

Determinants of Ecological Footprint: Empirical Evidence from Selected South Asian Economies

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Abstract: This study investigated the impact of globalization, tourism travel expenditures, technological innovations and population density on the ecological footprint of India, Pakistan and Bangladesh during the period of 1995 to 2020. To measure the short and long run association, Panel Auto Regressive Distributive Lag (ARDL) method is utilized. The results indicate that there is significant positive long run relationship between globalization & technological innovation with the ecological footprint of India, Pakistan and Bangladesh. While, contrarily, expenditures on tourism travel and population density has significant negative impact on the ecological footprint. The study suggests limiting the level of globalization at optimum level and favors innovations of green technology.

Key Words: Tourism, Globalization, Technological innovations, Population density, Ecological footprint

1. Introduction

It is an observed fact that climate change due to environmental degradation has adversely affected the economic and social sectors of subcontinent region during last few years. In order to fulfill the ambition of economic development, the economies of Sub Continent started adopting policies of globalization, technological innovations, promotion of tourism and management of population burden to maintain the population density less dense in their geographical and historical places. But the consequences of this growth had to be borne in the form of environmental degradation and climate change due to high emission of greenhouse gases and CO₂. During past few years environmentally sustainable development has become an important solicitousness for all economies of the world, with the goal of carbon neutrality in consideration (Tao et al., 2021). The multifarious nature of economic, social and environmental human pursuits has incited a negotiation between economic growth and ecological perseverance (Nathaniel et al., 2021b).

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India, Pakistan and Bangladesh are such countries in South Asia that have 14 out of the world's 15 cities that are hazardous contaminated by the noxious particles marked (P.M 2.5). The latest global alliance on health and pollution report on health data synthesis 2019 reveals that India stands second, while, Pakistan third following China, in the figures where people kick the bucket prematurely each year due to pollution. Whereas, during winter season in this region bloomy mist, substantial with Sulphur and lead condenses as winds and rains abate. Moreover, throughout November Delhi witnessed atrocious five-day span of smog since 2016. On the other hand, World Health Organization and epidemiologists expressed concerns that deadly air pollution in Pakistan and India may increase the ratio of Covid-19 death.

In no other region of the world has pollution become more intense in the past few years than in Pakistan, India and Bangladesh, which are home to one third of the global population. An if this situation continues for the next few years, the environmental degradation will have more devastated effects on these economies. Projections of the World Health Organization' recent report reveals that the life expectancy has decreased by 6.7 years in Bangladesh. The estimates of global climate risk index 2020 reveals that among the countries that are most effected by climate change during the period of 1999-2018, Pakistan ranks 5th and Bangladesh 7th with CRI score of 28.83 and 30.00 respectively. During this period Pakistan faces the loss of 3792.52\$ million and Bangladesh 1686.31\$ million. India, on the other hand, ranked 5th in this ranking in 2018 in terms of climate risk and bore the loss of 37807.82 \$ million.

Different scholars have utilized different variables to measure the environmental quality. Among these most of the researchers employed ecological footprint as a reliable quantitative scale to determine the environment finest. Ecological footprint is suitable indicator of environment quality in comparison with CO₂ emission (Anser et al., 2021; Shokoohi et. al 2022). The fundamental advantage of ecological footprint is that it quantifies the demand and supply side of the nature. To measure the demand aspect, it sums up all the productive fields for which an individual or merchandise compete. The ecological footprint calculates the

ecological capital that a specific group of individuals or goods demand to produce the natural resource it uses (comprising food items and fiber goods, livestock and fish items, places for urban framework) and to take up its byproduct, particularly the discharge of CO₂. The ecological footprint is a broad gauging metric used to compares the emission of greenhouse gases by resource utilization of human beings with natural means restoration and devastation assimilation ability (Nathaniel et al., 2021a;). Enhancement of industrial sector, tourism and globalization have substantially abated the environmental resources and accelerated the ecological footprint matrix (Sarkodie, 2021).

Carbon footprint is assumed as one of the significant and swiftly increasing element of environmental footprint. It is utilized to quantify the fossil fuel oriented outflow of greenhouse gases. This continuous concentration of carbon dioxide in air is termed as ecological debt. Presently, the share of CO₂ in overall global ecological footprint stands 60% (Global Footprint Network, 2020). Now a day, rapid roaring ecological footprint is assumed a foremost interest of researchers, who associate distinct economic and ecological footprint to find suitable answers. Hence the foremost objective of research is to empirically analyze the influence of globalization, tourism expenditures, technological innovations and population density on ecological footprint of Pakistan, India & Bangladesh by using the data from 1990 -2018.

