Environmental Kuznets Curve on Economic Structuration: South Asian Perspective

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Abstract

South Asia is one of the world's least economically integrated developing regions and every country is increasing its maturity. This economic expansion, nevertheless, degrades the environment and creates an environmental Kuznets curve (EKC). The principal aim of this paper is to ensure the presence of EKC and its current phase in South Asia. Applying the idea of ecological footprint which exceeds the threshold value and so negative, as a proxy variable of environmental degradation instead of carbon-dioxide emission on economic structuration. By using the ARDL method and time-varying causality test with the secondary data from 1975-2019 (systematically recorded environmental data frame), this paper supports the presence of EKC curve yet in the first phase- a gradual increase, for the South Asian region. The empirical findings suggest that real GDP, trade openness, and urbanization from the first lag are degrading the environment whereas efficient energy, globalization, and urbanization at the level estimates are upgrading this situation. Therefore, this paper suggests pro-environment criterion for urbanization, decoupling by service economies, massive implementation of no regret technologies, trade openness and globalization for advanced and green investors.

Key Words: EKC, Globalization, Urbanization, No Regret Technologies, Green Investors

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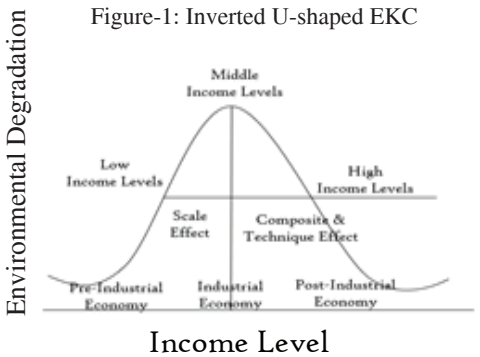
1. Introduction

Environmental issues have become significant in the Sustainable Development Goals (SDG), especially for developing countries. However, economic structuration1 matures unsurprisingly and inevitably hurts the environment. Environment degrades because of economic expansion, trade openness, urbanization, CO2 emissions, and energy consumption, etc. Surprisingly, the ecosystem is restored afterward and is known as EKC (Kuznet, 1955). The usual EKC is an inverted U curve. Sometimes it follows an N-shaped pattern indicating deterioration (Grossman- Krueger, 1991). Figure-1 represents degradation of environmental quality during pre-industrial level through utilizing additional economic resources. This is stated as the scale effect.

Figure-1: Inverted U-shaped EKC



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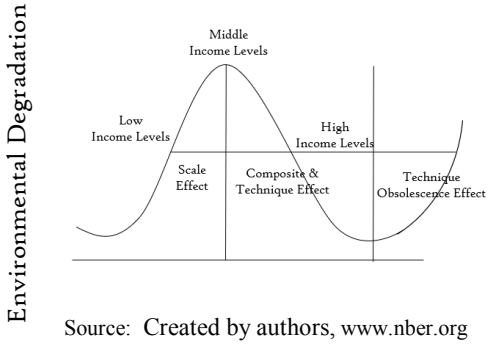
1. Economics structuration refers to the role of different economic sectors to the key macroeconomic variables of output and employment.

However, after incorporating technological (new and efficient devices) and compositional effects (realization of degradation hampers living standards), environmental degradation starts to decline. This relationship takes the form of an inverted U-shape curve. In certain cases, there is an identified N-shaped EKC curve (Figure 2). South Asia is one of the emerging regions worldwide and it is required to observe the recent trend of ecological footprint and its stage on earth.



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2. Objectives

South Asian countries are projected, by the World Bank, a continual increment in growth trajectory in forthcoming years up to 6.7% and so the environmental degradation. According to Sustainable Development Goal Index 2020 by the UN Sustainable Development Solutions Network., Bangladesh scored a rank of 109, Bhutan in ranking 80, the Maldives in ranking 91, Sri Lanka in ranking 94, Nepal in ranking 96, India in ranking 117, Pakistan in ranking 134, Afghanistan in ranking 139, out of 193 countries. As, therefore, it is significant to measure their EKC status over time. Hence the present study.

Figure-3: Map of South Asia

Source: worldgeo.pressbooks.com

This study is trying to quantify the following research questions:

Q-1. What are the ways of eco-structuration on the environmental degradation function?

Q-2. What are the short-run and long-run effects of these variables?

Q-3. Which factors are more liable for this environmental degradation either trade openness or

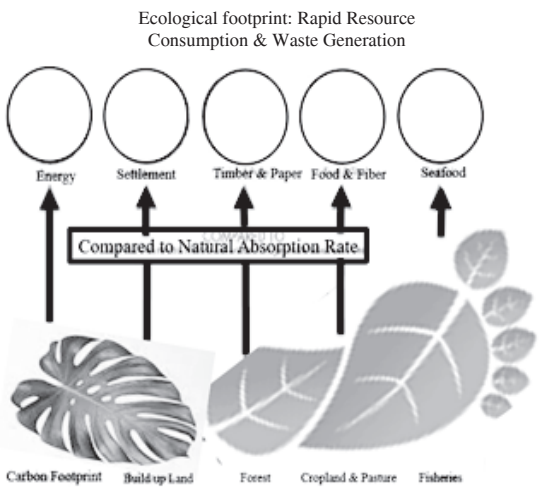
urbanization or GDP or GDP2 or energy structure, or globalization or all at a time?

