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Energy consumption, economic growth, and CO_2 emissions in SAARC countries: Does environmental Kuznets curve exist?

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ABSTRACT

The study has made an attempt to verify the existence of Environmental Kuznets Curve in selected SAARC countries (Bangaldesh, India, Nepal, Pakistan, and Sri-Lanka) from 1972 to 2010 on energy consumption, real per capita GDP (Economic Growth), CO_2 emissions, and openness of trade. The panel cointegration and Fully Modified least square results revel that there is a long-run relationship between CO_2 emissions, energy consumption and other variables. From the Fully Modified Least Square (FMOLS) estimation the study found that there is no significant evidence of EKC in SAARC countries in long-run. In case of initial economic growth (PRGDP) there is a negative relationship observed as economic growth leads to low emissions of CO_2. The study also found that there is a positive relationship between higher level of economic growth (Per capita real GDP Square) and CO_2 emissions.

Keywords : EKC, CO_2, Energy consumption, Pedroni cointegration, FMOLS.

JEL Codes : Q5, Q56, C33

1. Introduction

The phrase sustainable development has become the backbone of each and every economy in the world. Sustainable development means economic development with ecological sustainability. But in reality every economy gives more emphasis on its GNP and the calculation of GNP ignores the cost of depleting the environmental resources. Every economy wants to be in top at the cost of other economy, ignoring what damages they are causing to environment and its resources (Himani, 2010). Therefore, the relationship between economic growth and environmental quality has become a long debated issue in the last decades. The relationship between economic growth and environmental quality has been explained in terms of Environmental Kuznets Curve (EKC) hypothesis (Grossman and Krueger 1993, 1995). The EKC hypothesis postulates an inverted U-shape relation between environmental degradation and income per capita. The logic of EKC is that in the initial stage of industrialization people are more concerned about the material output than clean air and water which makes unwarranted damages to environment in the form of various pollutions. The rapid growth results in the greater use of natural resources and emission of pollutions, putting more pressure on the environment. People are too vulnerable to pay for abatement and disregard the environmental consequences of growth. In the later stage of industrialization with the continued growth of income people value the environment more and pollution level declines (Dina, 2004).

In South Asia, the winter has brought some major woes. The thickness of smog in some cities is wrecking havoc with mobility and air traffic. This problem is the outcome of burning of fossil fuels, biomass, as well as diesel transportation, factories, power plants, and dust and the cold winter weather is aggravating it. According to the Meteorological Department of both India and Nepal the intensity and duration of smog affected days have been on the rise in the past ten years. People are suffering from pulmonary and respiratory diseases. The World Health Organisation estimates that 2.4 million people die each year due to air pollution and 1.5 million of these deaths are due to indoor air pollution. Dhaka, the capital of Bangladesh shows an air pollution indexes as high as 40% reported by BBC. Pollution is likely to increase in India over next few years as its energy demands increase. The environmental effects such as earthquakes, floods, outbursts of fires, and epidemics, in the South Asian regions in the last two decades have forced the economists and environmentalists to seriously deal with the environmental deterioration.

In this backdrop the present study aims at investigating the Environmental Kuznets Curve (EKC) hypothesis in SAARC countries. We have focused on CO_2 pollutant to investigate the existence of an EKC hypothesis. The rationale for studying CO_2 emissions is that they have occupied a major place in current debate on environment protection and sustainable development. Most of the scientists have recognized that CO_2 as a major source of global warming through its greenhouse effects. CO_2 is responsible for 58.8% of Green House Gas (World Bank, Report). Another reason is that the use of energy has become an essential factor in the world economy, both for production and consumption where use of energy extensively has been resulted CO_2 emissions in the countries (Azomahou *et al.*, 2006).

Many time series and panel data studies have examined the relationship between income and pollution (Abdul & Mahmud, 2009). The empirical relationship between economic growth, energy consumption and environmental pollutions are analysed in different ways. However studies focusing these in the same framework for the countries investigated in this paper are very limited (Apergis and Ozturk, 2015). The present study tries to fill up that gap with application of panel cointegration and causality methods to verify the existence of EKC hypothesis in SAARC countries.

