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How does economic globalization affect the ecological footprint in India? A novel dynamic ARDL simulations

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Introduction

➢ Economic globalization has played a vital role in the day-to-day affairs of the people while making efforts to create a world-integrated economy.

➢ Although the economic growth effect of economic globalization is well established in the literature (Gurgul & Lach, 2014), the studies assessing the environmental impact of economic globalization are limited.

➢ However, few studies argued that economic globalization significantly deteriorates the environment directly through foreign aid flows, goods, and service-free movements, the spread of technology, barrier-free foreign direct investment, and trade openness (Shahbaz et al., 2017a; You & Lv, 2018).

➢ Similarly, the indirect effects of economic globalization on environmental degradation through the rise in energy demand and economic growth (Shahbaz et al., 2017b; Yaméogo et al., 2019). Likewise, the ecological footprint effect of economic globalization has been assessed by (Yilanci & Gorus, 2020) for 14 MENA countries, (Ahmed et al., 2021) for Japan, (Kirikkaleli et al., 2021) for Turkey, (Usman et al., 2020) for the USA, and (Pata & Yilanci, 2020) for G7 countries.

➢As an emerging economy globally, India needs better environmental quality to meet sustainable development goals. It requires the control of certain factors responsible for pollution in the county to attain a sustainable environment.

Against the stated background, economic globalization is a thrust area of research due to its twofold nature regarding the impact of environmental quality from empirical studies (Mahalik et al., 2021). Thus, this study considers India to analyze the effects of economic globalization on environmental quality in the post-reform period for many reasons.

First, significant transformations have taken place in India in the post-reform period. For instance, the average ecological footprint of an average Indian is 0.9 global hectares per capita . Further, although the Indian economy corrected the economic vulnerabilities, there is a significant rise in India's CO2 in the post-reform period, i.e., an increase from 1.13 (2000) to 1.67 (2010) carbon equivalents per capita (Shahbaz et al., 2015).

Second, after China and the USA, India is the largest emitter of CO2 (EIA, 2011).

Third, India is the second-most populous country and the fastest-growing economy globally by fostering environmental degradation and energy use, thereby creating pressure on the ecology by enhancing the demand for resources.

Unlike the existing studies, this study used ecological footprint (EF) to measure environmental quality in India, making the study unique and contributing to the literature in many ways.

First, unlike studies that employ CO2 emissions and globalization nexus, this study employs ecological footprint for measuring environmental quality in India; since EF is the broader measure of environmental quality, it can offer a wide range of climate change mitigation policies for India.

Second, the study executes a multivariate framework with updated series from 1990 to 2018 in India to explore the link between EF, economic globalization, energy consumption, and economic growth.

Third, a novel dynamic autoregressive distributed lag (ARDL) model has been used to explore the short and long-run association between the series. The result confirms the positive impact of economic growth on ecological footprint while economic globalization and energy consumption decrease the ecological footprint in the long run. However, the estimated findings convey a variety of policy implications for India to preserve the ecology as there is a significant causal link exists across the variables in the long run.

Finally, to our limited knowledge, this is the first study that uses economic globalization in the EF function of India amid facing a trade-off between sustainable economic growth and the environment in the era of globalization.

Data and Model Building

The study aims to investigate whether economic globalization upgrades or degrades the ecological footprint in India.

Towards the empirical side, this study uses India's time series yearly data from 1990 to 2018.

The period selection is based on the post-reform period in India for the following reasons.

India is moving from state-led growth to market-driven growth as part of economic reforms.

In other words, the transition of India to globalization from a closed economy (Kishore, 2002).

Thus, India's under-taken reform is termed liberalization, Privatization, and Globalization (LPG).

Although spectacular economic growth has been observed during the post-reform period, environmental degradation is the prime challenge in front of policymakers.

This is why the focus of the present study is on the post-reform data while assessing the nexus between globalization and environmental quality.