3. Ecological Footprint and EKC

3.1. Ecological Footprint

Ecological Footprint, primarily in 1990 by Mathis Wackernagel and William Rees at the University of British Columbia, is launched incorporating the carbon footprint, monitoring ecological resource use and advance sustainable development (Wackernagel & Rees, 1996). It is measured on two aspects. One in the demand side where the ecological assets that a given population requires for consumption through food, livestock and fish products, forest products, and finally absorb these wastes. On the other hand, in the supply side this tracks the productivity of ecological assets like cropland, grazing land, fishing grounds, built-up land, forest area, and carbon demand on land (Econation, 2008). An economy runs a bio-capacity or an ecological deficit whenever demand for ecological footprint exceeds the supply-region's bio-capacity. Likewise, there is a bio-capacity reserve when the contradictory happens. In recent days, the ecological footprint is generally used as an evaluation measure for environmental degradation (Ulucak & Bilgili, 2018)

Figure-4: EoFP Performance of South Asian Count



Source: Created by authors, https://footprintnetwork.org

3.2 Environmental Kuznets Curve

EKC is the utilization of natural resources for economic growth thereby fluctuates absorption from the environment and create a pressure on the economy.

3.3 How are these related?

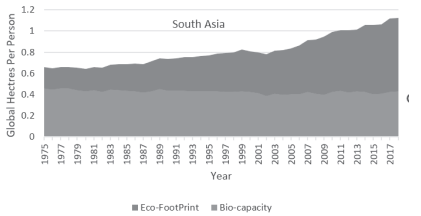
EEconomic expansion is evident for almost all countries. This expansion over-utilized ecological footprint of an economy. However, if the pace of these

over-tendency could be restored by the absorption of natural wastes like green technology, green investment, sustainable policy, effluent treatment plant, compensation to and by the firms, and by external funding, the bio-capacity reserve shall raise the standard of living. But the truth is the reciprocal one.

4. Present EKC Aggregate and Solo Performance of South Asian Countries

The EKC performance, in South Asia, varies among countries, influenced by economic structure, industrialization pace, energy use, and environmental policies. Some of these South Asian countries shows early evidence of environmental improvement as economic development progresses, while others still struggle with high levels of pollution due to the industrialization process. A few crucial factors, that are extracted from footprint network and World Bank database, rigorously degrade the environment are being discussed here.

Figure 5: EoFP Performance of South Asian Countries



Source: Created by authors, https://data.footprintnetwork.org

4.1 Performance in Ecological Footprint:

The ecological footprint condition in South Asian countries is in a precarious state. The following diagrams represent several vital disputes degrading the environment. Figure-5 represents the surpassing situation against their potential ecological footprint or bio-capacity in South Asia. Their potential capacity is of global 0.5 hectares per person however are using 1.20 global hectares per person. This desperate behaviour with the over-utilizing of existing natural resources degrades the environment enormously. However, the discrete eco-footprint diagrams 6, 6A and 6B

Figure 6A: EoFP Performance of South Asian Countries

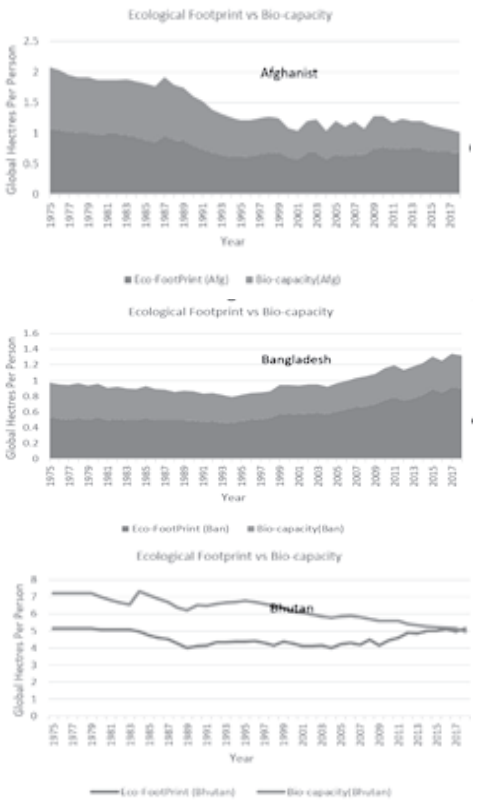


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Figure-6: Individual EoFP Performance of South Asian Countries

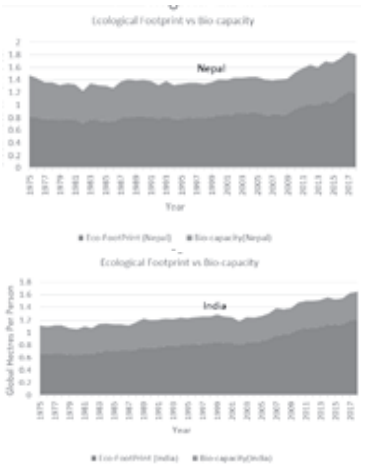

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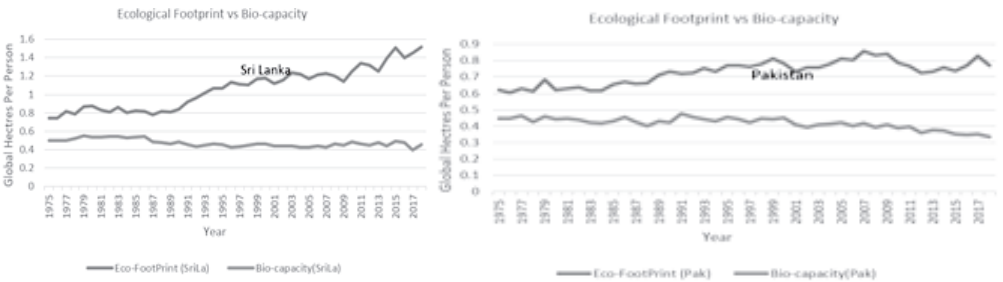
Figure 6B: EoFP Performance of South Asian Countries