2. Literature Review

The origin of EKC can be traced back to Simon Kuznets who predicted that as per capita income increases; income inequality also increases at first and then starts declining after a turning point. This phenomenon is known as Kuznets Curve (KC). From 1990s onwards, it was observed that the level of environmental degradation and income per capita follows the same relationship as income inequality and income per capita do. This relationship is commonly known as EKC (Halicioglu, 2009). The first empirical EKC study was conducted by Grossman and Krueger (1993, 1995). Using a random city specific effect model, they studied the effect of GDP per capita on various local environmental indicators and observed an inverted-U shape curve for most indicators. Selden and Song (1994) investigated this relationship for four air pollutants, SPM, SO_2, of Nitrogen Oxides, (NO_x) and Carbon Monoxide (CO) and observed an EKC for all four pollutants. After that many authors have tested the growth- environmental pollution nexus and found the EKC evidences (Shafik, 1994; Kaufmann *et al.*, 1998).

Literature on EKC studies highlight that EKC hypothesis has been tested and found only in the case of local air and water pollutants. For example, Sulfur Dioxide is one of such pollutants in which case the EKC hypothesis is found to hold mostly. On the other hand pollutants which are global in nature like $CO_{2,}$ the U-shaped relationship is more limited. Empirical relationship between income growth and emission of CO_2 is not (yet) apparent for many countries and in this case the relationship is observed mostly in relative manner rather than absolute (Mazznti *et al.*, 2008; Jalil and Mahmud, 2009). Based on updated data and new techniques, some recent studies have demonstrated the U-shaped relationship between CO_2 emission and income growth (Jalil and Mahmud, 2009; Holtz-Eakin and selden, 1995; Moomaw and Unruch, 1997). Although evidence is heterogeneous across various works, some EKC evidence is observed for CO_2 at least for OECD countries.

Based on a dynamic growth model, De bruyn *et al.*, (1998) studied the relationship between economic growth and three pollutants, CO_2, NO_x, and SO_2 in four countries i.e. Netherlands, UK, USA, and Western Germany. It is found that the time patterns of these emissions correlate positively with economic growth. It is also observed that EKC relationship discovered in panel data may not hold for individual countries.

Cole (2005) has re-examined the relationship between income and three pollutants, Sulfur Dioxide (SO_2), Nitrogen Oxides (NOx) and Carbon Dioxide (CO_2) by using a random coefficients model that allows for slope heterogeneity. Results found from OECD (110 countries) to those from non-OECD (26 countries) have been compared. For NOx an inverted U-shaped relationship is found. For SO_2 and CO_2 no such evidence of an EKC is found. Jalil and Mahmud (2009) examined relationship between CO_2 emission and per capita real GDP by using the auto regressive distributed lag (ARDL) model in China. A time series data over the period of 1971-2005 has been analysed and a U-shape relationship is found between income and CO_2. The results of Granger causality tests indicate one way causality runs through economic growth to CO_2 emissions.

An assessment of the existing literature reveals that beside economic growth, energy consumption and foreign trade are other determinants of CO_2 emissions (Jail and Mahmud, 2009; Ang, 2007; Halicioglu, 2009). In recent years, efforts have been made to examine the relationship between pollution emissions, energy consumption, economic development and foreign trade under the same framework. Kraft and Kraft (1978) are the first academics to examine the relationship between energy and GNP. By using a Sims causality test, they have found a unidirectional causality from GNP to energy use in the United States from 1947 to 1974. After that many studies have tested the relationship between energy consumption and economic growth by employing different techniques and different panel of countries (Masih and Masih, 1996; Yang, 2000; Wolde-Rufael, 2006; Narayan and Singh, 2007; and Narayan *et al.*, 2008). Ang (2007) examined the causal relationship among CO_2, energy consumption, and output for France. Using Cointegration and Vector Error-Correction modeling techniques, they have shown that there exist is an existence of long-run relationships between these variables. The results reveal that output growth causes CO_2 emissions and energy consumption in the long-run. However, in the short-run, a unidirectional causality running from growth of energy to output has been observed.

