Experiential EKC: Trade Openness for Optimal CO2 Emission in SAARC Region

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Impact of globalization in terms of environmental degradation over trade liberalization is renowned strong theoretical underpinning in the literature. Nevertheless, testing Environmental Kuznets model of trade liberalization is not adequately estimated to provide pragmatic evidences for optimal environmental policy designs. Besides identifying the Environmental Kuznets Hypothesis (EKH); testing for (i) CO_2 emission and economic growth (ii) CO_2 emission and trade openness, (iii) changes of emissions over simulated trade openness under the experiential Environmental Kuznets Curve (EKC) was estimated using dynamic panel data estimation with Instrumental Variable-Generalized Methods of Moments. The paper used innovative approach to measure the scale effect after performing series of approximations of EKH relationships, a non-linear relationship between percentage changes of CO_2 emission with respect to the simulated trade openness, are predicted using Monte Carlo simulation experiments. Data from WDI of World Bank was used to model the EKC relationships. The results provides evidences that the impacts are considered as the magnifier effect, as this experimentation shows that the increase of trade openness, under these economic situations need to increase 400% to reach the maximum % of CO_2 emissions to decrease gradually. The South Asian Association for Regional Corporation (SAARC) countries cannot increase the trade openness for eight times from current level of trade openness to minimize the emissions, thus high emission rates with increase of trade openness can't be avoided without incorporation of environmental policy instruments. This study also verified that when trade liberalization eliminates subsidies, inducing less environmental friendly effects in the production processes, both trade flows and quality of the environment improves. Finally, the study produced evidences for policymakers to consider the regulatory effect of the trade liberalization in the SAARC region. The paper recommends movements towards the free trade intimidate the optimal environmental standards. Thus, optimal trade openness is essential for amending the SAARC regional trade agreement for environmental effects with regulations for minimizing the environmental impacts and sharing the common benefits among partners for designing the open economic policies.

Keywords: EKC, IV-GMM, Emissions, Trade Openness, SAARC

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1. Introduction

The economic growth under the sustainability perspective is critical arguments in today's economic forums with the impacts of globalization create both pleasant and unpleasant scenarios because of the impacts on environment with trade liberalization. The environmental degradation regarding trade liberalization has often been absent from consideration in the regional trade agreements including South Asian Association for Regional Corporation (SAARC). But innovative thinking and evidence have highlighted the powerful contribution that scale effect of the liberalization towards environmental protection, and this line of inquiry has some salient implications for understanding sustainable growth and development in South Asia and assessing and shaping its future prospects for SAARC. The change in the free trade structure of the partners create potential for faster economic growth along with environmental deprivation. The Environmental Kuznets Curve (EKC) – which is reflected environmental degradation concerning with Gross Domestic Products- is a crucial indicator of country's potential for economic growth and environmental consequences. The similar hypothesis is applicable to the conditions of trade openness and environmental effects, and also towards the experimentation for measuring scale effect of the open economic policies.

The first part of the paper applied empirical model of EKC, and the second part used an innovative approach for experiential EKC using Monte Carlo simulation (MC) for the South Asia. The empirical model of Instrumental Variable-GMM panel data estimation has been paid less attention in evaluating the Kuznets Curve. Thus, this paper fill the research literature gap in the filed of economic modeling and policy for nexus between trade liberalization and environment under SAARC agreement.

EKC usually explains about several phenomenon which includes a natural progression of economic development, exportation of pollution from advanced economies to less developed countries, internationalization of externalities requires advanced institutions for collective decision making, threshold level and use of technologies, environmental quality degradation, demand for environmental quality, and decreasing cost of abatement. EKC implies that the growth and development need not lead to environmental degradation. EKC explains that the income elasticities of marginal damage are increasing with the increase of income; at low level of income, pollution will increase because of weak policy responses. Increase of income over time led the strong policy responses, and at some point of income elasticity of marginal demand is sufficiently high, pollution will start to fall as income increases. Further, it suggests that at low incomes, pollution initially rises with growth because increased consumption is valued higher than the environmental quality. The willingness to pay for environmental quality rises with income increase, and increasingly large sacrifices in consumption provide great environmental benefits.

Regulation of environmental impacts is mainly influenced by liberalization of economy, which is known as compositional effects of trade and scale of economies, informal regulation, pressure from market agents, proper method of environmental regulation and good source of information. Literature provides empirical evidences for the amount of environmental regulation increases with the level of income due to; after economy has competed investment in education and heath, pollution damages get higher priority; high income countries are capable of using personal and budgeting for monitoring enforcements; and higher income and education empower local communities to enforce higher environmental standards.

However, the economic liberalization eliminated subsidies given to the industries such as energy subsidies that promote energy efficiency and cleaner industries in privatization. The increase of market share of large plants has decreased level of pollution. Better environmental impacts are reached with the pervasive informal regulation, pressure from banks, investors and other market agents with adequate information for decisions. However, it is also true that the free trade creates the pollution havens and advocate high environmental standards in SAARC. This approach pays attention towards the SAARC countries with trade agreements and how so far these trade transactions have changed the environmental quality.

International Trade and the Environment

After the globalization, impacts on the environment with the increase of trade openness have highly affected. The sternness of the impacts was more severe with the open economic policies regardless of the environmental influences. Recently, many literatures have provided the impact on environmental degradation with respect to the open economic policies in the context of developing countries amid Regional Trade Agreements (RTAs). These considerations are not properly studies in the SAARC countries to impose regulatory policy instruments to minimize the impacts on environment i.e. CO_2 emissions. One of the fundamental questions is that increase in economic activities induced by the trade openness affect the environment. Nevertheless, even though many literatures provide the evidences of scale effect of trade liberalization on environmental degradation, an approach to measure the scale effect with respect to the simulation experiment of trade openness has not been address. This paper fills the gaps in literature with an innovative empirical method to estimating the scale effects of liberalization using EKC model. The conventional view that economic development and environmental quality are conflicting goals reflects the scale effect alone. In literature of the EKC hypothesis, it provides the fact that at higher levels of development, structural change towards information-intensive industries and services, coupled with increased environmental awareness, enforcement of environmental regulations, better technology, and higher environmental expenditures, result in leveling off and gradual decline of environmental degradation.

The paper is organized as with introduction. The second section presents a brief review of the literature. The third section explores the data and variables over last 54 years of SAARC region. The methodological procedures adopted for estimating the IV-GMM dynamic panel data model are presented in the fourth section and the results are discussed in the fifth section. Finally, the conclusion was included in the sixth section.

2. Literature Review

After the globalization, economies are adapted trade liberalization and it expanded rapidly through out the World with open economic policies. Even though the impacts of globalization are for gain the economic advantages through trade and financial liberalization, its impact on environment is substantial. World trade expansion towards the developing countries has rigorously raised the issue of the relationship between trade and the environment. The productions of goods regardless of imported and exported often develop environmental effects. Many literatures on EKC provide the facts that these effects increase or decrease with expanded trade for some regions, and some trade agreements can be amended to be responsible and need responding to environmental problems associated with trade.

Grossman and Krueger (1991, 1993) and Douglas and Selden (1995) tested the growth-environmental performance nexus in the literature. These empirical evidences revealed that environmental degradation increases at initial level of economic growth and then starts to decline at a higher level of economic growth (Suri and Chapman, 1998; Friedl and Getzner, 2003; Stern, 2004; Dinda and Coondoo, 2006; and Coondoo and Dinda, 2008). In most of the cases under the EKC, an inverted-U form relation for the CO_2 emission is hard to recognize. In literature, a large number of studies on CO_2 emissions find an ever-increasing positive correlation between CO_2 and economic growth; Chang (2010) for China; Ozturk and Acaravci (2010) for Turkey and Pao and Tsai (2010) for Russia. However, Martínez-Zarzoso and Morancho (2004), Cole (2003), Vollebergh et al. (2005), Galeotti et al. (2006) and Apergis and Payne (2010) applied panel data methods, reported an inverted U-shaped for CO_2 emissions in EKC.