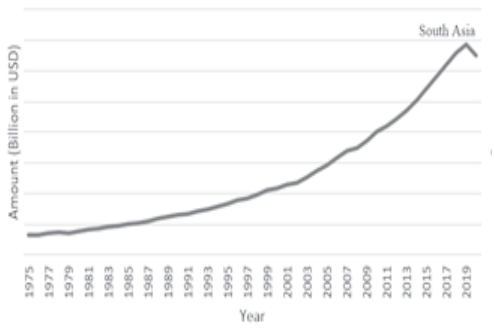
Source: Created by authors, https://data.footprintnetwork.org

reveal narrowly and surpassingly. These diagrams confirm that most countries in South Asia surpass their potential footprint share except for Bhutan which is around global 7.0 hectares per person.

4.2 Performance in Real GDP in South Asia

The real GDP incremental rate in South Asia is escalating. However, this rate is surprisingly roaring in India comparing to others. Bangladesh, after India, is maintaining a moderate growth which is then followed by Pakistan. Sri Lanka, Bhutan and Afghanistan are growing almost a constant real GDP from 1975-2019.

Figure 7: Real GDP Performance of South Asian Countries



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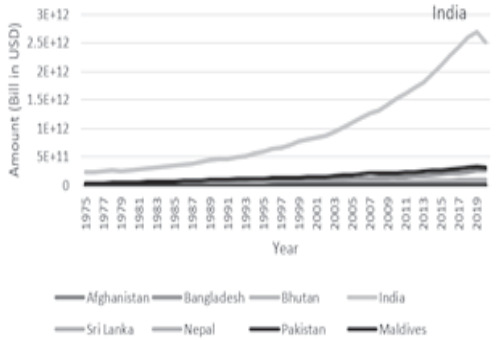
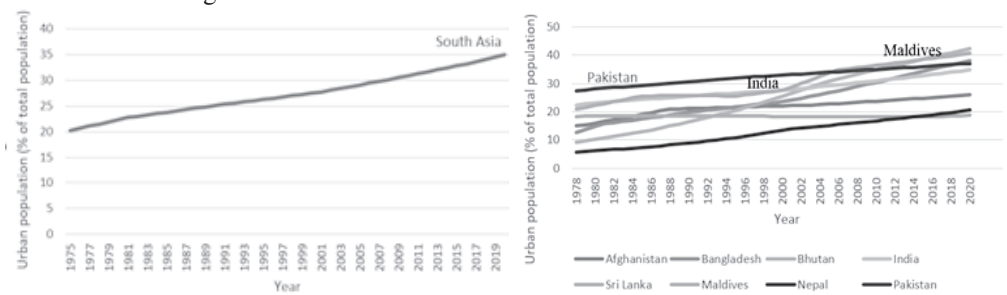


Source: Created by authors, https://data.worldbank.org/

4.3 Performance in Urbanization in South Asia: The following figure- 8 reveals that the incremental rate of urbanization in South Asia is a significant reason for degrading environment.

Figure 8: Urbanization Performance of South Asian Countries

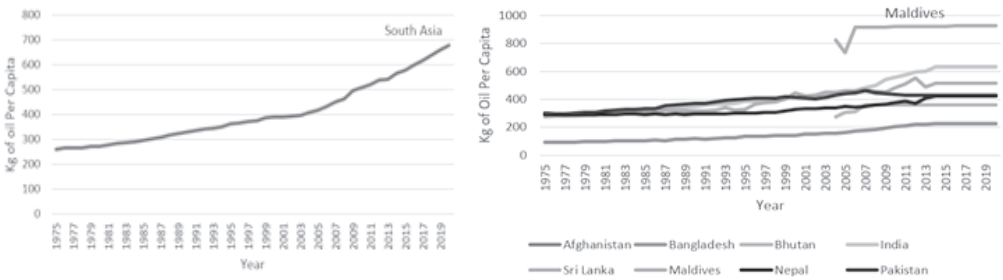


Source: Created by authors, https://data.worldbank.org/

4.4 Performance in Energy Consumption in South Asia

Other than green energy, energy consumption (typically) raises the rate of economic growth, however, falling the state of the environment. Figure 9 reveals the incremental rate of energy consumption in South Asia.