Study conducted by Halicioglu (2009) examined the inter-relationship between the same variables as has been done by Ang (2007), but he has included foreign trade as another independent variable. Using the time series data for the period 1960-2005 in the case of Turkey, the bounds testing to Cointegration procedure indicate that there exist two form of long-run relationship between the variables. In the first case, CO_2 are determined by energy consumption, income and foreign trade. In the second case income is determined by carbon emission, energy consumption and foreign trade. The result suggests that income is the most important variable responsible for carbon emissions followed by energy consumption and foreign trade.

3. Data and Methodology

The present empirical analysis is based on panel data of selected South Asian Association for Regional Cooperation (SAARC) Countries. India, Pakistan, Nepal, Bhutan, Bangladesh, Maldives, Sri Lanka, Afghanistan are the countries coming under SAARC. However, the country selection is done on the basis of availability of data on CO_2 emissions, Energy Consumption, Real Per Capita GDP, Real Per Capita GDP Square and Openness of Trade(Exports+Imports/GDP). Annual data spans from 1972-2010 and have extracted from World Development Indicators (World Bank), World Economic Outlook (WEO) and UNCTAD. Therefore, the data dimensions are N = 5 and T = 38. The time dimensions‘t’ is 38 years, which allow for ample period length to assess the long run relationship between the five variables.

3.1 Model Specification

Our model specification has been adopted from (Ang, 2007; Soytas et.al. 2007; Ang, 2008) in which they have applied in order to estimate the existence of Kuznets curve into a multivariate framework. In order to test the validity of EKC, the present study has specified a linear quadratic equation to form the long-run relationship between CO_2 emissions, energy consumption, economic growth and openness of trade. The model for the SAARC countries is as follows:

$$CE_{it} = \alpha_i + \beta_{2i}\, EC_{it} + \beta_{3i}\, PRGDP_{it} + \beta_{4i}\, PRGDP_{it}^2 + \beta_{5i}\, OPNT_{it} + \varepsilon_{it} \qquad (1)$$

CE_{it}= CO_2 Emissions

EC_{it}= Energy Consumption of i^{th} country for‘t’ times

$PRGDP_{it}$= Per Capita Real GDP (Economic Growth) of i^{th} country for‘t’ times

$PRGDP_{it}^2$= Per Capita Real GDP square (higher level of economic growth) of ith country for'‘t’ times

$OPNT_{it}$= Openness of international Trade (Exports+Imports/GDP) of ith country for ‘t’times

ε_{it}= Panel Error Term.

It is expected that $\beta_{2i} > 0$ in Eq. (1) because with the increase in the economic activities the need for energy consumption also increases, causing CO_2 emissions. Under the EKC hypothesis, the sign of β_{3i} is expected to be positive where as a negative sign is expected for β_{4i}. It is expected that the sign of β_{5i} depends on the stage of economic development of a country. This may be negative in the case of developed countries, because as a country develops it reduces the production of pollution intensive goods and instead import these from other countries with less restrictive environmental protection laws. On the other hand, the sign of β_{5i} may be positive in the case of developing countries as they tend to have dirty industries with heavy share of pollutants (Grossman and Krueger, 1995; Jail and Mahmud, 2009; Halicioglu, 2009).

4. Estimation Procedure

In order to test the panel Cointegration among variables, the first step is to examine the unit roots properties of the data, because the variables must be integrated of the same order. In the present study we have used four unit roots methods viz. Levin-Lin-Chu (LLC et al., 2002), Im-Pesaran-Shin (2003), Fisher ADF and Fisher PP tests respectively. The null hypothesis of all these Panel unit roots tests have always consider non-stationary of the data in its null hypothesis. IPS combines information from the time series dimension with that from the cross section dimension, such that fewer time observations are required for the test to have power. Most of the researches have opined that IPS test have superior test power to analyze the long-run relationships in panel data and therefore, the present study have employed this procedure. IPS begins by specifying a separate ADF regression for each cross-section with individual effects and no time trend.

$$\Delta Y_{it} = \alpha_i + \rho_i Y_{i,t,1} + \sum_{j=1}^{pi} \beta_{ij} \Delta Y_{i,t,j} + \varepsilon_{it} \tag{2}$$