Growing tourism is playing its significant role in global economic development. Development of tourism sector not only contributes in the growth of national income of the country but also considered essential for creating employment opportunities. Development of tourism proliferate the income of transporters, ameliorates the provision of infrastructure to elevate trade. Despite the key role of this sector in economic development, tourism sector is also a major contributor of climate deterioration caused by excessive emission of CO₂ and greenhouse gases (GHG) as a result of fuel consumption by transportation sector. The tourism sector's share in CO₂ emission is about 75% (Zhang & Liu, 2019). Besides, the development of tourism sector paves the way for developing the infrastructure on modern lines to provide adequate facilities to the tourists, which leads to environmental pollution by depleting natural resources (Razzaq et al., 2021a; Nathaniel et al., 2021b).

Another factor which may have eloquent effect on ecological footprint is globalization. Globalization refers to the multidimensional social, cultural, economic and political association among the nations of the world. Globalization has promoted trade activities, technological innovations, skills of the workers, social norms and tourism among the world community (Godil et al., 2021). Globalization lure nations to use modern technology and utilization of nonrenewable energy resources to meet the needs of energy requirements for different sectors of the economy that leads it towards the more emission of CO₂ and GHG that contaminate the environment. Only strong political will and determination can limit the impact of globalization on the environment by adopting environment friendly green technology (Pata, 2021; Saud et al., 2020). It is an observed fact that globalization promotes research and development and that leads to the invention of modern production tools and methods that are effective in controlling environmental degradation.

Technological innovations have reshaped the production sectors of the economies. Today, almost every economy of the world tries to invent such production equipment's and methods that may not only produce large amount of goods but also pose little effect on the ecological foot print. Most of the developed countries of the world have shifted their production units on modern technologies while, developing countries are also making steps to use those production techniques that are less harmful for environment. Therefore, it is essential to measure the impact of technological innovations on the ecological foot print.

Population is another key factor which contributes in increasing the level of ecological footprint. Population expansion escalates the need of fossil fuels and energy, this increase in demand brings increase in ecological footprint in return by releasing more greenhouse gases and CO₂ into the atmosphere. Population density is decisive element in deciding the level of ecological foot print (Gupta, Saini and Sahoo, 2022). Population density is inversely related with the ecological footprint (Kongbuamai, Zafar, Zaidi and Liu. 2022)

Pakistan, India and Bangladesh are emerging economies of Subcontinent with similar social, political and economic systems. For the sake of economic prosperity these economies are following multi-faceted strategies including tourism, technological innovations and globalization that have adversely affected the environment of these economies. Therefore, there is a dire need to examine the influence of these factors on the ecological foot print of Pakistan, India and Bangladesh. This study will measure the influence of globalization, technological innovations, tourism development and population density on the ecological foot print of Pakistan and India and Bangladesh by employing the data from 1990 to 2020.

Despite the rising fear about environmental sustainability and the growing significance of measuring ecological footprints, there is a prominent hole in the prevailing literature concerning the exact determinants of ecological footprints in South Asian economies. While several analyses have investigated this theme on a universal scale or in the setting of developed countries, there is an inadequate body of research that probes into the exclusive aspects and dynamics inducing ecological footprints in South Asian nations. This research gap is predominantly critical given the region's diverse socio-economic and environmental characteristics, along with its noteworthy population size and fast economic growth, all of which contribute to typical ecological footprint patterns. Hence, there is a need for empirical study and in-depth analysis to recognize and comprehend the vital determinants shaping ecological footprints in South Asian countries, which can enlighten policy-making and sustainable development policies tailored to the region's specific opportunities and challenges.

2. Review of the Literature

2.1 Globalization and Ecological Footprint Nexus

Sabir and Gorus (2019) empirically analyzed the impact of globalization measures FDI, trade openness KOF and technological innovations on the ecological footprint of South Asian economies during the period of 1975 to 2017. The study utilized ARDL method to examine the long-run associatio among the regress and regressors. The findings of the study suggest that globalization measures have significant impact on the

ecological footprint . While, technological changes have insignificant influence on the ecological footprint.