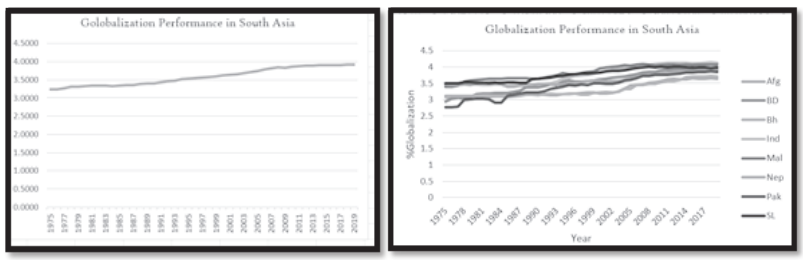
Figure 9: Energy Consumption Performance of South Asian Countries



Source: Created by authors, https://data.worldbank.org/

4.5 Performance in Globalization in South Asia

Figure 10: Globalization Performance of South Asian Countries



Source: Author's created. https://kof.ethz.ch/

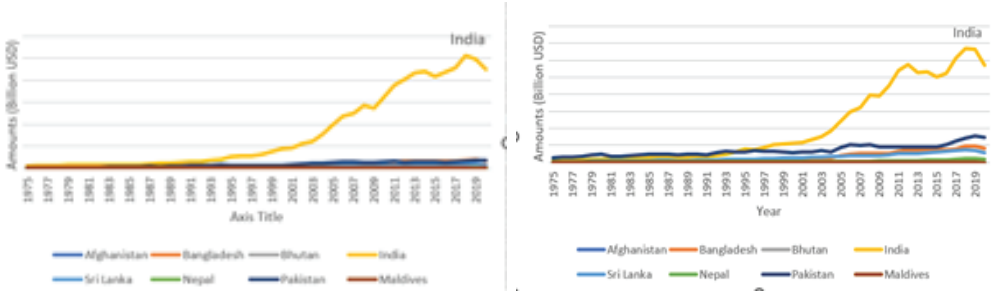
Like others, globalization, which is measured by the rate economic association among other countries, also raises the environmental degradation too and is revealed in Figure 10 in South Asia.

4.6 Performance in Trade Openness in South Asia

The performance of trade openness is determined through the rate of export-import of each country. Figure 11 depicts the real trade-openness scenario in South Asia. In 2019 trade openness was USD 4.03 Trillion which was lower than earlier year USD 5.32 Trillion. On the other hand, in 2019, this amount was USD 1.38 Trillion, USD 4.01 Trillion, USD 0.59 Trillion, USD

1.08 Trillion, USD 9.47 Billion, USD .01 Billion for Bangladesh, Pakistan, Sri Lanka, Nepal, Bhutan and Afghanistan respectively. However, one point is absolutely clear that either real GDP has increased sharply or in roll.

Figure 11: South Asian Exports-Imports (2015USD)



Sources: https://data.worldbank.org

5. Literature Review

Different researchers recommended different views toward EKC for an economy.

Rudolph and Figge (2015) examined the relationship between globalization and the ecological footprint, concluding that globalization could have mixed impacts on environmental degradation. While increased interconnectedness and awareness typically promote positive outcomes, their potential negative influence was minimal. However, in identifying the trade-offs among human activities, ecological footprint offers a framework that illuminates the connections between various anthropogenic drivers that lead to ecological overshoot (Alessandro, 2015). Also, the true value of ecological footprint lies in its ability to integrate competing demands on biocapacity into a single comprehensive equation, rather than addressing each issue separately (Wackernagel, 2013). Therefore, ecological footprints evaluate human impact on the biosphere, highlighting trade-offs like converting forests into cropland that potentially reduces crop productivity. (Goldfinger et al., 2014).

In his study (2016), Gozgor verified the export product diversification and pollution for Turkey and settled that divergence in export product leads to environmental degradation more.

In 2017, Charfeddine and Mrabet validated a constructive linking between income and ecological footprint for higher economic growth. Yurttagüler and Kutlu (2017) identified an N-shaped EKC for Turkey using CO2 emission as a regressand. Wei et. al (2021) found that dirty energy consumption and inefficient energy intensity are degrading the environment in South Asia which in turn reduces the pace of EKC through economic and political fluctuations.

Hafezali Iqbal et al. (2018) suggested asymmetric influence of globalization, economic growth and natural resources on the ecological footprint to detect inverted-U EKC in Thailand. They detected both positive and negative non-linear alignment by globalization and natural resources though negative shock dominated. In their review on South Asia, Murshed and Dao (2020) found that exports excellence was conditional on carbon dioxide emissions to expedite economic growth and so pertinent for confirming green sustainability.

For India, Villanthenkodath, Gupta, Saini, and Sahoo (2021) suggested that the conventional EKC hypothesis was unusual for both aggregated and disaggregated model as the components of the economic growth have a U-shaped influence on the environmental excellence. Dogana et. al (2021) used ecological footprint as a measure of EKC and suggested that the EKC hypothesis is not valid for BRICST countries (Brazil, Russia, India, China, South Africa, Turkey). Also, they ensured energy intensity and energy structure as significants factors of environmental degradation. Another article published by Mahmoodia and Dahmardeh (2022) considering ecological footprint for European and Asian emerging countries found an inverted U-shape nexus among the economic growth and ecological footprint.

EFSA (2021) for South Asia suggested that rapid industrialization, international trade and urbanization expedites intensified environmental degradation, however, if combined with the climate change, are going to intensify in future. However, EKC includes unlike CO2 emissions alone, this anlyze human impact, ecological footprint (EF) is increasingly used as a comprehensive measure of environmental degradation (Yang et al., 2021).