Many seminal studies in nexus of economic growth and environmental performance confirm the role of energy consumption in CO_2 emissions. A substantial number of researches have been dedicated to analyze the energy consumption and economic growth nexus (Ozturk, 2010). In EKC models, among the number of macroeconomic variables affect the CO2 emission, energy consumption is one of the highly influential factors. Therefore, this paper used the energy consumption in fitting the EKC model. In literature, Ang (2007), Soytas et al. (2007), Halicioglu (2009), and Jalil and Mahmud (2009), Narayan and Narayan (2010), Apergis and Payne (2010) and Shahbaz et al. (2010) used this approach to test the nexus in economic growth, energy consumption and environmental degradation.

The next component in investigating the emission dynamics is to test the links between the dynamics of macroeconomic factors and environmental performance. Shi (2003) and Cole and Neumayer (2004) found a positive relationship between CO2 emissions and other explanatory variables such as population, energy intensity and rate of urbanization. Cole et al. (1997), and Panayotou (1993), (1995) have discussed population density as an additional explanatory variable in the EKC framework. The study on rate of urbanization and CO2 emissions in China indicates that around 40% contribution in CO2 emissions is due to an 18% increase in population (Dhakal, 2009). Recently, Shahbaz et al. (2010) investigate the relationship between CO2 emissions, economic growth, energy consumption and trade openness for Pakistan. They found that EKC hypothesis exists when energy consumption and trade openness variables are added to the standard GDP variable. The variables of income per capita and the squared income per capita validate the EKC assumptions.

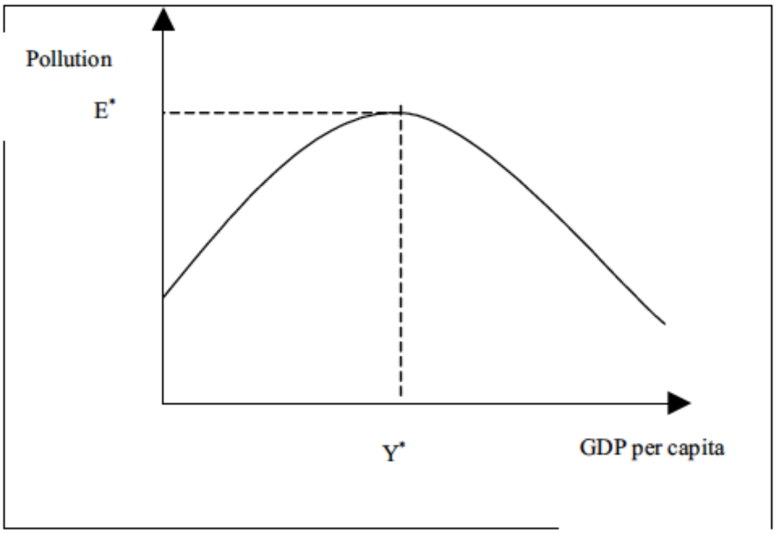
Grossman and Krueger (1991) studied the environmental impacts of the North American Free Trade Agreement (NAFTA) on SO_2 emissions and smoke emissions and found that a cubic polynomial of per capita GDP was the preferred functional form. In a later paper, Grossman and Krueger (1995) used panel data available from Summers and Heston (1991) and GEMS for the years 1979 to 1990 to investigate the presence of an EKC relationship for four environmental indicators: air pollution, and oxygen quality. The reduced form empirical specification included a cubic for real GDP per capita in this analysis. Using GMM estimation of dynamic panel data model, this analysis provided evidence of an EKC relationship for demographic and other indicators.

The empirical support for the emergence of an EKC for atmospheric pollutants such as CO_2 has also studied. Stern and Common (2001) investigated the presence of an EKC for emissions of SO_2 using a panel of 73 countries from 1960 to 1990. The results of their analysis provide evidences of a global inverted-U shaped EKC. Random effects estimation produces consistent results and again reveals an inverted-U shaped EKC for OECD countries. Selden and Song (1994) use cross-national panel data to investigate the EKC for four air pollutants. Selden and Song find evidence of the emergence of an EKC for suspended particulate matter (SPM), SO_2, NO and CO using pooled cross section, fixed effects and random effects estimation using the Grossman and Krueger (1991 and 1995) data. Interestingly, Kaufmann, Davidsdottir, Garnham and Pauly (1998) found a U-shaped relationship between per capita income and atmospheric concentration of SO_2.

Environmental Kuznets Curve and Policy

The econometric models that have commonly been used in EKC studies do not test the pro-growth hypotheses, or even investigate how changes in income influence environmental outcomes (Grossman et al., 1995). However some studies have analyzed the factors that influence environmental change on a more disaggregate level (Neumayer, 2003b). Selden, Forrest and Lockhart (1999) analyzed scale, composition and technique effects at the sector level to decompose changes in various US emissions. The scale is indicated through the growth of emissions when the ratio of emissions to GDP remains constant. They find that increased economic growth will trigger a shift of economic activity from heavy manufacturing to services, and that economic growth may also generate environmental benefits through the development and adoption of new technology, i.e. cleaner production and improved energy efficiency. Therefore the policy for eliminating at least some environmental problems equal more economic growth, but their finding that emissions abatement technology played a significant role in bringing about improvement in environmental quality towards a policy-induced response. The empirical literature has also examined a range of factors that may influence environmental quality, such as democracy, literacy, and income inequality (Grossman and Krueger, 1993; Grossman et al., 1995) established the EKC. Barrett and Graddy (2000) find that for EKC has policy relevance in political freedoms should be treated independently from incomes.

Figure 1. The environmental Kuznets curve



Source: Kuznets (1955, p. 5) and Grossman and Krueger (1991).

Environmental Kuznets Curve and Trade Openness

The EKC provides empirical evidence to test the trade, economic growth and environment hypothesis. The argument is that weather the trade as a driver of economic growth is either good or bad for the environment (Bhagwati, 1993; Daly, 1993). Studies have found that the EKC inverted-U relationship is a result of the changing scale patterns that appear to accompany liberalized trade and economic growth (Grossman et al., 1993, 1995; Heil and Selden, 2001; Suri and Chapman, 1998). The fact that developed countries are importing their pollution-intensive output from the developing world may therefore explain the reductions in local air pollution experienced in most developed countries in recent years (Cole et al., 2005). However, the pollution haven hypothesis is one attempt to explain the changes in trade patterns indicate that less stringent regulation in developing countries will provide them with a comparative advantage in the production of pollution-intensive goods over developed countries (Cole, 2004). But, some literature find no evidence suggesting that the severity of a country’s environmental regulation significantly impacts competitiveness of pollution-intensive firms (Jaffe, Peterson, Portney, and Stavins, 1995; Jänicke et al., 1997), whereas others have found some evidence of pollution haven pressures (Antweiler, Copeland and Taylor, 2001; Birdsall and Wheeler, 1993; Cole and Elliott, 2003; Mani and Wheeler, 1998; Van Beers and Van den Bergh, 1997). Cole (2004) examined North-South trade flows for pollution intensive products, and found evidence of pollution haven effects, but did not find they were widespread. In fact, he found that pollution haven effects may be small compared to other EKC explanatory variables such as increased demand for environmental regulations, increased investment in abatement technologies, trade openness, structural change away from manufacturing, and increased imports of pollution intensive outputs. Some empirical evidences shows that trade openness have severe effects on the environment; those suggest that countries more open to foreign trade have a less likelihood to ratify multilateral environmental agreements in developing countries. This insinuation provides the fact that dealing with the global pollution problems, institutions/corporations are needed to implement appropriate environmental conservation policies to direct the regulations in RTAs.

