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Research Article

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The impact of globalization on ecological footprint: A comparative study between india and Vietnam

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ABSTRACT

Globalization has significantly impacted the economic relations among countries. Recently, different countries depend on one another to a certain extent. This transformation has affected industrialized and developing countries like India and Vietnam in numerous ways. The study closely examined globalization in terms of the ecological footprint in these two nations by looking at the impact of trade openness and economic development impact on the environment through ecological footprints. The study summarized previous research on the environmental effects of globalization. It employed the STIRPAT model to compare the correlation of decentralized globalization indexes and ecological footprint in both India and Vietnam. To establishglobalization's long-run and short-run impacts on the ecological footprint, this study utilized the ARDL bound testing approach in conjunction with econometric analysis. The results prove evidence that environmental pressure declines in the long run due to a higher level of globalization, stressing the significance of environmentalism and responsible policies. This research provides a background of the effects of globalization on the environment in developing economies and recommends that for the future progress of policy on globalization, there must be a mixture of economic growth and protection of the environment. Consequently, this research affirms that it is imperative to investigate globalization's environmental effects, particularly in developing countries like India and Vietnam. Within this context that this study seeks to unveil how trade openness and economic growth influence ecological footprint to enhance understanding of sustainable development and other policy measures. The subjects about which relevant to this study's findings can be of importance for policymakers, particularly regarding the directions that need to be adopted to attain a reasonable balance between economic development on the one hand and conservation of the environment on the other.

Key words: Globalization, ecological footprint, ARDL, STIRPAT, India, Vietnam

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INTRODUCTION

The global economic landscape has witnessed a profound transformation catalyzed by the accelerating forces of globalization. It can be called to as the mutual relationships and multi-faceted associations among nations, primarily fostering trade and advancement between them[1]. Over the past decades, globalization has unfolded as a multifaceted phenomenon, characterized by the unprecedented interconnection and interdependence of economies worldwide. The hypothesis centered around globalization-driven growth suggests that the process of globalization fuels economic expansion through the rise of global trade, foreign direct investments, capital movements, knowledge, innovation, diffusion of technology, and the mobility of labor, goods, and services across international borders[2,3]. This expansive process of globalization has been instrumental in reshaping the economic dynamics not only of industrialized countries but also of developing economies like India and Vietnam[4,5]. These countries, positioned strategically in this global framework, have been both beneficiaries and participants in the evolving tide of globalization, experiencing shifts in their economic structures, trade patterns, and socio-cultural landscapes. The countries' total gross domestic product (GDP) of the countries has increased dramatically from $417.56 billion US (constant 2023 US$) in 1996 to $3.828 billion US in 2022[6]. This impressive growth is closely related to the rapid development of international trade between India and Vietnam.

Although the economic landscape of these developing countries has witnessed substantial growth from globalization, it is often associated with environmental concerns, which has sparked significant debates with numerous studies. Globalization, mainly linked to trade openness, contributes to environmental degradation by depleting natural resources and hastening

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pollution [7,8]. Previous research commonly relied on CO2 emissions as the primary metric for assessing environmental degradation. Nevertheless, a study revealed that more than just using the CO2 emissions index is needed to complete the measurement as it fails to encompass the entirety of damage inflicted by human activities on nature [9]. Their argument advocated for employing the ecological footprint (EF) index, which offers a more comprehensive evaluation by considering various impacts of economic activities on the environment, including factors like land use, forest depletion, and air quality.

Despite being limited in number in the past decade, studies have delved into the relationship between globalization and the ecological footprint in India and Vietnam separately, yielding controversial findings. In the context of India, the findings indicated that economic growth results in an increase in the ecological footprint within the country [10]. In the case of Vietnam, research explicitly focusing on the impact of globalization on the ecological footprint is even rarer, as studies often examined multiple countries, failing to identify the precise impact on Vietnam distinctly. There is a positive connection between globalization and the ecological footprint, yet this finding didn't precisely pinpoint Vietnam's individual impact [11]. So far in the literature, studies have yet to be conducted on researching the nexus between financial development and ecological footprint, especially regarding the relationship between India and Vietnam.

The effects of globalization on the ecological footprint remain a topic of ongoing debate. For instance, some studies revealed a correlation between globalization and a positive acceleration of environmental degradation in Azerbaijan and Turkey [12,13]. This is also in line with the results of Murshed et al. [14] as they also believe that globalization engages in heightened trade activities, and the demand for resources and energy amplifies, contributing to an increasing ecological footprint. However, there's also plentiful studies indicate that globalization contributes positively to environmental improvements. They believe globalization facilitates the introduction of innovative technologies that replace older, more energy-intensive methods, thereby elevating environmental standards [15–17]. In addition, there is a demonstration in a positive relationship where an elevation in trade openness improves environmental quality in Thailand and Singapore [18,19]. Hence, the impact of globalization on the environment remains unclear, emphasizing the necessity for additional research to comprehend this relationship thoroughly.

