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Trade Liberalization and Environmental Performance Index: Mediation Role of Climate Change Performance and Greenfield Investment

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Abstract: At present, concerns regarding climate change are common, especially in countries more vulnerable to environmental degradation. Greenhouse gases, including carbon emissions, are mainly considered to deteriorate the environment. Despite substantial agreement on many environmental issues, there are also important differences between regions and countries, and often, within nations. Accordingly, this study aims to examine the environmental performance of South and East Asian countries and its association with trade and other economic variables. Panel regression techniques and robust checks are used to examine the data, which covers 15 years from 2002 to 2016. The findings suggest an extensive negative association between trade liberalization and the environmental performance of selected countries. It is also shown that climate change performance is an important channel for the overall environmental change. The results regarding heterogeneous differences affirm the concept of sustainability and the pollution halo hypothesis. However, it is suggested that each country should make an effort to improve its environmental performance along with economic development. The role of green innovation and renewable energy is very crucial in this regard. The outcomes of this study could be helpful for researchers and policymakers to form better policies regarding the environment and climate change.

Keywords: trade liberalization; environmental performance index; climate change performance; green-field investment; mediation effect; South and East Asian countries

1. Introduction

The world has experienced substantial economic growth over the last few decades because of trade and industrialization [1]. However, the environment and climate change have become a hot issue for debate globally due to the concerns for sustainable development [2,3]. Worldwide, the effects of climate change are not uniform. It is argued that developing countries are more likely to experience adverse environmental and climate change effects [4]. According to the World Economic Forum [5], Asia's GDP will overtake the rest of the world's GDP in 2020. The economic growth rate of developing Asia is higher than the world average. Such economic activities are increasing the risk of environmental deterioration and climate change in this region. It is reported that the emerging countries of Asia are more vulnerable at present in the context of environmental menaces [6,7]. Rohde and Muller [8] argued that the excessive flow of investment and speedy economic development had put Asian countries at the menace of environmental degradation and climate change. In 2018, the two major Asian economic giants, China and India, caused 27.8% and



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Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/). 7.3% of the worlds' total carbon emissions [9]. The emerging markets of Southeast Asia are also experiencing similar environmental issues [10].

International trade is deliberated amongst various factors explaining the environmental issues [11–13]. The environment pollution and trade nexus was initially considered by economists such as Grossman and Krueger [14] and Shafik [15]. These researchers proposed a factual basis for the association between trade and the environment. The economic theory specifies that trade and foreign direct investment (FDI) lead to development and growth, especially in underdeveloped and emerging countries. Khan et al. [16] found that export of agricultural products improves the livelihood of local farmers. Trade liberalization and FDI across borders have formed several ecological challenges, locally and globally, through anthropogenic activities such as the rise in energy consumption, population growth, and economic growth and development [17]. Wacziarg and Welch [18] concluded that although trade liberalization leads to economic growth and creates employment opportunities, it worsens the ecological conditions of the host countries through the shift of contaminated and mass industrialization, higher energy consumption, and urbanization, which ultimately cause climate change.

In one aspect, trade liberalization augments the movement of goods and services and extends economic activities, while it puts grave effects on the environment. Liu et al. [12] demonstrated that international trade permits nations to transfer pollution-concentrated industries to other countries. In another aspect, international trade helps developing countries to increase their income level, which can be consumed to alleviate environmental pollution in the future [14]. Grether and DeMelo [19] stated that trade in developing countries led to either specialization or increased pollution-intensive production. Antweiler et al. [20] argued that the contradictory findings related to the emission–trade nexus arise from contradicting scale, technique, and composition effects. The study found that international trade creates relatively small changes in pollution concentrations when it alters the composition, and hence the pollution intensity, of national output.

Further, it is perceived that FDI amplifies the environmental degradation, as it increases the economic activities in the host countries. However, on the other side, FDI may introduce cleaner technologies and better management practices to improve the environmental quality of host countries. In this regard, by separating the effect of green-field FDI and mergers and acquisitions (M&A) on the environment, Ashraf et al. [21] found that green-field FDI increases pollution, supporting the pollution haven hypothesis, while M&A decrease pollution, in line with the halo effect hypothesis. Greenfield FDI refers to investment which involves building everything the business needs from the ground. In addition, global climate change has already had observable effects on the environment. Climate change may aggravate erosion, decline in organic matter, salinization, soil biodiversity loss, landslides, desertification, and flooding [22]. The effect of climate change on soil carbon storage can be related to changing atmospheric CO_2 concentrations, increased temperatures, and changing precipitation patterns.