South Asian Association for Regional Corporation (SAARC) Trade Agreements

The initiation of co-operation in South Asia begins as a result of the Asian relations conference (1947), Baguio Conference (1950), and Colombo Powers Conference (1954). Later, in 1970s, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka agreed upon the creation of a trade partnership and to provide a platform for the people of South Asia to work together in a spirit of friendship, trust, and mutual understanding. After, numerous efforts and works, the agreements were developed for strengthening the economic partnerships of the countries in the region. Officially, the first SAARC summit was held in Dhaka, Bangladesh on 7–8 December 1985. Later, Afghanistan also joined with the trade partners in SAARC.

The trade liberalization of the Regional Trade Agreements (RTA) initiated with the corporation among these countries. However, until recently, the impacts of the trade liberalization on environment have not been thoroughly studied in the region. The nexus of RTA and EKC emerged during the early 1990s with Grossman and Krueger's seminal study of the potential impacts of the North American Free Trade Agreement (NAFTA) and Shafik and Bandyopadhyay's background study for the World Development Report in 1992. However, the idea that economic growth is necessary for environmental quality to be maintained or improved is an essential part of the sustainable development argument disseminated by the World Commission on Environment and Development (WCED). The EKC theme was used to evaluate the view that greater economic activity inevitably harms the environment is based on static assumptions about technology, tastes, and environmental investments. Further, it is considered that as incomes rise, the demand for improvements in environmental quality will increase, as will the resources available for investment. Certain literature argued that although economic growth usually leads to environmental degradation in the early stages of the process, in the end the best—and probably the only—way to attain a decent environment in most countries is to become economically prosperous (Beckerman, 1992). Nevertheless, the EKC has never been shown to apply to simulated trade openness on environmental impacts in SAARC region for imposing the regulatory mechanism for mitigating the impacts on environment with the trade liberalization.

3. Data and Variables

Macroeconomic panel data was gathered from SAARC countries from 1960 to 2014 in World Development Indicators of the World Bank is used for the analysis. The variables are: LGDP is the logarithm of per capita gross domestic products; LTO is the logarithm of trade openness; LCO_2 is the logarithm of CO_2 emission; $LGDP^2$ is the logarithm of square of gross domestic products; $LGDP^3$ is the logarithm of cube of gross domestic products; LEC is the logarithm of energy consumption; LPD is the logarithm of population density; and LDP is the logarithm of demographic profile.

4. Empirical Model

Environmental Kuznets Curve (EKC) Hypothesis

Originally, EKC (Kuznets, 1955) was developed and estimated to understand the relationship between environmental degradation and economics growth. The hypothesis was further expanded to understand the impact of CO_2 emission on economic growth for many countries later on by researchers. The relationship between measures of pollution, per capita income and other possible control variables is traditionally estimated in the literature by means of the following equation (Khanna and Plassmann, 2004; Stern, 2004; Ang, 2007; Orubu and Omotor, 2011):

$$ln\, CO_{2_{it}} = \beta_0 + \beta_1 Y_{it} + \beta_2 Y_{it}^2 + \beta_3 Z_{it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(22)$$

Where i and t refer to the i-th country and the year respectively. The dependent variable is the environmental degradation, in here; CO_2 emissions per capita and Y_{it} is represented by per capita GDP. Z_{it} indicates other variables with potentially explanatory power including financial development factors and innovative indicators in the economies. The literature shows a variety of strong evidences of an EKC relationship. However, the evidences for an EKC relationship in cross-country empirical work are mixed (List and Gallet, 1999; Harbaugh et al., 2002; Barbier, 1997).

The basic panel data models is defined as:

$$ln(CO_{2it}) = \alpha + \beta_1 ln(GDP_{it}) + \beta_2 ln(GDP_{it}^2) + \beta_3 ln(GDP_{it}^3) + \beta_4\, ln\,(TO_{it}) + \beta_5\, ln\,(TO_{it}^2) + \beta_6\, ln\,(EC_{it}) + e_{it}$$

The basic panel data model was estimated based on the Instrumental Variable –Generalized Method of Moment (IV-GMM) with the use of three instrumental variables such as Population density (PD), and lag of other variables in the analysis. It is obvious that the dependent variable as CO_2 emission per GDP per capita is endogenous, and bi-directional relationship with the GDP; hence, GMM Panel data model was applied.

Instrumental Variable –Generalized Method of Moment Estimator (IV-GMM)

Considering the model:

$$y = X\beta + u, \qquad u \sim (0, \Omega) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(8)$$

With X ($N \times k$) and define a matrix Z ($N \times l$) where $l \geq k$. This is the Generalized Method of Moments IV (IV-GMM) estimator. The l instruments give rise to a set of l moments:

$$g_i(\beta) = Z_i' u_i = Z(y_i - x_i\beta)\; i=1, N \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(9)$$

where each g_i is an l-vector. The method of moments approach considers each of the l moment equations as a sample moment, which we may estimate by averaging over N:

$$\bar{g}_i(\beta) = 1/N \sum_{i=1}^{N} = Z_i(y_i - x_i\beta) = 1/N\, Z_i' u_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(10)$$

The GMM approach chooses an estimate that solves $\bar{g}(\hat{\beta}_{GMM}) = 0$ If l = k, the equation to be estimated, is said to be *exactly identified* by the *order condition* for identification: that is, there are as many excluded instruments as included right-hand endogenous variables. The method of moments problem is then k equations in k unknowns, and a unique solution exists, equivalent to the standard IV estimator:

$\hat{\beta}_{IV} = (Z'X)^{-1}Z'y$ ……………………………………………..……………………………(11)

In the case of *over-identification* (l >*k*) we may define a set of *k* instruments: $\hat{X} = Z'(Z'Z)^{-1}Z'X = P_Z X$, which gives rise to the two-stage least squares (2SLS) estimator $\hat{\beta}_{2SLS} = (\hat{X}'X)^{-1}\hat{X}'y = (X'P_Z X)^{-1}X'P_Z y]$ which despite its name is computed by this single matrix equation.

In 2SLS method with over-identification, the l available instruments are "boiled down" to the *k* needed by defining the P_Z matrix. In the IV-GMM approach, that reduction is not necessary. All l instruments are used in the estimator. Furthermore, a *weighting matrix* is employed so that we may choose $\hat{\beta}_{GMM}$ so that the elements of $\bar{g}(\hat{\beta}_{GMM})$ are as close to zero as possible. With l >*k*, not all l moment conditions can be exactly satisfied, so a criterion function that weights them appropriately is used to improve the efficiency of the estimator. The GMM estimator minimizes the criterion,

$J(\hat{\beta}_{GMM}) = N\,\bar{g}(\hat{\beta}_{GMM})'W\bar{g}\,(\hat{\beta}_{GMM})$ ……………………………………………………………..(12)

where *W* is a l × l symmetric weighting matrix.

Solving the set of FOCs, IV-GMM estimator can be derived of an overidentified equation:

$\hat{\beta}_{GMM} = (X'ZWZ'X)^{-1}X'ZWZ'y$ ………………………………………..………………………(13)

which will be identical for all *W* matrices which differ by a factor of proportionality. The *optimal* weighting matrix, as shown by Hansen (1982), chooses $W = S^{-1}$ where *S* is the covariance matrix of the moment conditions to produce the most *efficient* estimator: $S = E[Z'uu'Z] = \lim N_{\to\infty} Z^{-1}[Z'\hat{\Omega}Z]$ With a consistent estimator of *S* derived from 2SLS residuals, defining the feasible IV-GMM estimator as: $\hat{\beta}_{FEGMM} = (X'Z\hat{S}^{-1}Z'X)^{-1}X'Z\hat{S}^{-1}Z'y$, Where *FEGMM* refers to the *feasible efficient* GMM estimator.

