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# International Trade and Environmental Degradation: A Developing World Perspective

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## Abstract

*We investigate the multifaceted links between sectoral imports and exports, financial growth, energy consumption, GDP, and their ability to affect pollution emissions across 113 developing countries from 1990 to 2020. Using a large dataset, we used both fixed and random effects models to explore the various processes underlying this relationship. A major finding highlights the significant effect that sectoral imports have on the increasing trend of CO2 emissions, shedding light on the individual industries and sectors' imports responsible for the degradation of the environment. Our study efficiently accommodates country-specific differences and temporal fluctuations by utilizing both country and time-fixed effects as well as random effects models, resulting in a robust and detailed investigation of the relationship. This study provides critical insights into the continuing discussions about sustainable development in poor countries, emphasizing the importance of focused policy actions aimed at decoupling economic growth from environmental impact.*

**Keywords:** Trade, Imports, Economic Growth, Pollution, Developing Countries

**Authors:**

**Syeda Bano**: (Corresponding Author)
Graduate scholar, Department of Economics, Faculty of Humanities and Social Sciences, University of Central Punjab, Lahore, Punjab, Pakistan.
(Email: syedabano6102@gmail.com)

**Arslan Tariq Rana:** Assistant Professor, Department of Economics, Faculty of Humanities and Social Sciences, University of Central Punjab, Lahore, Punjab, Pakistan.

**Mohammad Irfan Ali:** Assistant Professor, Department of Political Science and International Relations, Faculty of Humanities and Social Sciences, University of Central Punjab, Lahore, Punjab Pakistan.

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## Title

**International Trade and Environmental Degradation: A Developing World Perspective**

## Contents




## Abstract

*We investigate the multifaceted links between sectoral imports and exports, financial growth, energy consumption, GDP, and their ability to affect pollution emissions across 113 developing countries from 1990 to 2020. Using a large dataset, we used both fixed and random effects models to explore the various processes underlying this relationship. A major finding highlights the significant effect that sectoral imports have on the increasing trend of CO2 emissions, shedding light on the individual industries and sectors' imports responsible for the degradation of the environment. Our study efficiently accommodates country-specific differences and temporal fluctuations by utilizing both country and time-fixed effects as well as random effects models, resulting in a robust and detailed investigation of the relationship. This study provides critical insights into the continuing discussions about sustainable development in poor countries, emphasizing the importance of focused policy actions aimed at decoupling economic growth from environmental impact.*


**Keywords:** Trade, Imports, Economic Growth, Pollution, Developing Countries


### Authors:

**Syeda Bano:** (Corresponding Author)
Graduate scholar, Department of Economics, Faculty of Humanities and Social Sciences, University of Central Punjab, Lahore, Punjab, Pakistan.
(Email: syedabano6102@gmail.com)

**Arslan Tariq Rana:** Assistant Professor, Department of Economics, Faculty of Humanities and Social Sciences, University of Central Punjab, Lahore, Punjab, Pakistan.

**Mohammad Irfan Ali:** Assistant Professor, Department of Political Science and International Relations, Faculty of Humanities and Social Sciences, University of Central Punjab, Lahore, Punjab Pakistan.


## Introduction

The exchange of products between countries has become the lifeblood of the global economy in an age of remarkable globalization and worldwide trade. Environmental implications of trade can be both favorable and unfavorable. Peters and Hertwich (2006) stressed the need to accurately assess trade-related pollution's environmental impacts. The current study analyses sector-specific trade patterns to determine the main causes of embodied carbon dioxide emissions in international trade. Walter (1976), Leonard (2006), Dean (1992), and Low and Safadi (1992) found inconsistent results on trade's environmental impact. While some studies show a positive association between decreased rates of growth in environmental damage and free trade practices, as indicated by Lucas et al. (1992), others, such as Rock (1996), believe that open trade policies contribute to increased pollution. To reconcile these opposing views, one must understand trade and embodied emissions in imports and exports. Yunfeng and Laike (2010) show that imports and exports transfer pollutants from one country to another. According to Copeland (1994), unrestricted trade often improves the environment in advanced economies but degrades it in developing countries.