Previously, different proxies of the environment have been used by researchers, such as sulfur dioxide (SO₂) emissions [23], nitrous oxide (N₂O) emissions [24,25], and particulate matter (PM 2.5) [26]. However, the most relevant and frequently used indicator of the environment is carbon dioxide (CO₂) emissions [27–30]. Each proxy provides a record of environmental change, but the process of spatially combining these indicators into a large scale requires careful statistical evaluation. In this respect, the Environmental Performance Index (EPI) developed by Yale University is regarded as an all-inclusive proxy to examine the country's environmental conditions [31,32]. Ozturk et al. [33] also argued that CO₂ emissions only cover a small part of the total environmental pollution. The recently revised EPI of 2020 comprises 32 performance indicators across 11 issue categories. It ranks countries under two domains, environmental health and ecosystem vitality, which demonstrate the environmental pollution impacts on human health and also the effects that ensue on the ecosystem through environmental pollution. The Environmental Health Index

(HLT) measures the quality of air, water, and exposure to heavy metals. The Ecosystem Vitality Index (ECO) considers issues such as climate change and biodiversity.

As discussed, EPI is a more suitable and wide-ranging indicator to examine environmental performance and offers concrete guidelines for nations that seek to move towards a sustainable future. The main research question of this study is how trade liberalization affects the environmental performance (EPI) of the selected South and East Asian countries. The study is expected to propose more robust policy implications concerning the trade and environment nexus. Specifically, this study contributes to the current literature in the following three ways. First, in the prevailing literature, the predominant measures used to examine the environment are CO_2 and greenhouse gas emissions, with a few exceptions. Unlike most previous studies, this study used EPI (2020) for the comprehensive analysis of environmental performance with regards to trade liberalization. Second, the role of climate change performance and green-field investment is also explored using the mediation method concerning the trade–environment nexus. Third, as we are using panel data, heterogeneous differences are also explored based on per capita income, manufacturing GDP, and population size. Such a broad analysis can help refine policy choices, understand the determinants of environment, and maximize the relevant policy implications based on the estimated results.

Section 2, which follows, presents the literature review. Section 3 explains the data, sources, and empirical models employed in the study. In Section 4, results based on empirical estimations are discussed. Sections 5 and 6 discuss the mediation and heterogeneous differences, respectively. Lastly, the conclusion and policy recommendations are given in Section 7.

2. Literature Review

In the prevailing literature, numerous studies have explored the association between trade and the environment in various countries. The role of trade liberalization in encouraging or discouraging environmental deterioration has been a contentious issue in the literature. It has been evident that the association between trade liberalization and the environment is not uni-directional [20,34–36]. Udeagha and Ngepah [37] examined the association between trade and environmental quality in South Africa. The findings show that the country has a comparative advantage in exports of products that necessitate energy that is met by consuming fossil fuels, which eventually deteriorates the environment significantly. By utilizing the instrumental variable quantile approach of panel data, Kim et al. [28] studied the trade and environment nexus for northern and southern regions of the US. The study revealed that international trade with the North increases CO₂ emissions, whereas trade with the South mitigates CO_2 emissions, with a relatively larger effect for less polluted host countries. The findings suggest that, in terms of CO₂ emissions, trade benefits the advanced countries but could hurt the developing countries when trade with high-income trading partners occurs. Dogan and Seker [27] explored the effect of real income, energy consumption, renewable energy, financial development, and trade on the environment by using the fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) approaches; the outcomes found a positive association between energy consumption and CO_2 emissions, while a negative association was found for renewable energy, economic growth, energy use, and trade.

Omri et al. [38] scrutinized the association between trade, economic growth, and financial development on CO_2 emissions by employing simultaneous-equation models for 12 MENA panels over the period 1990–2011. The outcomes showed a two-way directional causality between economic growth and CO_2 emissions, and a one-way directional causality was found between trade and CO_2 emissions. Aller et al. [39] explored the role of world trade in environmental sustainability by pinpointing the important countries engaged in social networking. The findings showed that trade networks adversely affect developed countries' environments while regenerating developing countries for multinationals may

help to alleviate environmental degradation. Mahrinasari et al. [40] considered the panel of ASEAN countries to study the trade and environment nexus using DOLS and FMOLS. The outcomes suggested that trade liberalization significantly and positively influence carbon emissions. Ahmed et al. [41] concluded that although trade liberalization spurs economic growth, it does so at the cost of environmental degradation. Several other prior studies also report similar findings [42–49].

In contrast to some of the studies discussed above, it has been argued that the effect of trade liberalization is not as detrimental for the environment as is considered [50–58]. Zhang et al. [59] argued that international trade generally affects industrial output composition, leading countries to concentrate on those productions where their relative costs are almost lower. If trade leads a country to concentrate on pollution-intensive production, then the composition effect increases pollution and causes climate change. Alternatively, if trade leads a country to focus relatively on clean goods production, this composition effect sinks pollution and recovers the quality of the environment. The enormous economic growth due to merchandise exports has been evident in the developing countries of Asia. Li et al. [60] argued that if economic gains stress protection of the environment or deliver funds to invest in environmental protection strategies, alterations in production techniques may be helpful, that is, the technique effect may lead to less pollution by utilizing income generated from trade. The evidence of effects of international trade on environmental performance in various countries differs by income, or maybe due to differences in policies, economic structure, economic openness level, and specific variations of the country [61–63].