Where i = 1. . . N and t = 1. . . T

IPS use separate unit root tests for the N cross-section units. Their test is based on the Augmented Dickey-fuller (ADF) statistics averaged across groups. After estimating separate ADF regressions, the average of the t-statistics for P_1 from the individual ADF regressions are as follow:

$t_{iTi}(P_i)$

$$\bar{t}_{NT} = \frac{1}{N}\sum_{i=1}^{N} t_{iT}\ (P_i\beta_i) \quad (3)$$

Then the t-bar has been standardized and it converges to the standard normal distribution as N and T approaches towards infinity. In panel unit root estimation they (IPS, 2003) proposed a cross-sectionally demeaned version of both test to be used in the case of errors of different regressions which contains a common time specific component.

4.1 Panel Cointegration Tests

Pedroni (1997, 1999) has proposed a heterogeneous panel Cointegration test which has been used to estimate the cointegration between CO_2 consumption and other variables in the study. This test allows various cross sectional interdependence along with other different individual effects in order to establish the cointegration. For the testing of long-run equilibrium in the panels Pedroni (1999) has proposed two types of residual-based tests that are i.e. without dimension tests (panel V static, panel e static, panel t statistic (Non-parametric) and panel t statistic (parametric) and within dimension. The tests are as follows:

Panel v Statistic:

$$Z_v = \left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\ \hat{e}_{it-1}^{2}\right)^{-1} \quad (4)$$

Panel ρ-statistic:

$$Z_\rho = \left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\ \hat{e}_{it-1}^{2}\right)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\ \left(\hat{e}_{it-1}\Delta\hat{e}_{it} - \hat{\lambda}_i\right) \quad (5)$$

Panel PP-statistic:

$$Z_t = \left(\hat{\sigma}^2\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\ \hat{e}_{it-1}^{2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\ \left(\hat{e}_{it-1}\Delta\hat{e}_{it} - \hat{\lambda}_i\right) \quad (6)$$

Panel ADF-statistic:

$$Z_t^* = \left(\hat{s}^{*2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\ \hat{e}_{it-1}^{*2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\quad \hat{e}^{*}{}_{it-1}\Delta\hat{e}_{it}^{*} \quad (7)$$

Group ρ-statistic:

$$\tilde{Z}_\rho = \sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{e}_{it-1}^{2}\right)^{-1}\sum_{t=1}^{T}\left(\hat{e}_{it-1}\Delta\hat{e}_{it} - \hat{\lambda}_i\right) \quad (8)$$

Group PP-statistic

$$\tilde{Z}_t = \sum_{i=1}^{N}\left(\hat{\sigma}^2 \sum_{t=1}^{T} \hat{e}_{it-1}^2\right)^{-1/2} \sum_{t=1}^{T}\left(\hat{e}_{it-1}\Delta\hat{e}_{it} - \hat{\lambda}_i\right) \tag{9}$$

Group ADF-statistic

$$\hat{Z}_t^* = \sum_{i=1}^{N}\left(\sum_{i=1}^{N} \hat{s}_i^2\, \hat{e}_{it-1}^{*2}\right)^{-1/2} \sum_{t=1}^{T}\left(\hat{e}^*{}_{it-1}\Delta\hat{e}_{it}^*\right) \tag{9}$$

where $\hat{e}_{it}$ is the estimated residual from Eq. (1) and $\hat{L}_{11i}^2$ is estimated long-run covariance matrix for $\Delta\hat{e}_{it}$. Similarly, $\hat{\sigma}_i^2$ and $\hat{s}_i^2$ $(\hat{s}_i^{*2})$ are, respectively, the long-run and contemporaneous variances for individual *i*. The entire seven statistics are normally and asymptotically distributed.

