tested PHH and have provided inconsistent results about it. Therefore, this study examines the validity of EKC and PHH for a sample of 42 countries from three continents i-e Asia, Africa and Europe for the time period 1990-2014. Moreover, the study applies ordinary least square, pooled OLS, fixed/random effect model and two-stage least square techniques to estimate the models. The existing literature on EKC on PHH is usually limited to a single country or a small group of countries however, this analysis is meant for three continents with advanced estimation techniques, and therefore, this analysis contributes to existing literature.

The paper is organized as follows. The review of literature is presented in section 2, while data has been discussed in section 3. Section 4 explains the methodology while estimation results are given in section 5. Finally, the last section 6 concludes the study.

2. Review of Literature

The relationship between income and environmental degradation has attracted a great deal of attention in recent years. The possible existence of an inverted U-shaped relationship between per capita GDP and emission of

pollution is generally known as an environmental Kuznets curve. The logic and rationale is that once certain level of income is achieved by countries/nations, then they start to pay heed to environmental issues such as pollution.

This relationship has been investigated in many studies and results of these studies largely tend to vary (Dinda, 2004). It suggests that existence of EKC is subject to choice of country. For example, following studies confirm existence of EKC for China, Indonesia and Malaysia (Jalil and Feridun, 2011; Shahbaz *et al*., 2013; Lau *et al*., 2014). While EKC does not hold for Vietnam (Al-Mulali *et al.*, 2015). In addition, the existence of EKC also differ for panel of countries, for example; Dong *et al*. (2017) validate EKC for the BRICS countries while Sayed and Sek (2013) shows non-existence of EKC for a panel of 40 countries.

Similarly, the studies on the relationship between FDI and pollution have contradictory results. For example, Neequaye and Oladi (2015) find positive impact of trade and FDI on environment of host country because it tends to bring improved and eco-friendly technology. In contrast, there are studies explaining that FDI inflows produce high levels of CO_2 emission and thus degrade environment either directly or via output growth (Acharyya, 2009; Lau *et al*., 2014; Bokpin, 2017). Therefore, the relationship between foreign direct investment (FDI) and pollution is still inconclusive in literature.

Although, FDI inflows to the host countries lead to economic growth, however, ultimately raise the level of CO_2 emission and thus deteriorate the quality of environment. It suggests that PHH and EKC are interlinked and existence of PHH validates the presence of EKC (Lau *et al*., 2014; Sapkota and Bastola, 2017). On the other hand, if FDI inflows lead to better environment and energy efficiency gains because of transfer of eco-friendly technology, then there will be absence of PHH and EKC (Eskeland and Harrison, 2003).

The focus of the study is to find out which factors are responsible for environmental degradation, particularly degradation of environment which occurs due to greenhouse gases. The issue of greenhouse gases is related with air pollution and it needs to be addressed immediately as it dangerously affects health of human beings and it is also responsible for global warming. It is important to mention that carbon dioxide is the major contributor to greenhouse gases and it is responsible for contributing approximately 76% of emission to atmosphere. As carbon dioxide is major contributor to global emissions, therefore, it will be wise to target carbon dioxide and consider CO_2 as the main factor responsible for environmental degradation (UNEP, 2014).

There are other indicators of air pollution and EKC as well as PHH may be examined for these different indicators. The very first study on empirical investigation of EKC by Grossman and Krueger (1991) takes sulphur (SO2) and other pollutants i-e fine smoke and suspended particles as indicators of air pollution and estimates income relationship with these pollutants. However, sulphur has localized impact while carbon dioxide has globalized impact. Therefore, carbon dioxide (CO_2) is usually considered dependent variable in the analysis of EKC and PHH (Cole, 2004; Shahbaz *et al*., 2013; Bae *et al.*, 2017; Chiu, 2017 Shahbaz *et al*., 2018).

Acharyya (2009) argues that validity of PHH is affected by the levels of human capital and economic growth. In other words, human capital and economic growth have important roles for the validity of PHH. Another study conducted by Lan *et al*. (2012) includes human capital along with unemployment and suggest that PHH holds only in those provinces of china which have low human capital. The study debates that advanced technology leads to lower environmental pollution, however, adoption of advanced technology is possible with higher level

of human capital. It suggests that impact of FDI on pollution emission is dependent on the level of human capital.