Variable Name	Unit of measurement	Sources
Ecological footprint (EF)	Ecological footprint Consumption Per Capita	Global footprint network
Economic Globalization (EGLOB)	KOF economic globalization Index	Gygli et al. (2019)
Economic growth (GDP)	GDP Per Capita	World development indicators
Energy consumption (EC)	Energy Consumption Per Capita	BP Statistical Review of World Energy June 2019
Financial development (FD)	Domestic credit to private sector as percentage of GDP (% of GDP)	World Development Indicators
Institutional Quality (IQ)	Index was created by using Principle Component Analysis with indicators such as Government Stability, Socioeconomic Conditions, Investment Profile, Internal Conflict, External Conflict, Corruption, Military in Politics, Religious Tensions, Law and Order, Ethnic Tensions, Democratic Accountability, Bureaucracy Quality indicators with the help of Principle Component Analysis	World Governance Indicators

$$LNEF_t = \alpha_0 + \alpha_1 LNEGLOB_t + \alpha_2 LNECt + \alpha_3 LNGDP_t + + \varepsilon_t$$

$$LNEF_t = \alpha_0 + \alpha_1 LNFD_t + \alpha_2 LNIQ_t + \alpha_3 LNEC_t + \alpha_4 LNGDP_t + \alpha_5 IQ*F$$
$$D_t + \alpha_6 IQ*EC_t + \alpha_7 IQ*GDP_t + \alpha_8 IQ*EGLOB_t + \varepsilon_t$$

ADF and PP tests

Variables	Augmented Dickey-Fuller (ADF)	Phillips Perron (PP)
Level	Test Statistics [p-value]	
LNEF	-1.542 [0.790]	-1.542 [0.790]
LNEGLOB	-0.635 [0.968]	-0.299 [0.987]
LNEC	-1.336[0.857]	-1.227 [0.885]
LNGDP	-1.927[0.613]	-3.458 [0.064]
LNFD	-0.387[0.898]	-0.571 [0.862]
IQ	-0.238[0.829]	-0.612[0.728]
First Difference	Test Statistics [p-value]	
ΔEF	-5.796*[0.000]	-5.796*[0.000]
ΔLNEGLOB	-3.590**[0.051]	-3.553**[0.054]
ΔLNEC	-5.889*[0.000]	-5.889*[0.000]
ΔLNGDP	-5.484*[0.001]	-5.536*[0.001]
ΔLNFD	-4.492*[0.007]	-4.621*[0.005]
ΔIQ	-5.314*[0.000]	-5.314*[0.000]
Structural break test		
	Level (Year)	First Difference (Year
LNEF	-2.974 (2009)	-7.988*(2013)
LNEGLOB	-2.745(2000)	-4.443*(2002)
LNEC	-3.943(1999)	-6.849*(2005)
LNGDP	-5.400*(2005)	-6.530*(2009)
LNFD	-3.498(1999)	-5.162*(2008)
IQ	-2.718(2001)	-6.923*(1995)

Note: *, **indicates 1%, 5% level of significance. The value inside [] is p-value.

ARDL bounds test analysis

Model 1: Simulated Reduced Model				
F-Bounds Test		H_0: No long-run relationship H_1: Relationship exists		
Test Statistic	Value	Signif.	I (0)	I (1)
				Asymptotic: n=1000
F-statistic	10.412*	10%	2.72	3.77
k	3	5%	3.23	4.35
		2.5%	3.69	4.89
		1%	4.29	5.61

Note: * indicates 1% level of significance.

Diagnostic analysis

Tests	Model 1: Simulated Reduced Model
	χ^2 [P-value]
Ramsey RESET test	1.127 [0.319]
Jarque-Bera test	2.408 [0.299]
ARCH	0.003 [0.956]
Breusch-Godfrey LM	0.831 [0.639]

Note: The value inside [] is p-value

Dynamic ARDL simulations analysis (Model 1)