The above studies emphasized ecological foot print that is more rigorous than the CO2 emission to identify EKC. I incorporated, therefore this into my study to estimate EKC in South Asia. Also, new variables like globalisation, energy

structure, and urbanization that were not concentrated at a time in earlier literature, is analyzed here to increase scope of EKC.

6. Methodology

6.1 Data, Measurement Unit and Sources

The secondary data over the 35 years from 1975 - 2019 are decided to be used in this study to identify EKC performance on economic structuration in SAARC countries. Environmental data for South Asia, including carbon emissions, deforestation, and ecological footprints, became systematically recorded in the mid-1970s. Also, key institutions like the World Bank and IEA provide consistent datasets from this period, ensuring reliable long-term trend analysis. The sources, and characteristics of the dataset are presented in table-1. Most data was collected from the World Bank database site and others were gathered from well-established international sources like global footprint network and KOF globalization index respectively.

Table 1: Dataset unit, sources, and definition

Variable	Definition	Measurement	Source
EoF	Eco Footprint	Global Hectares (gha)	Global Footprint Network
Real GDP	Gross domestic product	Constant of 2015 US$	World Development Indicators
URB	Urbanization	Percent	World Development Indicators
ES	Energy structure	Share of Fossil Fuel	World Development Indicators
G	Globalization	Principal Components Analysis (PCA)	KOFGI Index
To	Trade Openness	US$	World Development Indicators

Sources: various websites collected by authors

6.2 Variables Identification

In this research the endogenous and exogenous variables were

a. The ecological footprint: The amount of nature like cropland, grazing land, fishing grounds, built-up land, forest area, and carbon demand on land, utilized per capita of an economy measured by the global hectares. The collected negative value of ecological footprint ensured beyond the threshold value;

b. Trade Openness: Performance of Import-Export against GDP of an economy measured by USD;
c. Urbanization: Performance of urban people growth as a share of the total population measured in percentage term;
d. Energy usage: Data of energy in kg of oil corresponding per capita of an economy;
e. Real GDP: Base year as a constant of 2015 USD.
f. Globalization: The KOF Index of Globalization, by the Swiss Federal Institute of Technology Zurich, measures increment in the integration of economies on economic, social, and political dimensions.

6.3 Country

All South Asian Countries: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka.

6.4 Method

This study used the quadratic Auto-Regressive Distributed Lag (ARDL) approach for establishing the long-run relationship between the variables, the order of integration, and the problem of endogeneity for the optimal lag within the model. Therefore, the model of this study is,

$$\delta EoFP_{i,t} = \beta_1 + \beta_2 \delta RGDP_{i,t} + \beta_3 \delta RGDPSQ_{i,t} + \beta_4 \delta Ur_{i,t} + \beta_5 \delta ES_{i,t} + \beta_6 \delta GI_{i,t} + \beta_7 \delta TO_{i,t} + \beta_8 \delta EoFP_{i,t-j} + \beta_9 \delta RGDP_{i,t-j} + \beta_{10} \delta RGDPSQ_{i,t-j} + +\beta_{11} Ur_{i,t-j} + \beta_{12} \delta ES_{i,t-j} + \beta_{13} \delta TO_{i,t-j} + \varepsilon_{i,t};$$ where,

$\delta EoFP_{i,t}$ =	The percentage change (Log) in eco-footprint for i^{th} country with t-period;
$\delta EoFP_{i,t-j}$ =	Log in eco-footprint for i^{th} country, $(t-j)^{th}$ lag period;
$\delta RGDP_{i,t}$ =	Log in Real GDP in constant 2015 USD for i^{th} country with t-period;
$\delta RGDP_{i,t-j}$ =	Log in Real GDP for i^{th} country $(t-j)^{th}$ lag period;
$\delta RGDPSQ_{i,t}$ =	Log in Real GDP in constant 2015 USD for i^{th} country with t-period;
$\delta RGDPSQ_{i,t-j}$ =	Log in Real GDP for i^{th} country $(t-j)^{th}$ lag period;

$\delta Ur_{i,t}$= Log in the total urbanized person against total population for i^{th} country t-period;

$\delta Ur_{i,t-j}$= Log in total urbanized being against total people for i^{th} country & $(t-j)^{th}$ lag;

$\delta ES_{i,t}$ = Log in the Energy Sources for i^{th} country & period (t);

$\delta ES_{i,t-j}$ = Log in the Energy Sources for i^{th} country & $(t-j)^{th}$ lag;

$\delta GI_{i,t}$ = Log in Globalization for i^{th} country and for period (t);

$\delta GI_{i,t-j}$ = Log in Globalization for i^{th} country & $(t-j)^{th}$ lag;

$\delta TO_{i,t}$ = Log in Trade Openness for i^{th} country and for period (t).

$\delta TO_{i,t-j}$ = Log in Trade Openness for i^{th} country & $(t-j)^{th}$ lag;

Here, (t-j) lag variables are used to determine the ultimate lag period for every variables.

