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Renewable and Non-Renewable Energy and its Impact on Environmental Quality in South Asian Countries

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Abstract

The study explores the causal link between environmental quality, renewable and non-renewable sources of energy, per capita output and population density in the region of South Asia. Four countries i.e. Bangladesh, India, Sri Lanka and Pakistan from South Asia have been selected for the analysis. The study conducts both time series and panel analysis and covers the period of 1980-2013. The study applied Johanson co-integration, Larsson panel co-integration and DH causality approach. Empirical results confirm the presence of co-integration between variables. The study found positive impact of per capita output, population density and non-renewable energy sources on CO_2*. However, the negative sign of renewable energy sources indicates that* CO_2 *emissions per capita decrease 0.352% as 1% increase in renewable energy sources. The study likewise boosts the theory of the Environmental Kuznets Curve (EKC) which accepts a rearranged U-molded way. The study also found the substantiation of bi-directional panel causality running from* CO_2 *to RE sources and from population destiny to* CO_2*. Results provide evidence of feedback relationship between environment and renewable energy sources and there is also unidirectional causality running from* CO_2 *to non-renewable energy sources. In order to keep our environment clean and pollution free, the study prerequisites to devise the policies which rely on renewable energy sources to uplift economic growth.*

Keywords: Renewable Energy, Non-renewable Energy, CO_2 Emissions, Economic Growth, Environmental Quality, Population Density, South Asia

JEL Classification: Q42, O44, O05, Q56

I. Introduction

Energy is an essential part of every society and assumes an imperative part to improve social and economic living standard of society. With the passage of time mankind has used various types of resources to generate energy, starting

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from wood to nuclear energy (Mirza et al*.,* 2008). There are nine major energy sources that can further be categorized into two sources i.e renewable and non-renewable. The major renewable energy sources include wind, solar, hydro (water), biomass and geothermal. These sources are unlimited in supply and can be replenished naturally. The non-renewable energy includes oil, nuclear, gas, and coal. These are limited in supply and cannot be recycled or replaced. It is not possible to make use of non-renewable sources forever because once consumed they cannot be reproduced or regenerated with the same old capacity. Even the regeneration process requires years to complete. It is predicted that by 2100 the global energy demand will rise up to 5 times of current demand. Currently, fossil fuels are fulfilling the three forth of global energy demand. On the other hand due to the massive usage of fossil fuels, the amount of Co2 emission is increasing in the environmen, causing greenhouse gases (Halder et al*.,* 2015). The societies are also looking for other energy sources because of fossil fuels getting scarce and due to the threat to the security of energy sources. In this context, renewable energy resources are now more often used for electricity production. As many countries are on route to development so their consumption of electricity is increasing for both industrial and domestic use but contrary to that energy resources are scarce. Many ASEAN countries are still relying on fossil fuels to produce electricity. For instance in 2009, Malaysia's almost 95% production of electricity was based on traditional vestige energies (PTM annual report 2009). South Asian countries are highly dependent on imported oil although this region has a vast variety of resources such as natural gas, oil, coal, wind, solar and hydropower but still energy crises is common in this region. Pakistan has to face worst electricity crises in 2007 when electricity production went down to 6000 MW. In Bangladesh, only 30 % of rural households have the electricity available. In Nepal, load shading goes to almost 20 hours during the dry season (Halder at el., 2015). South Asian countries are highly populated and keeping other factors constant the population leads to lessen economic growth. According to Enrich and Holdin (1971) each individual has an adverse impact on the environment in a modern and technological society. The increasing population has become a leading component in accelerating pollution in developed and developing countries due to massive use of renewable and non-renewable energy. Thomas (1989) has also expressed that growth rate of population is directly or indirectly adding to the extraordinary rates of deforestation.