This complicated trading network has fueled economic expansion, technical innovation, and increased access to a diverse range of items. However, it also has negative effects: the rising environmental cost associated with the importation of commodities in diverse industries. The relationship between imports and environmental degradation is more important in the context of developing or emerging countries. Indeed, imports play a crucial role in their growth and development. Nevertheless, this growth comes at the cost of increased pollution emissions. The trade flows have an impact on pollution through various channels. Importing goods often involves transporting them over long distances, which can require the use of fossil fuel-powered ships, trucks, airplanes, or trains. These modes of transportation emit GHGs and more pollutants are released into the environment. The global value chain requires the production of goods that involve multiple stages, each contributing to emissions. The shipping industry is a major source of emissions, and importing goods via cargo ships can contribute significantly to pollution. Cargo ships often use heavy fuels that release GHGs and air pollutants. Further, importing goods can result in increased waste generation, especially when disposable or short-lived products are involved. The disposal of such goods at the end of their life cycle can contribute to pollution in developing countries. Finally, some imported products, such as agricultural commodities like palm oil or soy, can drive deforestation. These activities result in carbon emissions.

Liberalization of trade increases $CO_2$ emissions while initially improving the EPI, emphasizing the need for strong financial, energy, infrastructural, and regulatory reforms to achieve a sustainable environment in these countries (Bernard and Mandal, 2016). The worldwide trade context has changed dramatically, because of advancements in transportation, communication, and regulatory reform. This shift has allowed economies to engage in a huge global economy where products circulate across boundaries. Imports have increased in a variety of industries, including agriculture, industry, etc., as have demands for natural resources, energy consumption, and pollution emissions into the environment. This growth in global trade raises an important and serious question: How much do higher imports contribute to environmental deterioration across these many sectors? Environmental degradation encompasses an extensive array of important issues, including deforestation, air pollution, resource depletion, and climate change. Extensive research has been undertaken to investigate the nexus between economic development and environmental degradation, but the specific significance of imports in this multifaceted relationship is still being investigated and discussed. As the entire world struggles with the acute requirement of long-term development, It is important to investigate the multiple aspects of this relationship, including exploring the methods by which international trade either worsens or mitigates environmental challenges. Environmental pollution and climate change have emerged as major concerns to both human well-being and the environment in the last thirty years.

In environmental economics and international trade, the PHH suggests that environmentally technologically advanced sectors shift from strict regulatory environments (called "pollution havens") to regions with fewer environmental regulations as countries liberalize trade. This shift is motivated by cost reductions and competitive benefits as companies reduce compliance with environmental laws expenses. Relocating polluting companies could damage the environment, yet ecologically strict countries may see less pollution. This study aims to fill an important gap in understanding by performing a thorough examination of how imports affect environmental deterioration across diverse industries. It is supported by an extensive collection of scholarly references and research publications.

The current study addresses the environmental impact of international trade in countries across various industries.

## Literature Review

A complex relationship exists between international trade and the environment. Indeed, exports and imports have an impact on environmental quality. This has drawn the attention of researchers and scholars. Imports affect the environment negatively (Howladar et al., 2018). Nevertheless, exports may improve environmental conditions (Can et al., 2020). International trade has both negative and positive effects on the environment. This review provides theoretical insight and empirical methods that have discussed the impact of exports and imports on pollution emissions.

Safi et al. (2021) examine the relationship between international trade and Consumption-based Carbon Emissions (CCEs). They studied seven economies characterized as emerging economies from 1995 to 2018. They employ panel co-integration techniques and find that imports and economic growth increase pollution. They further find that financial risk, technological advancement, and exports reduce emissions significantly. The cross-section ARDL estimator is also employed for analyzing short and long-term relationships. The study emphasizes the significant influence of crucial financial events on the E-7 economies, such as the 1997 AFC, the 1998 RFC, the 2001 harmless economic downturn, and the 2008 GFC. The study concludes that technological advancement and exports reduce CCE in the short and long run whereas imports and economic development lead to increased pollution.

Rana and Sharma (2018) analyze the relationship between GDP, FDI, $CO_2$ pollution, and international trade in India. This study makes use of the dynamic multivariate Toda-Yamamoto technique. They employ data from the World Bank Group's WDI from 1982 to 2013. The results support the PHH and the EKC hypotheses in India. The data indicates that foreign direct investment (FDI) indirectly affects India's GDP through its effect on carbon emissions. The study also highlighted India's tendency to import polluting manufactured products. Furthermore, the analysis finds relationships between exports, Trade, imports, and $CO_2$ emissions, and bidirectional causation between CO2 emissions and GDP in the Indian context.

Liddle (2018) combines consumption and territory-based $CO_2$ emissions statistics to determine how carbon pollutants, imports and exports, income, energy composition, and economic growth connect across 20 Asian countries from 1990 to 2013. According to the CCE database, trade flows have a major impact on CCEs yet not on territory-based emissions. According to the study, exports lower CCEs whereas imports raise them.