Variables	Coefficient	St. error	t-value
C	0.1461	0.1553	0.9400
D_LNEGLOB	-0.367**	0.145	-2.530
L1_LNEGLOB	0.078***	0.044	1.770
D_LNEC	-0.542	0.484	-1.120
L1_LNEC	-0.831*	0.234	-3.550
D_LNGDP	0.206**	0.085	2.420
L1_LNGDP	0.256**	0.099	2.580
ECM_t (-1)	-0.8681*	0.2367	-3.670
R-squared	0.98	Simulation	5000
Adj R-squared	0.96	Root MSE	0.010
F (9, 15)	85.99	Prob > F	0.000

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

Linear Extended Model (Model 2)

Variables	Coefficient	SE	t-value
LNFD	-0.331***	0.041	-8.049
LNIQ	1.307**	0.097	13.468
LNEC	-7.576**	0.507	-14.931
LNGDP	4.436*	0.293	15.119
IQ*FD	-2.711***	0.271	-9.987
IQ*EC	-13.534**	1.034	-13.088
IQ*GDP	5.737**	0.491	11.675
IQ*EGLOB	4.986**	0.457	10.899
C	-2.321	0.090	-25.890
Short-run analysis			
Δ LNFD	-0.159***	0.017	-9.234
Δ LNIQ	0.014	0.018	0.754
Δ LNEC	-0.937**	0.094	-10.012
Δ LNGDP	0.408**	0.043	9.364
Δ IQ*FD	-0.1739	0.034	-5.052
Δ IQ*EC	0.827***	0.104	7.983
Δ IQ*GDP	0.440***	0.049	9.026
ΔIQ*EGLOB	-0.329**	0.027	-12.087
ecm(-1)	-0.124*	0.001	-139.216
R-squared		0.99	
Adj R-squared		0.99	

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

Result and Discussion

❑ The outcomes show that economic globalization reduces the ecological footprint in the long run but not in the short run. The outcome shows that despite having a short-run adverse effect on the environment, economic globalization helps India mitigate climate change in the post-reform period.

❑ The possible channel of linkage is that economic globalization necessitates new techniques of production and innovative goods, which are efficient in terms of economy and ecology by reducing the extraction of resources from the natural environment.

❑ Another possible reason is to survive the competitive market as the business expands globally. The firms improve their service levels and product quality, which helps them stay competitive at the international level, thereby reducing the natural environment in India. This finding is corollary with Figge et al. (2017) for 171 countries and Mahalik et al. (2021) for India while deviating from (Ahmed et al., 2016; Shahbaz et al., 2017a; Shahbaz et al., 2017b; Usman et al., 2019).

❑ The variations in findings attributed to various factors such as the employed proxy for measuring environmental quality, the use of either panel or time-series data, and the different analysis periods.

❑ The examined outcome of energy consumption indicates a negative and insignificant effect on the ecological footprint in the long run.

❑ This finding may be possible in India as the people are moving towards renewable energy instead of relying on dirty energy consumption for their day-to-day survival as the income level of the people moves to a certain threshold.

❑ Another possible cause could be the higher price of dirty energy compels people to shift toward renewable energy sources for their needs. Moreover, the spreading the knowledge related to the environment makes people use clean energy to escape from the worry of climate change in India.

❑ The finding aligns with Mahalik et al. (2021) for India. However, it differs from Khan et al. (2022) for South Asia. The possible reasons for such differences in finding may be the employed data. For instance, Khan et al. (2022) considered panel data, while this study used country-specific analysis.

❑ Economic growth reveals a positive and significant relationship both in the short and long run with the ecological footprint. It means that economic growth hampers the environmental quality.

❑ The possible reason could be India's quest for rapid economic growth foster environmental degradation due to over-exploitation of natural resources, pollution and others.

❑ It also suggests that the Indian economy is not benefiting from higher economic growth in terms of a clean environment.

❑ However, economic growth is necessary for a developing country like India to meet the population's needs. Thus, there is a need for a prudent move to have a sustainable environment in India to reap the gains of economic growth in the long run. The outcome is on par with India's Mahalik et al. (2021).

❑ However, it contradicts Villanthenkodath & Mahalik (2022). The finding deviation is primarily attributed to the different analysis periods within the time series framework.