Rehman et al. (2021) analyzed the effect of globalization, energy use and trade on the environmental footprint of Pakistan by utilizing data from 1974 to 2017. The study used ARDL method to measure the long run relationship among the dependent variable and regressors. Results of the study indicate that globalization, energy use and trade have significant positive impact on the ecological footprint of Pakistan. Likewise, Yang et al. (2021) have empirically examined the impact of globalization and population aging on the ecological footprint of OECD countries by using panel data during 1970 to 2017. The study used pooled mean group method to calculate the association between the variables. The findings of the study reveals that globalization and population aging have significant negative impact on the ecological footprint of OECD countries.

Awosusi et al. (2022) studied the effect of globalization, political risk and technological innovations on the ecological footprint of BRICS countries. The study utilized panel quantile regression to investigate the relationship between variables. The results of the study reveal that political risk, economic growth and technological innovations have positive significant impact on the ecological footprint in BRICS countries. On the other hand, globalization has significant positive association with the ecological footprint. Moreover, Amegavi, Ahenkan and Buebeng (2022) empirically analyzed the impact of economic globalization and bureaucratic quality on the ecological footprint of Ghana during the time period of 1990 to 2016. To measure the short run and long run association among variables the study has used autoregressive distributive lag method. The results of the study show that economic globalization has negative impact on the ecological footprint of Ghana. Inversely, institutional quality has shown meaningful positive impact on the environmental footprint.

2.2 Tourism and Ecological Footprint Nexus

Salih, Gokmenoglu and Even (2018) evaluated the effect of tourism advancement on the environmental quality of top 10 tourists visiting countries of the world. The study utilized ecological footprint as proxy for

environmental quality. The findings of the study reveal that there is evidence of inverted U shaped Kuznets curve existence. Moreover, tourism development has shown significant negative effect on the ecological footprint of Turkey.

Godi, Sharif, Rafique and Jermstittiparsert (2020) measured the implication of tourism, financial improvement and globalization on the ecological footprint of Turkey during the period of 1988 to 2018. The ARDL model is utilized to estimate the short and long run relation between ecological footprint and regressors. The results of the ARDL show that tourism, financial growth and globalization have positive meaningful effect on the ecological footprint of Turkey. Similarly, Xiaojuan et al. (2022) measured the outcome of inbound tourism on the ecological footprint in top 10 densely populated countries of the world during the period of 1995 to 2021 by using dynamic panel threshold model. The estimates of the study indicate that tourism improves the environment at some extent and after reaching at optimal level enhancement in inbound tourism adversely affect the environment.

Liu, Farah, Wajahat and Tafazal (2022) empirically analyzed the presence of environmental Kuznets curve travel & tourism and ecological footprint of Pakistan during the period of 1980 to 2017. In order to measure the influence of tourism expansion, economic growth, energy consumption, trade openness and foreign direct investment on the ecological footprint, the study used ARDL method. The results of the study confirm that the regressors have significant contribution in environmental degradation of Pakistan. Guven and Bolu (2022) analyzed the effect of tourism, energy consumption and economic growth on the environmental quality of Turkey during the period of 1963 to 2016. The results of the Vector Error Correction model show that tourism development has no effect on the environment of Turkey. Whereas, on the other hand, energy consumption and economic growth have adversely affected the environmental quality of Turkey .

2.3 Population Density and Ecological Footprint Nexus

Audi et al.:(2016) discovered the essence of significant positive correlation among energy use, financial advancement and population density in Lebanon during the time period of 1974 to 2014. Also, Sasleem

at al.; (2018) in their empirical study found the presence of meaningful positive relationship between the population density and carbon dioxide (CO₂) emission for selected panel of economies during the time span of 1975 to 2015. Sciubba and Weber (2019) evaluated the implication of population growth on the CO₂ emission by using panel data of 1062 regions of 22 European nations during the time span of 1990 to 2006. The estimates of the study indicate that regions with high population growth witnessed higher level of carbon emission as compared to lower population growth regions of Europe.

Edwards (2020) examined the significance of total population, immigration and alternative energy usage on the CO₂ emission in United States of America. The findings of the estimation show that there exists positive significant relation between population, immigration and CO₂ emission in USA. While Chaurasia (2020) empirically investigated the influence of population on the CO₂ emission via global energy demand. The study used the panel of 44 most CO₂ emitted countries of the world during the period of 1990 to 2019.. The estimates of the study reveal that increase in global energy use due to increase in population has positively contributed in the CO₂ emission of selected countries.