Adeel et al. [32] examined the influence of foreign direct investment, energy consumption, economic growth, and urbanization on EPI. The findings showed that foreign investment has a significant adverse effect on environmental performance, but economic growth is positively associated with EPI. Ashraf et al. [21] found that green-field investment flowing into poorer countries worsens the environment, while M&A flowing to industrialized economies reduce pollution. Liu et al. [64] argued that FDI had distinct effects on different environmental pollutants. The study finds that FDI reduced waste soot and dust but increased wastewater and sulfur dioxide. Bildirici and Gokmenoglub [65] found that changes in CO₂ emissions are linked with terrorism, FDI, and growth in the long run. However, Demena and Afesorgborb [66] argued that the underlying effect of FDI on emissions is close to zero. The results remain robust for different groups of countries and for different pollutants.

By reviewing the prevailing literature, it can be observed that there are not many studies available that analyze the relationship between trade and a comprehensive proxy of the environment, and the evidence is mixed [67]. Therefore, to enrich the limited literature on this topic, the current research examines the effects of trade on the environment by measuring EPI. This research is also significant in that there was no prior research that used mediation analysis to investigate the potential mechanism between trade liberalization, climate change, green-field investment, and environmental performance. Further, difference analysis based on per capita income, manufacturing economy, and population is incorporated to explore study sample differences. It is believed that this research could probably help policymakers form their strategies based on the results gained through systematic empirical analysis.

3. Materials and Methods

The dataset related to twelve South and East Asian countries was collected for empirical investigation as these countries are predominantly considered emerging economies. The countries included in the analysis are Bangladesh, India, Pakistan, Sri Lanka, China, South Korea, Indonesia, Malaysia, Singapore, Thailand, Vietnam, and the Philippines. The dataset is diverse as it covers both upper and lower-middle-income countries. The study focused on these countries due to the greater environmental and climate change concerns in these regions. Based on data availability, the study duration consists of 15 years, from 2002 to 2016. All the data is collected from secondary sources. Specifically, the GDP, urbanization, and FDI data was collected from the World Development Indicators (WDI). Trade and green-field investment data was collected from the United Nations Conference on Trade and Development (UNCTAD). Energy consumption data was collected from British Petroleum (BP). EPI and climate change indicator data was obtained from NASA's open data portal.

The main variable, environmental performance (*EPI*) is measured according to the latest environmental performance index of 2020. The EPI scores of each country are calculated from 2002 to 2016 by weighing each indicator percentage suggested in EPI 2020. The variable *Climate* is the climate change performance score of the selected countries. It is also measured according to the weightage given in the EPI report of 2020. The variable *lnGFI* is the natural log of green-field investment value in USD at the destination. The primary explanatory variable *Trade* is measured as the ratio of exports and imports value in USD over total GDP of the country. The study also included *lnGDP*, *lnFDI*, *lnEnergy*, and *lnUrban* as control variables based on the prior empirical literature. The variables *lnGDP* and *lnFDI* are measured as the logged value of the country's total gross domestic product and foreign direct investment in USD. The variable *lnEnergy* is the log of total energy consumption, and *lnUrban* is the log of the urban population of each country. The variables are used in log form to address nonlinear association concerns and interpret results as elasticities.

Further, the dummy variables included in the analysis are measured as $PCI_dummy = 1$ if per capita income >10,000 in USD, otherwise it is 0; the variable $Mfg.GDP_dummy = 1$ if manufacturing GDP of the country >20% of total GDP, otherwise it is 0; the variable Population_dummy = 1 if the country's population size >100 million, otherwise it is 0.

Empirical Estimations

The empirical specification used in this paper derives from the standard trade and environment framework. The study equation with control variables is constructed in the following panel regression model:

$$EPI_{it} = \beta_0 + \beta_1 Trade_{it} + \beta_2 lnGDP_{it} + \beta_3 lnFDI_{it} + \beta_4 lnEnergy_{it} + \beta_5 lnUrban_{it} + \varepsilon_{it}$$
(1)

where *i* denotes the number of countries included in the sample, and *t* indicates the time; β_1 , β_2 , β_3 , β_4 , β_5 are the coefficients parameters, whereas ε_{it} is the error term.

The study further employed mediation analysis by including *Climate* and *lnGFI* variables. Firstly, it is argued that climate change performance (*Climate*) has a considerable role in the overall environmental performance of the country. Therefore, to examine this affect empirically, the following equations have been derived by using the step-by-step mediation method of Baron and Kenny.

$$Climate_{it} = c_0 + \delta_1 Trade_{it} + \beta_1 lnGDP_{it} + \beta_2 lnFDI_{it} + \beta_3 Energy_{it} + \beta_4 lnUrban_{it} + \varepsilon_{it}$$
(2)

 $EPI_{it} = c_1 + \varphi_1 Climate_{it} + \varphi_2 Trade_{it} + \beta_1 lnGDP_{it} + \beta_2 lnFDI_{it} + \beta_3 lnEnergy_{it} + \beta_4 lnUrban_{it} + \varepsilon_{it}$ (3)