Islam et al. (2016) employ a FE model and substantial, well-balanced panel data from 187 nations, covering 26 to 501 sectors. Their research intends to collect data on carbon dioxide emissions, gross outputs, and imports as well as exports of goods and services from 1990 to 2011 to analyze the influence of trade liberalization and Sector trading in global trade with embodied emissions. The results demonstrate a significant positive correlation between trade liberalization and embodied GHG and air pollutant emissions.

Chang (2012) employs a Vector Autoregressive (VAR) model to analyze how China's international trade openness and FDI impact the degradation of the environment. The study shows complex, long-term consequences of openness on industrial pollution, challenging environmentally friendly assessments. Short-term trends include increasing exports that raise $SO_2$ emissions and higher imports and FDI that increase solid waste output. $SO_2$ emissions reduce exports, whereas wastewater controls increase imports. Data from 1981 to 2008 is used to calculate exports (EX), imports (IM), and FDI, as well as pollution indicators such as $SO_2$ emissions, solid waste production, and wastewater discharge.

Oktavilia and Firmansyah (2016) investigate Indonesia's economic-environmental relationship from 1976 to 2014 using an error correction model (ECM). Their study employs linear, quadratic, and cubic regression to determine how TL affects Sustainability in the environment and to investigate the presence of the EKC. CO2 emissions and Gross domestic product per capita are included in the dataset to study their dynamic relationship. The research supports the EKC concept that trade liberalization has a long-term impact on the environment. Trade liberalization partially affects $CO_2$ emissions across all equation types in the short run, but via the quadratic equation, per capita income influences CO2 emissions.

The research by Chen et al. (2021) aims to investigate the link between trade openness and CO2 emissions, with a particular focus on countries along the Belt and Road from 2001 to 2019. The study employed quantile regression methodology to address potential variations, utilizing panel data from 64 economies. Their results exhibit that trade openness had a reducing and significant impact on CO2 emissions.

Cole (2004) employs fixed effects methodology to examine how GDP per capita affects pollution. He examines four types of pollutants: $CO_2$, $NO_x$, $SO_2$, and BOD. Their findings support Antweiler et al. (2001)'s results that environmental legislation and capital-labor endowments affect $SO_2$. An increase in GDP per capita leads to a decrease in $SO_2$ and BOD. The study also shows that higher capital-labor ratios increase $SO_2$, NOx, and $CO_2$ emissions.

Frankel and Rose (2005) explore trade's environmental impact by using instrumental variables to address endogeneity concerns. Their study indicates that trade generally reduces air pollution, notably $SO_2$, moderately affects $NO_2$, and has a minimal impact on particulate matter. Focusing on 1990 air pollution indicators- average $SO_2$, $NO_2$, and PM concentrations research also examines environmental quality metrics like per capita $CO_2$ emissions, deforestation changes, energy-related GDP contributions, and rural clean water accessibility. Incorporating variables such as income, trade openness, governance, and land area, the findings show trade's association with lowered air pollution across measures, significantly for $SO_2$, moderately for $NO_2$, and insignificantly for particulate matter. The study underscores a negative link between population density and pollutant concentration, reinforced by its relation to land area per capita. Furthermore, the research validates the Environmental Kuznets Curve. The trade openness coefficient holds negative implications for all air pollution metrics, suggesting positive trade gains outweigh potential "race-to-the-bottom" pollution effects.

Schaeffer and de Sá (1996) examine how developed countries might transfer carbon emissions to Brazil by importing energy-intensive goods. From 1970 to 1993, Brazil's trade practices were studied to estimate CO2 and energy contents of international trade that are not energy-related. Their findings indicate that Brazil's exported carbon content exceeds its imports, indicating that exports are based on a large amount of its carbon emissions.

In their study, Salman et al. (2019) explore the effects of international trade on $CO_2$ emissions across 7 ASEAN countries for the period 1990 - 2017. Their study reveals that technological advancement leads to a reduction in environmental degradation and confirms that the environmental Kuznets curve Hypothesis is valid in ASEAN countries. Furthermore, this analysis establishes a connection between exports and an increase in emissions. The dependent variable is $CO_2$ emissions, and independent variables encompass exports, imports, income per capita, squared income per capita, population, and energy intensity. Ordinary Least Squares (OLS) are employed for comparative purposes. The results highlight that technological advancement significantly reduces the emissions of carbon dioxide. Moreover, the analysis affirms the positive relationship between exports and carbon emissions, suggesting that heightened export activity corresponds to elevated emissions.