2.4 Technological Innovations and Ecological Footprint Nexus

Manga and Destek (2021) empirically analyzed the significance of technological innovations and financialization process with renewable and non renewable energy sources as control variables on the carbon emission and ecological footprint of big emerging economies during the period of 1995 to 2016. The study has utilized second generation panel methods to calculate the interdependence among variables. The evidence of the study show that technological innovations and financialization have significant role in CO₂ emission, While, they have insignificant effect on the ecological footprint.

LiXu, Wang, Wang and Zhang (2022) measured the role of technological advancement, natural resources prices, foreign direct investment and renewable energy prices on the ecological footprint of

China by using time series data from 1990 to 2017. The study used FMOLS, DOLS and CCR methodologies to investigate the effect. The results of the study indicate that technological advancement natural resources prices and renewable energy sources reduced the ecological footprint in China. Whereas, on the other hand, foreign direct investment has contributed in the enhancement of ecological footprint. Moreover, Gao et al., (2022) analyzed the role of green technology innovations on the CO₂ emission in 30 Chinese provinces over the period of 2008 to 2020. The study has used fixed and mediating effect methodologies to estimate the parameters. The results indicate that green technology innovations has limited the CO₂ emissions in the selected panels of China.

Mohini, Saini and Sahoo (2022) empirically assessed the potential of ecological footprint of Bangladesh during the period of 1990 to 2016. The study utilized technological innovations, urbanization and natural resources as key determinants of ecological footprint of Bangladesh. In order to measure the long run effect, the study used ARDL bound method. The findings suggest that technological innovations and natural resources have reduced the ecological footprint. While, urbanization has adverse effect on the ecological footprint of India.

3. Research Design and Methodology

During last two decades a serious attention has been given to the issue of environmental degradation in developing and developed countries and various factors are held responsible for this degradation. Among these, globalization, tourism and population growth are important contributors in carbon emission in developing countries. Countries of South Asian Regions Pakistan, India and Bangladesh are top in the list among those countries where the issue of environmental degradation is becoming more serious with the passage of time.

The study is designed to investigate the impact of globalization, tourism development, Technological innovations and population density on the ecological footprint of Pakistan, India and Bangladesh during the period of 1995 to 2020. The functional form of the model will be as follows

$$EFP_{it} = f(GLOB_{it}, TE_{it}, PRN_{it}, POPD_{it})$$

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In order to measure the association among the parameters of dependent and explanatory variable, the econometric form of the model is as follows

$$\ln EFP_{it} = \beta_0 + \beta_1 \ln GLOB_{it} + \beta_2 \ln TE_{it} + \beta_3 \ln PRN_{it} + \beta_4 POPD_{it} + \mu_{it}$$

Where

EFP_{it} = Ecological footprint

$GLOB_{it}$ = Globalization

TE_{it} = Expenditures on Tourism travel

PRN_{it} = Number of Patent Rights Registered

$POPD_{it}$ = Populatioin Density

μ_{it} = Residual

\ln = Natural Log

Demonstration and Sources of Data

Variable	Demonstration	Unit	Sources of Data
EFP_{it}	Ecological footprint	% Per Capita	Global Footprint Network (GFN)
$GLOB_{it}$	Globalization	% KOF Globalization Index	WDI
TE_{it}	Expenditures on Tourism travel	Percentage	WDI
PRN_{it}	Number of Patent Rights (Proxy of Technological Innovations)	In numbers	WDI
$POPD_{it}$	Populatioin Density		WDI

		Total Numbers	
Ln	Natural Log		

As mentioned in the above table, we used globalization, expenditures on tourism travel, technological innovation and population density as independent variables. Globalization often leads to increased international trade, which can boost consumption and production. As countries engage in global supply chains, they may produce and consume goods and services that have higher ecological footprints. This can result in increased resource extraction, energy use, and emissions. Likewise, tourism generates a significant amount of waste, including plastic bottles, packaging, and disposable items. The disposal of waste in environmentally responsible ways can mitigate the ecological impact of tourism travel. Further, innovations in energy-efficient appliances, building design, and transportation can lead to lower energy consumption and, consequently, a reduced ecological footprint in terms of energy-related emissions. Moreover, as a population grows, there is typically an increase in the demand for essential resources such as food, water, energy, and raw materials. This heightened demand can lead to over-exploitation of natural resources, resulting in a larger ecological footprint.