Secondly mediator *lnGFI* included in the model as it is perceived that green-field investment inflows deteriorate environmental quality more than other type of investment [32]. The mediation equations are as follows:

$$lnGFI_{it} = c_0 + \delta_1 Trade_{it} + \beta_1 lnGDP_{it} + \beta_2 lnFDI_{it} + \beta_3 lnEnergy_{it} + \beta_4 lnUrban_{it} + \varepsilon_{it}$$
(4)

 $EPI_{it} = c_1 + \varphi_1 lnGFI_{it} + \varphi_2 Trade_{it} + \beta_1 lnGDP_{it} + \beta_2 lnFDI_{it} + \beta_3 lnEnergy_{it} + \beta_4 lnUrban_{it} + \varepsilon_{it}$ (5)

where c_0 is the constant, δ_1 is the parameter for trade liberalization and β_1 to β_4 are the parameters for the control variables in Equations (2) and (4). For step 2, in Equations (3) and (5), φ_1 and φ_2 are the parameters for mediating variables and trade liberalization, otherwise it is the same.

Additional to the above estimations, the heterogeneous differences among sampled countries are also explored. The dummy variables are used to group the sample countries based on per capita income, manufacturing GDP, and population size. The equations are as follows:

 $EPI_{it} = \beta_0 + \beta_1 Trade_{it} + \beta_2 PCI_dummy_{it} + \beta_3 lnGDP_{it} + \beta_4 lnFDI_{it} + \beta_5 lnEnergy_{it} + \beta_6 lnUrban_{it} + \varepsilon_{it}$ (6)

 $EPI_{it} = \beta_0 + \beta_1 Trade_{it} + \beta_2 lnGDP_{it} + \beta_3 Mfg.GDP_dummy_{it} + \beta_4 lnFDI_{it} + \beta_5 lnEnergy_{it} + \beta_6 lnUrban_{it} + \varepsilon_{it}$ (7)

 $EPI_{it} = \beta_0 + \beta_1 Trade_{it} + \beta_2 lnGDP_{it} + \beta_3 lnFDI_{it} + \beta_4 lnEnergy_{it} + \beta_5 lnUrban_{it} + \beta_6 Population_dummy_{it} + \varepsilon_{it}$ (8)

The coefficient parameters describe the relationship between dummy variables and the environmental performance of sample countries.

4. Results

4.1. Descriptive Statistics

Table 1 show that the mean score of *EPI* for the study sample is 55.92, with a minimum score of 25.03 and a maximum of 65.21. The mean score of climate change performance *Climate* is 13.42, with a minimum score of 6 and a maximum of 15.60. The sample mean of *lnGFI* is 3.94, and the minimum and maximum values are 1.72 and 5.11, respectively. The variable *Trade* has a mean percentage of 88.78 with a minimum of 20.89 and a maximum of 345.36 percent. The summary statistics of other control variables show the normal trend.

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
EPI	180	55.920	12.299	25.034	65.210
Climate	180	13.421	2.952	6.008	15.601
lnGFI	180	3.941	0.602	1.723	5.110
Trade	180	88.781	73.128	20.886	345.355
lnGDP	180	11.469	0.583	10.218	13.047
lnFDI	179	3.759	0.692	2.164	5.132
lnEnergy	180	0.555	0.656	0.747	2.104
lnUrban	180	7.623	0.629	6.544	8.893

4.2. Main Regression Results

To estimate the relationship between EPI and other independent variables, the study employed panel regression analysis techniques. Due to unobserved heterogeneity, the results could be biased in OLS, so to get unbiased results, random and fixed effects models are employed. The results are shown in Table 2 below. The findings illustrate that trade liberalization is strongly associated with the EPI at a 1% significance level. The result specifies that a 1 percent increase in *Trade* lessens the *EPI* score by 0.093 in random effect estimation and 0.132 in fixed effect. The direction of the relationship is negative, which supports the idea that countries with more international trade are more vulnerable to deteriorating environment quality and aggravating climate change. It suggests that trade in emerging countries mostly comprises energy-intensive products, which necessitates energy consumption and eventually leads to a deteriorating ecosystem. Moreover, the fossil fuels share in the total energy mix in developing countries is also getting higher, lessening the developing countries' environmental performance. According to the World Bank [68], since 1990 to 2014 energy consumption has risen to 1922.5 kg of oil equivalent per capita from 1662.93 kg of oil equivalent per capita globally. The increased use of energy prompts numerous environmental issues [69]. Compared to the 1970s, total CO₂ emissions in 2018 rose to 33,890.80 million tons [9].