The major contribution of this study is to survey the influence of energy from renewable, non-renewable sources, income with the expansion of population density on the environmental quality. In this context, the paper scrutinizes the sound effects of using RE and NRE on the environmental sustainability outcomes in selected four countries of South Asia over the period of 1980–2013. In similarity to the popular notion that renewable energy sources have environmental benefits, the central hypothesis of the study is regulating the practice of replaceable energy sources in South Asian region. These energy sources in turn might lead to a reduction in environmental externalities and mitigate the negative effects of non-renewable energy sources. The study conducted an empirical analysis of individual country-wise time series and panel wise by applying FMODL technique. The included economic indicators are renewable and non-renewable energy resources, income (per capita GDP) and population density across their influence on environmental quality.

2. Literature Review

There has been across the board hypothetical and experimental research that attempts to concentrate on renewable and nonrenewable energy sources and its development. The researchers have also focused on the impact of energy use on the environment quality. Soytas et al., (2007) analyzed that energy depletion Granger cause per capita emissions in US economy but output does not. He concluded that in the long run only output results cannot solve the environmental problems. Sadorsky (2009) conducted an empirical estimation of consumption of renewable energy in G7 countries. He used panel co-integration estimator and found that increase in real output and CO2 per capita emission were the major factors that stimulated per capita renewable energy consumption in the long run. Chiu and Chang (2009) found negative impact of renewable energy on CO2 emissions. Furthermore, they observed that positive impact on economic growth and non-renewable energy on Co2 emissions. Apergis et al., (2010) inspected the relationship between CO2 and renewable energy consumption in 19 developed and developing countries. Panel Granger causality results presented a significant and increasing relation between the aforesaid parameters. The statistical results indicated that energy consumption from renewable sources does not contribute to reduction in CO2 emissions. According to them this might be possible because of the absence of sufficient stockpiling innovation to beat discontinuous supply issues. Subsequently electricity makers need to depend on emissions creating energy sources to take care of the highlighted load of electricity demand.

Tiwari et al., (2011) analyzed multidimensional affiliation between CO2 emissions, use of renewable energy and growth in India. The results did not find any proof of co-integration among the three variables. The innovation analysis of study revealed that positive and negative shocks on the consumption of renewable energy source in different ways. In the first case, it has increased GDP and decreased CO2 emissions. In the second case the impact of GDP on the CO2 found positive and statistically significant. Alam et al., (2011) used dynamic modeling approach by incorporating data from India to investigate the causal relationship among income, energy use and per capita emissions. He found long-run one way causal link between variables from energy consumption to per capita emissions. Moreover, no causality was found in income and energy consumption and also in income and CO2 emissions.

For the case of Bangladesh Alam et al., (2012) found dynamic causality existence among CO2, real GDP and utilization of energy and electricity. Johansen co-integration and ARDL approaches were applied for long run relation; VECM was applied for short run analysis. Sulaiman et al. (2013), Baek and Pride (2014) found renewable energy reduced CO2 emissions and economic growth and non-renewable energy increased CO2 emissions. Shafiei and Salim (2014) found boosting link of CO2 with non-renewable energies and destructive link of CO2 with renewable energy. Their findings also showed that industrialization, urbanization, per capita GDP and population size had a significant and positive influence on per capita CO2 emissions. Bölük and Mert (2014) examined future aspects of renewable energy sources in Turkey. The results indicated that in long-run, RE bases and CO2 emissions were negatively and significantly related. But on the other hand in short this effect was observed positive and statistically significant. The renewable electricity production tends to contribute towards the enhancement of environmental quality. The results also suggested a U-shaped (EKC) relationship between income and per capita GHGs. Jebli et al., (2015) found statistically significant positive relationship between CO2 emissions, gross domestic product (GDP), renewable energy consumption and international trade in twenty four sub-Saharan Africa countries. Granger causality results showed bi-directional causality between economic growth and CO2 emissions. The results also revealed a relationship between CO2 and exports and uni-directional causality running from imports to CO2. The long-run estimates suggested that the inverted U-shaped EKC hypothesis is not supported in case of these countries. Jebli et al., (2016) established a positive relationship between non-renewable energy and CO2 emissions while inverse relation between RE and CO2 emissions in selected countries of OECD. Granger Causality Tests results confirmed that there was uni-directional causality from Growth to Renewables. Wang et al., (2016) led an examination in twenty eight regions of China and watched the causal relationship. They inferred that CO2 emanations were bi-directionally connected to energy utilization and there was a long run co-coordinated connection between CO2 discharges, energy utilization and financial development.