7. Empirical Discussion

By using statistical software of R and ARDL bound regression analysis following estimation has been performed to find the EKC performance of South Asian countries:

$$\delta EoFP_{i,t} = \beta_1 + \beta_2\delta RGDP_{i,t} + \beta_3\delta RGDPSQ_{i,t} + \beta_4\delta Ur_{i,t} + \beta_5\delta ES_{i,t} + \beta_6\delta GI_{i,t} + \beta_7\delta TO_{i,t} + \beta_8\delta EoFP_{i,t-j} + \beta_9\delta RGDP_{i,t-j} + \beta_{10}\delta RGDPSQ_{i,t-j} + +\beta_{11}Ur_{i,t-j} + \beta_{12}\delta ES_{i,t-j} + \beta_{13}\delta TO_{i,t-j} + \varepsilon_{i,t}$$

$$= 276.10 + 2.24\ GDP_t - 1.05\ GDPSQ_t - 6.67\ Ur_t - 24.69\ ES_t - 0.435\ GI_t + 0.125TO_t + 0.515\ EoFP_{t-1} + 0.303GDP_{t-1} + 0.25GDPSQ_{t-1} + 5.99\ Ur_{t-1}$$

7.1. Augmented Dickey-Fuller (ADF) Test

This test has been carried out to operate the unit root test for time series data whether the data is stationary or non-stationary.

$$\partial_t = \beta_1 + \beta_2 t + \partial_{t-1} + U_t$$

H_0: $\partial = 0$ [Non-stationary]

H_a: $\partial < 0$ [Stationary]

Table 2 shows that the ecological footprint is stationary in order I(2). Also, urbanization, trade openness and globalization all three were also stationary in I(2). This integration in I(2) reflects the non-linear impact on others. Other variables are I(1) implying linear influencer for environmental degradation.

Table 2: Stationary Test: Augmented Dickey-Fuller (ADF)

Variable	Critical Values		Decision	ADF
	1%	5%		Calculated
LnEoFT_SA	-3.57	-2.92	H_0 rejected	-4.35 (I(2))
LnRGDP_SA	-3.57	-2.92	H_0 rejected	-5.12(I(1))
LnRGDP2_SA	-3.57	-2.92	H_0 rejected	-5.12(I(1))
LnUr_SA	-3.57	-2.92	H_0 rejected	-4.11(I(2))
LnES_SA	-3.57	-2.92	H_0 rejected	-5.20(I(1))
LnTO_SA	-3.57	-2.92	H_0 rejected	-4.47(I(1))
LnGI_SA	-3.57	-2.92	H_0 rejected	-3.95(I(1)

Table 3- Data Summary for South Asian Countries

	LNEoF	LnGDP	LnGDP2	LnUr	LnES	LnTO	LnGI
Min	-0.46	26.49	52.98	3.0	1.37	2.75	3.24
Max	0.11	28.86	57.72	3.53	1.40	3.96	3.92
1.Quartile	-0.37	26.97	53.95	3.17	1.38	2.94	3.35
3.Quartile	-0.08	28.18	56.37	3.40	1.39	3.71	3.83
Mean	-0.22	27.58	55.2	3.28	1.38	3.31	3.58
Median	-0.24	27.54	55.09	3.28	1.38	3.28	3.55
Sum	-10.18	1241.81	2483.63	147.91	62.5	149.31	161.31
LCL Mean	-0.27	27.38	54.75	3.24	1.38	3.2	3.51
UCL Mean	-0.17	27.81	55.62	3.33	1.39	3.43	3.65
Variance	0.02	0.52	2.08	0.021	0.0004	0.16	0.05
Skewness	0.5	0.14	0.14	-0.040	0.1	0.17	0.13
Kurtosis	-0.97	-1.26	-1.26	-1.05	-1.28	-1.49	-1.55

Source: Estimated by author

7.2. Summary Statistics

The summary statistics in table-3 presents the mean, median, and the quartile range for each of the factors influencing the economic growth through environmental degradation for South

Asian countries. The data summary shows that ecological footprint has a negative mean of -0.226 implying that in average the utilization of the environment through economic activities has exceeded the threshold level. On the other hand, all other determinants have a high average value for incrementing higher economic activities which is identified from the mean nearer to the maximum value. LCL (lower control limit) and UCL (upper control limit) express the amount of variation in the process. On the other hand, a skewness value between (0.5-1) or (-0.5-1) is moderately skewed. A value between -0.5 and 0.5 indicates that the distribution is fairly symmetrical. Also, the negative value of kurtosis- Platykurtic, expresses that curve indicates the small number of outliers in a distribution.

7.3 Optimal Lag Determination: AIC Criterion

This table shows that the optimal lag for LnEoFP, LnRGDP, LnRGDP2, LnUr (first lag) whereas others are level estimates. These are determined by the lowest negative value of the

AIC criterion. This otherwise implies that energy usage, trade openness and globalization factors have no forward degradation in the environment.

Table 4: Optimal Lag Determination by AIC (Akaike Information Criterion)

	LNEoF	LnGDP	LnGDP2	LnUr	LnES	LnTO	LnGI	AIC
1	1	1	1	1	0	0	0	-233.11
2	1	1	1	1	0	1	1	-229.56
3	1	0	1	1	1	1	1	-227.86
4	2	2	2	1	0	0	0	-225.56

Source: Estimated by author

However, the remaining factors are clearly forward its deteriorating tendency to the next period.

