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Article

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Exploring the Links between Renewable Energy, FDI, Environmental Degradation, and International Trade in Selected Developing Countries

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ABSTRACT

Trade may be significantly impacted by Foreign Direct Investment (FDI), which refers to investments made outside of the investor's place of origin. Carbon emissions, in particular those that are the result of industrial activity and transportation, have the potential to have a number of important effects on commerce on both the national and international levels. The environmental, economic, and social repercussions of these effects are intricately interwoven with one another. Because it has an immediate bearing on a nation's production capacity, level of competitiveness, and the kinds of products and services that may be exported from or imported into the nation, the value added in the industry has a considerable influence on international commerce. The level of government spending may have a considerable impact on the way a nation does in terms of commerce. There are several facets of commerce that might be affected, either favorably or badly, by the method that a government utilizes to distribute its money. The current study aims to examine the linkages among renewable energy, FDI, Environmental degradation, and their impact on trade. The findings of the study are obtained from a panel of 58 developing countries from 2000 to 2022. The results of Panel unit roots and Kao co-integration tests recommend applying the panel ARDL to get the empirics of desirable relationships. The results of the study recommend that it is essential for governments to find a balance when making choices about their expenditures in order to guarantee that the resources allotted support sustainable economic growth, improve trade competitiveness, and fit with larger development goals. Spending decisions made by the government that are both strategic and well-targeted have the potential to play a significant part in improving the economic performance of a nation and its integration into the global economy.

Keywords: Renewable Energy, FDI, Environmental Degradation, International Trade, Government Expenditure
JEL Classifications: Q56, Q59, B22

1. INTRODUCTION

Both the nation in which the investment is made, known as the host country, and the country in which the investment originates, known as the home country, may be significantly affected by the foreign direct investment that occurs between the two countries (Kayani and Kayani, 2017; Kayani et al., 2023; Yan et al., 2023). Foreign direct investment (FDI) may result in the creation of new enterprises or the development of existing ones in the nation that hosts the investor (Helpman, 2006; Razzaq et al., 2023). The host nation's exports might potentially increase as a result of the production of products and services by these companies, which would then be sold in other countries. FDI often entails the transfer of cash, technology, and know-how from the investor's home nation to the country that is the recipient of the investment. This may result in improved levels of productivity and efficiency

in the industries of the host nation, making those sectors more competitive and able to generate higher-quality items that can be exported (Xu et al., 2021; Keller, 2021).

Foreign direct investment has a strong connection to the idea of global value chains, in which various phases of manufacturing are carried out in a number of different nations (Aysan et al., 2020; Kayani et al., 2022). Businesses often make investments in other countries in order to take advantage of the reduced costs of manufacturing or the specialized talents that are available at certain phases of the production process (Idrees et al., 2023). As a consequence of this, there may be a rise in the trade of intermediate commodities between the country of origin and the country of destination (Kahouli and Chaaben, 2022; Soomro et al., 2022). FDI may, under some circumstances, encourage the expansion of local supplier industries in order to satisfy the needs of foreign investors, which further contributes to an increase in exports. overseas direct investment has the potential to improve a company's access to overseas markets. firms may be able to circumvent trade restrictions, such as tariffs or quotas, by investing in a foreign nation, which then enables the firms to grow their exports to that market (Azam et al., 2023).

FDI has the potential to have a beneficial impact on the economy of the nation that receives it, including the transfer of technology, the acquisition of management knowledge, and the improvement of human resources. These secondary impacts have the potential to improve the overall competitiveness of the sectors of the host nation, which should result in an increase in exports (Pan and Chong, 2023; Keho, 2020). On the other hand, a rise in FDI may also lead to an increase in the level of import competition in the host country. This is because foreign companies may import items either to supply the local market or to utilize as inputs in the manufacturing processes of the foreign companies. The impact of FDI on trade balance, whether it results in a deficit or surplus, depends on various factors, including the specific characteristics of the FDI and the economic conditions in both the home nation and the host country (Pan and Chong, 2023). These different investment patterns are known as vertical FDI. Vertical FDI and horizontal FDI are distinguished by their effects on trade. Horizontal FDI tends to replace trade, while vertical FDI tends to stimulate trade. Some economic perspectives suggest that vertical FDI is more prevalent between industrialized nations and developing countries, whereas horizontal FDI is more common among industrialized nations (Nasim et al., 2023).