Ahmed et al., (2016) empirically demonstrated a unidirectional causality from trade openness towards CO2 emissions and economic growth in case of four newly industrialized economies. The results showed that economic growth was triggered by trade liberalization which also induced CO2 emissions. Rafiq et al. (2016) concluded that population density and economic growth expanded CO2 emissions and energy intensity twenty-two progressively developed rising economies from 1980 to 2010. They found that renewable energy sources seem to be helping in reducing CO2 emissions while non-renewable energy increases both energy intensity and CO2 emissions. Bilgili et al. (2016), Al-Mulali and Ozturk (2016), Dogan and Seker (2016b, c), and Bento and Moutinho (2016) additionally discovered negative effect of sustainable power source on CO2 discharges which alleviated the contamination and positive effect of monetary development and non-sustainable power source on CO2 outflows which prompts toxin condition.

The most of the studies have investigated the connections between inexhaustible, non-sustainable power source utilization and development with CO2 outflows. The researchers have incorporated diverse philosophy for various eras as per the requirement. In any case, past research was generally in view of individual city or nation utilizing time arrangement information. This exploration work may incorporate sustainable and non-sustainable power sources with respect to causality and economic development to relieve CO2 emissions and increment in output.

3. Econometric Model and Data Sources

The relationship between environment degradation (CO2), economic growth (Y), renewable energy sources (RE), nonrenewable energy sources (NRE) and population density (PD) is modeled in model I and Environmental Kuznets hypothesis is presented in model II.

3.1. Model I

$$CO2_{it} = f\left(Y_{it}, RE_{it}, NRE_{it}, PD_{it}\right) \quad (1)$$

Its general form can be written as:

$$CO2_{it} = \beta_{1i} + \beta_{2i}Y_{it} + \beta_{3i}RE_{it} + \beta_{4i}NRE_{it} + \beta_{5i}PD_{it} + \varepsilon_{it} \quad (2)$$

$$i = 1, 2, \ldots\ldots, \text{N}$$

3.2. Model II

$$CO2_{it} = f\left(Y_{it}, Y_{it}^2, RE_{it}, NRE_{it}, PD_{it}\right) \quad (3)$$

t = 1, 2,….., T

Its general form can be written as:

$$CO2_{it} = \beta_{1i} + \beta_{2i}Y_{it} + \beta_{3i}Y_{it}^2 + \beta_{4i}RE_{it} + \beta_5 NRE_{it} + \beta_{6i}PD_{it} + \mu_{it} \quad (4)$$

4. Estimation Strategy

In equation (ii) and (iv), ε and μ are stochastic random terms. The proxy of CO2 emissions (metric tons per capita) is used to measure environmental quality. For real GDP per capita the constant international dollar is used to measure economic growth. The electricity production from renewable sources (includes solar, biofuels, hydropower, tides, geothermal, wind, and biomass) is used as proxy for renewable energy sources, electricity production from coal, oil and gas (% of total) is used as nonrenewable energy sources and population density (people per sq. km of land area). The study includes four South Asian countries i.e. Bangladesh, India, Pakistan and Sri Lanka. The annual data on CO2 emissions, real GDP per capita, renewable energy sources, nonrenewable energy sources, merchandise exports, merchandise imports and population density is obtained from published statistics of the World Bank which is commonly known as World Development Indicators i-e WDI (2013). The variables environment, real output, renewable energy sources, nonrenewable energy sources, and population density are in logarithmic form. The study used the balanced panel data for the time spam of 1980-2013.

According to the literature, the expected relationships between the variables are as: there should be the negative impact of renewable energy sources on environmental quality. This is so because the literature showed that the energy from renewables is environment-friendly. While the impact of other remaining variables per capita GDP, energy from non-renewables and population density expected to positive. All these indicators seem to be the major contributors to polluting the environment.