4.2 Fully Modified Least Square

The fully modified least square estimation has been adopted form (Christopoulos and Tsionas, 2004) for estimating the asymptotically efficient consistent in panel series where the method takes in to consideration of non-exogeneity, serial correlation and heterogeneity (Pedroni, 1996). As all the explanatory variables are cointegrated with time trend , henceforth there is a existence of long-run equilibrium relationship among the variables through the panel unit root test (LLC, IPS, Fisher ADF & PP) and panel cointegration test (Pedroni, 1990). The study proceeds to estimate the Equation (1) by the method of fully modified OLS (FMOLS). The FMOLS allows consistent and efficient estimation of cointegratioin vector and at same time it addresses the problem of nonstationary regressors, as well as the problem of simultaneity biases in the heterogenous cointegrated panels. The OLS estimation is not as powerful as FMOLS and it yields biased results in regressors that are endogenously determined in the *I(1)* cases. The model can be written as:

$$\begin{aligned} Y_{it} &= \alpha_{it} + X_{it}^{'}\beta + \varepsilon_{it} \\ X_{it} &= X_{i,t\,1} + \varepsilon_{it} \end{aligned} \tag{11}$$

Where $\xi_{it} = [e_{it}, \varepsilon^{'}_{it}]$ is the stationary with covariance matrix Ω_i . The estimators will be consistent with the error process ω_{it} + $[e_{it}, \varepsilon^{'}_{it}]^{'}$ statistics the assumption of cointegration between y_{it} and x_{it}. The limiting distribution of OLS estimator depends upon nuisance parameters. Following Phillips, and Hansen (1990), a semi- parametric correction can be made to the OLS estimators that elements the second order biases caused by the fact regressors are endogenous. Pedroni (1990 and 2000) follows the same principle in the panel data context, and allows for the heterogeneity in the short run dynamic and fixed effects. FMOLS Pedroni's estimator is constructed as follows.

$$\hat{\beta}_{FM}\beta = \sum_{i=1}^{N} \hat{\Omega}_2\, 2_i^2 \sum_{t=1}^{T} (x_{it}\hat{x}_t) \sum_{i=1}^{N} \hat{\Omega}_{11}\, i^1\hat{\Omega}_{22}i^1 \sum_{t=1}^{T} (x_{it}\bar{x}_t) e_{it} T\hat{\gamma}_i \quad (12)$$

$$\hat{e}_{it} = e_{it}\hat{\Omega}_{22^1}\Omega_{21i,}\hat{y}_i = \hat{\Gamma}_{22i} + \hat{\Omega}_{22i^0}\hat{\Omega}_{21i}(\hat{\Gamma}_{22i} + \hat{\Omega}_{22i^0}) \quad (13)$$

Where the covariance matrix can be decomposed as $\hat{\Omega}_1 = \hat{\Omega}_1 + \hat{\Gamma}_i + \hat{\Gamma}_i$ where Ω_i^0 is the contemporaneous covariance matrix and $\hat{\Gamma}_i$ is a weighted sum of autocovariance. The $\hat{\Omega}_i^0$ represents an appropriate estimator of $\hat{\Omega}_i^0$.

This study has used panel group FMOLS test from Pedroni (1996, 2000). This test allows for greater flexibility in the presence of heterogeneity of the cointegrating vectors. The null hypothesis constructed for the test statistics of the panel group estimators is that H_o: $\beta_i = \beta$ for all i against the alternative hypothesis H_A: $\beta_i \neq \beta$, so that the values for β_i are not constrained to be the same under the alternative hypothesis. This is clearly an advantage. Another advantage lies with the interpretation of the point estimates in the event that the true cointegrating vectors are heterogeneous. It can be interpreted as the mean value for the cointegrating vectors (Pedroni, 2001).

5. Results and discussion

The results of the panel unit roots test (LLC, IPS, Fisher ADF and PP) are shown in the **Table 1**. It indicates that all variables are I (0) in their level form in the constant of the panel unit root regression. Therefore, we cannot reject the null hypothesis of a panel unit root in the level of the series at various lag lengths. In level the study assumes no time trend. Therefore, again we have tested for stationarity by allowing for a constant plus time trend and found that there is significant evidence of nonstationary in level of all panel series. Henceforth the study concludes by rejecting the null hypothesis of stationarity both in constant ant time trend in its level for all the panel series. By applying the above panel unit roots tests in heterogenous panel the study confirms that all variables take first difference to be stationary and in level all are nonstationary.