Udeagha and Ngepah (2021) analyze trade openness and quality of the environment in South Africa using time series data from 1960 to 2020. Using an innovative dynamic ARDL modeling paradigm, the study uncovers a complex relationship. Trade openness first benefits the environment, but it gradually damages it in the long run. In line with EKC, their results demonstrate that the scale effect causes pollution to increase whereas the technique effect reduces it. Energy consumption and FDI pollute the environment, whereas technological innovation enhances it.

Iorember et al. (2022) employ the Pooled Mean Group Autoregressive Distributed Lag model to examine the impacts of energy consumption, international trade, and GDP per capita on environmental pollution in African OPEC countries. The results show insignificant effects of trade flows on pollution.

Bernard and Mandal (2016) focus on the relationship between trade openness and environmental quality in 60 emerging and emerging countries. The EPI and $CO_2$ emissions are used as environmental quality indicators in the analysis, which uses a dynamic panel data model spanning 2002-2012. FE model results suggest that trade openness enhances the EPI but also raises $CO_2$ emissions. After controlling for endogeneity, trade openness has little effect on the EPI, but its relationship with greater $CO_2$ emissions remains. Political variables favorably affect environmental quality based on the EPI in the Generalized Method of Moments (GMM) estimation, whereas income level and population growth have a negative impact. Trade openness, income, energy usage, and population growth all have a negative influence on environmental quality in terms of $CO_2$ emissions. These findings contribute to continuing arguments regarding the environmental impact of trade.

Sinha et al. (2017) utilize the GMM estimation approach on the panel data spanning from 1990 to 2014 for N-11 nations. Their research investigates the relationship between energy consumption and the deterioration of the environment. The authors also examine per capita GDP, labor force, human development index, combustible renewable energy waste, gross capital formation, and urbanization. Employing subsamples by categorizing the countries into developed, industrialized, and emerging ones based on World Bank classification. The findings suggest the presence of an N-shaped EKC, indicating the complicated link between energy usage and environmental deterioration under various economic conditions.

Awan and Azam (2021) apply the EKC theory to the five most significant G-20 economies from 1993 to 2017. The analysis focuses on GDP per capita, environmental degradation, technical and financial growth, energy consumption, and social globalization. The N-shaped EKC pattern in veto-power economies suggests that ecological quality initially falls but improves when GDP per capita increases over a threshold. The study found a positive correlation between energy use and CO2 emissions. Instead, financial development and social globalization reduce adverse effects on the environment. The research emphasizes targeted strategies that prioritize GDP per capita, CO2 emissions, ecologically sustainable practices, financial development, and low-polluting technology.

Ahmad et al. (2022) employ the CS-ARDL method using panel data from 1984 to 2017 to analyze the relationship between economic growth, human resources, institutional quality, and the ecological footprint (EF) in 17 emerging countries, including short-term and long-term dynamics. The results suggest that financial development in developing countries contributes to an increase in EF, indicating a negative impact on the environment. The slope homogeneity test by (Pesaran and Yamagata 2008) is used to account for demographic, economic, and social differences among countries. To validate the findings of CS-ARDL analysis, the study employs the Augmented Mean Group approach.

## Data and Methodology

This study utilizes data from 1990 to 2020, encompassing 113 developing and emerging countries including low-income, lower-middle-income, and upper-middle-income countries. The data for the dependent variable, carbon dioxide emissions (metric tons per capita), is attained from the World Bank. The data for imports and exports, in sectors of agriculture, manufacturing, chemical, textile, and transportation is taken from World Integrated Trade Solution (WITS). The data for control variables, FDI (% of GDP), energy use (kg of oil equivalent), government expenditure (% of GDP), Gross domestic product (GDP) per capita (constant 2015 US), and financial development (Domestic credit to private sector % of GDP) are obtained from World Bank. All variables have been transformed into a log form.

We employed two models in this paper. The first model is the Fixed Effects Model. The second is the Random Effects Model. A random effects model can be used to account for both observed and unobserved heterogeneity across countries. This approach assumes that the unobserved country-specific effects are random and not associated with the independent variables. While the FE model can be used to account for unobserved heterogeneity across countries. Different countries may have varying levels of environmental policies, regulations, and other country-specific factors that affect their environmental outcomes. The comparative reliability of a RE model over a FE model relies on assuming uncorrelated unobserved effects, providing enhanced efficiency and broader applicability, especially when periods are constrained relative to entities.