4.1. Unit Root Tests

The study has been applied both the scrutiny of time series and as well as panel data techniques. In this context, to check the stationary properties of the variables the study applies DF GLS unit root test on time series data. Levine *et* *al.,* 1993 (LLC), Im *et al.,* 1997 (IPS) have been applied for panel unit root tests. Both panel unit root tests are applied with demean to remove the effects of unobservable common shocks particularly in the case of trade openness and economic developmentin the presence of cross-sectional dependence. IPS exemplifies the test for a heterogeneous panel, however, LLC can be reflected a pooled panel. Levin *et al.,*(2002) argued that in panel data analysis, implementation of unit root tests on time demeaned series allows mitigating the impact of cross-sectional dependence.

4.2. Panel Co-integration Tests

Advance panel co-integration tests can be expected to have high power than the traditional tests. These advanced tests are developed by Larsson *et al.,* (2001) and mostly applied for long-run examination. The panel Larsson *et al.,* (2001) likelihood ratio test statistics is resultant after the average of the likelihood ratio test statistics of Johanson (1995) an individual level. The following equation describes the modified version of Larsson equation is defined as:

$$\lambda_{L\bar{R}}[H(r)/H(k)] = \frac{\sqrt{N}(L\bar{R}_{NT}[H(r)/H(k)]) - E(Z_k)}{\sqrt{VAR(Z_k)}}$$

Where $E(Z_k)$ is mean and $Var(Z_k)$ is variance of the asymptotic trace statistics, mean and variance can be attained from the simulation.

4.3. Estimation of Panel Co-integration Regression

On the off chance that every one of the factors is co-coordinated, the following stage is to estimate the related long-run co-incorporation parameters. Within the sight of co-integration, OLS estimators are known to yield one-sided and conflicting outcomes. Consequently, a few estimators have been proposed. To take into account cross-sectional heterogeneity in the option theory, endogeneity and serial connection issues to acquire reliable and asymptotically fair-minded assessments of the co-integrating vectors, Pedroni (2000; 2001) recommended FMOLS estimator for co-integrated panels.

Consequent upon the views of Pedroni (2001), the Fully Modified OLS system creates consistent estimates in little specimens. Further, this system does not experience the ill effects of vast size bends within the sight of endogeneity and heterogeneous flow. The panel FMOLS estimator for the coefficient β is characterized as:

$$\hat{\beta} = N^{-1} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} (y_{it} - \overline{y})^2 \right)^{-1} \left(\sum_{t=1}^{T} (y_{it} - \overline{y}) \right) z_{it}^{*} - T \hat{\eta}_i$$

4.5. Panel Granger Causality Test

The panel Cointegration tests imply the presence of the long runs affiliation among variables, but it does not notify regarding the direction of the affiliation amongst the variables. If the relationships of variables existed, then causality test by Granger can be utilized. Here, we used the more advanced form of causality test Granger (1969) for panel data, which is developed by DH. The panel Granger Causality test is also measured in light of $\overline{W}$& $\overline{Z}$ test measurements of Homogenous Non-Causality (HNC) theory. In the test, the null hypothesis implies there is no relationship for all the cross-units of the panel. Under the alternative, there is a relationship between variables in the long run. This test is applied to a balance data. The $\overline{W}$ measurements compare to the cross-sectional normal of the N standard individual Wald statistics of Granger non causality tests. The $\overline{Z}$ measurements compare to the standardized statistic (for fixed T sample). Both measurements tend to a normal distribution when both T and N dimension tends to infinity (for $\overline{W}$) or only when N tends to infinity (for $\overline{Z}$).

5. Empirical Results and Discussion

In Table 1 the unit root results of DF GLS with and without trend are reported. All the series are stationary at first difference in our selected panel. The results suggested that environment (CO2), economic growth (Y), renewable energy sources (RE), nonrenewable energy sources (NRE), and population density (PD) are integrated at I(1).

