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International Transfer of Ecological Footprint: An Analysis for the Countries with Different Income Levels

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Abstract

Environmental repercussions driven by economic activities have caused developed nations to incur higher costs depending on the adherence to environmental standards adopted along with public pressure. Because of their lower environmental standards, developing countries have secured a competitive cost edge in polluting sectors, attracting foreign direct investment and triggering debates about pollution havens. Such a scenario poses a potential risk of amplified carbon releases (CR) in developing nations. However, foreign direct investments originating from developed nations can enhance management practices, disseminate environmentally friendly advanced technologies, and ultimately reduce CR in developing nations. The primary aim of this study is to examine the effects of economic variables that seem to contribute to the carbon footprint, utilizing data from 10 developed and developing countries. This study investigates the impacts of foreign direct investment, national income, and export variables on the ecological footprint during the period spanning from 2000 to 2022, making use of the CS-ARDL method. The results revealed that the ecological footprint is affected by foreign direct investments, increased national income, and the expansion of exports. It is essential to raise environmental standards to an international level and promote eco-friendly production and growth approaches to reduce the ecological footprint and protect environmental values globally, not just in developed countries. Moreover, policymakers must ensure considering environmental values in foreign direct investments in developing countries, supporting this through regulations, and preventing the exploitation of low environmental quality for export advantages.

Keywords: Ecological Footprint, Economic Growth, Foreign Direct Investment, Export.

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1. INTRODUCTION

The environmental drawbacks accompanying foreign investments is one of the commonly debated issues related to foreign direct investment. It is crucial to assess the environmental impacts of foreign direct investment to achieve contemporary environment friendly economic growth. Many developing countries changed their strategies from import substitution to export-oriented growth, which led to a new international trade and investment model based on the comparative advantages of both developed and developing countries concerning productivity and production costs. The correlation among economic growth, environmental pollution, and foreign direct investment has been thoroughly discussed. The literature emphasized two different approaches investigating the environmental impacts of foreign direct investments. The first one is the pollution haven hypothesis (PHH) which posits the existence of a positive relationship between foreign direct investments and environmental pollution (Al-mulali & Foon Tang, 2013). In accordance with the assumptions associated with this hypothesis, developing economies attract foreign investments in environmentally harmful production processes under global conditions where different environmental standards are in practice, leading to an escalation in CO_2 levels in these nations (Musah et al., 2022).

The national strategies in terms of environmental regulation differ between developed and developing countries. While companies in developing countries often specialize in high-pollution-intensity manufacturing sectors, those in developed ones tend to move away from pollution-intensive sectors (Cole, 2004, p. 73). In developing countries, increases in foreign investment inflows are commonly linked to multinational companies seeking access to a cheap workforce and ample natural resources. Nevertheless, according to the PHH, developing countries' attractiveness for foreign direct investment stemmed from their more lenient environmental regulations compared to developed ones (Destek & Okumus, 2019, p. 23689). In this context, even as foreign direct investments stimulate growth, developing economies experience adverse effects attributable to a rise in energy demand and associated environmental impacts (Liobikienė & Butkus, 2019). As a result of variable environmental regulations, developing countries gain a competitive advantage, causing pollution-intensive industries to migrate from developed to developing nations to reduce production costs (Bayraktutan, 2022, p. 89).

The second approach is the pollution halo hypothesis, which posits the existence of an adverse nexus between foreign direct investments and environmental pollution, indicating that the production structure of multinational companies is generally based on clean technology. As a result, the increase in such investments will aid in the propagation of universal environmental standards in host nations through the implementation of high-tech and eco-friendly technologies (Destek & Okumus, 2019, p. 23689; Terzi & Pata, 2020). The environmental quality will be enhanced domestically if foreign firms carry out foreign direct investments in accordance with implementing cleaner and energy-efficient technologies along with advanced ecological management (Balsalobre-Lorente et al., 2019).

The primary goal of this paper is to investigate the validity of the pollution haven hypothesis for selected 10 countries, including both developed and developing nations, over the period spanning from 2000 to 2022. This study has the potential to contribute to the existing literature in the following ways: 1) examining the validity of the pollution haven hypothesis through the ecological footprint, with a sample including both developed and developing nations which vary in terms of environmental regulations and standards; 2) differentiating the validity of this hypothesis in both the short and the long terms, thanks to its empirical methodology, i.e., making use of the CS-ARDL boundary test.