Given the academic gaps in the literature, although there is a considerable volume of research investigating the effects of globalization within individual countries, there remains a notable research gap in comprehensively analyzing how globalization influences the ecological footprint across multiple countries, particularly concerning both India and Vietnam, especially within the timeframe spanning from 1996 to 2022. This research aims to bridge this gap by analyzing and comparing the relationship between globalization and the ecological footprint in the unique contexts of Vietnam and India. Focusing on the period from 1996 to 2022, this study endeavors to provide comprehensive insights into the environmental implications of globalization in these two economies within the given time frame. Analyzing these nations' ecological footprints offers invaluable insights into the nuanced interplay between economic development, policy interventions, and environmental sustainability at a distinct cross-country level.

The remainder of this paper is structured as follows. Section 2 presents a comprehensive review of the existing literature, encompassing studies that have explored the environmental implications of globalization, trade openness, and their impact on the ecological footprint in various countries. Section 3 elaborates on the theoretical framework adopted for this research, outlining the STIRPAT model employed to examine the relationship between globalization and the ecological footprint in the contexts of India and Vietnam. Section 4 details the estimation model and the data utilized for the econometric investigation, including the variables, sources, and statistical summaries. Section 5 outlines the results and discussions derived from the ARDL bound testing method, presenting both globalization indicators' the long-run and short-run effects on the ecological footprint in India and Vietnam. Lastly, Section 6 concludes the paper by summarizing the key findings, discussing their implications, and suggesting potential areas for future research.

LITERATURE REVIEW AND METHOD

In the current era marked by rapid economic expansion, scholars are increasingly delving into the environmental implications of globalization, notably focusing on factors like the ecological footprint. For example, in their study exploring the co-integration between trade openness and CO2 emissions within Bangladesh, Islam et al. [20] conclude the impact of globalization reducing environmental degradation throughout the period in the long run. This is consistent with the study of Yousaf et al. [21]. Furthermore, research by Adebayo et al. [22] also supports

this by presenting evidence suggesting that globalization can contribute to a reduction in environmental pressure in Sweden. These studies highlight how increased global integration damages environmentally sustainable practices and encourages the needs of eco-friendly policies, leading to a decline in ecological pressures within individual countries. Conversely, investigations by Warsame et al.[23] and Abid et al.[24] propose contrasting findings, suggesting that globalization might intensify environmental degradation at a country level. Moreover, many scholars packed this up by emphasizing beliefs that globalization with maximizing global trade can lead to better resource reservation, reducing the ecological pressures[25,26]. y studying the relationship between trade openness and ecological footprint in Pakistan, Liu et al.[27] contribute nuanced insights, highlighting contextual factors where globalization might have varying impacts on the environment within specific country settings.

Expanding the research to further perspective, in examining globalization's impact on the environment across nations, Awan et al.[28] and Aydın & Turan[29] shed light on how the integration of economies can potentially improve environmental status. Their research suggests that globalization might mitigate environmental pollution through its facilitation of global knowledge exchange and the spread of sustainable practices. Similarly, findings by Muhammad and Khan[30] indicate that through trade openness agreements, countries can foster international cooperation, leading to the adoption of environmentally conscious policies that benefit multiple countries. Pata et al.[15] and Alola et al.[31] obtain similar conclusions, as they underscore how globalization, by enabling the diffusion of green technologies and innovative solutions, could play a pivotal role in curbing environmental degradation on a global scale.

However, studies of Le & Öztürk[32] and Kalaycı & Hayaloğlu[33] suggest a contrasting narrative, focusing on globalization's potential to inadvertently exacerbate environmental pressures. Their research revealed that increased economic activities and global integration might escalate resource consumption and ecological strain. Similarly, Balsalobre-Lorente et al.[34] and Adebayo et al.[35] present insights pointing to the complexities within the globalization-environment nexus, emphasizing that economic globalization could inadvertently lead to heightened environmental degradation.

Table 1 summarizes studies empirically investigating the effect of globalization, represented by trade openness, by using ecological footprint as a proxy for environmental pressure. These studies provide controversial conclusions due to different time periods, regions, explanatory variables, theoretical models, and estimation techniques. However, based on previous research, there reports is a lack of analysis on the impacts of the ecological footprint impacts inon India or Vietnam. Further, no previous study has yet compared between these two countries for the analysis. Following the STIRPAT framework, our study will explore and compare the impact of trade openness as an index for globalization on the ecological footprint between India and Vietnam.

THEORETICAL FRAMEWORK

Over the past decades, several empirical studies have implicated population, affluence, and technology as driving forces of the environmental impact[48]. Ehrlich & Holdren[49] were the first to conduct the IPAT formulation to explain the impact of environmental pressure (I) on population (P), economic affluence (A), and technology (T), as depicted in the equation (1).