## Fixed Effects Model

The fixed effects model reduces bias from omitted variables in panel data analysis by incorporating country-specific intercepts for persisting individual-specific characteristics. It addresses time-invariant heterogeneity and within-entity dynamics effectively. In the analysis concerning the relationship between environmental degradation and various independent variables, the FE model is expressed as:

$$\begin{aligned} CO2_{it} = \beta_0 + \beta_1 Imports_{it} + \beta_2 Exports_{it} \\ + \beta_3 Financial\ Development_{it} \\ + \beta_4 Govt.Expenditure_{it} + \beta_5 GDP_{it} \\ + \beta_6 Trade_{it} + \beta_7 Energy\ Use_{it} + \alpha_i \\ + \varphi_t + \varepsilon_{it} \end{aligned}$$

Where $\alpha_i$ and $\varphi_t$ represent country and time-fixed effects respectively. $\varepsilon_{it}$ is the error term.

## Random Effects Model

A random effects model would offer a comprehensive perspective that takes into account both observed and unobserved heterogeneity across these countries. The equation for a random effects panel data model analyzing how Imports, Exports, Financial Development, Government Expenditure, GDP, Trade, and Energy Use affect $CO_2$ emissions is:

$$\begin{aligned} CO2_{it} = \beta_0 + \beta_1 Imports_{it} + \beta_2 Exports_{it} \\ + \beta_3 Financial\ Development_{it} \\ + \beta_4 Govt.Expenditure_{it} + \beta_5 GDP_{it} \\ + \beta_6 Trade_{it} + \beta_7 Energy\ Use_{it} + \varepsilon_i \\ + \mu_{it} \end{aligned}$$

Where, $\varepsilon_i$ are cross-sectional random effects and $\mu_{it}$ is the error term specific to country $i$ at time $t$.

## Results and Discussion

Tables 1 and 2 present the results. The results of fixed effects estimation are shown in Table 1:

### Table 1

*Trade and pollution. Fixed effects estimates.*

| VARIABLES | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| GDP | 0.348*** | 0.388*** | 0.379*** | 0.377*** | 0.345*** | 0.387*** | 0.359*** | 0.376*** | 0.351*** | 0.391*** |
| | (0.0770) | (0.0798) | (0.0796) | (0.0780) | (0.0785) | (0.0794) | (0.0803) | (0.0797) | (0.0758) | (0.0804) |
| TRADE | -0.0521* | -0.0416 | -0.0459 | -0.0467 | -0.0532* | -0.0413 | -0.0491 | -0.0444 | -0.0465 | -0.0408 |
| | (0.0300) | (0.0306) | (0.0297) | (0.0302) | (0.0299) | (0.0307) | (0.0299) | (0.0305) | (0.0291) | (0.0305) |
| FDI | 0.00494 | 0.00688 | 0.00609 | 0.00623 | 0.00464 | 0.00691 | 0.00652 | 0.00680 | 0.00637 | 0.00690 |
| | (0.00507) | (0.00504) | (0.00520) | (0.00482) | (0.00511) | (0.00493) | (0.00521) | (0.00502) | (0.00521) | (0.00504) |
| FINDEV | 0.0340* | 0.0384** | 0.0361** | 0.0378** | 0.0318* | 0.0387** | 0.0315* | 0.0385** | 0.0307* | 0.0386** |
| | (0.0185) | (0.0186) | (0.0179) | (0.0181) | (0.0179) | (0.0186) | (0.0178) | (0.0187) | (0.0177) | (0.0185) |
| GOVEXP | 0.0385 | 0.0357 | 0.0260 | 0.0318 | 0.0388 | 0.0360 | 0.0390 | 0.0335 | 0.0301 | 0.0402 |
| | (0.0533) | (0.0513) | (0.0510) | (0.0507) | (0.0536) | (0.0502) | (0.0518) | (0.0529) | (0.0499) | (0.0455) |
| ENERGYUSE | 0.233*** | 0.240*** | 0.231*** | 0.239*** | 0.229*** | 0.238*** | 0.232*** | 0.237*** | 0.231*** | 0.237*** |
| | (0.0482) | (0.0493) | (0.0480) | (0.0491) | (0.0476) | (0.0490) | (0.0472) | (0.0483) | (0.0475) | (0.0491) |
| TRANSIMP | 0.0353* | | | | | | | | | |
| | (0.0180) | | | | | | | | | |
| TRANSEXP | | -0.00130 | | | | | | | | |
| | | (0.00694) | | | | | | | | |
| TEXTIMP | | | 0.0307** | | | | | | | |
| | | | (0.0143) | | | | | | | |
| TEXTEXP | | | | 0.00778 | | | | | | |
| | | | | (0.00944) | | | | | | |
| MANUFIMP | | | | | 0.0512** | | | | | |
| | | | | | (0.0223) | | | | | |
| MANUFEXP | | | | | | -0.000188 | | | | |
| | | | | | | (0.0139) | | | | |
| CHEMIMP | | | | | | | 0.0494** | | | |
| | | | | | | | (0.0199) | | | |
| CHEMEXP | | | | | | | | 0.00988 | | |
| | | | | | | | | (0.0107) | | |
| AGRIMP | | | | | | | | | 0.0596** | |
| | | | | | | | | | (0.0244) | |
| AGREXP | | | | | | | | | | -0.00539 |
| | | | | | | | | | | (0.0152) |
| Constant | -3.576*** | -3.801*** | -3.774*** | -3.724*** | -3.661*** | -3.785*** | -3.704*** | -3.681*** | -3.710*** | -3.800*** |
| | (0.570) | (0.591) | (0.602) | (0.574) | (0.582) | (0.585) | (0.590) | (0.596) | (0.561) | (0.599) |
| Country FE | YES | YES | YES | YES | YES | YES | YES | YES | YES | |
| Time FE | YES | YES | YES | YES | YES | YES | YES | YES | YES | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **No of countries** | | | | | | | | | | |
| **Observations** | 1,664 | 1,663 | 1,664 | 1,669 | 1,664 | 1,675 | 1,664 | 1,673 | 1,664 | 1,675 |
| **R-squared** | 0.992 | 0.992 | 0.992 | 0.992 | 0.992 | 0.992 | 0.992 | 0.992 | 0.992 | 0.992 |