This paper is organized as follows: following the introduction, the second section provides a summary of the pertinent literature. In the third section, the methodology and model are introduced, and empirical findings are presented. Lastly, the findings are examined, and policy recommendations are presented.

2. LITERATURE REVIEW

There are various empirical studies concerning the direct link between foreign direct investment and environmental factors in the literature. Aliyu (2005) assessed the pollution haven hypothesis by utilizing data over the period from 1990 to 2000, encompassing 11 OECD countries and 14 non-OECD countries and employing panel data analysis. The results revealed no significant connection between foreign direct investments and pollution levels in non-OECD countries and a positive relationship between foreign direct investments and environmental policy in OECD countries. He (2006) revealed that the pollution haven hypothesis holds true for 29 cities in China using data from the period 1994-2001 and the Generalized Method of Moments (GMM). Shahbaz et al. (2011) also confirmed the validity of the pollution haven hypothesis from 1985 to 2006 utilizing data from 110 developed and developing nations and employing the Pooled, Fixed, and Random Effects methods for the analysis. Shahbaz et al. (2015) confirm the validity of the PHH during the period spanning from 1975 to 2012, utilizing data from 99 countries and employing the Fully Modified Ordinary Least Squares (FMOLS) and Pedroni cointegration test. Moreover, the results indicated a reciprocal causation between CO_2 emissions and foreign direct investments, identified on a global scale. Neequaye & Oladi (2015) investigated foreign direct investments' impacts on the environment during the period spanning from 2002 to 2008, focusing on a selected sample of 27 developing countries, revealing that while environmental aid helps reduce emissions in these countries, foreign direct investment inflows adversely impact the environment. Sapkota & Bastola (2017) revealed that the pollution haven hypothesis holds true for 14 Latin American nations from 1980 to 2010, using the Fixed and Random Effects method. The mutual nexus between foreign direct investment, institutional factors, financial development, and sustainability have been investigated by Singhania & Saini (2021). They tested the validity of PHH with the context of 21 developed and developing nations with high carbon releases during the period spanning from 1990 to 2016, utilizing the GMM and System Generalized Method of Moments (Sys-GMM), revealing that foreign direct investments exhibit a notable positive impact on environmental deterioration. In the context of Turkiye, Mike (2020) confirmed the validity of the PHH since foreign direct investments demonstrate an increasing impact on CO_2 releases, utilizing annual data of 1971-2015 for the carbon dioxide model, and that of 1970-2012 for the nitrogen oxide and total greenhouse gas models.

Recent studies conducted by Arslan et al. (2021) and Farooq et al. (2021) shed light on the potential adverse effects stemming from investments by advanced economies on environmental quality in developing economies, indicating that foreign direct investments contribute to extended impact on environmental deterioration in developing countries. In opposition to the pollution haven hypothesis, there are studies demonstrating a significant positive impact on the environment from foreign direct investors. For instance, Haisheng et al. (2005) asserted that, based on data related to trade, foreign direct investment, economic development, and environmental conditions in 30 provinces of China from 1990 to 2002, neither trade nor foreign direct investment had a distinct impact on the environment, indicating that foreign direct investment shows a positive impact on economic evolution and helps in inventing new technologies to reduce pollution. Honglei et al. (2011) delve into foreign direct investment's impact on environmental pollution for 30 regions in China utilizing data covering the period from 1993 to 2007 and corporating variables such as economic growth and foreign trade, revealing that foreign direct investment did not have a destructive impact on the local environment. The result drawn from the simultaneous equation model indicated that China was not acting as a pollution haven for developed countries. Rafindadi et al. (2018) delve into the relationship between foreign direct investments and environmental pollution, aiming to investigate the influence of global economic integration on environmental quality, specifically for the Gulf Cooperation Council (GCC) nations, employing the Pooled Mean Group method for the period spanning from 1990 to 2014, revealing that foreign direct investment inflows significantly reduce environmental deterioration.

To summarize, mixed results with different specifications and datasets have been observed in the literature.