It is vital to keep in mind that the effect of FDI on trade may vary depending on a number of variables including the kind of investment, the sector in which it is invested, the degree of development of the host nation, the policies of the government, and the circumstances of the global economy (Liargovas and Skandalis, 2012; Yang and Shafiq, 2020). In addition, foreign direct investment has the potential to effect other macroeconomic variables as well as the trade balance between the home country and the host country. Foreign direct investment and international commerce are intricately linked to one another and may impact one another in a variety of different ways.

Considering, it has an immediate bearing on a nation's production capacity, level of competitiveness, and the kinds of products and services that may be exported from or imported into the nation, the value added in industry has a considerable influence on international commerce. Industrial value added is a measurement of the contribution of industries to the total gross domestic product (GDP) of a nation. It represents the value created by such industries via their production processes, and it is a measure of the contribution of industries to the GDP of a country (Ellahi et al., 2011). Countries that have sectors that significantly increase the value of their goods have a better chance of being competitive on international marketplaces. A high industrial value added indicates that a country's industries are inventive, efficient, and able to create items at prices that are competitive with those of other countries. This may result in increased exports of manufactured products and services, which will contribute to a trade balance that is in a positive position. The degree of industrial value added in a nation may have an effect on the make-up of the goods that it exports and those that it buys. Economies that have a robust industrial base are more likely to export manufactured products, which typically have a greater value-added compared to raw materials or basic commodities (Zinilli and Marchi, 2020; Nasim et al., 2023). Exporting manufactured goods also helps economies diversify their revenue streams. On the other side, nations that have a lower industrial value added may be more reliant on importing completed goods.

Industries that have a high value-added often create intermediate items or components that are then used in the manufacture of final goods in other nations. This may result in an increase in the trading of intermediate commodities, which are an important component of global value chains (GVCs). Processes that need a significant amount of expertise and often make use of cutting-edge technology are typical of value-added industries. When such sectors are present in a nation, they have the potential to entice foreign direct investment, as well as assist the transfer of technology and expertise, which ultimately results in an increase in the economy's overall competitiveness and its performance in trade (Nasim et al., 2022). Businesses that provide a lot of value to their products or services are often more productive and may pay their competent employees more. This may result in changes in the labor market and the way money is distributed within a nation. The value added and industrial structure of a nation are two factors that might impact its trade policy. In order to promote economic expansion and job opportunities, governments could provide particular sectors with a high value-added component more assistance and protection (Karim et al., 2023). On the other hand, they have the potential to lower trade barriers for sectors that significantly depend on imported intermediate products (Cui and Song, 2019; Liu et al., 2020).

Increasing the proportion of an economy's output that comes from industries with a greater value-added potential may help diversify that economy by lowering its dependence on a small number of sectors or commodities (Yang and Khan, 2022; Leitão and Balogh, 2020). The ability of a nation to withstand shocks from the outside world and shifts in the pricing of commodities may be improved by diversification. In general, a country's capacity to perform well

in international commerce and to successfully participate in the functioning of the global economy is directly correlated to its level of industrial value added (Yazdani and Pirpour, 2020; Neumann and Tabrizy, 2021). As a component of their plans for long-term economic growth and the expansion of trade, governments often endeavor to foster the growth of economic sectors that contribute significantly to the overall value of the economy.