The derivation makes no mention of the form of Ω, the variance-covariance matrix (*vce*) of the error process *u*. If the errors satisfy all classical assumptions are *i.i.d.*,$S = \sigma_u^2 I_N$ and the optimal weighting matrix is proportional to the identity matrix. The IV-GMM estimator is merely the standard IV (or 2SLS) estimator. If there is heteroskedasticity of unknown form, we usually compute *robust* standard errors. In this context, $\hat{S} = 1/N\sum_{i=1}^{N}\hat{u}_i^2 Z_i\, Z_i$ Where $\hat{u}$ is the vector of residuals from any consistent estimator of β. For an overidentified equation, the IV-GMM estimates computed from this estimate of *S* will be more efficient than 2SLS estimates.

Innovative Approach in EKC Experimentation using Monte Carlo simulation

The EKC mode has been applied in many forms to provide evidences for the understanding of environmental degradation and economic growth nexus. More innovatively, its impacts over changes of GDP in a simulation experiment are not explicit in the previous literature. Further, even though number of researches attempts to identify the impacts of globalization for the environment, in broader terms, the measured impacts from the trade openness on direct CO_2 emission has not been studied. In order to capture the nonlinear relationships between simulated trade openness on changes of CO_2 emission, this macroeconomic experiment, new trend of the literature, has been conducted. In addition to its innovativeness of the methodology, it provides vital evidences on increase of trade openness for optimal CO_2 emission. In considering the Monte Carlo (MC) simulation, those numerical experiments are reserved to econometrics. This experimentation basically provides the scale effect of the environmental degradation with respect to the trade liberalization using the EKC model.

In this experiment, randomly selected % simulated of Trade Openness was obtained; then those 44 different scenarios of simulated % of trade openness was re-estimated using IV-GMM to obtain the coefficients on % of CO2 emission with respect to % change of Trade Openness (TO). Therefore, TO coefficients shows that % increase of CO_2 emissions with respect to 1% change in TO at simulated levels. From these simulated coefficients, MC simulation approach was applied to estimate the average of the change for 10,000 replications and then the simulated models were predicted for robust estimation of the values as in the Annex Table A.1. It also includes the elasticities of CO_2 emission with respect to the simulated trade openness. However, in order to robustness check and validity, the experiment was conducted using Bootstrap methods and obtained the comparative estimates.

5. Results and Discussion

Table 1 provides the summary statistics of the variables used in the empirical analysis.

Table 1: Summary statistics of the variables

Variable	Mean	Standard Deviation	Min	Max	Observations
LCO_2	-0.613	0.545	-2.103	0.522	407
LGDP	2.561	0.491	1.665	3.883	381
$LGDP^2$	6.761	0.455	2.773	15.078	381
LTO	8.698	0.949	5.741	11.088	365
LEC	2.475	0.210	0.210	1.932	225
LPD	2.135	0.635	0.690	3.126	432

Note: LCO2 = Log of CO2 emissions per capita; LGDP = Log of Gross Domestic Product; LTO = Log of Trade Openness; LEC = Log of Energy Consumption; LPD = log of Population Density

Given the availability of the data, proposed empirical equation for the EKC is estimated and the results are shown in the table (2).

Table 2: IV GMM estimation results of Environmental Kuznets Curve

Dependent Variable:	IV GMM			
In (CO_2)	(1)	(2)	(3)	(4)
GDP	3.523***	15.970***	0.657***	24.527***
	(0.724)	(4.009)	(0.087)	(4.416)
GDP^2	-0.510***	-5.093***		-8.229**
	(0.132)	(1.461)		(1.600)
GDP^3		0.551***		0.924
		(0.176)		(0.191)
TO	0.098***	0.105***	0.441***	1.208***
	(0.029)	(0.030)	(0.342)	(0.264)
TO^2			0.034**	0.075***
			(0.018)	(0.015)
EC	0.453***	0.157***	0.460***	0.586***
	(0.161)	(3.830)	(0.166)	(0.143)
Constant	-8.190***	-19.663***	-2.174	-21.479**

	(1.050)	(3.714)	(1.804)	(3.783)
N	224	224	224	224
Wald Chi2	383.72	356.48	369.41	408.27
P-value	(0.000)	(0.000)	(0.000)	(0.000)
R^2	0.587	0.588	0.563	0.611

Cluster robust standard errors in parenthesis. a * denotes statistical significance at the 10 percent level and a ** denotes statistical significance at the 5 percent level and a *** denotes statistical significance at the 1 percent level. Both time and year fixed effects are used. Instrumental variables: log of population density and lag variables of the explanatory variables.

As the first step of the empirical analysis, instrumental variable GMM application for the Environmental Kuznets Curve was estimated. The predicted non-linear relationship between the CO2 emission and GDP, and trade openness was vital for understanding the relationships. The model has evaluated to understand thoroughly the factors governing the CO2 emission of the SAARC economies and to find the nexus between trade openness and CO_2 emissions per capita. Four models were tested for Environmental Kuznets Curve relationships presented in the above Table (2).

Particularly, IV GMM estimation (1) exposes that GDP, GDP^2, trade openness, energy consumption are significant predictors of CO_2 emissions. In particular, GDP, TO and EC are positively significant in the estimation, implies that increase of those variables increase the emission in the SAARC economies. The second (2) equation revealed that the GDP, GDP^2, GDP^3, TO and EC are significantly affected the emissions as signs are remained the same.

The estimation (3) discloses that GDP, Trade Openness, TO^2, and energy consumption are significant predictors, while the trade openness is positively signed. This result revealed that, in this region, increase of trade openness is increasing the level of emissions. This can be supported with the previous studies that trade liberalization can induce the emissions considerably in South Asian region. Equation (4) revealed that GDP, GDP^2, Trade Openness, square of Trade Openness, and energy consumption significantly affect the environmental degradation and all signs are positive. However, in order to predict the graphical relationships between CO2 emissions and GDP, and Trade Openness following figures were provided.