3. EMPIRICAL ANALYSIS

3.1. Methodology

3.1.1. Dependence Across Sections and Homogeneity of Slopes

The analysis should focus on whether all cross-sectional units uniformly impacted when a shock occurs in a series in panel data scrutiny. Standard panel data approaches presume the absence of dependence among cross-sectional units and homogeneity in slope coefficients. However, neglecting cross-sectional dependence can lead to inaccurate interpretations (Chudik & Pesaran, 2013). Furthermore, estimated coefficients may exhibit variation across cross-sectional units. Accordingly, the presence of cross-sectional dependence and slope homogeneity will be scrutinized as a first step. Pesaran's (2004) CDLM and Pesaran et al.'s (2008) Bias Adjusted LM test are applied to achieve this objective. These methods remain applicable when the number of cross-sectional units (N) is greater than the time periods (T), as well as when the time periods are more significant than the number of cross-sectional units. CDLM and Bias Adjusted LM (LMadj) tests and the corresponding statistics can be computed in the following manner:

$$CD_{LM} = \sqrt{\frac{N}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}(T\,\hat{\rho}_{ij}{}^2 - 1) \quad (1)$$

$$LM_{adj} = \sqrt{\frac{2}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\frac{(T-k)\hat{\rho}_{ij}{}^2 - \mu_{Tij}}{V_{Tij}} \quad (2)$$

Equations-1 and 2 respectively present the statistical formulas for Pesaran's (2004) Cross-Section Dependence Lagrange Multiplier (CDLM) test and Pesaran et al.'s (2008) Bias Adjusted LM test.$\hat{\rho}_{ij}$, which denotes the correlation between cross-sectional units, μ_{Tij} denotes the cross-sectional averages and V_{Tij} denotes the variance. For both tests, the null and alternative hypotheses are shown as follows:

H_0: the absence of dependence across cross-sections.

H_1: the presence of dependence across cross-sections.

In panel data analysis, heterogeneity testing seeks to check whether other nations are influenced to the same extent by a shock that occurs in one of the nations involved in the analysis. Whether or not variables exhibit homogeneous influences determining the appropriate unit root tests to be utilized. With this respect, the homogeneity/heterogeneity inquiry is implemented by applying the Delta test introduced by Pesaran & Yamataga (2008). The hypothesis is as follows:

$$H_0: \beta_i = \beta$$

$$H_1: \beta_i \neq \beta$$

The null hypothesis' rejection signals the heterogeneity of slope coefficients within panel data approaches. After these preliminary scrutinizations, the stationarity levels of the variables will be inspected utilizing the Cross-sectionally Augmented Dickey-Fuller (CADF) test.

3.1.2. Testing for the Presence of Unit Roots

It is crucial in econometric explorations to conduct a stationarity or unit root examination to avoid spurious regression consequences. Several panel unit root tests exist in the literature, and each of them has some advantages and disadvantages depending on the sample size (Narayan & Narayan, 2010). As well, the existence or nonexistence of cross-sectional dependence in the series employed in the analyses also determines the unit root test to be applied. After the detection of cross-sectional interdependence among units in the countries covered by this analysis, second-generation unit root tests that account for cross-sectional dependence have been utilized. With this respect, the CADF test developed by Pesaran (2007) has been employed. The statistics for CADF are estimated utilizing the following equation:

$$\Delta y_i = a_i + b_i y_{i,t-1} + c_i \bar{y}_{t-1} + \sum_{j=0}^{p} d_{ij} \Delta \bar{y}_{t-j} + \sum_{j=1}^{p} \delta_{ij} \Delta y_{i,t-j} + e_{i,t} \quad (3)$$

Equation-3 represents $\bar{\boldsymbol{y}}_{\boldsymbol{t}}$ which denotes the means of all N cross-sections at time T. The outcomes of the CADF investigation are employed to detect the stationarity of each series within its respective cross-section, not for the whole panel data. Moreover, the arithmetic mean of the estimated CADF t statistics for each cross-section is calculated to identify the stationarity of the entire panel. The estimated arithmetic mean is the CIPS (Cross-Sectionally Augmented IPS) statistic. The CIPS statistic is estimated as follows:

$$CIPS = N^{-1} \sum_{i=1}^{N} CADF \quad (4)$$

To decide whether to refute the null hypothesis suggested that the series contains a unit root, the CADF and CIPS test statistics obtained through equations 3 and 4 are compared with the critical values in Pesaran's table (2007). The series is stationary, meaning it does not contain a unit root, if the estimated test statistic is greater in absolute value than the critical table value. Thus the null hypothesis is rejected.