*Robust standard errors, clustered at the country level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

All columns show a different regression equation in which the controlled variables are the same but explanatory variables change according to sector. Column 1 shows the outcome of imports in the transport sector along with other control variables. i.e., GDP, trade, govt. expenditure, financial development, and energy use. The effects of imports in the transport sector for developing countries include an increase in pollution, however, significant at a 10% level. Furthermore, GDP has a coefficient of 0.348. Increasing by 1 percent, economic growth will increase $CO_2$ by 0.348 percent in the 113 developing countries. The results of the panel data output show that the probability value of GDP growth is smaller than the alpha value of 0.01 so it has a significant effect on environment degradation.

The next variable is TRADE, which has a coefficient of -0.0521. It indicates that the increase of 1 percent will decrease $CO_2$ by -0.0521 percent. However, the estimation result of the variable has a probability value less than the alpha value of 0.10, so it has a significant impact on carbon dioxide emissions. The variable of financial development has a coefficient value of 0.0340 with a probability value of less than 0.10.

Furthermore, the energy consumption variable has a coefficient value of 0.233. With the increase of 1 percent in exports, $CO_2$ emissions will increase by 0.233 percent. The probability value is less than the alpha value <0.01. It indicates that it has a significant effect on $CO_2$ emissions. Furthermore, the govt. expenditure has a coefficient value of 0.0385, however, significant.

In column 2, the exports in the transport sector for developed economies have a coefficient of -0.00130 but are insignificant. All other variables GDP, FDI, GOVEXP, and ENERGYUSE have the same effect on $CO_2$, but the coefficient of TRADE is -0.0416 with a probability value greater than an alpha value of 0.10 indicating that TRADE has a positive effect on CO2 but insignificant. Furthermore, financial development with a coefficient of 0.0384 and a probability value is less than 0.05 indicates a positive and significant effect on $CO_2$ in 113 developing countries.

In column three, the imports in the textile sector exhibit a coefficient of 0.0307. The probability value is less than 0.05 indicating a positive and significant effect on $CO_2$ emissions. The exports in the textile sector (see column 4) do not affect $CO_2$ emissions.

In column 5, the manufacturing sector imports significantly increase $CO_2$ emissions. Trade openness has a coefficient of 0.05and the probability value is less than 0.10 showing a positive, however, weakly significant impact on $CO_2$. The MANUEXP and TRADE in column 6 show that it has no impact on pollution Emissions. The imports in the chemical sector in column 7 have a coefficient of 0.0494 and a probability value is less than 0.05. This indicates a positive and significant impact on environmental degradation.

The exports in the chemical sector have no effect (column 8).