Carbon emissions, in particular those that are the result of industrial activity and transportation, have the potential to have a number of important effects on commerce on both the national and international levels (Chen and Lin, 2021; Khan et al., 2020). The environmental, economic, and social repercussions of these effects are intricately interwoven with one another (Choudhury et al., 2023). Concerns about carbon emissions and their role to climate change have caused some governments to put trade restrictions or tariffs on items produced in countries with bigger carbon footprints (Guo and Feng, 2021). These limits and levies target commodities manufactured in countries with larger carbon footprints. This is something that is sometimes referred to as a "carbon border adjustment" or a "carbon tax." Such policies try to level the playing field for local companies by accounting for the environmental costs that are involved with imported products (Zhang et al., 2022).

Both individual customers and commercial enterprises are developing a heightened awareness of the ecological footprint left by the goods they purchase and sell. The high levels of carbon emissions that are connected with some items can cause a decline in demand, which might then shift consumers' preferences toward products that have smaller carbon footprints. As a direct consequence of this, eco-labeling and eco-certification programs have come into existence, which in turn have an effect on trade patterns. Regulations and policies on carbon emissions have the potential to cause disruptions in supply chains (Ayad et al., 2023). For instance, limits placed on certain manufacturing processes or transportation methods may have an effect on the availability and cost of inputs, which in turn may have an effect on international commerce and the competitiveness of particular sectors. Countries that produce a lot of carbon dioxide may find it difficult to enter some export markets, particularly those that have severe environmental rules or have made pledges to limit the amount of carbon dioxide they produce. It is becoming more important for parties involved in trade talks and market access to comply with environmental requirements (Iqbal et al., 2022; Mundaca et al., 2021; Shen et al., 2023).

Investments in environmentally friendly technology and renewable energy sources are being driven by the worldwide quest to reduce carbon emissions (Yan et al., 2023). Countries that are in the forefront of developing and manufacturing environmentally friendly technology may have an edge over their competitors in global commerce (Ibrahim and Ajide, 2021). Carbon leakage happens when strict carbon emission rules in one nation lead to the migration of carbon-intensive businesses to countries with weaker regulations. This results in an increase in the amount of carbon that is released into the atmosphere. It is possible that this may lead to increased global emissions without resulting in a large net decrease (Yang et al., 2022). It also has an effect on the balance of commerce between the nations that are participating (Kayani et al., 2023). High carbon emissions are often the result of inefficient use of energy and practices that squander materials during manufacturing. Reducing carbon emissions may result in industrial processes that are more sustainable and resource-efficient, which may, over the long run, improve an economy's overall efficiency and competitiveness (Amin and Song, 2023; Wang et al., 2023; Xie et al., 2023).

Climate change itself can lead to extreme weather events that have the potential to disrupt supply chains and damage infrastructure. Consequently, this disruption can hinder the smooth movement of products and services in international commerce. Carbon offsetting strategies have been developed by several nations and industry as a means of making up for the emissions they've caused (Khan et al., 2021; Leitão, 2021). Carbon offsetting programs might entail sponsoring renewable energy or forestry activities in other countries, which can have an effect on the patterns of trade and investment. Carbon emissions will continue to be an important factor in international commerce even as measures to mitigate climate change are being ramped up on a global scale. In order to develop sustainable and ecologically responsible business practices, policymakers, firms, and consumers will need to negotiate the obstacles and possibilities posed by these emissions (Usman et al., 2021; Rafiq et al., 2022). The level of government spending may have both direct and indirect effects on trade, which in turn can shape the performance and patterns of a nation's commercial activity. The magnitude of the effect will be determined by the particular characteristics of the expenditures made by the government, the conditions of the economy, and the goals of the policy that is being followed. Spending money on infrastructure projects like roads, ports, airports, and telecommunications networks that are funded by the government may help a nation's connectedness and make it easier for it to facilitate commerce (Khan et al., 2020). The improvement of infrastructure may result in increased trade activity by lowering the costs of transportation, improving the effectiveness of logistics, and attracting foreign investment.