$I = PAT$ (1)

This model continues to be widely used as a framework for analyzing a complex relationship among its variants on environment[50]. However, since the multiplicative structure presumes proportional connections among explanatory variables without substantial empirical backing, the structure lacks adaptability for hypothesis testing or allowing for non-monotonic or non-proportional effects. To overcome the limitation of this model, Dietz & Rosa[51] reformulated IPAT into a stochastic model, known as the Stochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT) model. The equation (2) is as follows:

$I = aP^b A^c T^d$ (2)

Then, they apply logarithms to the terms before converting it into the following form:

$I_{it} = a + b(\ln P_{it}) + c(\ln A_{it}) + d(\ln T_{it}) + e_i$ (3)

where a is the constant; b, c, and d are the exponents of P, A, and T, respectively; e is the error term; the subscript i indicates that these quantities (I, P, A, T and e) vary across observational units; t denotes the year.

Eq (3) illustrates the linear relationship between population, affluence, technology, and environment pressure. Since international trade significantly influences economic activity and environmental behaviours[52], we consider there is a strong correlation between globalization and ecological footprint in both India and Vietnam. Additionally, the rise of globalization

Table 1: Summary literature on the nexus between trade openness and ecological footprint.

Author	Country	Time period	Method	Explanatory variables	Findings
Al-Mulali et al. (2015) [36]	93 countries	1980 – 2008	GMM	Trade openness GDP Energy consumption Urban population Financial development	TO increases EF
Aşıcı and Acar (2016) [37]	116 countries	2004 – 2008	Panel OLS	Trade openness GDP per capita Biological capacity Population density Energy use per capita	TO increases EF
Mrabet et al. (2017) [38]	Qatar	1980 – 2011	ARDL	Trade openness Energy use Financial development	TO reduces EF
Destek et al. (2018) [39]	15 EU countries	1980 – 2013	FMOLS DOLS	Trade openness GDP per capita Renewable energy Non-renew energy	TO reduces EF
Ulucak et al. (2018) [40]	45 countries	1961 – 2013	CUP-FM CUP-BC	Trade openness GDP Human capital	TO increases EF
Sabir and Gorus (2019) [41]	South Asian	1975 – 2017	ARDL	Trade openness GDP per capita KOF index FDI inflows	TO increases EF
Destek and Sinha (2020) [42]	24 OECD countries	1980 – 2013	FMOLS	Trade openness GDP per capita Renewable energy Non-renew energy	TO reduces EF
Kongbuamai et al. (2020) [19]	Thailand	1974 – 2016	ARDL VECM	Trade openness Population density GDP per capita Energy use	TO increases EF
Lu (2020) [43]	13 Asian countries	1973 – 2014	PMG CCEMG	Trade openness GDP Energy consumption	TO reduces EF
Zahra et al. (2022) [44]	Pakistan	1970 – 2015	NARDL	Trade openness Rail route Length of roads Airline route	TO increases EF
Okelele et al. (2022) [45]	23 Sub-Saharan African	1990 – 2015	FGLS	Trade openness GDP per capita Renewable energy Urbanization FDI	TO reduces EF
Magazzino (2023) [46]	China	1960 – 2019	QR	Trade openness Electric consumption Life expectancy GDP per capita Urban population	TO reduces EF
Eweade et al. (2023) [47]	UK	1990 – 2020	ARDL	Trade openness Energy consumption GDP Renewable energy KOF index	TO increases EF

Source: Research team' synthesis, 2023

contributes to an increasing level of ecological footprint for the two countries in the long run.

Hypothesis: Globalization is positively associated with Ecological footprint.

ESTIMATION MODEL AND DATA

Estimation model

Our study aims to analyze and compare the effect of globalization on ecological footprint between India and Vietnam. We focus on constructing ecological footprint functions that contain primary driving factors based on STIRPAT model. Following many pioneer researches utilizing STIRPAT framework, driving forces including population, affluence, and technology level are generally analyzed to examine the influence on ecological footprint[53–55]. Following the work of Ahmed et al.[56] and Wang et al.[57], we employ urbanization and GDP per capita as the population and affluence effect, respectively. Furthermore, energy consumption is adopted to examine the impact of technology on ecological footprint. Thus, we build the EF function as Equation (4):

$$EF_{it} = GDPpc_{it}, UR_{it}, EC_{it}, TO_{it}) \quad (4)$$

where i and t denote country and year, respectively; EF represents ecological footprint; TO stands for trade openness; $GDPpc$ signifies the gross domestic product per capita; UR indicates urbanization level; EC is depicted by the energy consumption.

All the variables are taken into logarithmic form, except for the UR variable. The basic model is represented as follows:

$$\ln EF_{it} = \alpha_0 + \alpha_1 GDPpc_{it} + \alpha_2 UR_{it} + \alpha_3 EC_{it} + \alpha_4 TO_{it} + \varepsilon_{it} \quad (5)$$

where ε_{it} and α_0 is the random error terms and constant, respectively. α_1 - α_4 indicate as the parameters of the determinants in the model. The coefficient of trade openness α_1 is expected to be positive. The others stay the same as the estimation above.