7.4 Correlation-Matrix

Table 5: Correlation Matrix

	LNEoF	LnGDP	LnGDP2	LnUr	LnES	LnTO	LnGI
LNEoF	1	0.98	0.98	0.968	0.978	0.896	0.963
LnGDP	0.98	1	0.76	0.994	0.999	0.93	0.989
LnGDP2	0.98	0.76	1	0.994	0.999	0.93	0.989
LnUr	0.968	0.994	0.994	1	0.995	0.918	0.979
LnES	0.978	0.999	0.999	0.995	1	0.931	0.989
LnTO	0.896	0.930	0.930	0.918	0.931	1	0.97
LnGI	0.963	0.989	0.989	0.979	0.989	0.97	1

Source: Estimated by author

The correlation matrix from table-4 shows that all regressors are highly significant for increasing ecological footprint, in another way, degrading environment.

7.5 ARDL Results

Table 6: ARDL Results

	Estimate	Std. Error	t-value	p-value
Intercept	276.10	69.80	3.95	0.00035 ***
LNEoF_1	0.515	0.10	5.056	1.36xe-5 ***
LnGDP	2.24	0.57	3.93	0.00038 ***
LnGDP_1	0.30	0.14	2.15	0.038*
LnGDP2	-1.05	0.57	3.93	0.00038 ***
LnGDP2_1	0.25	0.14	2.15	0.038*
LnUr	-6.67	2.11	-3.15	0.003**
LnUr_1	5.99	1.99	3.012	0.005**
LnES	-24.69	61.22	-4.034	0.00028 ***
LnTO	0.125	0.046	2.68	0.011*
LnGI	-0.43	0.215	-2.017	0.056

Source: Estimated by author

Significance: 0 "***'' 0.001 "**'' 0.01"*"

$R^2 = 0.993$; Adjusted $R^2 = 0.99$

F-statistic: 652.7, p-value= $2.21e\text{-}^{16}$

The table shows that GDP, GDPSQ, ES, and UR all are highly significant determinants of an increase in ecological footprint (degradation) for South Asia. The lower p-value determines the rejection of null hypothesis of having no relationship. On the other hand, TO and GI are also significant by lower p-value 1% and 5% (approximate) level of significance.

However, urbanization (UR) at level estimates plays a barrier to this degradation. This can be for planning for efficient urbanization however this efficiency decreases over time. The same explanation has occurred for energy use (EU). Efficiency energy keeps reducing environmental degradation by reducing eco-footprint. For instance, the positive and highly significant coefficient for LNEoF_1 is 0.515, suggesting that the previous period's ecological footprint positively influences the current period's footprint. Also, higher GDP is associated with an increase in the ecological footprint which is confirmed by the coefficient for LnGDP (2.24). The lagged term LnGDP_1 reinforces the positive relationship between GDP and ecological footprint. However, coefficient for LnGDP^2 (-1.05) suggests a negative relationship when considering the non-linear relationship. On the other hand, negative LnUr (-6.67), LnES (-24.69) and LnGI (-0.43) shows an inverse association among unemployment rates, energy sources, and globalization but by ecological footprints. Besides, also indicate a strong negative relationship between energy sources, and globalization by the ecological footprint. F-statistic ensures that the model is highly significant overall.

7.6 Granger- Causality Analysis

The Granger-Causality analysis rejects the null hypothesis that there is no relationship of eco-footprints on others. However, this shows unidirectional link showing the reverse is not true.

Table 7: Granger-Causality Test

Variable	Df	F	Probability	Significance	
LnEoFT_SA on					Ho: No Granger Cause
LnRGDP_SA	2	8.0604	0.001208	1%	Ho Rejected
LnRGDP2_SA	2	8.0604	0.001208	1%	Ho Rejected
LnUr_SA	2	3.2468	0.04991	5%	Ho Rejected
LnES_SA	2	7.6855	0.001574	1%	Ho Rejected
LnTO_SA	2	1.3024	0.2838	Not	Ho Rejected
LnGI_SA	2	2.3223	0.1018	10%	Ho Rejected
LnRGDP_SA on					
LnEoFT_SA	2	1.569	0.2215	Not	Ha Rejected
LnUr_SA	2	1.0095	0.374	Not	Ha Rejected
LnES_SA	2	1.1207	0.336	Not	Ha Rejected
LnTO_SA	2	1.3024	0.2838	Not	Ha Rejected
LnGI_SA	2	2.3223	0.1118	Not	Ha Rejected

Source: Calculated by Authors

7.7 ARDL Bound Test

Table 8: Peasaran, Shin and Smith Co- integration F Test

Critical Value	I(0)	I(1)
1%	2.458	3.647
5%	2.922	4.268
10%	4.03	5.598

F-statistics = 11.737
Source: Calculated by Authors

Peasaran co-integration test is used for determining the long-run relationship between the variables. The result of Peasaran's ARDL Bounds test is as follows:

Ho: Long Run Relationship = 0
Ha: Long Run Relationship $\neq 0$

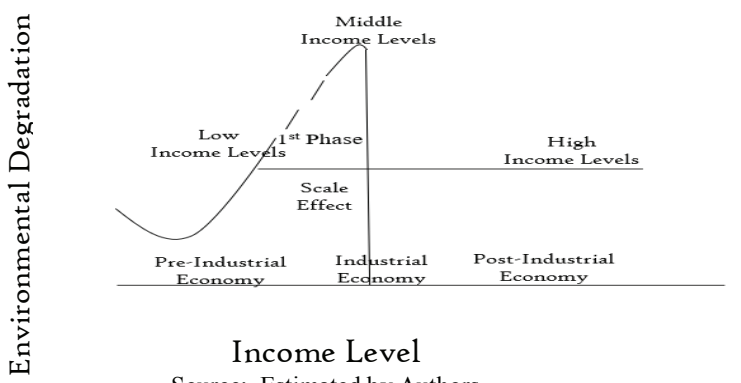
The F-test in table 8 shows that null hypothesis is rejected even for I (1) with level of significance 0.01 or 0.05. This implies a significant long-term relationship between independent variables for the SAARC countries.