The literature also shows that most of the air pollutants including CO_2 are energy related (Baek, 2016). It suggests that energy consumption increases the level of CO_2 emission (Shahbaz *et al.*, 2013). Similarly, Shahbaz *et al*. (2018) examine the effects of GDP, FDI and energy consumption on CO_2 emission for France and concludes that energy consumption is positively linked with carbon emission while FDI degrades the quality of environment.

Besides, Dinda (2004) argues that environmental quality may deteriorate as population pressure increases more and more while Wheeler (2000) makes a case that increased competition for investment and employment can affect the quality of environment and especially globalization could trigger the environmental deterioration.

The relationship between FDI, growth and environment of host country is important because it has implications for the formulation of sustainable development polices. However, this review of literature suggests that there is inconsistent evidence about the existence of EKC and PHH. Therefore, considering the importance of global climate change, there is an urgent need to explore the issue in details.

3. Data

The study tests the existence of EKC and PHH for a sample of 42 countries for the period 1990 to 2014. The existing literature on EKC and PHH hypotheses either considers analysis for a specific country (Lan *et al*., 2012; Shahbaz *et al.*, 2018) or considers a small panel of countries (Dong *et al*., 2017; Sapkota and Bastola, 2017). This study, however, includes a panel of 42 countries from three continents (Asia, Africa and Europe). These countries are randomly chosen on the basis of availability of data.[3] This study also contributes to the existing literature as it offers cross-sectional as well as panel data analysis at continental level. The study utilizes panel data to correct for continuously emerging country-specific differences in production, technology and socioeconomic dynamics (Acharyya, 2009).

The data on carbon dioxide emission (CO_2) is measured in metric tons per capita. While GDP per capita is gross domestic product per capita (that is GDP divided by midyear population) measured in constant 2010 US$. The study has taken foreign direct investment (FDI) as percent of GDP while energy use is taken in kg of oil equivalent per capita. Moreover, population density is measured in people per square kilometer of land area and unemployment is measured as a percentage of total labor force. The data for these variables has been taken from World Development Indicators (WDI) whereas, data for globalization and human capital is extracted from KOF index 2015 and Penn world Tables 9.0 respectively. The study has provided summary statistics for these variables in Appendix A2.

4. Methodology

The study plans to tests the validity of environmental Kuznets curve (EKC) and pollution haven hypothesis (PHH). Therefore, the study includes dependent and explanatory variables according to EKC and PHH literature

[3] The list of countries is given in appendix A1.

(Dinda, 2004; Acharyya, 2009; Sapkota and Bastola, 2017; Shahbaz *et al*., 2018). We have following models to estimate:

$$CO2_i = \alpha_0 + \alpha_1 GDP_i + \alpha_2 GDP_i^2 + \alpha_3 FDI_i + \alpha_4 EU_i + \alpha_5 PD_i + \alpha_6 Glob_i + \alpha_7 HC_i + \alpha_8 Unem_i + \mu_i \quad (4.1)$$

here CO_2 presents emission of carbon dioxide and it is our dependent variable while GDP is GDP per capita, FDI is foreign direct investment, EU refers to energy use, PD stands for population density, Glob is globalization, HC shows human capital and Unem is unemployment rate. Whereas, *i* denotes cross-section,α's are coefficients and μ_i is error term. This model (4.1) is used for cross sectional analysis. While the model (4.2) given below is used for panel data analysis:

$$CO2_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 GDP_{it}^2 + \beta_3 FDI_{it} + \beta_4 EU_{it} + \beta_5 PD_{it} + \beta_6 Glob_{it} + \beta_7 HC_{it} + \beta_8 Unem_{it} + \mu_{it} \quad (4.2)$$

here i denotes cross section, while *t* in subscript denotes time series. β_0 is constant while $\beta's$ are coefficients and μ_{it} is error term.

The study utilizes ordinary least square (OLS) technique for cross sectional analysis and pooled OLS (POL) for panel estimation. Whereas, OLS technique is the most widely used estimation technique and it follows BLUE properties, i-e best, linear, unbiased and efficient estimator (Gujarati, 2004). Therefore, the study has used it for comparison purpose.

For panel data analysis, fixed effect model (FEM) and random effect model (REM) are also well established estimation techniques and we have also applied these estimation techniques. The literature suggests different criteria to make a choice between REM and FEM. However, researchers usually follow Hausman test developed by Hausman (1978) to make a choice between fixed effect and random effect models.