Data

For our econometric investigation, we take a sample of India and Vietnam over the period 1996 to 2022. The World Bank[6] is used to accumulate the data. Table 2 depicts the indicator features (abbreviation, unit, and source) for the analysis. The ecological footprint indicator is employed as an dependent variable, and the explanatory variables include GDP per capita (GDPpc), urbanization (UR), and energy consumption (EC). Trade openness (TO) is calculated by the share of total exports and imports of total GDP.

Table 3 and Table 4 provide an overall understanding of the descriptive statistics between selected variables in India and Vietnam. They witness small fluctuations in all variables in both nations as their standard deviations are relatively small. The ecological footprint in Vietnam is reported to be higher than India over the sampled period. Furthermore, the observation is observed to be right tailed, indicating the highly positive skewness of all variables except urbanization and trade openness. This explains why most of the variables are not normally distributed.

The correlation of different variables in India and Vietnam is also represented in these tables, respectively. Regarding India, all variables are strongly correlate with ecological footprint (EF). Particularly, GDP per capita, economic consumption, and trade openness entertains effects on EF with 96.4%, 97.2%, and 79.3%. This indicates that these economic indicators are detrimental to environmental quality in India. In the context of Vietnam, the coefficients also show an expressively integrated relationship between GDP per capita, economic consumption, and trade openness with 99.5%, 99.3%, and 98,2%, respectively. It has revealed that these factors contribute to the environmental degradation in Vietnam.

Indeed, Figure 1 and Figure 2 display the trend integration at the series level of all variables in India and Vietnam, respectively. Obviously, all variables in both nations are bearing upward movements, except for the urbanization index. Figure 1 shows the absence of trend in the log of ecological footprint (lnEF), urbanization (UR), and the log of trade openness (lnTO) while the log of GDP per capita (lnGDPpc) and the log of energy consumption (lnEC) witness constant upward trend in India. However, all variables of Vietnam in Figure 2 constantly increase, except for the urbanization. It is evident that the trends are associated with trade liberalization in the two nations. Specifically, both India and Vietnam mainly focus on exporting goods and services overseas. Therefore, an increasing impact of trade could contribute to an escalation of production activities, hence promoting continuous economic growth. However, this may result in the abuse of scarce energy resources and the degradation of environmental quality as ecological footprint increases.

RESULT AND DISCUSSION

Unit root test

The initial step in time series analysis involves checking whether the data is stationary at the level, first, and second difference or not. Determining the stationarity level plays a crucial role in avoiding spurious regression[24] and guiding the subsequent methodology selection for estimation, thereby providing policy

Table 2: Description and data sources of the indicators.

Indicators	Abbrev.	Unit	Source
Ecological footprint	EF	Global hectares	Footprint network
GDP per capita	GDPpc	Constant 2015 US$	World bank (2023)
Urbanization	UR	%	World bank (2023)
Energy consumption	EC	TWh	Energy Institute (2023)
Trade openness	TO	% of GDP	World bank (2023)

Source: Research team' synthesis, 2023

Table 3: Summary statistics and correlation matrix in India.

Variable	EF	GDPpc	UR	EC	TO
Obs.	27	27	27	27	27
Mean	-.113153	7.05891	2.532672	8.652677	-1.003537
Std. Dev.	.1379488	.3790084	.2166574	.3837455	.324259
Minimum	-.3073216	6.479981	2.024671	8.033214	-1.625223
Maximum	.0790098	7.642582	2.937708	9.222609	-.5996791
Skewness	0.8103	0.9887	0.4768	0.8040	0.1028
Kurtosis	0.0000	0.0047	0.7181	0.0018	0.1790
Correlation matrix					
EF	1.000				
GDPpc	0.964	1.000			
UR	-0.895	-0.861	1.000		
EC	0.972	0.997	-0.868	1.000	
TO	0.793	0.785	-0.622	0.816	1.000

Source: Research team' synthesis, 2023

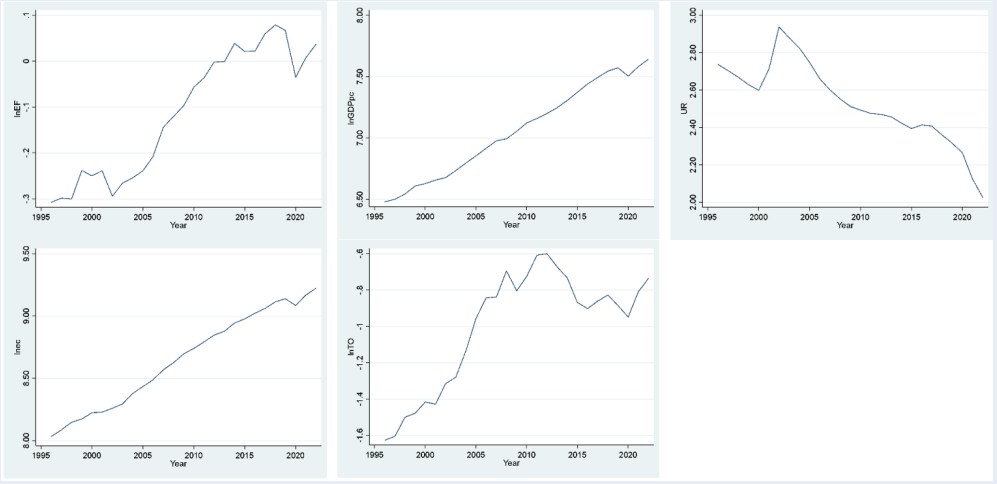

Figure 1: All individual graphs for dataset trends in India

Table 4: Summary statistics and correlation matrix in Vietnam.