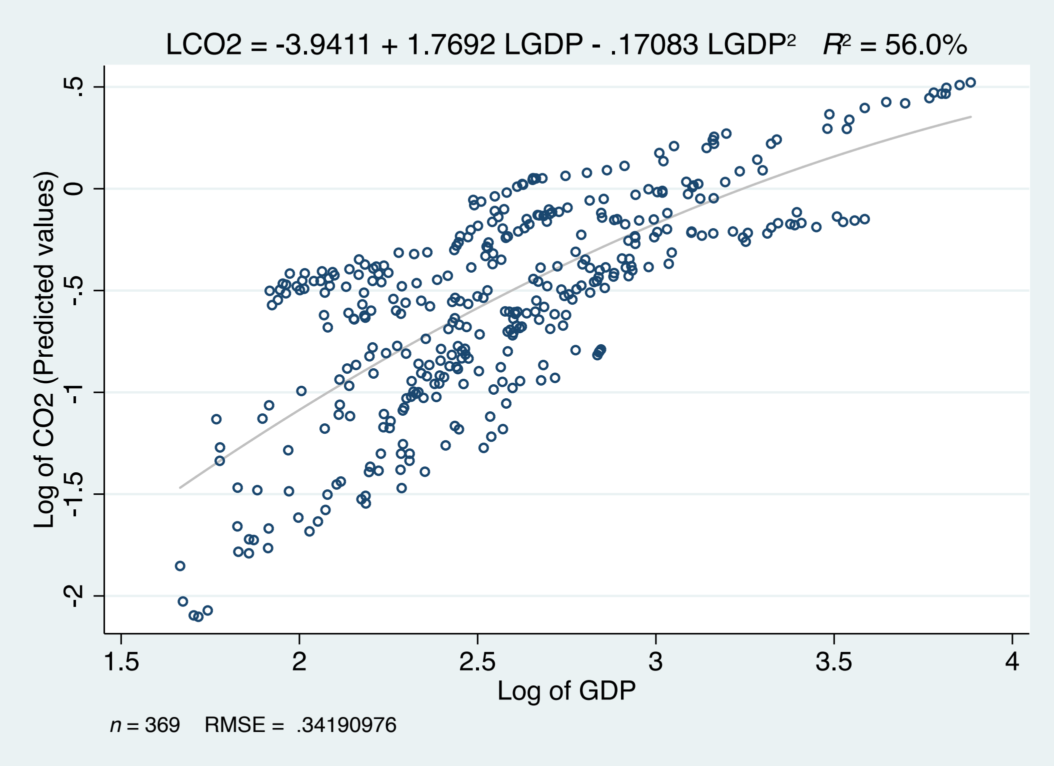


Figure 2: Nonlinear relationship of CO_2 emissions and GDP

The figure 2 indicates a nonlinear relationship of CO2 emissions and GDP relationship. Based on the estimates, it can predict that the increase of GDP increases the CO2 emission in the region. The predicted model follows the EKC hypothesis and extreme point is at 5.178, which is beyond the boundaries, and at 56% of the predicted level.

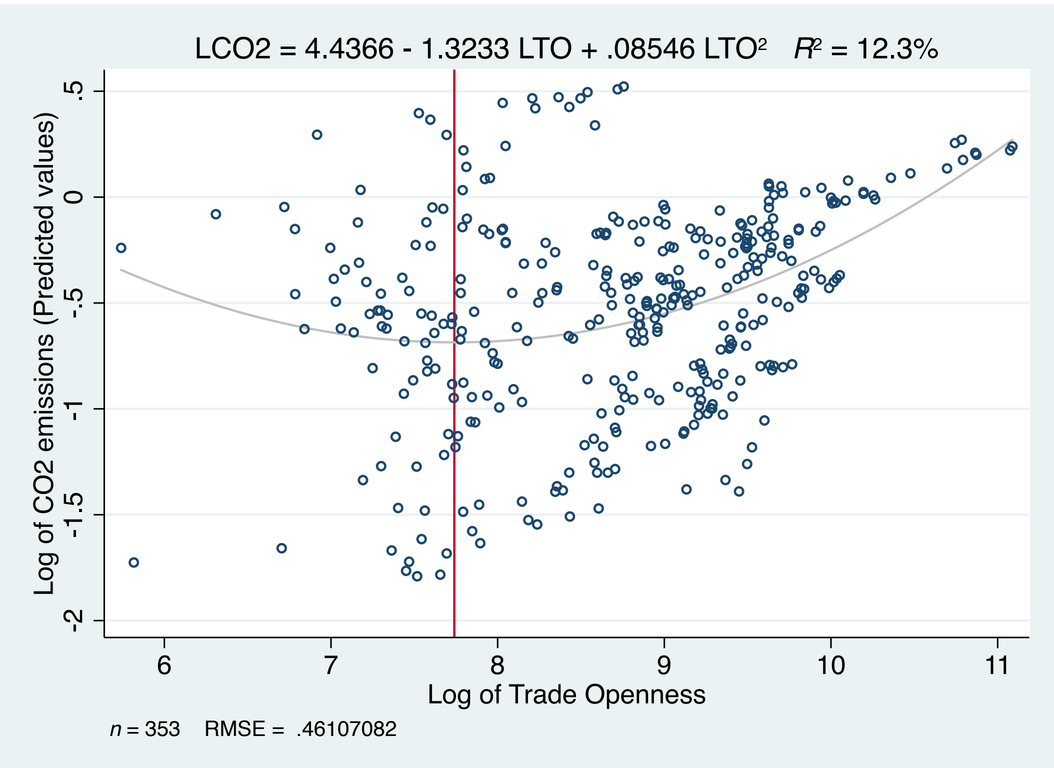


Figure 3: Nonlinear relationship of CO_2 emissions and Trade Openness

Following the Kuznets curve hypothesis, nonlinear relationship between trade openness and CO_2 emissions was also estimated as depicted in the above Figure 3 and the extreme point is at 7.742. This curve shows an U-shape of a relationship between the trade openness and CO_2 emission for the region. Therefore, it clearly indicates that the increase of trade openness beyond the optimal level at 7.7 will automatically increase the CO_2 emission. Therefore, an environmental taxation for preventing negative externalities of the environment under trade openness can be suggested.

However, the insight of the above analysis shows that trade openness is a significant factor that determines the level of emissions in SAARC region. This outcome imply that emissions rise with the trade liberalization impacts on scale effect, which suggesting that these countries have expanded the scope of the industrial base to meet enlarged trade demands (Dinda, 2004). This consequence presents some complications for the SAARC countries since it worsens their environment, which then can negatively impact further sustainable economic growth.

Trade relationships in South Asian Association for Regional Corporation (SAARC)

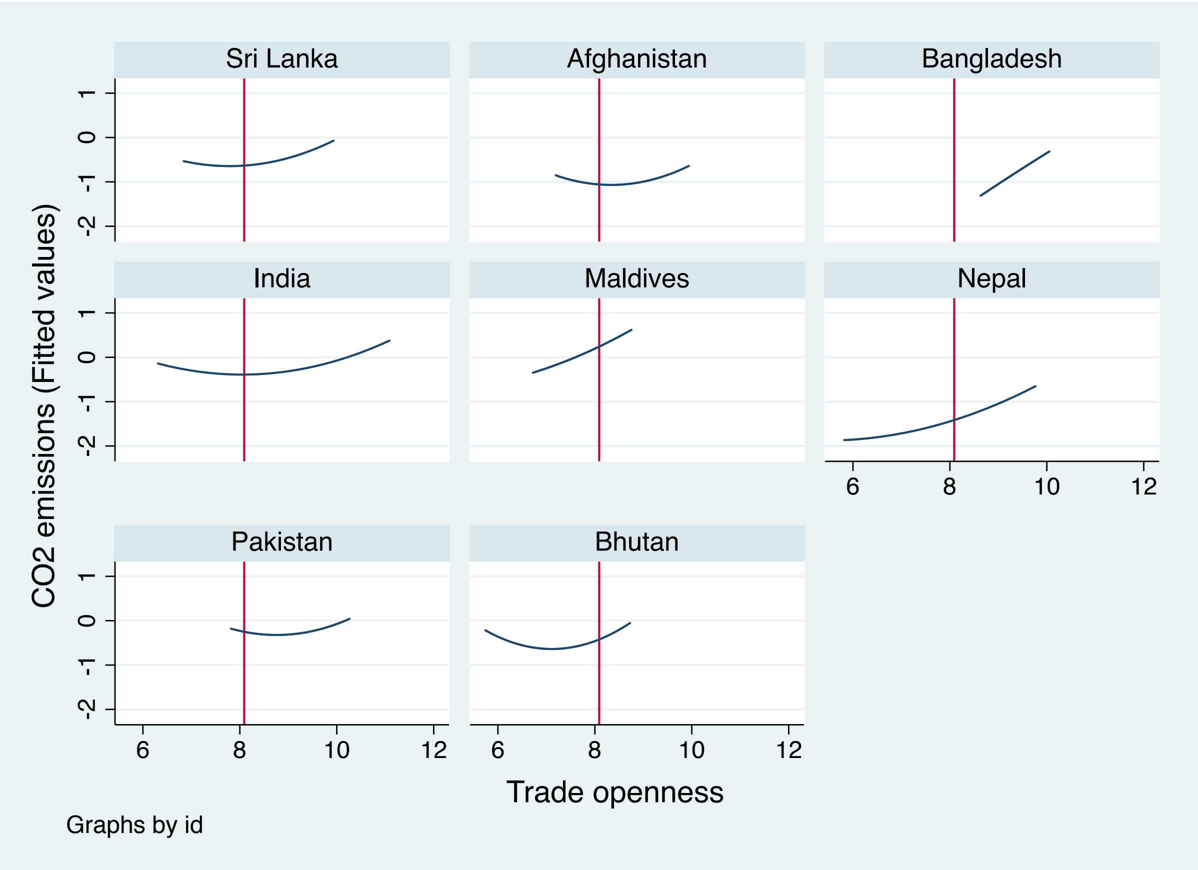


Figure 4:Nonlinear relationship between CO_2 emissions and Trade Openness (U-test extreme point: 8.09)