Two-stage least squares (2SLS) technique is an extension of renowned OLS technique. It is very useful for estimation when error term of dependent variable is correlated with explanatory variables, or if there is problem of endogeneity. This problem makes estimators biased and inefficient. The 2SLS is appropriate technique to address the problem of endogeneity. Therefore, 2SLS method is used to estimate model by including instrumental variables while instrumental variables should be strongly correlated with endogenous variables but should be uncorrelated with error term.

While each technique has its own significance and limitations, this study tests the existence of EKC and PHH with three different estimation techniques (POLS, FEM/REM, 2SLS) rather than just one estimation technique to provide unambiguous results about environmental Kuznets curve and pollution haven hypothesis.

5. Results and Discussion

The Table 5.1 presents the estimation results for whole sample of 42 countries. The model 1 shows the estimation results for cross sectional data while model 2 shows estimation results for panel data. The study

applies OLS and two stages least squares techniques for the estimation of model 1 while pooled OLS, fixed effect model and two stages least squares techniques have been applied for the estimation of model 2.[4]

The model 1 shows that co-efficient of GDP per capita is positive while co-efficient of squared GDP per capita has negative signs for both techniques (i-e OLS and 2SLS). However, both coefficients are significant at conventional levels. Likewise, model 2 (panel results) confirm these findings for panel estimation techniques (POL, FEM and 2SLS). It suggests that we have positive relationship between carbon dioxide and GDP per capita at initial level but further we can find negative relationship between these variables.

As discussed earlier, EKC shows deterioration in the quality of environment at earlier stages of growth, while at latter stages of growth, there is improvement in the quality of environment. Therefore, these findings suggest that EKC holds for the whole sample of 42 countries (Grossman and Kruger, 1993; Dinda, 2004; Sapkota and Bastola, 2017). Similarly, Neequaye and Oladi (2015) also use fixed effect model and suggest the existence of EKC for carbon dioxide for developing countries. Although, the existence of EKC is generally subject to the choice of estimation technique, however, our results show the existence of EKC for all estimation techniques and for cross-sectional as well as for panel data.

The Table 5.1, however, shows that FDI has insignificant impact on CO_2 emission for both models and for all estimation techniques. It means our results do not support the existence of PHH for our sample. Cole (2004) also highlights that pollution havens are mostly temporary and limited to certain sectors. Shahbaz *et al*. (2016) explain it with the help of technique effect. According to the study, if a country can adopt advanced technologies with FDI inflows, then better techniques of production consume lesser energy and therefore emit lower CO_2 yet produce higher level of output. It is known as technique effect. In this case, FDI inflows do not deteriorate the quality of environment of the host country.

Table 5.1: Estimation Results for Whole Sample

VARIABLES	Model 1		Model 2		
	OLS	2SLS	POLS	FEM	2SLS
GDP/capita	3.745***	6.360**	2.094***	1.578***	2.216***
	(1.031)	(3.071)	(0.265)	(0.209)	(0.274)
Sqrd GDP/capita	-0.214***	-0.410**	-0.0711***	-0.0574***	-0.0789***
	(0.0678)	(0.174)	(0.0173)	(0.014)	(0.0179)
FDI	0.00811	0.171	-0.00568	-0.00831	-0.00705
	(0.0308)	(0.183)	(0.00482)	(0.00196)	(0.00722)
Energy use	1.040***	2.105***	0.0615***	0.382***	0.0546***
	(0.143)	(0.808)	(0.0157)	(0.0675)	(0.0166)
Pop dens	0.105*	0.185	0.000159	-0.0048***	-0.000857
	(0.0585)	(0.118)	(0.00224)	(0.00139)	(0.00259)
Glob	0.00702	0.00391	0.00238***	0.00224***	0.00248***
	(0.00992)	(0.0334)	(0.000557)	(0.00044)	(0.000613)
HC	0.144	-0.477	0.0575***	0.0483*	0.0576***

[4] The study has chosen FEM on the basis of Hausman test P-Value. Moreover, the average VIF for both models is less than 10 which indicates that there is no problem of multicollinearity in our models.

	(0.153)	(1.256)	(0.00597)	(0.0267)	(0.00644)
Unempl	0.00499	-0.0649	0.0898***	0.0503*	0.105***
	(0.0845)	(0.16)	(0.0321)	(0.0299)	(0.0342)
Constant	-23.78***	-38.31***	-13.41***	-11.20***	-13.81***
	(3.978)	(10.87)	(0.978)	(0.837)	(1.016)
Observations	42	42	1,050	1,050	1,050
R-squared	0.902	0.731	0.763	0.491	0.766

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Among other explanatory variables, energy use is significant for both models and for all estimation techniques. It is positively related with the emission of CO_2 and it is significant everywhere. It means increased energy consumption contributes to environmental degradation. It also suggests that improvement in quality of environment is possible with energy saving techniques of production (Shahbaz *et al*., 2018).