Streamlining the processes involved in international commerce may be accomplished by increased government investment on updating customs procedures, removing trade barriers, and introducing trade facilitation measures (Karim et al., 2023). This might result in shorter lead times for imports and exports, which in turn would reduce transaction costs and increase trade volumes. Many times, governments will devote resources to the promotion and support of sectors that are export-oriented. It is possible for domestic goods to become more competitive on international markets via the use of export subsidies, financial support, and export credit facilities (Bao, 2020; Sujianto and Azmi, 2020). This would result in a rise in exports. In some instances, government spending could be redirected to help domestic companies become self-sufficient in the production of items that were before brought in through import. Government expenditure has the potential to influence trade patterns and lower the demand for goods produced in other countries by encouraging import substitution. The provision of financial support by the government for research and development activities may

encourage the development of innovative technologies across a variety of business sectors (Lei et al., 2023). This may result in the creation of innovative goods and processes that boost the competitiveness of indigenous enterprises in international markets (Arvin et al., 2021; Liu et al., 2022).

The investment of government funds on education and the development of skills may increase the quality of the labor force, which in turn makes the country more productive and appealing to investors from other countries (Jiang et al., 2023). A labor force that is both educated and competent has the potential to contribute to the creation of commodities with greater value-added, which may have a favorable effect on commerce. The policies of the currency exchange rate may be impacted by government spending. The method that a government employs to determine the value of its currency has the ability to influence the competitiveness of both exports and imports, which in turn may alter trade balances. The level of spending made by the government is an essential component of fiscal policy, which has the potential to affect economic expansion in general. A robust expansion of the economy may result in an increase in consumer demand for products and services, which can result in an increase in trade in both directions.

The trade balance of a nation may be impacted by the government's spending habits. A high level of government expenditure may result in an increase in imports, which might result in a wider trade imbalance. On the other hand, successful measures for promoting exports may contribute to a reduction in trade deficits and lead to an increase in trade surpluses. The choices that a nation makes about its level of government spending may also have an effect on its approach to trade policy and trade talks. It is possible for a country's perspective on trade liberalization and market access to be influenced by the budget allocations for trade-related activities. It is essential for governments to find a balance when making choices about their expenditures in order to guarantee that the resources allotted support sustainable economic growth, improve trade competitiveness, and fit with larger development goals (Rafiq et al., 2022). Spending decisions made by the government that are both strategic and well-targeted have the potential to play a significant part in improving the economic performance of a nation and its integration into the global economy (Haider and Tehseen, 2022). In actuality, In reality, hybrid patterns are likely to emerge, where multinational companies opt for a combination of both vertical and horizontal FDI strategies. Existing empirical research on FDI trends primarily examines the variations that occur across different countries. This study aims to assess the potential intertemporal relationship between FDI, industrial value added, carbon emissions, government consumption expenditures, and international trade flows. To be more precise, the selected independent factors are expected to lead to an increase in the availability of skilled employees, which, in turn, may result in a boost in future trade activities.

2. LITERATURE REVIEW

According to the findings of the United Nations Conference on Trade and Development, theoretical frameworks of international commerce and FDI have typically been established in isolation from one another. The integration of ideas on foreign direct investment and commerce is still in its infancy stage. Even while the relevance of FDI and international trade (IT) as independent factors in economic development has been well demonstrated, very little research has been done on the probable links between the two. Are FDI and trade alternatives or complements? Do Foreign Direct Investments (FDI) and Commercial Trade Have Any Causal Relations? When these connections are understood, governments are better able to harmonize the foreign direct investment and trade policies that support growth and development.