The above figure 4 shows that the CO_2 emissions with respect to the trade openness for particular countries. The most obvious fact is that the all curves are U-shaped indicates that the increase of liberalization after specific level of trade openness can increase the level of emission in all SARRC countries. Therefore, identification of level of trade openness under the SAARC trade agreement is essential for countries to avoid severe level of environmental pollution.

Experimentation of EKC with Monte Carlo Simulation

Even though, EKC can predict the nonlinear relationship between the CO_2 emissions and trade openness, impact of increased trade openness on environmental degradation cannot be determined. Therefore, as the next step of estimation procedure, EKC model was experimented with the Monte Carlo simulation to study the simulation effects. Monte Carlo procedure is simulated for 10000 replicates and find that the following experiential results for the simulated EKC model.

Table 3: Results of Non-linear Regression

Variables %CO_2	**Coefficient**	**Std. Err.**
Sim TO	0.516***	0.035
Sim TO^2	-0.001***	0.000
Constant	10.405***	2.959
No of Observations	43	
R-squared	0.98	
F-value	251.16	
P-value	0.0000	
U-test		
Extreme point	391.3468	
	Lower bound	Upper bound
Interval	0	500
Slope	0.516	-0.143
P-value	2.22e-08	
H1: Inverse U shape vs. H0: Monotone or U shape		

Table provides the predicted nonlinear relationship between the CO_2 emissions and simulated trade openness in the estimation. Further, Figure shows that the nonlinear relationship of those variables as quadratic model as percentage change of CO_2 emission and simulated percentage of trade openness.

Percentage change of CO_2 emission and simulated Trade Openness

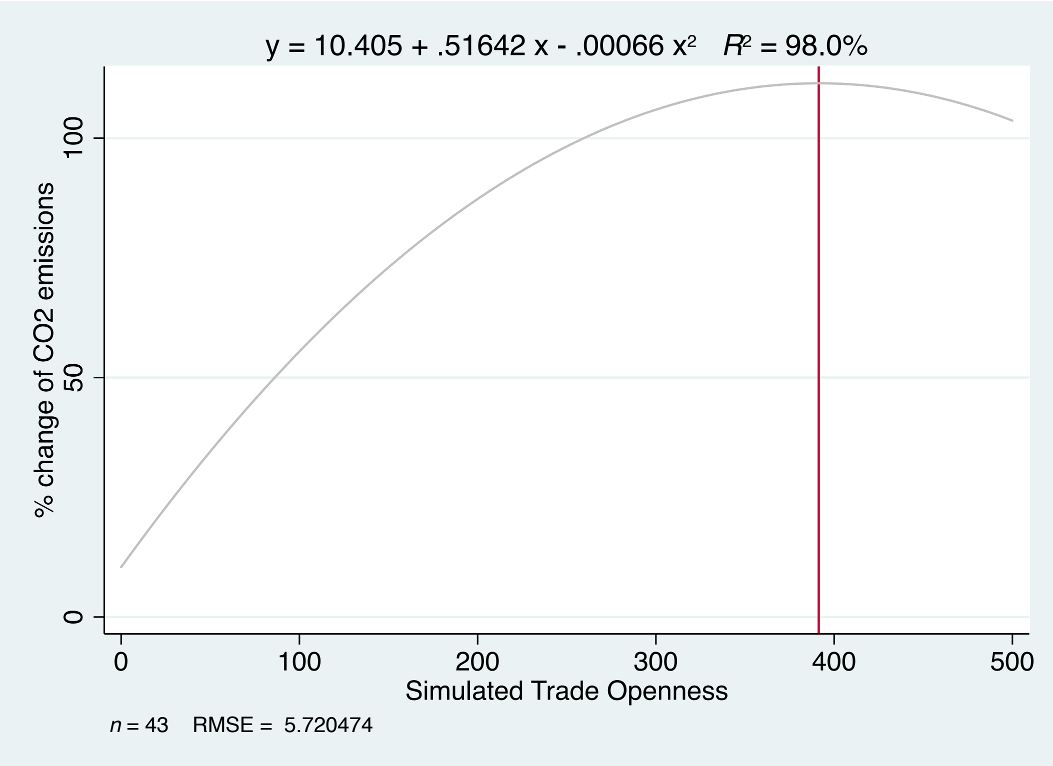


Figure 5: Nonlinear relationship of % change of CO_2 emissions and Simulated Trade Openness

Almost 8 times increase of the trade openness can reach the maximum level of CO_2 from this experiment. Since these SAARC negotiations have not implemented trade regulation for the environmental concern, this provides evidences to minimize the environmental degradation for enforcing new tax systems to prevent over-action of trade openness. Even though this experiments analytical approach evaluate the trade openness on the regional trade, most of the SAARC countries are not implementing a proper system to advocate the "Dumping-off" effects and other trade related issues on environment in the region; this is a common issue for the regional environmental agreements to be deliberated. One clear observation of this experiment is that increase of trade openness over 250 level (5 times) of simulation, double the CO_2 emission, until it reaches around 400 level (8 times) to reduce the emission after maximum level.

Table 4:Summary of Monte Carlo simulation experiment

Variables	Mean	Std. Dev.	Min	Max	No of Obs
sim_1:r(seb1)Constant	0.5055362	0.1151243	0.1262737	1.0446473	10000
sim_2: r(b1) Constant	10.404876	0.5162575	8.2318565	12.351641	10000
sim_3: r(seb3) X2	0.0000125	2.84e-06	3.12e-06	0.0000259	10000
sim_4: r(b3) X2	-0.000699	0.0000129	-0.000752	-0.000645	10000
sim_5: r(seb2) X	0.0060314	0.0013674	0.001498	0.0124541	10000
sim_6: r(b2) X	0.519919	0.0061695	0.4962519	0.5443447	10000

The summary of the MC simulation experiment was presented in the above table. It predicts the mean variations of the impact of trade openness for the percentage of change in CO_2 emissions. This EKC experiment provides the evidences of degree of increase in trade openness for optimal CO_2 emissions in the SAARC region.

The most of the arguments in the literature provides that the trade liberalization brings opportunities for developing countries to growth. The context is not entirely different even in the SAARC countries; the agreements provide opportunities for share the goods and services that benefit the partner countries. However, the degree of open economic policies on economic growth is always challenging since trade not only gives positive results but negative environmental externalities. Therefore, imposing environmental regulations for minimizing the environmental damages and sharing the common benefits among partners is vital for designing the open economic policies. This study provides macroeconomic overview for the SAARC countries to deliberate on the effects of the trade openness on environmental degradation delegating for CO2 emissions.