The Table 5.2 shows panel estimation results for three continents Asia, Africa and Europe. The study employs POLS, FEM/REM and 2SLS estimation techniques. The results for Asia shows that GDP per capita positively affects air pollution (CO_2) while squared GDP per capita has negative impact on air pollution for all techniques employed. It means our results support existence of EKC for Asia continent (Jalil and Feridun, 2011; Lau *et al.*, 2014). Besides, FDI is insignificant for all three panel estimation techniques. Our results also show that FDI inflows do not contribute significantly to environmental degradation in Asia, therefore, we can conclude that PHH does not exist for Asia continent.

Moreover, the coefficient of globalization is positive and significant at 1% level of significance throughout all estimation techniques employed. It indicates that globalization positively affects emission of CO_2. It may be the case when there is higher level of economic activity because of globalization but techniques of production are old which consumes too much energy for higher output. In that case, globalization may positively affect emission of pollution (Dinda, 2004).

The Table 5.2 also reports estimation results for Africa continent. The results show that both the variables GDP and squared GDP are positive for Africa. It means that with increase in GDP per capita there is increase in emission of pollution and growth is not taking care of quality of environment (Sayed and Sek, 2013; Al-Mulali *et al.*, 2015). This finding suggests that there is no inverted U shaped curve for GDP per capita and environmental degradation in Africa. It implies that EKC does not hold Africa continent. The Table 5.2 also shows that the coefficient of FDI is insignificant for REM and 2SLS techniques, therefore, we cannot accept PHH for Africa (Cole, 2004).

Energy use is positive and significant throughout all techniques employed. It means increased energy consumption multiplies CO_2 emission. If old techniques of production are used then it will increase energy consumption as well as emission of pollution (Shahbaz *et al.*, 2013). However, energy efficient techniques of production may improve quality of environment (Shahbaz *et al*., 2018).

In case of Europe continent, the existence of EKC is supported with our results however, the study could not find evidence for the presence of PHH. The Table also shows that FDI has insignificance impact for emission of

CO_2, indicating that PHH does not hold for Europe (Eskeland and Harrison, 2003). The table also shows that globalization positively effects emission of CO_2. It may be because of increased competition for investment and employment which can adversely affect the quality of environment (Wheeler, 2000).

Table 5.2 Estimation Results for Continents

VARIABLES	Asia			Africa			Europe		
	POLS	FEM	2SLS	POLS	REM	2SLS	POLS	FEM	2SLS
GDP/capita	4.282***	1.000***	4.199***	0.876**	0.931**	1.054***	11.85***	7.075***	14.03***
	(0.41)	(0.269)	(0.418)	(0.359)	(0.458)	(0.375)	(1.319)	(1.163)	(1.75)
Sqrd GDP/capita	-0.238***	-0.0239	-0.232***	0.0187	0.00841	0.00843	-0.726***	-0.373***	-0.853***
	(0.027)	(0.0175)	(0.0278)	(0.0245)	(0.0317)	(0.0259)	(0.0849)	(0.0786)	(0.109)
FdI	0.0068	-0.0140	-0.00202	-0.0148***	-0.00553	-0.0143	-0.00664	-0.00254	-0.0113
	(0.00825)	(0.00367)	(0.0131)	(0.00567)	(0.00336)	(0.00946)	(0.00417)	(0.00341)	(0.01529)
Energy use	-0.415***	0.655***	-0.419***	0.120***	0.133*	0.111***	-2.651***	4.853***	-3.099***
	(0.0352)	(0.103)	(0.0415)	(0.0238)	(0.0696)	(0.0275)	(0.207)	(1.364)	(0.522)
Popdens	0.00166	-0.0114***	0.00195	0.0319***	-0.00305	0.0297***	-0.0221***	-0.00799**	-0.0240***
	(0.00295)	(0.00236)	(0.00362)	(0.00392)	(0.00345)	(0.00607)	(0.00319)	(0.00319)	(0.0039)
Glob	0.00386***	0.00265***	0.00425***	-0.00734***	0.000528	-0.00762***	0.00532***	0.00548***	0.00566*
	(0.00071)	(0.000507)	(0.000774)	(0.00108)	(0.00115)	(0.00129)	(0.00153)	(0.0011)	(0.0029)
HC	0.216***	0.154***	0.219***	-0.0165*	0.0348*	-0.0139	0.360***	0.0784	0.457***
	(0.016)	(0.0394)	(0.0162)	(0.00957)	(0.0198)	(0.0143)	(0.0561)	(0.061)	(0.11)
Unempl	-0.143***	-0.116***	-0.142**	-0.0169	-0.114	0.003	0.714***	0.304*	0.202
	(0.0503)	(0.0428)	(0.0556)	(0.0457)	(0.0751)	(0.0509)	(0.186)	(0.152)	(0.513)
Constant	-21.82***	-12.21***	-21.58***	-8.939***	-8.999***	-9.592***	-42.15***	-55.35***	-51.64***
	(1.521)	(1.074)	(1.547)	(1.267)	(1.586)	(1.305)	(5.958)	(6.024)	(7.818)
Observations	478	478	469	472	472	469	72	73	72
R-squared	0.858	0.714	0.862	0.868		0.868	0.969	0.852	0.966
Number of id		20			19			3	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results presented in Table 5.1 and Table 5.2 reveals that increase in GDP per capita first degrade the quality of environment by emitting pollution and then after achieving a certain level of income, it tends to improve the quality of environment. Moreover, this study finds that foreign direct investment do not deteriorate the environment of the host country. These results suggest that EKC exits for Asia and Europe however, PHH doesn't exist for any of the three continents.