Table 1 : Panel Unit Root Test

Variables	LLC Test		IPS Test		FISHER ADF		FISHER PP	
	Level		Level		Level		Level	
	C	C & T	C	C & T	C	C & T	C	C & T
CO^2	3.35	0.20	5.69	0.98	5.35	0.98	6.85	0.63
EC	6.71	4.21	8.60	4.62	7.54	4.19	9.27	5.35
PGDP	8.91	7.56	8.15	7.20	6.99	6.47	7.68	7.08
$PGDP^2$	14.13	13.46	12.25	11.94	9.86	9.83	0.73	10.96
OPNT	-3.08	-3.09	-1.92	-2.33	-1.63	-1.86	-1.87	-1.61

Δ CO^2	-5.39*	-4.77*	-6.60*	-6.32*	-6.26*	-5.65*	-10.22*	-14.54*
Δ EC	-2.90*	-4.13*	-4.48*	-5.55*	-4.18*	-4.87*	-8.04*	-9.18*
Δ PGDP	0.63*	1.44*	-1.83*	-1.83*	-1.87*	-1.99*	-5.52*	-5.29*
Δ $PGDP^2$	4.77*	3.38*	0.64*	0.47*	0.67*	0.50*	-3.10*	-3.78*
Δ OPNT	-6.90*	-6.24*	-7.09*	-6.33*	-6.26*	-5.55*	-9.06*	-8.59*

Notes : Numbers in parentheses are p-values. C refers to the specification with intercept; C & T refers to the specification with intercept and trend.

Δ presents the variables take first difference to be stationary conforming the order of integration i.e. I (I) for the cointegrating relationship between the variables. All the variables are stationary only after first difference with different lags. As per the panel cointegration approach the variables can be cointegrated if they take same order to be stationary.

5.1 Panel Cointegration results

The next step is to estimate whether the variables in the study are cointegrated. Using Pedroni (1999, 2001 and 2004) cointegration method the study confirms that all the eight statistics (Panel V Statistic, rho Statistic, PP Statistic, ADF Statistic, and Group ADF Statistic) rejects null hypothesis of no cointegration at 1% level of significance with dimensions and panel rho statistic at 5% without dimensions. From **Table 2** it is observed that cointegration and long-run relationship exist between variables.

Table 2 : Pedroni cointegration Test

	Panel cointegration test	Individual Intercept	Individual Intercept & trend
Within Dimension	Panel v-Statistic	3.559362(0.00)***	3.094693(0.00)***
	Panel rho-Statistic	3.086915(0.00)***	-2.507344(0.00)***
	Panel PP-Statistic	5.512060(0.00)***	-5.818635(0.00)***
	Panel ADF-Statistic	1.669142(0.00)***	-1.875448(0.03)***
Without Dimensions	Group rho-Statistic	1.534855 (0.06)**	1.692181(0.04)***
	Group PP-Statistic	-3.518806 (0.00)***	-15.49059(0.00)***
	Group ADF-Statistic	-7.150709 (0.00)***	-2.760139(0.00)***

Null Hypothesis : No Cointegration between CO_2 and OPNT, ENERGY Consumption, Per-capita Real GDP, and Economic Growth (PRGDP). *** & ** Represents Rejection of Null Hypothesis at 1%, 5% level of significance.

The study found that the variables are having cointegration at 1% level of significance in both constant and constant plus trend in selected SAARC Countries with respect to CO_2 emissions. Henceforth, all the statistics conclude in favor of cointegration.

5.2 FMOLS results

Table 3 presents the long-run elasticity coefficients from FMOLS of cross section and panel group. The estimated coefficients for EC, there are positive and significant impact of EC on CO_2 in all the SAARC countries at one percent level except Nepal.

Table 3 : Long-run Elasticity coefficient of FMOLS

Dependent variable is Carbon emission.