Variable	EF	GDPpc	UR	EC	TO
Obs.	27	27	27	27	27
Mean	.337	7.555	3.13	6.164	-.041
Std. Dev.	.39	.409	.195	.685	.484
Minimum	-.329	6.883	2.594	4.982	-.971
Maximum	.889	8.204	3.429	7.151	.643
Skewness	0.554	0.923	0.012	0.797	0.250
Kurtosis	0.024	0.023	0.164	0.025	0.303
Correlation matrix					
EF	1.000				
GDPpc	0.995	1.000			
UR	-0.77	-0.809	1.000		
EC	0.993	0.997	-0.791	1.000	
TO	0.982	0.978	-0.752	0.977	1.000

Source: Research team' synthesis, 2023

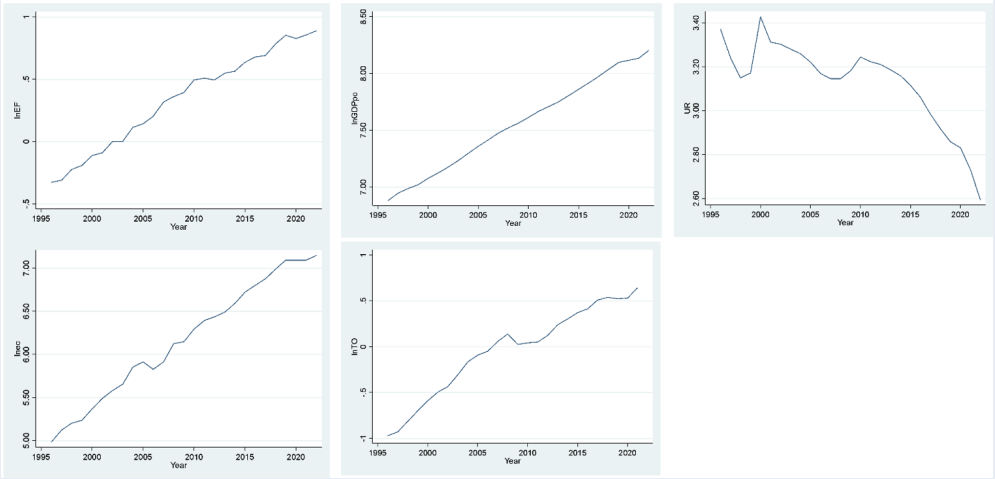

Figure 2: All individual graphs for dataset trends in Vietnam

formulation for the future. The Augmented Dickey-Fuller (ADF) test, developed by Dickey & Fuller, (1979), has been conducted to evaluate the stationarity level of regressors and the regressed variable. This process aims to identify a level of cointegration among the variables using an appropriate econometric technique for result extraction[58]. Additionally, the Phillips and Perron test for unit root (PP unit root test), introduced by Phillips and Perron[59], is also employed to validate the findings obtained from the ADF test, ensuring alignment in the stationarity levels of all variables. The results at the level and at first difference for both ADF and PP unit root tests are presented in Table 5. The findings from both ADF and PP unit root tests indicate that all variables (including Ecological Footprint, GDP per capita, Urbanization, Energy consumption, and Trade openness) are integrated at the I(1) level with a significance level of 1%, 5% and 10%. The analysis found that none of the data sets are stationary at the level or after taking the second difference. The good news, however, is that all the data sets became stationary at the first difference. Thus, apply-

Table 5: Unit root results.

Variables	Vietnam		India	
	ADF		ADF	
At level				
lnEF	-1.680	-1.411	-1.614	-1.735
lnGDPpc	-1.922	-2.156	-2.407	-2.542
UR	-0.622	-0.602	-1.096	-1.519
lnEC	-2.575	-2.526	-1.375	-1.491
lnTO	-1.622	-1.663	-1.13	-1.223
At first difference				
lnEF	-7.358***	-7.8***	-5.03***	-5.032***
lnGDPpc	-3.675**	-3.603**	-4.779***	-4.778***
UR	-4.931***	-5.111***	-3.195*	-3.166*
lnEC	-5.015***	-5.16***	-4.952***	-4.951***
lnTO	-3.852**	-3.823**	-1.136***	-4.196***

Source: Research team' synthesis, 2023

Note: Significance of the symbols: *p < 0.1 (significant level of 10%), **p < 0.05 (significant level of 5%) and ***p < 0.01 (significant level of 1%)*

ing the ARDL bound test is appropriate for the data to investigate the India and Vietnam's short-run and long-run effects.