8. Discussion

There is a presence of EKC hypothesis in South Asia. This is confirmed by the positive and the negative value of real GDP and real GDPSQ. The complex relationships involving lagged terms and squared GDP terms highlight the nuanced dynamics in the model. Policy analysts should focus on balancing economic growth with sustainable practices in energy use and trade to mitigate the ecological footprint. Also, the EKC for the developing countries in South Asia is in the first phase showing in the aggregate level the environmental degradation does not restore altogether by the variables. On the other hand, there is a significant long run relationship between independent variables for the SAARC countries which is confirmed by the ARDL bound test. This is also supported for Polland byJozwik et al. (2021).

The study also estimates an increment of Ecological footprint by 2.24 hectares per unit increase in real GDP. Nevertheless, the first lag denotes a lower increment by 0.50 hectares. This alternatively implies a short-term transfer of the previous year's economic activities to the current year. An opposite shape of impact found for real GDPSQ and decremental value for its first lag.

Figure 10- EKC Phase



Source: Estimated by Authors

Although by first lag, urbanization and ecological footprint shows a positive association by 5.99 percent, there is a good sign of negative ecological footprint in the present case. This means, sharp urbanization raises focus on sustainable or green strategies to decrease ecological footprint. Similar findings are confirmed in the study of Hongbo Liu et al. (2018).

This study also confirms the per unit increase in trade openness for raising ecological footprint and thereby is continuously degrading environment. Interestingly, globalization has been found to have negative correlations with energy consumption. In the case of globalization, the study finds that a per unit increase in the principal components shall decrease the ecological footprint by 0.43 global hectares. On the other hand, the rate of energy structure has become greener comparatively than earlier. This study estimates a 24.69 decrease in the ecological footprint for per global hectare for per unit increase in the share of fossil fuel perhaps for sharp green energy investment, refined energy and implementation of huge charges and fees in the energy sector.

9. Recommendations

It is true that South Asian countries are developing, their policies vary significantly the strategies and policies of India are not unique compared to other nations in the region. Moreover, the policies for Afghanistan, Sri Lanka, Pakistan, Bhutan, and Nepal do not align with those of Bangladesh. Based on these observations, this study recommends as follows:

a. Balancing Economic Growth with Sustainable Practices

Economic growth must be balanced with sustainable practices in energy use and trade to mitigate the ecological footprint. This involves integrating environmental considerations into economic planning and decision-making processes. Long-term economic growth cannot be compromised in the case of the environment. Sustainable practice can secure enduring economic growth that respects environmental integrity (OECD, 2023).

b. Decoupling by Service Economies

This study suggests moving towards service economies with a smaller ecological footprint. Transitioning from heavy manufacturing to service

economies can reduce energy intensity, supported by energy efficiency standards (Saha & Jaeger, 2020). This transition will aid decoupling to less ecological footprint service economies.

c. Pro-environment Criterion for Urbanization

Urban areas boost productivity (5.5x higher than rural) and promote green practices, as shown by Shresta et al. (2021). This study encourages environmentally responsible urbanization among homeowners and the middle class to promote green practices and regulations.

d. Massive Implementation of No Regret Technologies

No-regret technologies, which promise cost and energy savings, are key for future energy efficiency (WIPO, 2021). ADB predicts Bangladesh could save 14,227 kilotons of oil equivalent by 2030 through such technologies (ADB, 2016). This study proposes a collaborative platform under SAARC to amplify these technologies' impact.

e. Trade Openness and Globalization for Advanced Investors

Globalization fosters environmental sustainability by attracting international investors and facilitating the adoption of advanced technologies. This study emphasizes the role of trade openness in driving business efficiency and reducing energy consumption.

10. Future Research Directions

Future studies could explore specific policies and frameworks. Likewise, researchers can investigate the long-term economic and environmental impacts of such a transition on a regional scale. This framework can then be applied to other developing regions. Also, there are barriers to the adoption of no-regret technologies. Researchers can identify strategies to overcome them on a larger scale. Investigators can also focus on attracting foreign direct investment (FDI) in advanced technologies and the role of international collaboration.

11. Conclusion

This study identifies the Environmental Kuznets Curve (EKC) by using the ecological footprint of South Asia as a proxy variable to assess the state of environmental degradation. This implies existence of inverted U curve opens down by the negative value. By verifying the ARDL method with the secondary data from 1975-2019, this paper supports a gradual increase in the EKC curve for the South Asian region. The evidence presented here indicates that real GDP, urbanization, globalization, energy structures and export diversification have a robust relationship with ecological footprint; therefore, the EKC hypothesis holds in South Asia in the long run and thereby suggesting pro-environment criterion for urbanization, decoupling by service economies, massive implementation of no regret technologies, trade openness and globalization for advanced and green investors on the individual economy. There is always still a room to look for the individual performance of South Asian countries and incorporate its policies on others.

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