Lastly, the coefficient of imports in the agricultural in column 9 is 0.0596 and has a probability value of less than 0.05. This depicts the positive and significant effects of CO2.

Despite the restrictions imposed on economic liberalization, privatization, and globalization (LPG), imports of goods from all sectors have been established to have a positive and significant influence on environmental deterioration. These findings are in line with Rana and Sharma (2019) and Haug and Ucal (2019). Indeed, LPG measures have boosted economic activity, with large-scale firms playing a critical role in driving economic growth through manufacturing, mining, imports, and exports. National governments across the world prioritize economic development, particularly in growing economies like India and Turkey, where FDI and international trade, such as imports and exports, are critical to economic development. FDI has a twofold influence, directly and indirectly increasing exports and, as a result, impacting trade volumes. Import amounts and quality must be strictly regulated to reduce $CO_2$ emissions. As an example, Howladar et al. (2020) highlight the disturbing features of coal imported into Bangladesh's Tamabil region, such as excessive ash, volatile matter, and Sulphur content, indicating poor-quality lignite coal with detrimental trace element concentrations above permitted limits. The increasing Sulphur content of coal is a main source of environmental deterioration owing to increased acidity in water and soil ecosystems, as evidenced by the environmental tests that revealed a considerable reduction in pH values after contamination, indicating the sulfur-rich nature of coal. Our results indicate that if exports in all five selected sectors increase or decrease, it will not affect $CO_2$ emissions.

Economic growth has a positive and significant effect on $CO_2$ emissions. Economic growth, as measured by Gross Domestic Product, often results in increased Greenhouse Gas emissions in emerging economies, In the early stages of economic development, rising GDP per capita is associated with heightened emissions due to factors such as industrialization, urbanization, and greater energy consumption. Emerging countries frequently rely heavily on fossil fuels for energy production and transportation, further exacerbating emissions as economic growth boosts energy demand. Research by Shahbaz et al. (2013) and Lee and Chang (2007) supports this link between GDP and $CO_2$ emissions in developing countries. Targeted policies, technical advancements, and international cooperation are required to establish an equilibrium between economic development and emissions. First, developing economies may employ cleaner, more efficient technologies and industrial practices from higher-income countries, thereby decreasing pollution emissions. Second, trading enables countries to specialize and reduce emissions in unproductive sectors. Trade can increase economic growth and green technology investments with the appropriate policies. Cole (2004) claims economic openness reduces emissions by transferring greener technologies. With supporting policies, trade may help emerging economies reduce emissions and prosper economically.

Financial development and energy use might inevitably increase $CO_2$ emissions in developing countries. In this study energy use and financial developments have a positive and significant effect on carbon dioxide emissions. As these countries industrialize, they increase their reliance on fossil fuels for energy, increasing $CO_2$ emissions. Along with the fast expansion of the social economy, energy consumption and environmental pollutant emissions continue to rise. Sasana and Putri (2018) explain that a country must create more energy to meet rising energy demand as its population expands. Population expansion can increase urbanization, which increases energy use. This increased energy usage harms the environment by increasing emissions and pollutants. Over time, these pollutants can contaminate water, soil, and air, while carbon dioxide emissions from energy production contribute to air pollution. This has posed a significant challenge for both carbon dioxide control and the pursuit of sustainable economic growth (Jian, et al., 2019). Financial advancement may also favor high-carbon sectors, contributing to emissions. The empirical outcomes unveiled that financial development degrades the ecological quality by raising the ecological footprint. This is in line with Ahmad et al. (2022). Financial development and growing energy requirements can significantly increase $CO_2$ emissions in emerging economies without proper regulations and investments in clean energy options and emissions control measures.