ARDL bound testing method for cointegration test

After confirming the cointegration among variables, the long-run and short-run relationships are estimated to estimate the impacts of GDP per capita, urbanization, energy consumption and trade openness on the ecological footprint using the ARDL bound testing approach. This model, conducted by Pesaran and Shin[60], has been widely used in previous studies by Danish et al.[61], Rahman[62], Rahman and Kashem[63], and Shahbaz et al. (2013)[64].

The results of ARDL bound testing model are shown in Table 6. In the long run, the 1% change in trade openness would cause a reduction of 0.405% in the scale of the ecological footprint in India. This result defines that the expansion of trade improves the environmental quality in India, according to the findings of recent researches[45,46]. This means that India has focused on importing more rather than exporting to lessen the industrial production, thereby mitigating the environmental degradation. This could stem from the purpose of following environmentally friendly practices by implementing import substitution. As India significantly relies on the import portfolio of crude oil, the import substitution policies have effectively decreased the importation of crude oil and other petroleum products, resulting in a subsequent reduction in CO2 emissions[65]. The work of Liu et al.[27] supports this implication that trade openness is negatively related with the ecological footprint in Pakistan due to the shift in production processes. Nonetheless, this outcome contradicts the study of Eweade et al.[47] which shows evidence that trade openness contributes to the exacerbation of ecological footprint in the UK due to the lack of sustainable trading practices.

On the other hand, the coefficient of lnTO in Vietnam is 0.1912746 at 0.1% level of significance, indicating that the long-term positive impact of trade openness on Vietnam's environmental indicator suggests that an escalation in trade openness leads to an increase in the ecological footprint. The finding is consistent with studies of Warsame et al. (2023) and Abid et al. (2022)[23,24]. Being considered an export-oriented nation in the agricultural industry, the potential explanation for this implication in Vietnam is the comparative advantage in manufacturing and exporting these products to overseas and hence, expanding the markets. Thus, an escalation of demand for these commodities requires significant natural resources, leading to a deterioration of the environmental quality. Thanh et al.[66] also investigate and claim that a large amount of emissions would be released and worsen the environment during the production pro-

cesses. Moreover, regarding energy-intensive activities, trade openness also facilitates transportation and manufacturing, leading to a significant energy consumption and thus, contributing to pollution. This finding is consistent with the study of Udeagha et al. [67] and Aslam et al. [68].

The short-run estimate of our finding indicates that trade openness negatively affects ecological footprint with a coefficient of-0.075 in India, however, the impact is not statistically significant due to the p-value of 0.260. Conversely, the coefficient on trade openness is significantly negative to Vietnam's ecological footprint. This outcome is alignswith the results investigating 24 OECD countries [42], 15 EU countries [39], Qatar [38], and Pakistan [69].

Granger causality test

In the essence of cross-checking, the Granger causality test, conducted by Granger [70], has been employed and reported in Table 7 to examine the causal relationship between trade openness (TO), GDP per capita (GDPpc), urbanization (UR), and ecological footprint (EF) in India and Vietnam, either it is unidirectional or bidirectional and vice versa.

Generally, the results do not show a the causal relationship from GDP per capita, energy consumption, and trade openness to the ecological footprint level in Vietnam. Simultaneously, in India, we also observe that ecological footprint drives economic development (i.e. GDP per capita, energy consumption and trade openness) in one-way, while urbanization also suffers the same impact in Vietnam. The outcomes are consistent with the study of Abid et al. [24] who state that GDP per capita and trade openness influence the environmental quality regarding the Granger test. Expectedly, this is insightful for policymakers and environmentalists to pay more attention to the adverse effects of the economic growth and predict their future characteristics on the environment in both India and Vietnam.

The Granger causality test results for India present varying relationships between different variables and the ecological footprint (EF). For instance, the test between GDP per capita (GDPpc) and EF shows a less significant relationship, with an F-statistic of 3.106 and a probability of 0.212, indicating that GDPpc might not significantly predict changes in EF. However, the reverse relationship, assessing if EF causes changes in GDPpc, displays more promising results with an F-statistic of 7.343 and a probability of 0.025, suggesting a potential causal link where EF could influence changes in GDPpc. Other tests, like the relationship between trade openness (TO) and EF, reveal significant outcomes, with an F-statistic of 14.745 and a probability of 0.001, indicating that TO might significantly predict or cause changes in EF. In contrast, the reverse relationship yields similar significant results, implying a potential causal relationship.

In Vietnam, the Granger causality test outcomes unveil distinct relationships between variables and the ecological footprint (EF). The test between GDP per capita (GDPpc) and EF presents a statistically significant relationship, with an F-statistic of 8.522 and a probability of 0.014, suggesting that GDPpc might predict or cause changes in EF. Conversely, the test examining if EF causes changes in GDPpc indicates less significance, with an F-statistic of 2.8695 and a probability of 0.238, implying that EF might not significantly predict changes in GDPpc. Additionally, the test between trade openness (TO) and EF reveals a significant relationship, with an F-statistic of 14.679 and a probability of 0.001, indicating that TO might significantly predict changes in EF. However, the reverse relationship shows a higher probability (0.630) and a lower F-statistic (0.92508), suggesting that EF might not significantly predict changes in TO.