Environmental effects of trade liberalization in SAARC

Trade liberalization creates environmental problems; increase of trade openness leads more environmental problems, therefore, the many evidences show that the proper taxation for minimizing the environmental degradation in liberalization is necessary and demanding for SAARC region. In many environmental studies gives the fact that expansion of international trade lead to further industrialization and hence to additional environmental problems, which can be avoided with the microeconomic policies like polluter-pay principle based industrial polices. In macroeconomic level, trade liberalization prop up the economic growth that results in increased pollution, the consumption of non-renewable resources at alarming rate and unsustainable use of those resources. Consequently, this study gives the basis for imposing the taxation incorporating the environmental policy commitments into the trade liberalization effort in SAARC countries.

The open economic policies in the region are promoted with environmental friendly technologies and services, while minimizing the circulation of environmentally harmful products such as hazardous waste. This study is further from these environmental impacts since it addresses the scale effects of trade liberalization as increase the amount of resources for environmental investments; it encourages the production under the negative effects. Another consideration of the impacts are the magnifier effect, as this experimentation shows that the increase of trade openness, under these economic situation – without proper environmental measures, needs to increase 400% to reach the maximum % of CO_2 emissions, and then only the reduction of the CO_2 emission starts. Hence, the SAARC countries cannot increase the trade openness for eight times from current level of trade openness, the region is always under the high emission rates. The implication of taxation for minimizing the environmental consequences is a better solution for the region until its industries use the green technologies to protect the environment. Further as the Figure shows, the region under the 400% of the trade openness is emitting high CO2 with respect to the increase of trade openness. Henceforth, the study provides the pragmatic evidences to the regional corporation to take actions for reduction of environmental externalities under the open economic policies.

Trade liberalization is environmentally harmful when it is an incentive for producers to create more globally polluting goods since they are reluctant to pay the full costs for the environmental effects of their production. Moreover, extent of environmental degradation arises due to certain resources constitute a public good, that trade will intensify overuse of common property resources. In the absences of collective actions in SAARC region to control the environmental degradation due to liberalization, public goods lack incentives to restrain behaviour. Amplified export increase producers to use public goods increase the profits under the free trade agreements without paying for the environmental controls in their production processes. Therefore, this study also in line with the argument that the incentive to produce externalizing environmental degradation can be considerable and increases under the circumstances of trade liberalization in the region. Further, it verified that when trade liberalization eliminates subsidies, inducing less environmental friendly effects in the production processes, both trade flows and quality of the environment improves. Technological effects of the trade openness can also be good and bad for the environment. Therefore, it is suitable for the regional corporations to adapt the green technologies for the mitigating the hazard effects of the liberalization process.

Finally, all the results produced in this study relate the policymakers to consider the regulatory effect of the trade liberalization across the region. One of the considerations in the regulatory effects is trade agreements result in the downward corporation of trade standards. Thus, the goal of the regional trade agreement is to improve the trade liberalization with improved environmental protection. Trade liberalization not only relate to the economic effects but also to the political impacts of freer trade. Therefore, movement towards the free trade create problems with the optimal environmental standards. Hence, as in arguments in the literature, relates with this study, that some of the SAARC countries can become "pollution haven", even though this paper doesn't address this issue. Consequently, optimal trade liberalization upon trade openness is essential for incorporating into the SAARC regional trade agreement for mitigating the environmental effects using regulatory policy instruments.

6. Conclusion

The approaches in empirical analysis of Environmental Kuznets Curve is used to build relationships for environmental degradation and degree of trade liberalization using macroeconomic indicators of the SAARC region. The purpose of the paper is to provide robust estimates, and rate of CO2 emissions in terms of simulated trade openness - which is imperative to provide the pragmatic evidences for optimal open economic policy - while proposing incorporation of policy instruments for minimizing the environmental consequences of trade liberalization in RTA. Hence, in this paper, EKC is estimated to identify the factors determining the optimal CO2 emissions and its relationships with trade openness, employing the recently developed econometric methods, IV-GMM regression predicting non-linear behaviour. In EKC trade openness --significant predictor-- is positively signed. In SAARC region, increase of trade openness is increasing the level of emissions that is supported by previous studies in trade liberalization can induce the emissions considerably. Further, it shows a nonlinear relationship of CO_2 emission and GDP relationship as an inverted U-shaped.

In contrast, nonlinear relationship of CO2 emission and trade openness is U-shaped curve clearly indicates that the increase of trade openness beyond the optimal level at 7.7 increase the CO_2 emission. Specifically in SAARC region, the most obvious fact is that all curves are U-shaped indicating the increase of liberalization after specific level of trade openness can increase the level of emission. In line with the literature, the study provides evidences that emissions rise with the trade liberalization impacts on scale effect. To measure the scale effects – experiential EKC, simulated experiment for the CO2 emissions and trade openness is conducted with Monte-carol experiment. This innovative approach with the MC simulation experiment predicts the mean variations of the impact of trade openness for the percentage of change in CO_2 emissions.

The open economic policies in the region are promoted with environmental friendly technologies and services, while minimizing the circulation of environmentally harmful products such as hazardous waste. The impacts are also considered as the magnifier effect, as this experimentation shows that the increase of trade openness, under these economic situations – without proper environmental measures – need to increase 400% to reach the maximum % of CO_2 emissions. The SAARC countries cannot increase the trade openness for eight times from current level of trade openness, thus high emission rates with increase of trade openness can't be avoided without incorporation of environmental policy instruments. This study also verified that when trade liberalization eliminates subsidies, inducing less environmental friendly effects in the production processes, both trade flows and quality of the environment improves. Technological effects of the trade openness can also be good and bad for the environment. Finally, the study produced evidences for policymakers to consider the regulatory effect of the trade liberalization in the SAARC region.

7. Policy Recommendations

The findings from the study can be inferred to provide environmental policy recommendations to the policymakers for SAARC region. The implications of the study are cautious on the EKC model building and experiential EKC with MC simulation for trade effects for robust estimation for the evaluation of trade agreements in South Asia. The estimated results depicted that increase of trade liberalization results in increase of CO_2 emissions. Robust estimated determinants are vital for preparing the environmental policy instruments such as taxation for mitigating the environmental effects. The research leads to generate key major recommendations based on the empirical evidences of the study.

(i) It is recommended to develop a corporate system for South Asia to monitor the environmental impacts with adjustment of the environmental taxation based on this study for SAARC countries in general, and in particular for the specific countries, from the research.

(ii) Inclusion of environmental policy instruments into the trade partners to improve the environmental quality standard of trade liberalization. The implication of taxation for minimizing the environmental consequences is a better solution for the region until its industries use the green technologies to protect the environment. The region is under the 400% of the trade openness, means emitting high CO_2 with respect to the increase of trade openness regardless of no environmental protection. Henceforth, the study provides the pragmatic evidences to the regional corporation to take actions for reduction of environmental externalities under the open economic policies.

(iii) The movements towards the free trade intimidate the optimal environmental standards. Hence, with this study, SAARC countries can become “pollution haven” with the increased trade liberalization. Consequently, optimal trade openness is essential for amending the SAARC regional trade agreement for environmental effects. Therefore, amending the environmental regulations for minimizing the environmental damages and sharing the common benefits among partners is vital for designing the open economic policies. This study provides macroeconomic overview for the SAARC countries to deliberate on the effects of the trade openness on environmental degradation allotting for CO_2 emissions.