3.1.3. Durbin-Hausman and Edgerton Cointegration Test

The Durbin-Hausman (DH) cointegration test, developed by Westerlund (2008), has several advantages. Firstly, it facilitates the scrutiny of a large number of independent variables without considering the stationarity levels of them, thanks to the utilization of the standard normal distribution. Secondly, it considers both cross-sectional dependence and heterogeneity. However, for the DH cointegration test to be applicable, the dependent variable should be integrated of order 1 (I(1)).

$$DH_{panel} = \hat{s}_n (\varphi_1 - \varphi_2)^2 \sum_{i=1}^{N} \sum_{t=2}^{T} \hat{e}_{i(t-1)}^2 \, ; \, DH_{group} = \sum_{i=1}^{N} \hat{s}_n (\varphi_1 - \varphi_2)^2 \sum_{t=2}^{T} \hat{e}_{i(t-1)}^2 \quad (5)$$

DH_{panel} test supposes that the autoregressive parameter is the same across the panel, while the DH_{group} test supposes that the parameters are heterogeneous. For both test statistics, the null hypothesis suggests no cointegration. In this study, the relationship between the series has also been scrutinized utilizing the LM test, considering cross-sectional interdependence. The LM statistic is as follows (Westerlund & Edgerton, 2007, pp.187-188):

$$LMN^T = \frac{1}{N \cdot T^2} \sum_{i=1}^{N} \sum_{i=1}^{T} w_i^{-2} s_{i,t}^2 \quad (6)$$

w_i^{-2} and $S_{i,t}^2$ respectively symbolize the long-run variance and the partial sums of error terms. The null hypothesis (Ho) signifies that the cointegration nexus occurs for all countries in the panel.

3.1.4. Coefficient Estimation: CS-ARDL Model

To estimate the long and short-term coefficients, the Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) model developed by Chudik & Pesaran (2015) was employed in this investigation. The principal benefit of the CS-ARDL estimator is that it maintains the consistency of predictions, irrespective of whether the series exhibits cointegration and stationarity at different levels. Likewise, functioning as the ARDL version of the Dynamic Common Correlated Estimator (CCE) and utilizing lagged dependent variables and lagged cross-sectional means, it incorporates cross-sectional dependence (Chudik & Pesaran, 2015). An additional advantage lies behind its allowance for average group predictions in the presence of heterogeneity in slope coefficients. The CS-ARDL model's average group version rests on enhancing the ARDL predictions for each section, incorporating cross-sectional averages to represent unobserved common factors and their respective lags (Chudik et al., 2016). Another advantage of this method is that it effectively tackles the weak externalities problem that arises when introducing lagged dependent variables into the model. The CS-ARDL investigation is formulated based on the following regression model:

$$y_{i,t} = \alpha_i + \sum_{l=1}^{p_y} \lambda_{l,i} y_{i,t-1} + \sum_{l=0}^{p_x} \beta_{l,i}\, x_{i,t-1} \sum_{l=0}^{p_\varphi} \varphi'_{i,l}\, \bar{z}_{i,t-1} + \varepsilon_{i,t} \qquad (7)$$

where, y_{it} denotes the dependent variable, $x_{i,t}$ denotes the function of the independent variables. $\bar{z}_{i,t-1}$ denotes the delayed horizontal cross-sectional means. The equation below is utilized in the long-term coefficient approximation of average group predictions:

$$\hat{\theta}_{CS-ARDL,\ i} = \frac{\sum_{l=0}^{p_x} \hat{\beta}_{l,i}}{1-\sum_{l=1}^{p_y} \hat{\lambda}_{l,i}}\ , \hat{\theta}_{MG} = {}^{1}/_{N} \sum_{i=1}^{N} \hat{\theta}_i \qquad (8)$$

3.2. Model and Variables

In this paper, the impact of foreign direct investment, national income, and exports on environmental pollution (ecological footprint) in the economies of 10 developed and developing nations, namely Germany, the United Kingdom, France, Italy, Brazil, China, India, Colombia, Mexico, and Vietnam is investigated utilizing annual data for the period spanning from 2000 to 2022. The logic behind the sample is to have a representative group of countries with inflow and outflow of FDIs in polluting industries due to their differentiating environmental standards. The time period preferred, on the other hand, provides quite sufficient observation to reach at convincing empirical findings.

Equation-9 presents the model which was designed to identify the above-mentioned nexus:

$$lnEF = \beta_0 + \beta_1 lnY_t + \beta_2 lnFDI_t + \beta_3 lnX_t + \epsilon_t \qquad (9)$$

The explanation of variables, and the sources from which the dataset was obtained are shown in Table-1.

Table 1. Explanatory Information for the Utilized Variables

Abbreviation	Variable	Unit	Source
EF	Per Capita Ecological Footprint	Gha	GFN
Y	Per Capita GDP	Current Prices, $	WDI
FDI	Foreign Direct Investment Inflow	Current Prices, $	UNCTAD
X	Total Exports	Current Prices, $	WDI

Table 2 presents descriptive statistic.