- It is evident that financial development and energy consumption reduce the ecological footprint both in the short and long run. It means that these two factors improve the environmental quality in India.

- Thus, financial development can divert the funds towards climate change mitigation, and the energy structure may be favourable for renewables in India.

- Further, it found that economic growth and institutional quality harm the environment by enhancing the ecological footprint in India in the long run.

- However, the role of institutional quality is meaningless in the short run, but economic growth hurts the environmental quality. The corrupted and ill-managed institutions may be a possible cause for such findings. Besides, the production activities for economic growth may harm India's natural environment.

- Moreover, the indirect effect of financial development through institutional quality on ecological footprint is negative and significant in the long run and short run. It means that a better institutional mechanism helps financial development influence the ecological footprint since the strength of the coefficient is more for the indirect effect.

- Further, energy consumption through institutional quality improves the environment in the long run but not in the short run. It means that the institutional quality may be weak to reduce the environmental quality via energy consumption management. However, the continuous growth in energy consumption may be forcing them to manage energy consumption through the proper institution to reduce ecological harm.

- Besides, it shows that the indict effect of economic growth in institutional quality on ecological footprint is positive both in the short and long run. It may be due to corruption that emerges in the different e institutions, which leads to economic growth, and such an effect hurts the environment since it less cares about the natural environment.

- Further, it evidenced that globalization in the presence of institutional quality on ecological footprint is positive in the long run but not so in the short run. The possible reason could be that the economy that is opened up and the institutional setup performs well to maintain the different globalization-related environmental protocols. However, as time passes, the institution may weaken to influence globalization to have better environmental quality.

Conclusion and policy insights

As economic globalization improves the environment by reducing the ecological footprint, India needs to engage more in international integration to preserve the environment. Hence, we suggest exploiting the advantages of economic globalization, like knowledge exchange, new technology transmission, and clean technology transfer, to attain sustainable development.

To this end, India needs to integrate with international groups like BRICS (Brazil, Russia, India, China, and South Africa) and others. The creation of such an opportunity will further benefit India to preserve the environment and other countries since environmental degradation is a global issue.

Moreover, energy consumption reduces India's ecological footprint because of India's movement from a significant dependency on fossil fuels to clean energy sources. Therefore, India should increase the further production of renewable energy.

As India is the largest production hub of renewable energy, India's Government is also taking lots of initiatives to enhance more of it. So, more production will lead to less economic degradation in the long run. In this regard, policymakers need to execute energy conservation policies to ensure higher economic growth.

Further, the estimated findings evidenced that economic growth is one of the leading factors in enhancing the ecological footprint. On this note, India needs to focus on improving sustainable economic growth, which leads to a decrease in the ecological footprint. To bring momentum for sustainable development, installing a green economy and integrating renewable energy are required.

Converting into a green economy would be an excellent strategy for minimizing the issues related to economic degradation and enhancing economic growth and development in the long run. Besides, future research should focus on the relationship between ecological footprint and different aspects of globalization by using some regional data in the case of India.

❑The result also suggests that policymakers of the Indian economy should develop an innovative and more effective policy for research and development activities with the help of globalization, which may bring more creativity in energy efficiency and emissions regulation policies.

❑As a result, the growth of the research and development sector is expected to lower the cost of energy-related technologies and help firms and individuals to adopt clean technologies in their daily activities.

❑In this context, the government should provide financial incentives to the industries providing more energy-efficient products for end-users. By providing personal loans and funds for housing, cars, and other consumption activities, the banks can prioritize and motivate the consumers to install energy-efficient products in their houses (e.g., lighting and other electronic appliances) and buy more fuel-efficient cars.

❑Finally, banks can provide loans to individuals and firms who want to go for small solar energy plants for their houses and businesses.

❑These policies will enhance the possibility of green economies by reducing environmental risks and ecological threats. Besides, it brings sustainable development without degrading the environment.

❑Concerning globalization, policymakers should consider both economic connectedness and environmental sustainability more seriously.