6. Conclusion

The study tests the existence of EKC and PHH for a sample of 42 countries for the period 1990 to 2014. The study has estimated two models for EKC and PHH. The model 1 is based on cross-sectional analysis while model 2 is based on panel data analysis. The study employs simple OLS and two stages least squares techniques for cross-sectional data while pooled OLS, fixed/random effect models are used for panel data. Moreover, two stages least squares is also used to address the possible issue of endogeneity. The cross-sectional analysis reveals that EKC holds for whole sample of forty two countries, however, there is no evidence of PHH.

The study also provides panel estimation results for Asian, African and European countries. The results for Asia continent show the existence of EKC however, PHH does not hold. For Africa continent, findings show that both EKC and PHH do not hold in Africa while for Europe continent, findings suggest that EKC holds for all techniques, whereas, there is no evidence of PHH for Europe. The study also concludes that energy use, globalization and human capital positively impact pollution when estimated for full sample. However, for continents findings are technique sensitive.

The study suggests that use of cleaner energy should be promoted to mitigate CO_2 emission. Therefore, the policy makers should design alternative policies for Arica to reduce global environmental degradation. In addition, the policy makers should encourage innovations and technological developments for improvement in the quality of environment.

Appendix A1

List of Countries

S. No	Asia		Africa		Europe
1	Pakistan	21	Algeria	40	Albania
2	Bangladesh	22	Egypt, Arab Rep.	41	Bulgaria
3	Cambodia	23	Morocco	42	Romania
4	India	24	Tunisia		
5	Indonesia	25	Benin		
6	Malaysia	26	Cameroon		
7	Nepal	27	Congo, Rep.		
8	Philippines	28	Congo, Dem. Rep.		
9	Sri Lanka	29	Gabon		
10	Thailand	30	Kenya		
11	Vietnam	31	Mauritius		
12	Armenia	32	Mozambique		
13	Iran, Islamic Rep.	33	Namibia		
14	Jordan	34	Nigeria		
15	Kazakhstan	35	Senegal		
16	Tajikistan	36	South Africa		

17	Turkey	37	Sudan		
18	China	38	Tanzania		
19	Moldova	39	Togo		
20	Ukraine				

Appendix A2

Summary Statistics for Variables

Variable	Observations	Mean	Std. Dev.	Min	Max
CO2	1050	0.012026	1.4282	-4.08	3.07572
GDP per capita	1050	7.507924	0.98213	5.07718	9.38485
Sqrd GDP per capita	1050	57.33258	14.6948	25.7778	88.0753
FDI	1050	2.998019	4.18687	-8.5894	41.8096
Energy use	1050	4.298899	1.25616	0.54189	7.10831
Population density	1050	4.197447	1.22386	0.83653	6.93307
Globalization	1050	45.37826	15.3881	2.7358	79.12
Human capital	1050	21.94512	4.91837	1.24259	28.9687
Unemployment	1050	-0.38269	0.63853	-1.7617	1.31049

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