Table 2. Descriptive Statistics

Variables	Observations	Median	Std. Dev.	Minimum	Maximum
EF	230	3.384609	1.673723	.75	8.82
Y	230	18655.49	16646.62	442.0348	51203.55
FDI	230	2.03e+09	2.65e+09	-8.96e+09	9.58e+09
X	230	6.27e+11	6.52e+11	1.45e+10	3.71e+12

3.3. Empirical Findings

Both cross-sectional dependence and homogeneity conditions were investigated initially to obtain consistent predictions. Table-3 presents the outcomes of the Pesaran (2004) CDLM and Pesaran et al. (2008) Bias Adjusted LM tests investigating cross-sectional interdependence, along with the outcomes of the Pesaran & Yamagata (2008) Delta test examining homogeneity.

Table 3. The Outcomes of Cross-Sectional Dependence and Homogeneity Tests

			CDLM	*LMadj*
$\boldsymbol{lnEF = (lnY_t, InFDI_t, lnX_t)}$			59.874* (0.000)	18.625* (0.000)
Homogeneity Test $\boldsymbol{lnEF = (lnY_t, InFDI_t, lnX_t)}$				
$\hat{\boldsymbol{\Delta}}$ test	p-value	$\hat{\Delta}_{adj}$ test	p-value	
13.854	0.000	14.810	0.000	

Note: * Indicates the 1% significance level.

In both CDLM and LMadj tests, the null hypothesis positing no cross-sectional dependence has been rejected at a significance level of 1% as shown in Table-2, signifying the presence of cross-sectional dependence. Moreover, the Delta test-based null hypothesis of homogeneity has been rejected at the 1% significance level, indicating heterogeneity in slope coefficients in the panel data model. Accordingly, in the subsequent inquiries, methods permitting for cross-sectional dependence and slope heterogeneity were utilized. Table-4 presents the variables' stationarity properties investigated utilizing the CIPS unit root test, implying that both level I(0) and first difference I(1) values are provided by the test procedure.

Table 4. The Results of the Testing the Presence of Unit Root

Variables	I(0)	I(1)	Result
lnY	(t-bar: -2.319)**	-	I(0)
lnFDI	(t-bar: -2.610)*	-	I(0)
lnEF	(t-bar: -1.356)	(t-bar: -3.704)*	I(1)
lnX	(t-bar: -2.158)	(t-bar: -2.358)**	I(1)

Note: *, **, *** correspondingly signify the significance levels of 1%, 5%, and 10%. The critical CIPS values at levels -2.210 (10%), -2.330 (5%), and -2.570 (1%).

The series of lnY and lnFDI are stationary since the t-bar (CIPS) statistics series are significantly larger than the critical values given at 5% and 1% confidence levels. However, lnEF and lnX series become stationary when their first differences are taken. For the subsequent step of the analysis, the variables' different degrees of stationarity do not pose an issue. In the subsequent step, the long-term nexus between the investigated variables was scrutinized utilizing the DH and Westerlund & Edgerton cointegration tests, and the conclusions are offered in Table-5.

Table 5. The Results of the Cointegration Test

DH Cointegration Test	Statistic	p-value	Westerlund & Edgerton Cointegration Test			
dh_p	9.178 ***	0.000	LMNT	LM Statistic	asymp p-value	boost p-value
dh_g	279.156 ***	0.000		5.106	0.000	0.570

Table-4 represents the conclusions of the DH cointegration test, comprising both panel and group tests 'statistics and probability values, revealing that the null hypothesis is declined at the significance level of1%. Consistent with the Westerlund & Edgerton cointegration test, bearing in mind the cross-sectional dependence in the panel, the bootstrap probability value was considered, revealing that the H0 hypothesis cannot be rebuffed at the significance level of 5%; thus the series are cointegrated. In the subsequent step, to explore short and long-term relationships, the CS-ARDL approach was utilized in light of the quantitative conclusions akin to CSD, heterogeneity, unit roots, and DH cointegration test. In the presence of cross-sectional dependence and varying degrees of stationarity, the CS-ARDL approach provides consistent outcomes. An average group CS-ARDL model was estimated to obtain country-specific coefficients in the cross-section, and the conclusions are afforded in Table-5. The coefficients in Table-6 express the elasticities of the ecological footprint concerning independent variables since the logarithmic values of the variables are borne in mind. According to the CS-ARDL conclusions, a 1% increase in per capita income increases the ecological footprint by 0.13% in the short term and 0.22% in the long term. The results revealed that the nations included in the analysis achieve economic growth in a way that harms the environment. A 1% increase in foreign direct investment is found to increase the ecological footprint by 0.007% in the short term and 0.01% in the long term. Ultimately, a 1% increase in exports increases the ecological footprint by 0.14% in the short term and 0.24% in the long term, based on the CS-ARDL conclusions.