Variables	(1)	(2)	(3)
vuriubies —	OLS	Random Effect	Fixed Effect
Trada	0.032 *	-0.093 ***	-0.132 ***
Trude	(0.019)	(0.023)	(0.024)
hac D.D.	34.457 ***	37.702 ***	26.211 ***
INGDP	(4.219)	(3.911)	(5.822)
	0.199	-2.091	-2.781
INFDI	(2.317)	(1.807)	(1.758)
la Farance i	-17.152 ***	-0.417	8.953
inEnergy	(4.335)	(7.297)	(13.539)
lul Juhan	-15.761 ***	-37.084 ***	3.333
inGrbun	(2.853)	(6.387)	(23.709)
Constant	-213.232 ***	-77.473	-252.816
Constant	(55.346)	(69.393)	(162.168)
Observations	179	179	179
<i>R</i> -squared	0.587	0.636	0.656
Hausman test:			
Chi-square (5)	35.88		
Prob > chi-square	0.00		

Table 2. Main regression results.

Note: Standard errors are in parentheses; ***, **, * show significance at the 0.01, 0.05, and 0.1 level, respectively.

Further, the environmental deterioration in South and East Asian countries reflects the fact that these economies have less-regulated laws for the environment. Baek et al. [61] and Bernard and Mandal [70], in their study models, found that trade has no substantial influence on the environment, though it intensifies carbon emissions to some extent. The results suggest that international trade also helps to shift cleaner production technologies to developing countries, which enhances environmental quality. The prior studies of Jamel and Maktouf [71] and Shahbaz et al. [34] supported this study's findings, stating that trade causes poor environmental conditions due to unsustainable use of resources. The findings correspond well with the recent study of Essandoh et al. [72], who also proved that trade decreased CO₂ emissions in developed countries, but international transactions increased CO_2 emissions in developing regions. Other studies that supported our results include Adeel et al. [32], Kohler [73], Raza and Shah [74], Solarin and Al-Mulali [75], Fernández-Amador et al. [76], and Balin et al. [77]. Ozturk and Acaravci [78] also explored the associations among economic growth, energy, financial growth, and trade openness. They found that energy is increasingly consumed as a result of economic development and trade. In contrast, some studies have argued that trade liberalization benefits climate change and improve the environmental quality, as openness to trade in developing countries has led to specialization [50-54,79,80].

The other variable *lnGDP* was found to influence the environmental performance of the country strongly. It is inferred that GDP increases the environmental performance as the countries become more able to adapt to environmentally friendly technologies. The result suggests that South and East Asian countries, after improving their industrial structure, employment, and income, are inclined to opt for environmentally friendly technologies to mitigate pollution (halo effect). They have maximized their reliance on renewable sources of energy to meet the requirement of economic activities. More economic growth leads to more income that leads to more environmentally friendly sources of energy for goods production. The results are consistent with the findings of Aziz et al. [81], Si et al. [82,83], and Koondhar et al. [84]. In the case of BRICS and the MINT panel, Aziz et al. [85,86] revealed that countries, after attaining a certain level of income, are inclined to regenerate the environment.

Unlike the previous literature, the *FDI* and *Energy* results in the current study are not statistically significant in the main regression models. This result also shows that trade liberalization is the most adverse determinant of low environmental performance.

However, previous studies using individual proxies of the environment show the strong association between *FDI* and energy consumption. Xie et al. [87] stated that *FDI* directly upsurges CO₂ emissions, even though the spillover effect through economic growth shows a negative association. Likewise, Shahbaz et al. [88] also found that *FDI* deteriorates the environment in various countries based on income level. In low-income countries such as Pakistan, Khan et al. [89] found that *FDI* negatively influences the environment in the long run, while the results were insignificant in the short run. Tamazian and Rao [90], Hossain [91], and Omri [92] show that energy consumption is a leading factor for emissions. Further, urbanization negatively affects environmental performance in the random effects model but not in fixed effects.

Overall, the model is a good fit and has R^2 value of 0.63 in the case of random effect and 0.65 in fixed effect. The study also employed the Hausman's specification test to identify the more appropriate model. The significant *p*-value (35.88) of chi-sq suggests that the fixed effect model is more appropriate, as shown in Table 2. There is not much difference in the values of R^2 in both the random effect and fixed-effect models. Overall, the results are reliable in both models and signify that trade liberalization has an unfavorable impact on environmental performance. Still, income growth in these countries may help reduce this effect.

4.3. Robust Test

To get the robust standard errors and determine the accuracy of the estimations, the study employed the VCE robust test and EPI lagged model [93]. Table 3 shows that the findings are consistent with the main random and fixed effects models and are approximately parallel to the previous findings attained in Table 2. Trade liberalization adversely influences the environmental performance of the selected Asian panel. The results are substantially affirmed by robust standard errors as well as with lagged regression model.