CONCLUSION AND POLICY RECOMMENDATIONS

Based on the data of India and Vietnam from 1996 to 2022, we investigate the relationship between globalization and the environment. In the introductory phase, we conducted ADF and PP unit root tests for all variables before employing the Autoregressive Distributed Lag (ARDL) bound testing model to capture the essence of estimation elasticities significance in the short-run and the long-run on environment quality (ecological footprint). The Granger causality test is also conducted to verify the result. Moreover, the research is conducted to analyze whether any difference exists between India and Vietnam.

Concerning the result of India, urbanization and energy consumption positively affect on ecological footprint, promoting environmental degradation. In contrast, growth and globalization, represented by GDP per capita and trade openness respectively have a negative impact on the ecological footprint, which is beneficial for the environment in the long run. Meanwhile in Vietnam, trade openness has a significant and negative relationship with ecological footprint in the short run but deteriorates the environmental quality in the long run. The disparity in the two countries' results might be due to the difference in the scale of the economy, technology development as well as trading policies.

Table 6: Result of ARDL approach in India and Vietnam

D.lnEI	India ARDL(2,0,2,2,1)						Vietnam ARDL(2,0,0,2,1)					
	Coef.	Std.Er	t	P>t	95%(	Interv	Coef.	Std.Err.	t	P>t	95%Conf.	Interval
ADJ												
lnEF												
L1.	0.490	0.248	1.980	0.070	-0.04(	1.025	-.742561	.1688206	-4.40	0.001	-1.104646	-.3804775
Long run												
lnGDI	-2.320	0.956	-2.430	0.030	-4.38!	-0.255	1.20201	.3274046	3.67	0.003	.499798	1.904224
UR	0.545	0.272	2.000	0.066	-0.04:	1.133	.065835	.0774761	0.85	0.410	-.1003339	.2320055
lnEC	3.182	1.173	2.710	0.018	0.64!	5.715	-.299469	.1733394	-1.73	0.106	-.6712459	.0723063
lnTO	-0.405	0.177	-2.290	0.039	-0.78:	-0.023	.191274	.0904873	2.11	0.053	-.0028013	.3853504
Short run												
lnEF												
LD.	-0.677	0.221	-3.060	0.009	-1.15(	-0.199	-.238482	.1424166	-1.67	0.116	-.5439359	.0669707
UR												
D1.	0.070	0.082	0.850	0.412	-0.10!	0.248						
LD.	0.145	0.091	1.590	0.135	-0.05:	0.341						
lnEC												
D1.	1.361	0.228	5.970	0.000	0.86!	1.853	.361328	.0959429	3.77	0.002	.1555511	.5671053
LD.	0.598	0.222	2.690	0.018	0.11!	1.078						
lnTO												
D1.	-0.075	0.064	-1.180	0.260	-0.21:	0.063	-.303038	.0952847	-3.18	0.007	-.5074034	-.0986727
LD							-.233854	.1047213	-2.23	0.042	-.458459	-.0092495
_cons	6.345	1.702	3.730	0.003	2.66!	10.02:	-5.24031	1.818378	-2.88	0.012	-9.140348	-1.340282

Source: Research team' synthesis, 2023

Table 7: Granger causality test in India and Vietnam.

Null hypothesis	India			Vietnam		
	Observat	F-statistic	Probability	Observation	F-statistic	Probability
GDPpc does not Granger cause EF	26	3.106	0.212	26	8.522	0.014
EF does not Granger cause GDppc	26	7.343	0.025	26	2.8695	0.238
UR does not Granger cause EF	26	1.027	0.598	26	2.4638	0.292
EF does not Granger cause UR	26	3.616	0.164	26	7.2449	0.027
EC does not Granger cause EF	26	0.995	0.608	26	7.9366	0.019
EF does not Granger cause EC	26	6.621	0.037	26	2.1967	0.333
TO does not Granger cause EF	26	1.986	0.370	26	14.679	0.001
EF does not Granger cause TO	26	14.745	0.001	26	0.92508	0.630

Source: Research team' synthesis, 2023

According to the findings above, several implications have been highlighted. For India, urbanization and energy consumption promote ecological footprint. Therefore, policymakers should develop and implement strategies aimed at creating more environmentally friendly urban areas by planting trees, and promoting public transportation. Additionally, the country should shift to green and renewable energy and have effective energy conservation plans among industries and households. Concurrently, the positive relationship between economic growth (as indicated by GDP per capita) and trade openness to environmental sustainability presents an opportunity for proactive policy interventions. Policymakers should focus on fostering economic growth through environmentally sustainable practices and globalization to increase trade should be promoted by signing of FTAs. In the context of Vietnam, the research results emphasize the imperative for targeted policy interventions to address the concerning positive relationship between GDP per capita, trade openness, and ecological footprint. Adopting sustainable practices, green energy and fuels should be focused. Also, policymakers should prioritize the development and the implementation of measures that promote responsible trade practices, including stringent environmental standards in international agreements. While urbanization and energy consumption showed no significant impact, ongoing monitoring and management are essential. A collaborative approach involving government, businesses, and civil society, alongside public awareness campaigns, is crucial for fostering a culture of environmental responsibility.