Country	EC	OPNT	PRGDP	$PRGDP^2$
Bangaldesh	0.0030(33.41) ***	0.089(-1.41)	16.524(1.13)	-5.122(0.01)
India	0.004(32.04) ***	-0.017(-2.78) ***	-335.5(-4.32)***	3.088(3.37)***
Nepal	7.022(0.23)	0.001(3.22) ***	-295(-5.39) ***	9.28(4.61)***
Pakistan	0.001(8.35) ***	-0.004(-0.72)	-585 (3.12) ***	9.44(2.32) ***
Sri-Lanka	0.025(13.45) ***	0.001(1.97) **	698(32.17) ***	-381(-2.98) ***
Panel Group	0.002(9.99)***	-0.022(-6.28)***	-105(-3.03)***	853(2.15)***

The null hypothesis for the *t*-ratio is H0=βi=0; Figures in parentheses are *t*-statistics. *, **, and *** denotes 5%, 10% and 1% level of significance.

However the elasticity coefficient has very negligible impact on CO_2. In case of OPNT there is negative and significant effect of Openness of trade on CO_2 emission in India (-0.017) and Pakistan (-0.004) where as in Nepal and Sri-Lanka (0.001) have positive and significant impact on CO_2. One unit change in EC will have 7.022 unit increases in CO_2 in Nepal. Only Bangaldesh and Sri-Lanka have positive impact of per-capita real GDP on CO_2 emission. But Bangaldesh has no statistical significant impact on CO_2 emission. One unit changes in real per-capita GDP which lead to 16.52 units and 698 units increase in CO_2 emissions in Bangaldesh and Sri-Lanka. Other countries have negative and significant impact on CO_2 as the real per-capita GDP changes. This postulates that as in case of initial stage of economic growth, there is no such impact on CO_2 in these countries (India, Nepal, and Pakistan). One unit changes in real per-capita GPD (economic growth) has very negative impact (-335,-295, -585) on CO_2.

The coefficients of per-capita real GPD square which represents the higher level of economic growth in these SAARC countries are highly significant at one percent level and have positive impact on CO_2 emission. Bangaldesh and Sri-lanka are the two countries having negative impact of real per-capita GDP growth on CO_2 . But higher economic growth in case of Bangaldesh is not statistically significant unlike Sri-Lanka. One unit increase in real per-capita economic growth will have 5.122 units and 381 units CO_2 reductions in both the countries. On the other hand, India, Nepal and Pakistan are having positive and significant impact of real per-capita Square (higher economic growth) on CO_2 emissions. In these three countries, one unit increase in real per-capita economic growth will have 3.088, 9.28, 9.44 units increase in CO_2 emissions. This finding goes against the EKC hypothesis because according to EKC hypothesis we expect a negative relationship between higher economic growth and CO_2 emissions. This means in these countries, as rate of economic growth increase there will be more emissions of CO_2 in the long-run. Only Bangladesh and Sri-lanka are supporting EKC hypothesis whereas India, Nepal and Pakistan are against the existence of EKC hypothesis. But as panel group we the results are supporting the existence of EKC hypothesis.

6. Conclusion

This study has made an attempt to examine the long-run relationship between CO_2 emissions and other variables. Five SAARC countries are selected on the basis of availability of data. To estimate the long-run relationship, panel cointegration method is used followed by Fully Modified Lest Square method for estimating the long-run elasticity coefficients. The panel cointegration revels long-run equilibrium relationship among the variables in the selected SAARC countries. However, the estimated long-run coefficients from FMOLS reject the existence of EKC hypothesis in these countries. In case of individual analysis, only Bangladesh and Sri Lanka supports EKC hypothesis whereas others are not. At the very initial stage of economic growth there is very less significant impact of energy consumption on CO_2 emissions because of low industrialization in India, Pakistan and Nepal. The results of long-run coefficients of PRGDP have negative impact on CO_2 emissions. That represents countries expressing initial growth will have negative or less impact on CO_2 emissions as compared to Bangladesh and Sri Lanka. When the economic growth continues to grow at higher level there will be more CO_2 emissions because of increasing industrialization. In case of OPNT, Bangladesh, Nepal and Sri Lanka, the long-run coefficients explain as the country opens to international trade there will be less CO_2 emissions meaning that there is production of pollution intensive goods as they tend to have dirty industries with heavy share of pollutants (Grossman and Krueger, 1995; Halicioglu, 2009). From the panel group long-run coefficient the study concludes that the EKC hypothesis is not supporting in SAARC countries.

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