The DF GLS test estabished the stage for Johansen co-integration. Here, Table 2 represents Johansen Co-integration approach results. We fail to reject the null hypothesis i.e. we found four co-integrating vectors in India and Pakistan and three co-integrating vectors in Bangladesh and Sri Lanka. These co-integrating vectors approve the occurrence of co-integration among the variables which indicates that environment (CO2), economic growth (Y), renewable energy sources (RE), nonrenewable energy sources (NRE) and population density (PD) have long run relationship. The study prompts us to apply panel co-integration approach to resolve the ambiguity in individual country based results. In this context, panel unit root tests have been applied to series to check the properties for stationary.

Table 1: DF GLS Test Results

Country/ Variables	At Level		At first difference	
	Without Trend	With Trend	Without Trend	With Trend
India				
Y_t	0.793	-0.676	-4.294*	-5.601*
NRE_t	-0.872	-2.572	-1.953**	-2.262***
RE_t	-0.129	-2.465	-6.035*	-6.065*
$Co2_t$	0.166	-2.429	-3.978*	-4.272*
PD_t	-0.196	-0.521	-1.769***	-7.232*
Pakistan				
Y_t	0.582	-2.287	-3.289*	-3.704**
NRE_t	0.163	-1.266	-1.782***	-3.083***
RE_t	-0.314	-2.169	-5.721*	-5.926*
$Co2_t$	0.603	-2.234	-7.677*	-8.331*
PD_t	-0.013	-1.449	-1.945***	-4.616*
Bangladesh				
Y_t	-0.718	-1.477	-1.782***	-5.331*
NRE_t	-1.409	-2.362	-5.571*	-5.597*
RE_t	-4.963	-5.588	-9.152*	-9.205*
$Co2_t$	0.388	-2.209	-7.934*	-8.179*
PD_t	0.277	-1.298	-1.847***	-6.669*
Sri Lanka				
Y_t	0.719	-0.889	-3.406*	-4.787*
NRE_t	-2.487	-4.344	-6.826*	-7.105*
RE_t	-1.145	-2.902	-7.563*	-7.666*
$Co2_t$	0.049	-1.657	-4.943*	-5.724*
PD_t	-0.065	-0.844	-4.445*	-5.385*

Note: *, ** and *** indicate 1%, 5% and 10% level of significance, respectively.

Table 2: Johansen Co-integration Approach Results

Country	likelihood ratio	Critical valueat 5%	p-value
India			
R=0	176.011	69.819	0.000
R≤1	72.049	47.856	0.000
R≤2	33.747	29.797	0.017
R≤3	16.897	15.495	0.031
R≤4	4.922	3.841	0.027
Pakistan			
R=0	207.385	69.819	0.000
R≤1	111.202	47.856	0.000
R≤2	65.270	29.797	0.000
R≤3	28.575	15.495	0.000
R≤4	1.894	3.841	0.169
Bangladesh			
R=0	170.834	69.819	0.000
R≤1	82.668	47.856	0.000
R≤2	40.465	29.797	0.002
R≤3	14.404	15.495	0.073
R≤4	0.990	3.841	0.320
Sri Lanka			
R=0	132.291	69.819	0.000
R≤1	67.448	47.856	0.000
R≤2	31.135	29.797	0.035
R≤3	12.559	15.495	0.132
R≤4	1.623	3.841	0.203

In Table 3 the LLC, IPS with demean unit root tests results are reported with and without trend. The results showed that at the1stdifference, all variables are stationary and integrated i.e. I(1).

Table 3: Panel Unit Root Test

LLC TEST with demean								
Variable	Level				1st Difference			
	W. Out Trend	P-value	With Trend	P-value	W. out Trend	P-value	With Trend	P-value
Y	0.884	0.812	-1.046	0.148	-1.766	0.038	-5.849	0.000
NRE	0.702	0.758	1.932	0.974	-7.199	0.000	-5.999	0.000
RE	0.717	0.763	0.975	0.835	-14.064	0.000	-12.753	0.000
CO2	-0.973	0.165	-0.135	0.446	-5.559	0.000	-4.312	0.000
PD	-1.027	0.152	-2.400	0.008	-9.600	0.000	-7.677	0.000
IPS TEST with demean								
Variable	Level				1st Difference			
	W. out Trend	P-value	With Trend	P-value	W. out Trend	P-value	With Trend	P-value
Y	0.005	0.988	0.818	0.794	-6.094	0.000	-5.588	0.000
NRE	-0.885	0.188	-0.786	0.216	-10.687	0.000	-10.141	0.000
RE	-1.237	0.108	-0.662	0.254	-13.068	0.000	-12.564	0.000
CO2	-0.574	0.283	0.747	0.773	-8.358	0.000	-7.220	0.000
PD	2.716	0.996	-0.511	0.304	-8.454	0.000	-6.044	0.000