	(1)	(2)	(3)	(4)		
X7 • 1 1	VCE_R	obust	VCE_Robust wi	VCE_Robust with Lagged EPI		
Variables	Random Effect	Fixed Effect	Random Effect	Fixed Effect		
Tuele	-0.093 *	-0.132 ***	-0.131 ***	-0.218 ***		
Truue	(0.053)	(0.032)	(0.044)	(0.017)		
In CDP	37.702 ***	26.211 ***	19.602 ***	0.655		
InGDF	(6.437)	(8.217)	(7.127)	(6.160)		
	-2.091	-2.781	-1.869	-3.333		
INFDI	(2.286)	(2.041)	(2.376)	(2.020)		
In Francis	-0.418	8.954	15.149	19.847		
inLhergy	(11.712)	(14.997)	(11.973)	(15.771)		
In Luban	-37.084 ***	3.333	-40.704 ***	45.701*		
inurban	(12.075)	(36.467)	(11.591)	(23.191)		
Constant	-77.473	-252.816	151.516	-278.893		
Constant	(116.969)	(205.212)	(120.614)	(171.723)		
Observations	179	179	178	178		
R-squared	0.636	0.656	0.358	0.421		

Table 3. Regression results with robust standard errors.

Note: Standard errors are in parentheses; ***, **, * show statistical significance at the 0.01, 0.05, and 0.1 level, respectively.

5. Mediation Analyses

5.1. *Climate Change*

For mediation analysis, primarily, climate change performance is used as a mediator to cover considerable weightage in the total environmental performance index. Using a step-by-step approach, the Panel A model in Table 4 shows a huge impact of trade liberalization on climate change performance, as the 1% change in *Trade* decreases the *Climate* by 0.022 and 0.032 in the case of both random effect and fixed effect. As shown in the Panel B model, climate change performance significantly and positively improves environmental performance. Therefore, the relationship between trade and environmental performance is found to be partially mediated by climate change score. Many earlier studies also proved that trade exacerbates the ecosystem and leads to climate change [28,38,40]. Prior studies of Apergis and Payne [43], Acaravci and Ozturk [44], Nasir and Ur-Rehman [45], Jayanthakumaran et al. [46], Shahbaz et al. [47], Kasman and Duman [48], and Dogan and Turkekul [49] also affirm similar results and conclude that although trade liberalization spurs economic growth, it does so at the cost of environmental deterioration and climate change.

	(1)	(2)	(3)	(4)	
** * 1 1	Pane	1_A	Panel_B		
Variables	Random Effect Fixed Effect		Random Effect	Fixed Effect	
Climata			132.697 ***	132.258 ***	
Climute	-		(2.366)	(2.664)	
Tuada	-0.022 ***	-0.032 ***	-0.022 ***	-0.042 ***	
Iruue	(0.006)	(0.006)	(0.005)	(0.006)	
ha CDR	9.049 ***	6.291 ***	-3.292 ***	-2.861 *	
InGDP	(0.939)	(1.397)	(1.159)	(1.560)	
	-0.502	-0.667	1.362 ***	0.771 *	
INF DI	(0.434)	(0.422)	(0.448)	(0.442)	
In Frances	-0.100	2.149	3.144 **	7.676 **	
inEnergy	(1.751)	(3.249)	(1.245)	(3.363)	
In Inhan	-8.900 ***	0.799	-1.835 *	-10.582 *	
interbun	(1.533)	(5.690)	(1.072)	(5.896)	
Constant	-18.594	-60.676	-45.569 ***	18.215	
Constant	(16.654)	(38.920)	(13.575)	(40.649)	
Observations	179	179	179	179	
R-squared 0.636		0.656	0.977	0.979	
Hausman test	-	-	-	-	
Chi-square (5) (6) 35.88 -		268.93	-		
Prob > chi-square	0.000	-	0.000	-	

Table 4. Regression results with Mediator_Climate.

Note: Standard errors are in parentheses; ***, **, * show significance at the 0.01, 0.05, and 0.1 level, respectively.

5.2. Green-Field Investment

Green-field investment is also used as a mediator because green-field projects are riskier for the environment. The Panel A model in Table 5 shows no statistically considerable impact of trade liberalization on green-field investment, as both random and fixed effect models are non-significant. However, as shown in the Panel B model, *lnGFI* has a strongly significant adverse effect on the overall environmental performance in random and fixed effects models. This result is interesting, as the results for *FDI* in the above estimations are not significant, but *lnGFI* considerably lessens the *EPI* score of sample South and East Asian countries. The mediation role of green-field investment with regards to trade liberalization and environmental performance is not established. This result is consistent with the prior findings of Adeel et al. [32].

Table 5.	Regression	results	with	Mediator_	GFI.
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(1)	(2)	(3)	(4)
Pane	1_A	Panel_B	
Random Effect	Fixed Effect	Random Effect	Fixed Effect
		-3.214 **	-5.581 ***
-		(1.831)	(1.707)
-0.000	-0.001	-0.059 ***	-0.137 ***
(0.001)	(0.001)	(0.022)	(0.023)
0.009	0.535 **	37.870 ***	29.199 ***
(0.163)	(0.260)	(3.858)	(5.728)
	(1) Pane Random Effect - -0.000 (0.001) 0.009 (0.163)	(1) (2) Panel_A Fixed Effect - - -0.000 -0.001 (0.001) (0.001) 0.009 0.535 ** (0.163) (0.260)	(1) (2) (3) Panel_A Pane Random Effect Fixed Effect Random Effect - -3.214 ** (1.831) -0.000 -0.001 -0.059 *** (0.001) (0.001) (0.022) 0.009 0.535 ** 37.870 *** (0.163) (0.260) (3.858)