**Table 2**

*Trade and pollution. Random effects estimates.*

| VARIABLES | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| GDP | 0.356*** | 0.387*** | 0.379*** | 0.380*** | 0.355*** | 0.386*** | 0.365*** | 0.375*** | 0.359*** | 0.390*** |
| | (0.0578) | (0.0611) | (0.0602) | (0.0596) | (0.0593) | (0.0605) | (0.0613) | (0.0601) | (0.0574) | (0.0613) |
| TRADE | -0.0419 | -0.0348 | -0.0367 | -0.0385 | -0.0422 | -0.0350 | -0.0386 | -0.0366 | -0.0354 | -0.0341 |
| | (0.0280) | (0.0286) | (0.0279) | (0.0282) | (0.0279) | (0.0287) | (0.0280) | (0.0286) | (0.0274) | (0.0285) |
| FDI | 0.00472 | 0.00652 | 0.00579 | 0.00588 | 0.00456 | 0.00646 | 0.00630 | 0.00643 | 0.00608 | 0.00653 |
| | (0.00482) | (0.00478) | (0.00489) | (0.00458) | (0.00485) | (0.00468) | (0.00491) | (0.00475) | (0.00490) | (0.00477) |
| FINDEV | 0.0305* | 0.0352** | 0.0322* | 0.0344** | 0.0286* | 0.0356** | 0.0288* | 0.0351** | 0.0270 | 0.0358** |
| | (0.0172) | (0.0171) | (0.0165) | (0.0168) | (0.0167) | (0.0171) | (0.0166) | (0.0173) | (0.0165) | (0.0172) |
| GOVEXP | 0.0484 | 0.0429 | 0.0365 | 0.0404 | 0.0491 | 0.0433 | 0.0486 | 0.0417 | 0.0418 | 0.0481 |
| | (0.0502) | (0.0478) | (0.0476) | (0.0474) | (0.0504) | (0.0473) | (0.0486) | (0.0497) | (0.0469) | (0.0421) |
| ENERGYUSE | 0.242*** | 0.250*** | 0.240*** | 0.250*** | 0.237*** | 0.248*** | 0.239*** | 0.247*** | 0.240*** | 0.248*** |
| | (0.0456) | (0.0464) | (0.0454) | (0.0464) | (0.0452) | (0.0464) | (0.0448) | (0.0455) | (0.0450) | (0.0463) |
| TRANSIMP | 0.0333** | | | | | | | | | |
| | (0.0155) | | | | | | | | | |
| TRANSEXP | | -0.000449 | | | | | | | | |
| | | (0.00652) | | | | | | | | |
| TEXTIMP | | | 0.0290** | | | | | | | |
| | | | (0.0123) | | | | | | | |
| TEXTEXP | | | | 0.00721 | | | | | | |
| | | | | (0.00842) | | | | | | |
| MANUFIMP | | | | | 0.0462** | | | | | |
| | | | | | (0.0182) | | | | | |
| MANUFEXP | | | | | | 0.00168 | | | | |
| | | | | | | (0.0118) | | | | |
| CHEMIMP | | | | | | | 0.0417*** | | | |
| | | | | | | | (0.0156) | | | |
| CHEMEXP | | | | | | | | 0.0106 | | |
| | | | | | | | | (0.00949) | | |
| AGRIMP | | | | | | | | | 0.0559*** | |
| | | | | | | | | | (0.0204) | |
| AGREXP | | | | | | | | | | -0.00674 |
| | | | | | | | | | | (0.0131) |
| Constant | | -3.898*** | | | -3.853*** | -3.890*** | -3.935*** | -3.829*** | -3.989*** | -3.886*** |
| | | (0.430) | | | (0.433) | (0.424) | (0.433) | (0.427) | (0.418) | (0.441) |
| Observations | 1,664 | 1,663 | 1,664 | 1,669 | 1,664 | 1,675 | 1,664 | 1,673 | 1,664 | 1,675 |
| Number of countries | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 113 | 113 |

*Robust standard errors, clustered at the country level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1*
*Table 2 shows the results obtained through random effects.*

In the random effect model, economic growth and energy use have a positive and significant effect on $CO_2$ emission. However, trade openness, FDI, and government expenditure show a positive but insignificant effect on $CO_2$ emissions. The main results of imports creating pollution are consistent with our fixed effects model.

## Conclusion and Policy Recommendations

In the context of environmental policy and sustainable development, our three-decade study (1990-2020) comprising 113 developing countries revealed critical insights into the complicated relationship between economic indicators and Environmental degradation. These developing countries comprise a mix of fast-growing economies as well as those that are growing at a slow pace. For all of these economies, energy remains a significant requirement in order to maintain growth. The findings of the study shed light on the nuanced relationship between international trade and environmental pollution, particularly from the perspective of developing countries. Importantly, our analysis reveals that imports are associated with increased levels of pollution, whereas exports do not have a significant influence on CO2 emissions. The detrimental effects of sectoral imports, financial growth, energy usage, and GDP on the environment emphasize the critical necessity for specialized solutions that balance economic expansion with environmental responsibility. Policies must prioritize the promotion of environmentally aware imports, the usage of environmentally friendly energy sources, and the creation of finance systems that reward sustainable investments. The governments need to regulate the imports that cause pollution. In this way, they can achieve a sustainable environment.

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