Table 4: Larsson et al., Panel Co-integration Test

Hypothesis	Likelihood Ratio	1% critical value
R=0	30.141*	2.45
R≤1	16.532*	2.45
R≤2	11.139*	2.45
R≤3	7.408*	2.45
R≤4	1.641	2.45

Larsson et al., (2001) panel co-integration results are reported in Table 4. In the case of panel, the maximum rank is r =3. We find that the values of maximum likelihood ratio i.e. 30.114, 16.532, 11.139 and 7.408 are significant at

1% significance level. (Thus, all these values are greater than table value 2.45.) Hence, the result of Larsson et al., (2001) panel co-integration indicates the existence of at least three co-integrating vectors in selected panel of South Asia.

Table 5: FMOLS Country Specific Results (CO_2 Dependent Variable)

Country	Variables	Model I		Model II	
		Coefficients	p-value	Coefficients	p-value
India	Y_t	0.154	0.000	1.841	0.000
	Y_t^2	--------	--------	-0.134	0.000
	RE_t	-0.086	0.000	0.033	0.035
	NRE_t	0.004	0.699	-0.068	0.000
	PD_t	1.845	0.000	1.756	0.000
Pakistan	Y_t	0.666	0.008	5.412	0.000
	Y_t^2	--------	--------	-0.355	0.000
	RE_t	0.007	0.445	-0.016	0.093
	NRE_t	0.013	0.000	-0.009	0.005
	PD_t	0.502	0.000	0.453	0.000
Bangladesh	Y_t	0.518	0.000	10.155	0.011
	Y_t^2	--------	--------	-0.781	0.014
	RE_t	-0.111	0.017	-0.133	0.002
	NRE_t	-0.021	0.429	-0.058	0.042
	PD_t	1.636	0.000	1.103	0.001
Srilanka	Y_t	0.469	0.033	22.536	0.000
	Y_t^2	--------	--------	-1.423	0.000
	RE_t	-0.472	0.013	-0.321	0.000
	NRE_t	0.087	0.002	0.041	0.000
	PD_t	2.192	0.058	-6.297	0.000

Finally, panel co-integrating results confirm a stable long-run relationship between environment (CO2), economic growth (Y), renewable energy sources

(RE), nonrenewable energy sources (NRE) and population density (PD) in four South Asian countries.

The model I in Table 5 displays the results of FMOLS at the individual level. In this approach, all selected countries have significant and positive coefficients of income and population density. Both the positive coefficients suggest that increment in GDP and population density prompts increment in environmental pollution. The coefficients of non-renewable energy sources are significant and positive in Pakistan and Sri Lanka but insignificant in case of India and Bangladesh. Renewable energy sources decrease the environmental pollution in all three countries except Pakistan. However, in the case of Pakistan, the coefficient of renewable energy sources is found insignificant. These results indicate that point in Pakistan the renewable energy sources are not much helpful in Pollution control. This is because Pakistan is facing worst energy crises due to mass increase in the demand for electricity and population growth simultaneously. The demand for electricity from non-renewable sources is tend to increase exponentially because Pakistan is facing the high cost of production of electricity from renewables than non-renewables. Model II shows the occurrence of EKC assumption in all the selected countries.