Table 6. The CS-ARDL Forecast Results

$lnEF = (lnY_t, InFDI_t, lnX)$			
Long run	coefficient	Std. Error	p-value
lnY	0.223**	0.091	0.015
lnFDI	0.010***	0.006	0.091
lnX	0.244**	0.113	0.031
Short run	coefficient	Std. error	p-value
L.lnEF	0.333*	0.068	0.000
lnY	0.134**	0.068	0.050
lnFDI	0.007***	0.004	0.075
lnX	0.143***	0.086	0.096
ECTt-1	-0.666*	0.068	0.000

4. CONCLUSION AND RECOMMENDATIONS

In the last decade, the motivation and outcomes of international direct investments have been at the forefront of popular research topics. In addition, and with efforts to maintain global competitiveness and the variability in environmental standards across countries, the geographical distribution of CO_2 emissions has become a more momentous determinant. In low and middle-income nations, economic evolution has the potential to have harmful impacts on the environment. In this paper, the impacts of national income, foreign direct investments, and exports on the ecological footprint were investigated for the period spanning from 2000 to 2022 utilizing annual data of 10 developed and developing nations. The investigation utilized unit root and cointegration methods, considering cross-sectional dependence, and the CS-ARDL test for short and long-term coefficient examination, revealing a positive nexus between economic growth and environmental deterioration in both the short and long term. Moreover, the results revealed that the increase in foreign direct investments increases environmental degradation, indicating that the pollution haven hypothesis holds true in this case. Ultimately, an increase in exports was also observed to contribute to environmental degradation. Our conclusions were supported by several studies from the literature such as He (2006), Shahbaz et al. (2011, 2015), Sapkota & Bastola (2017), Singhania & Saini (2021), Mike (2020), Neequaye & Oladi (2015), and the recent studies by Arslan et al. (2021) and Farooq et al. (2021) further corroborate this by showing that FDI exacerbates environmental harm, especially in developing nations. However, the results found by Aliyu (2005), Haisheng et al. (2005), and Honglei et al. (2011), Rafindadi et al. (2018) didn't align with our results. These opposing studies highlight the challenge to the notion that FDI universally leads to environmental degradation, indicating the complexity and variability of FDI impacts across different contexts.

While developed nations make efforts to curb environmental damage, such as implementing green agreements to restore ecological balance and reduce emissions, the low environmental standards of low and middle-income countries contribute to an increase in the ecological footprint during the growth process. Pollution havens result from foreign direct investments considering differences in environmental regulations and related spatial cost differentials. As growth, foreign direct investments, and exports increase in low and middle-income countries, the global footprint increases. Solving global environmental issues will not be facilitated by the migration of polluting industries between countries. Thus, developing nations should immediately adopt higher environmental standards, as part of global solutions. International organizations, like related UN programs need to become more effective. Financial instruments aiming to protect environmental values have to be implemented to ensure pollution-related costs are uniform worldwide. Developing economies should increase their competitiveness by increasing productivity, renewable energy sources, human capital, etc, not relying on being pollution havens due to low environmental standards.

Beneficial outcomes can be achieved by developing growth strategies associated with sustainable development goals, providing incentives for foreign direct investments with universally harmonized environmental standards, addressing unfair competitive advantages gained from low environmental standards in exports through international sanctions, and establishing financing mechanisms with contributions from high-income nations to deal with short-term challenges for low and middle-income nations. Moreover, it is crucial to cherish the economic advantages associated with attracting eco-friendly foreign direct investments in developing nations.

Ethics Committee approval was not required for this study.

The authors declare that the study was conducted in accordance with research and publication ethics.

The authors confirm that no part of the study was generated, either wholly or in part, using Artificial Intelligence (AI) tools.

The authors affirm that there are no financial conflicts of interest involving any institution, organization, or individual associated with this article. Additionally, there are no conflicts of interest among the authors.

The authors affirm that they contributed equally to all aspects of the research.

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