	(1)	(2)	(3)	(4)	
	Panel_A		Panel_B		
Variables	Random Effect	Fixed Effect	Random Effect	Fixed Effect	
In EDI	0.295 ***	0.248 ***	-0.130	-1.399	
INFDI	(0.077)	(0.079)	(1.953)	(1.759)	
In Transmost	0.331	-0.680	-5.623	5.156	
inEnergy	(0.273)	(0.605)	(6.011)	(13.203)	
In Luban	0.122	-0.287	-30.829 ***	1.730	
inarbun	(0.233)	(1.060)	(5.018)	(23.035)	
Complement	1.617	-0.489	-121.886 **	-255.548	
Constant	(2.708)	(7.251)	(61.638)	(157.526)	
Observations	179	179	179	179	
R-squared	0.181	0.214	0.639	0.678	
Hausman test:	-	-	-	-	
Chi-square(5)(6)	Chi-square (5) (6) 4.88		79.10	-	
Prob > chi-square	0.430	-	0.000	-	

Table 5. Cont.

Note: Standard errors are in parentheses; ***, **, * show significance at the 0.01, 0.05, and 0.1 level, respectively.

6. Heterogeneous Differences

The current study includes the dummies based on manufacturing economy, per capita income, and population size to explore the differences among the panel data sample. The panel regression results are shown in Table 6, and columns (1) and (2) indicate that countries with higher per capita income positively influence *EPI*. This finding is quite satisfactory and implies that earned income, as an outcome of economic growth, is spent on boosting environmental quality. In emerging countries, the initial stage of economic growth emphasizes increasing economic output rather than focusing on environmental quality. Prior studies by Ahmed et al. [41], Ang [42], Lau et al. [94], Lopez-Menendez et al. [95], and Iwata et al. [96] revealed that consistent growth in per capita income helps the regeneration of the environment as countries become more able to opt environment friendly technologies. The explanations lying behind this fact are attributed to factors such as strong institutions, environmental rules and regulations, awareness amongst people regarding the environment, and the efficient utilization of resources [49].

Table 6. Regression results with heterogeneous differences.

	(1)	(2)	(3)	(4)	(5)	(6)	
	Per Capita Income		Manufactu	Manufacturing GDP		Population	
variables	Random Effect	Fixed Effect	Random Effect	Fixed Effect	Random Effect	Fixed Effect	
Tuada	-0.076 ***	-0.127 ***	-0.022	-0.101 ***	-0.085 ***	-0.128 ***	
Truue	(0.023)	(0.025)	(0.021)	(0.024)	(0.023)	(0.024)	
DCI Aumun	3.296 *	2.960					
PCI_aummy	(2.762)	(2.949)	-	-	-	-	
1	37.886 ***	26.889 ***	37.462 ***	30.015 ***	37.879 ***	26.310 ***	
INGDP	(3.874)	(5.861)	(3.957)	(5.595)	(3.901)	(5.817)	
MG CDD A			-2.031 *	-10.055 ***			
Mfg.GDP_aummy	-	-	(1.848)	(2.318)	-	-	
	-1.878	-2.999 *	-0.687	-3.737 **	-1.947	-3.012 *	
INFDI	(1.835)	(1.771)	(2.019)	(1.683)	(1.844)	(1.768)	
1	-5.079	10.168	-10.774 **	-10.265	-1.679	7.818	
inEnergy	(6.957)	(13.593)	(5.355)	(13.593)	(7.024)	(13.564)	
lal Julana	-32.135 ***	-2.296	-25.644 ***	16.318	-36.561 ***	4.844	
inarbun	(6.263)	(24.362)	(4.188)	(22.701)	(6.524)	(23.724)	
Danulation Annual					-0.915 *	-3.901	
Population_aummy	-	-	-	-	(3.201)	(3.431)	
Constant	-117.666 *	-218.634	-166.642 ***	-378.289 **	-84.439	-266.021	
Constant	68.174	(165.700)	(58.470)	(156.615)	(69.165)	(162.438)	
Observations	179	179	179	179	179	179	
R-squared	0.637	0.659	0.612	0.692	0.634	0.659	
Hausman test:	-	-	-	-	-	-	
Chi-square (6)	234.85	-	288.50	-	59.10	-	
Prob > chi-square	0.000	-	0.000	-	0.000	-	

Note: Standard errors are in parentheses; ***, **, * show statistical significance at the 0.01, 0.05, and 0.1 level, respectively.

In the context of *Mfg.GDP_dummy*, the result is negative and statistically significant, as shown in columns (3) and (4) of Table 6. It is found that countries having higher manufacturing GDP reduce their *EPI* score by 2.031 percent in the case of the random effects model and 10.055 percent in the case of fixed effects estimation. It has been witnessed that economic growth and development come from good performance of the manufacturing sector, but it occurs at the expense of environmental degradation. The manufacturing sector relies more on fossil fuels in developing countries to meet energy needs, which is the key factor of economic activity and a prime cause of pollutant emissions. Ali et al. [97] and Doytch and Narayan [98] also argued that a higher manufacturing share of the GDP negatively impacts a country's environmental performance.