Table 6 displays the results of FMOLS panel estimates taking CO2 as the dependent variable in both models. Results of the model I show significant coefficients and their signs are according to economic theory. FMOLS results indicate that 1 percent rise in growth, energy from non-renewable sources and population density builds CO2 emanations per capita by around 0.727 percent, 0.067 percent and 0.931 percent individually. In any case, the negative indication of sustainable energy sources demonstrates that 1 percent expansion in sustainable energy sources will prompt decline CO2 discharges per capita by around 0.352 percent. The nearness of the EKC speculation has been additionally found in results of FMOLS in Model II. The results of factors like development, population (PD) and non-sustainable energy source (NRE), are similar to the studies conducted by Chiu and Chang (2009), Hossain (2011), Sulaiman*et al.* (2013), Sadorsky (2014), Shafiei and Salim (2014), Boluk and Mert (2015) and Jebli*et al.* (2016). Population growth, nonrenewable vitality and GDP adds to CO2 emanations and sustainable energy source have lessen the CO2 outflows. The reduction in the CO2 emissions due to the contribution of the renewable energy in the computed model are related to the estimations of the study of Rafiq*et al.*(2016).The tendency in the results of above-reviewed studies is in the favour of renewable energy consumption because it causes less carbon dioxide emission to the environment.

Table 6: FMOLS Panel Estimates (CO₂ Dependent Variable)

Variables	Model I		Model II	
	Coefficients	p-value	Coefficients	p-value
Y_{it}	0.727	0.000	2.078	0.001
Y_{it}^2	--------	--------	-0.099	0.029
RE_{it}	-0.352	0.000	-0.250	0.000
NRE_{it}	0.068	0.000	0.064	0.000
PD_{it}	0.931	0.000	0.681	0.000

Table 7 represents the direction of causality between variables. The outcomes indicate that there is a bi-directional causality running between CO2 and sustainable energies and between populace predetermination and CO2. Results pass on a sign of criticism connection between sustainable energy sources and per capita CO2 emanations. There is unidirectional causality running from CO2 to non-sustainable sources. There is no causality amongst growth and CO2.

Table 7: DH Panel Causality Test

Direction of Causality	$W_{N,T}^{HNC}$	$Z_{N,T}^{HNC}$	P-Value
$Y_{it} \rightarrow CO2_{it}$	2.365	0.175	0.861
$CO2_{it} \rightarrow Y_{it}$	3.344	1.012	0.312
$NRE_{it} \rightarrow CO2_{it}$	2.562	0.343	0.731
$CO2_{it} \rightarrow NRE_{it}$	11.352	7.855	0.000
$PD_{it} \rightarrow CO2_{it}$	10.670	7.272	0.000
$CO2_{it} \rightarrow PD_{it}$	8.781	5.658	0.000
$RE_{it} \rightarrow CO2_{it}$	6.382	3.608	0.000
$CO2_{it} \rightarrow RE_{it}$	5.456	2.817	0.005

6. Conclusions

This study employs the panel data from 1980 to 2013 comprising of information from India, Pakistan, Bangladesh and Sri Lanka. The Unit root test, DF GLS and Panel unit root test LCC and IPS are applied to investigate the coordinating properties of the previously mentioned factors. In addition, to test co-integration and direction of causality among variables, likelihood-based panel co-integration and Granger causality approaches have been applied. Empirical results indicate that all variables are integrated at first difference and a similar derivation is drawn about co-integration among environment, income (per capita GDP), population density and both energy sources (RE, NRE).The effect of financial development, population density and non-sustainable energy source on CO_2 discharges is discovered positive which proposes that expansion in the above parameters tends to increment in per capita CO_2 outflows. Nevertheless, the negative indication of sustainable power sources demonstrates that it is probably going to decrease in per capita CO_2 emissions. Likewise, an upset U-formed way amongst income and environmental quality was found.

Moreover, the results show the presence of bi-directional causality amongst CO_2 and sustainable power sources and between populace predetermination and CO_2. Results give proof of criticism connection amongst condition and sustainable energy sources and there is unidirectional causality running from CO_2 to non-sustainable power sources. The study suggests that there is need to explore new and efficient energy sources to accelerate economic growth quickly and actively and decrease in CO_2 emissions. Renewable energy sources are environment-friendly and tend to decrease emissions. In order to keep our environment clean and pollution free, we need to devise the policies which rely on renewable energy sources to uplift economic growth.

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