3.1 Econometric Specification

3.1.1 Panel Auto Regressive Distributive Lag (ARDL)

Economic literature provides various methods to estimate the panel data models. On one side from the perspective of Loyza and Racieenodel (2006) there are traditional panel models like pooled OLS, fixed and random effects. But the drawback of these usual techniques is that these are unable to distinguish between short run and long run results. Moreover, according to Campos and Kinoshitev (2008) the estimates of traditional methods give biased results in the presence of endogenous regressors. While, on the contrary, the methods of dynamic panel models GMM-difference and GMM-system estimates are fruitful when the panel contains

large number of countries (N) as compare to the time span (T) i.e. N>T (Arellano and Bond; Arellano and Bover).

Considering the drawbacks of different panel methods, the study focused on panel auto regressive distributive lag model (Panel ARDL). The advantage of this technique is that on one side it provides short run and long run estimates separately and on the other side, it is applicable in the case when variables are stationary at different level of order. This technique is also suitable when we have large number of time and smaller group of countries, as in the case of this study. When variables are of $I(1)$ and co-integrated the residual will follow $I(0)$ process. One of the fundamental property of co-integrated variable is its return to any divergence from long run equilibrium. This property predicts the dynamics of error correction which arises due to the divergence of the variables in the model from equilibrium. Therefore, it is rational to re-characterize the above model into the error correction form

$$\Delta Y_{it} = \phi_i Y_{t-j} + \theta_i X_{i,t-j} \sum_{j=1}^{p-1} \gamma_{ij} \Delta Y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij} \Delta X_{i,t-j} + \mu_t + \varepsilon_{it}$$

Here ϕ , which is error correction parameter reveal the rapidity of correction. In case, when $\phi = 0$ long run relationship does not exist. Therefore, for a long run relationship among dependent variable and repressors it is essential for ϕ_i to be significant with the negative sign and its value must lie between 0 and 1. Because only in that case, it will reveal the convergence tendency.

4. Results of The Estimation

4.1 Panel Unit Root Test

Before applying an appropriate technique to estimate the model, it is proposed to check the stationarity of the variables. In the literature there are various methods available to predict the unit root. Among these the study has used Lin Li Chu (2002) test. The null hypothesis of this test shows the

presence of unit root. The findings of this test indicate that ecological footprint is stationary at level, while, globalization and tourism travel expenditures and number of patent rights are stationary at first difference. Hence the given model also supports the application of panel ARDL methodology for estimation.

4.2 Results of the Estimation

The study used panel ARDL method to estimate the association among ecological footprint and regressors. The results of the estimation are given in the following table.

Table 1. Short Run Results

	Coefficient	St. Erroe	t-Statistic	Prob.*
COINTEQ01	-0.670065	0.292076	-2.294143	0.0327
D(LNGLOB)	-1.617241	0.840462	-1.924229	0.0687
D(LNTTE(-2))	0.087477	0.009272	9.434869	0.0000
D(LNPRN)	-0.343420	0.133774	-2.567160	0.0184
D(POP_DENSITY)	-0.219889	0.766864	-0.286738	0.7773
D(POP_DENSITY(-3))	-0.542320	0.538386	-1.007308	0.3258
C	2.648288	1.306294	2.027329	0.0562

Table 2. Long Results of Panel ARDL

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNGLOB	1.728667	0.125010	13.82821	0.0000
LNTTE	-0.440725	0.053333	-8.263727	0.0000

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LNPRN	0.618447	0.022509	27.47580	0.0000
POP_DENSITY	-0.008767	0.000718	-12.21341	0.0000

Author's own calculations (EViews 10)

The results of the estimation indicate that there exist long run relationship between the dependent variable and regressors as the value of error correction is negative significant and lies between zero and one i.e. - 0.670065. Globalization has shown positive significant impact on the ecological footprint of Pakistan, India and Bangladesh. A 1 percent increase in the globalization bring 1.013599 increase in the ecological footprint of these nations. The same significant positive long run relation has also been endorsed by the studies of Sabir & Gorus (2019) Rehman et al. (2021), Guan et al., (2022) and Awasusi et al. (2022). This positive impact may infer that the globalization has assisted the spread of innovation and technology across the globe that led to the expansion of more helpful and environmental technologies that help to reduce the ecological footprint. Also, globalization has promoted greater intercontinental cooperation and intelligence sharing on environmental issues. Nations and governments are now able to switch information, research conclusions, and appropriate methods on sustainability and environmental conservation. This collective knowledge assists in discovering helpful answers to moderate the ecological footprint internationally. In other words, from the perspective of knowledge sharing and partnerships, globalization has encouraged greater global collaboration and knowledge sharing on environmental issues which helps in finding effective solutions to reduce the ecological footprint globally.