Moving towards population growth, which is the main reason for elucidating the environment quality dynamics [99], it is argued that human activities due to increased population rate constitute a significant portion of pollutants in the form of NO₂, CO₂, and SO₂, through the combustion of fossil fuels, and so on. The concentration of pollutants in the atmosphere increased as a consequence of such anthropogenic activities. Table 6 columns (5) and (6) show that the Population_dummy result was not significant. However, previous studies of Nasir and Ur-Rehman [45] and Alvarado et al. [100] have pointed out that population growth exacerbates emissions and worsens environment quality, as it is linked with the use of fossil fuels energy, urbanization, massive transportation, deforestation, and so on.

7. Conclusions

Debates over the merits of trade liberalization have been going on for some time. Still, over the last decade, the issue has intensified as environmentalists and economists have squared off over the environmental consequences of trade openness. It is argued that trade contributes majorly to the economic growth and development of a country. On the one hand, it generates wealth by providing employment opportunities; while on the other hand, it leads to environmental deterioration. The earlier studies have reported mixed results regarding trade liberalization and the environment. To the authors' knowledge, previous studies have generally assessed the causal association of trade and CO₂ emissions, but they have not considered a comprehensive proxy to measure the environment, (i.e., EPI). This study investigated trade liberalization and EPI in developing Asian countries from 2002 to 2016 based on available data; the conventional methods for panel data (i.e., random effects and fixed effects) were employed. Unlike previous studies, mediation and difference analyses were performed to investigate the systematic effect of trade liberalization.

The empirical findings indicate that the environmental quality measured by EPI score slumps as more trade liberalization occurs. It suggests that in developing countries, trade liberalization has more hazardous environmental effects. It may suggest that trade liberalization boosts energy consumption and potentially causes the deterioration of the environment. However, GDP has a beneficial effect on environmental performance as the countries are more inclined to invest in energy-efficient technologies. Economic growth and increase in per capita income amplify the likelihood of people to claim an unpolluted environment. There is no doubt that FDI is a principal factor for economic development. Still, developing countries should focus more on clean investment and technology transfer, as the results are found to be insignificant. Urbanization was also found to be adversely related to EPI. Moreover, mediation analysis and group differences were also conducted to address the endogeneity and cross-sectional differences. The mediation analysis showed that trade and EPI are partially influenced by climate change; while in the case of greenfield investment the results are not found to be significant. In group analysis, the findings showed that countries having higher per capita income improve environmental performance. On the contrary, countries having higher manufacturing industries and population growth lessens the environmental performance.

However, the emerging countries of Asia are moving towards an eco-friendly-based domestic production process, yet the international trade in such countries is not focused

on environmentally friendly goods. The key policy upshot from the outcomes is that developing countries must not only focus on implementing the strategies needed for trade liberalization but also focus on environmental reforms to decrease the worst environmental effects of climate change. Countries should emphasize the quality of exports instead of just the quantity. The conclusion suggests that these emerging countries of South and East Asia should put forth an inclusive strategy to negotiate and collaborate on green trade by diminishing bad energy and emission-intensive imports and improving climate change performance measures. A general method to lessen environmental pollution and climate change is through emphasizing green domestic consumption. Our empirical outcomes also specify that South and East Asian emerging countries should emphasize substituting energy-efficient production processes for trade and domestic products. It is necessary to stress the dual role of reducing the adverse externalities deriving from trade liberalization. The other issues, such as urbanization, industrial development, overcrowding, and exploiting the positive externalities such as public provisioning of waste management, eco-friendly infrastructure, and transportation systems, also need to be improved. The policy implications discussed here are aligned with the prior studies [21,27,32,38–40,67,81].

Moreover, the emerging developing nations should speed up the shift from fossil fuels to less polluting alternative energy sources to reduce carbon and other emissions locally and globally. Use of energy from fossil fuels is an important channel for trade and FDI's negative impact on the environment. According to the IPCC, renewable energy such as solar, wind, and hydropower can be very beneficial to reduce the pollution levels in Asia. The sustainable and healthy use of natural resources is very important for the betterment of future generations. The findings emphasize the need to have effective and improved methods of energy production and distribution. The governments of South and East Asian countries should allocate more budgets for research and development to plan environmentally friendly trade policies. More investment, training, transparency, education, and collaboration are required to reduce the negative effects of trade on the environment. There are also some limitations, which future studies could consider with regards to examining environmental performance. Our dataset consists of a sample from selected Asian countries; however, future studies could work on large sample for more generalized findings. In addition, advanced econometric techniques can help to further explore the heterogeneous differences among countries. Overall, the results of this study are helpful to understand the trade-environment nexus in emerging countries.

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