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Annex:

Table A.1: Results of Non-linear Regression

Variables LCO_2	**Coefficient**	**Std. Err.**
LGDP	1.77***	0.357
$LGDP^2$	-0.17***	0.066
Constant	-3.94***	0.476
No of Observations	369	
R-squared	0.55	
F-value	232.73	
P-value	0.0000	
U-test		
Extreme point	5.178	
	Lower bound	Upper bound
Interval	1.665	3.883
Slope	1.200	0.442
H1: Inverse U shape vs. H0: Monotone or U shape		

Table A.2: Results of Non-linear Regression

Variables LCO_2	**Coefficient**	**Std. Err.**
LTO	-1.323***	0.368
LTO^2	0.085***	0.021
Constant	4.436***	1.579
No of Observations	353	
R-squared	0.1175	
F-value	24.44	
P-value	0.0000	
U-test		
Extreme point	7.742	
	Lower bound	Upper bound
Interval	5.741	11.088
Slope	-0.342	0.572
P-value	0.0003	
H1: Inverse U shape vs. H0: Monotone or U shape		

Robustness Check of Simulation

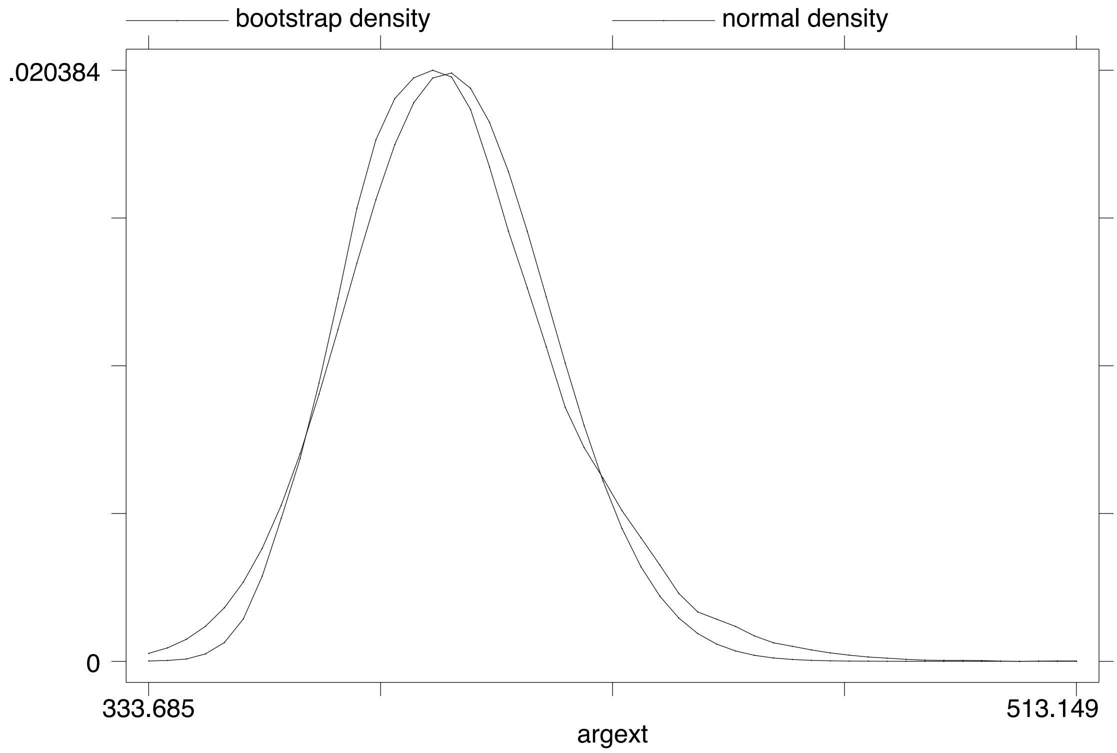

Figure A.1: Distribution of bootstrap density and normal density

Table A.3: Simulated values for CO_2 emissions in margins and elasticities

		Conditional Margins for CO_2 emissions		Elasticities of CO_2 emissions	
No.	**% Simulated of Trade Openness**	**Conditional margins (dy/dx)**	**Std. err.**	**Elasticities (ey/ex)**	**Std.err.**
1	3	0.0022022	0.0005855	0.0001523	0.0000628
2	5	0.0036704	0.0009758	0.0004230	0.0001745
3	7	0.0051386	0.0013661	0.0008290	0.0003419
4	10	0.0073408	0.0019515	0.0016910	0.0006971
5	14	0.0102772	0.0027321	0.0033117	0.0013641
6	17	0.0124794	0.0033176	0.0048792	0.0020082
7	20	0.0146817	0.0039030	0.0067469	0.0027743
8	25	0.0183521	0.0048788	0.0105221	0.0043184
9	30	0.0220225	0.0058545	0.0151169	0.0061899
10	36	0.0264270	0.0070254	0.0216961	0.0088544
11	40	0.0293633	0.0078060	0.0267174	0.0108760
12	48	0.0352360	0.0093672	0.0382482	0.0154789
13	52	0.0381723	0.0101478	0.0447400	0.0180462
14	60	0.0440450	0.0117090	0.0591268	0.0236737
15	64	0.0469813	0.0124896	0.0670002	0.0267173
16	69	0.0506517	0.0134654	0.0774567	0.0307199
17	74	0.0543221	0.0144411	0.0885739	0.0349259
18	80	0.0587266	0.0156121	0.1027516	0.0402159
19	85	0.0623971	0.0165878	0.1152338	0.0448046
20	90	0.0660675	0.0175636	0.1282942	0.0495370
21	100	0.0734083	0.0195151	0.1560400	0.0593571
22	110	0.0807491	0.0214666	0.1857648	0.0695252
23	120	0.0880900	0.0234181	0.2172401	0.0798947
24	130	0.0954308	0.0253696	0.2502365	0.0903265

25	140	0.1027716	0.0273211	0.2845276	0.1006916
26	150	0.1101125	0.0292726	0.3198926	0.1108731
27	175	0.1284645	0.0341514	0.4116340	0.1348798
28	200	0.1468166	0.0390301	0.5057778	0.1559050
29	225	0.1651687	0.0439089	0.5998321	0.1732586
30	250	0.1835208	0.0487877	0.6918606	0.1867057
31	275	0.2018728	0.0536664	0.7804549	0.1963499
32	300	0.2202249	0.0585452	0.8646687	0.2025151
33	320	0.2349066	0.0624482	0.9284941	0.2052385
34	350	0.2569291	0.0683027	1.0179820	0.2062265
35	380	0.2789516	0.0741573	1.0998880	0.2042349
36	400	0.2936332	0.0780603	1.1503660	0.2016289
37	450	0.3303374	0.0878178	1.2629720	0.1920272
38	500	0.3670415	0.0975753	1.3580600	0.1798450
39	550	0.4037457	0.1073329	1.4381740	0.1666856
40	600	0.4404498	0.1170904	1.5057340	0.1535303
41	700	0.5138581	0.1366055	1.6113860	0.1291824
42	800	0.5872664	0.1561205	1.6882710	0.1085687
43	900	0.6606747	0.1756356	1.7453660	0.0916829
44	1000	0.7340830	0.1951507	1.7886330	0.0779907

Note: Delta method applied in estimating the margins and elasticities.

Table 6: Nonlinear relationship of CO_2 emission and GDP

Dependent Variable: CO_2	**Coefficient**	**Std. Err.**	**t-value**	**p-value**
GDP	0.000932***	.0000397	23.47	0.000
GDP^2	-1.58e-08	9.69e-10	-16.30	0.000
Constant	.7285782	.2168163	3.36	0.001
N	400			
R-square	0.6897			
F-value	441.10			
p-value	0.000			

Cluster robust standard errors in parenthesis. a * denotes statistical significance at the 10 percent level and a ** denotes statistical significance at the 5 percent level and a *** denotes statistical significance at the 1 percent level. Both time and year fixed effects are used.

Table A.4: U-test results for nonlinear relationship

	Value	**Lower bound**	**Upper bound**
Extreme point	29488.4***	-	-
Interval	-	97.15	56007.29
Slope	-	0.000	0.000
t-value	-	23.50	-11.61
p-value	-	0.000	0.000
Overall test	11.61	H1: Presence of a Inverse U shape	
p-value	0.000	-	-