Whereas, on the other hand tourism travel expenditures has significant negative effect on the ecological footprint. Increase in tourism travel expenditures make tourism costly and as a result only a few tourists visit the tourist's spots. It limits the demand and consumption of fossil fuels

at lower level which is beneficial for ecological footprint. These findings are consistent with the findings of Khan and Hou (2021) and Balli et al. (2019) but contrary with the results of Guan et al. (2022). A 1 % increase in the tourism travel expenditures brings 0.440725 % fall in the ecological footprint. Moreover, technological innovations have shown the positive and significant impact on the ecological footprint. Chunling et al. (2021) also found the same positive association of technological innovation in the case of Pakistan but inconsistent with the results of Adebayo & Odugbesan (2021) for Brazil, Khan et al. (2020), and Ahmad et al. (2020) for China. A 1 % increase in the number of patent rights brings 0.618447% increase in the ecological footprint. While population density has shown the negative impact on the ecological footprint. A 1% increase in the population density of India, Pakistan and Bangladesh brings 0.008767 fall in the ecological footprint. At present, population density of Pakistan, India and Bangladesh is 288.55, 464.15 and 1265.18 respectively (World Bank 2020). Whereas, only few big cities of these countries are densely populated. Moreover, this negative association is due to the fact that consumption mainly depends on availability of natural resource. While, abundant resources are presently available in these countries to explore which are adequate to maintain balance within the ecosystem. This negative association of population density with the ecological footprint endorsed the findings of Kongbuamai, Zafar, Zaidi and Liu (2022), Aşıcı and Acar (2016), Aşıcı and Acar (2018) for 87 economies and Dogan et al. (2020) for BRICST.

5. Conclusion and Policy Recommendation

5.1 Conclusion

Environmental degradation is the ultimate result of various human activities. Almost all the developing and developed countries of the world are facing the severe issue of environmental degradation and climate change. Among these, India, Pakistan and Bangladesh are the main countries in South Asia who are facing the consequences of this environmental degradation in the form of economic damages. It is therefore needed to determine those factors who are responsible for this issue. For

this purpose, the study has used globalization, tourism development, technological innovations and population density as the key determinants of ecological footprint during the period of 1995 to 2020. The study utilized panel ARDL method to measure the association among the variables. The results of the study indicate that there exist significant long run relationship among ecological footprint and regressors. Globalization and technological innovations have shown positive effect on the ecological footprint. Whereas, tourism development and population density have negative impact on the ecological footprint of India, Pakistan and Bangladesh.

5.2 Policy Recommendations

Considering the results of estimated the study proposed following policy measures to policy makers

- As globalization and innovations have positive significant impact on ecological footprint therefore, policy makers should focus on the promotion of globalization and innovations at sustainable level to save the environment. Moreover, policy makers should devise such policies that may help to create environment friendly green technological innovations.
- While, on the other hand, tourism and population density has shown negative effect. Hence, policy makers should make sustainable level of tourism and population density.
- To harness the positive impact of globalization on ecological footprints and promote sustainable development, policymakers can implement a range of policies and strategies: 1) Encourage international trade agreements that prioritize environmental sustainability. This can include provisions for the promotion of sustainable practices, reduced trade barriers for green technologies, and the incorporation of environmental standards in trade negotiations. 2) Implement carbon pricing mechanisms, such as carbon taxes or cap-and-trade systems, to internalize the environmental costs of greenhouse gas emissions associated with global trade. Revenue generated from these mechanisms can be reinvested in clean energy and sustainable infrastructure projects.

- Governments of South Asian economies need to prioritize investments in renewable energy sources, such as solar, wind, and hydropower. Provide financial incentives, subsidies, and tax breaks to promote the adoption of clean energy technologies.
- As our study reported that technological innovation has positive impact on ecological footprints in long run so governments need to allocate additional funding for research and development (R&D) initiatives focused on environmentally friendly technologies and practices. Also, need to provide tax incentives for businesses and organizations that invest in R&D aimed at reducing their Ecological Footprint.

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