Although this study has demonstrated the nexus between globalization and ecological footprint in India and Vietnam, several limitations still exist. First, considering the globalization variable, we use the most common equation, which is the share of total trade (export plus import) over total GDP. However, there are still other measurements of this variable that might yield a more precise result. Also, measuring method of different types of variables can be used as a proxy for globalization, such as the KOF index, which also needs investigation. Second, expanding the data set. Our research utilizes the data of Vietnam and India from 1996 to 2022, the number of observations is still relatively small, and further studies that include a more extensive scope should enhance the robustness of the result.

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ABBREVIATION

ADF: Augmented Dickey-Fuller test
ARDL: autoregressive distributed lag
CCEMG: common correlated effects mean group

CUP-BC: continuously-updated and bias-corrected
CUP-FM: continuously-updated and fully modified
DOLS: dynamic ordinary least square
FGLS: feasible generalized least square
FMOLS: fully modified ordinary least squares
Granger: granger causality test
NARDL: non-linear autoregressive distributed lag
PMG: pooled mean group estimation
PP: Phillips and Perron test
QR: quantile regression.

CONFLICT OF INTERESTS

The author(s) declared no potential conflicts of interest. with respect to the research, authorship, and/or publication of this article.

AUTHORS' CONTRIBUTION

Pham Hoang Uyen is responsible for writing content of the research, including abstract, result and discussion

Tran Pham Anh Duy is responsible for collecting data, analyzing models, and writing content of the research, including conclusion.

Nguyen Ngoc Thao Nguyen is responsible for writing content of the research, including theoretical framework and discussion.

Nguyen Quang Phat is responsible for writing content of the research, including abstract, introduction and literature review.

Le Phuong Thao is responsible for writing content of the research, including results and discussion.

Trinh Minh Quy is responsible for summarizing and correcting the whole paper.

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Bài nghiên cứu

Tác động của Toàn cầu hóa lên Dấu chân Sinh thái: Nghiên cứu so sánh giữa Ấn Độ và Việt Nam

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TÓM TẮT

Toàn cầu hóa đã tác động lớn đến các quan hệ kinh tế giữa các quốc gia, khiến các quốc gia phụ thuộc lẫn nhau ở một mức độ nhất định. Sự biến đổi này đã ảnh hưởng đến các quốc gia công nghiệp hóa và đang phát triển như Ấn Độ và Việt Nam theo nhiều cách khác nhau. Nghiên cứu đã xem xét kỹ lưỡng toàn cầu hóa liên quan đến dấu chân sinh thái ở hai quốc gia này bằng cách xem xét tác động của sự mở cửa thương mại và phát triển kinh tế đến môi trường thông qua dấu chân sinh thái. Nghiên cứu đã tổng hợp các nghiên cứu trước đây về tác động môi trường của toàn cầu hóa và sử dụng mô hình STIRPAT để so sánh mối quan hệ giữa các chỉ số toàn cầu hóa phân quyền và dấu chân sinh thái ở cả Ấn Độ và Việt Nam. Để xác định tác động dài hạn và ngắn hạn của toàn cầu hóa lên dấu chân sinh thái, nghiên cứu này đã sử dụng phương pháp kiểm tra biên ARDL cùng với phân tích kinh tế lượng. Kết quả cung cấp bằng chứng rằng áp lực môi trường giảm trong dài hạn do mức độ toàn cầu hóa cao hơn, nhấn mạnh tầm quan trọng của chủ nghĩa môi trường và các chính sách có trách nhiệm. Nghiên cứu này cung cấp cơ sở về tác động của toàn cầu hóa lên môi trường trong các nền kinh tế đang phát triển và khuyến nghị rằng để tiến bộ chính sách về toàn cầu hóa trong tương lai, cần có sự kết hợp giữa tăng trưởng kinh tế và bảo vệ môi trường. Do đó, nghiên cứu này khẳng định rằng điều quan trọng là phải điều tra những tác động mà toàn cầu hóa mang lại cho môi trường, đặc biệt là ở các quốc gia đang phát triển như Ấn Độ và Việt Nam. Trong bối cảnh này, nghiên cứu này nhằm khám phá cách thức mở cửa thương mại và tăng trưởng kinh tế ảnh hưởng đến dấu chân sinh thái nhằm nâng cao hiểu biết về phát triển bền vững và các biện pháp chính sách khác. Những phát hiện có liên quan của nghiên cứu này có thể quan trọng đối với các nhà hoạch định chính sách, đặc biệt là về các hướng cần được áp dụng để đạt được sự cân bằng hợp lý giữa phát triển kinh tế và bảo tồn môi trường.

Từ khoá: Toàn cầu hóa, dấu chân sinh thái, ARDL, STIRPAT, Ấn Độ, Việt Nam

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