The high fixed costs of research and development and other headquarters operations are another factor that justifies FDI. At the plant level, "concentration" refers to the process of increasing returns to scale. If the benefits of closeness are greater than the benefits of concentration, then there will be an increase in FDI rather than trade. As a result, there is the potential for a connection of substitution to exist between FDI and trade. In light of the reality that nations vary in terms of the relative endowments they possess, Markusen, 1998 and Markusen and Venables, 1998 develop the concept of asymmetries between nations in order to explain the decision between international commerce and FDI. The majority of businesses choose to operate on a national scale and establish their headquarters in economically developed nations. As the underdeveloped nation improves in terms of its local market size, factor endowments, and the efficacy of its technical infrastructure, an increasing number of businesses from the developed nation will create subsidiaries in the underdeveloped nation. Therefore, FDI and trade are not mutually exclusive from one another. As nations become increasingly comparable to one another in terms of size and relative endowments and as global affluence increases, the importance of multinational corporations in relation to trade increases. According to Brainard and Martimort, 1997, there is a correlation between the degree to which domestic and international markets are comparable and the likelihood of multinational engagement. This means that international production will replace international commerce in situations when nations are comparable to one another.

As can be seen from the previous, there is a complicated web of connections that exist between FDI and commerce. Predicting whether FDI and trade are complementary or competitive is very difficult, if not impossible. According to Dunning, 1998 and Ali et al., 2020, the link between trade and FDI is contingent on the kind of trade and FDI that are being studied as well as the circumstances under which each of these activities takes place. According to Ganda, 2021 and Keller, 2021 production affiliates that prioritize the market above efficiency will reduce the amount of international trade, whereas production affiliates that prioritize efficiency would increase the volume of trade.

Current studies investigating the relationship between economic development, trade, and the utilization of renewable energy can be categorized into three sections. The first subfield examines the correlation between renewable energy usage and the rate of economic expansion (Yan et al., 2023). The findings from this research indicate a lack of consensus on the causality between these factors, leading to the identification of four distinct

assumptions. The "neutrality" assumption posits that there is no significant correlation between the growth of renewable energy sources and economic development (Vural, 2021; Usman et al., 2021; Rahman and Vu, 2020). This viewpoint implies that there is no meaningful connection between these variables. For example, Payne (2010) analyzed annual data from the United States spanning from 1949 to 2006 and found support for the neutrality hypothesis. Similarly, Menegaki (2008) studied the relationship between renewable energy use and gross domestic product (GDP) across Europe from 1997 to 2007, also concluding that there is no apparent connection between them. Omri et al. (2015) and Saidi and Omri (2020) utilized panel data models to investigate the relationship between renewable energy, nuclear energy, and GDP in seventeen developing and developed nations from 1990 to 2011, finding support for the neutrality theory in Switzerland, Brazil, and Finland. Additionally, Yildirim et al. (2012) found no correlation between various classifications of renewable energy and GDP in the United States from 1949 to 2010. The "feedback" assumption suggests two-way linkages between renewable energy production and input (Rojas Suárez et al., 2022), implying that the utilization of renewable energy sources and GDP are interconnected.

In their study on Latin American economies, Al-mulali et al. (2013) utilized a multivariate panel data model that incorporated trade, non-renewable energy, labor, and capital into a Cob-Douglas production function. Their findings revealed a bi-directional causal relationship between production and renewable energy, indicating that policymakers should promote the adoption of renewable energy sources. Examining the nations of Eurasia between 1990 and 2007, Apergis and Payne (2012) focused their research on the correlation between renewable energy and production. By constructing panel data models that included additional variables such as labor and capital, they identified a feedback loop between these variables. Their analysis, encompassing data from eighty different nations, demonstrated a feedback relationship that can be integrated into a panel data growth model. This underscores the importance for countries to prioritize the development and utilization of renewable energy.

Lin and Moubarak (2014) conducted a study using a multivariate model that incorporated labor and CO_2 emissions to explore the potential connection between renewable energy and GDP. Their research, focusing on China from 1977 to 2011, revealed the existence of a feedback relationship between renewable energy and GDP. This finding emphasizes the urgent need for the development and adoption of alternative energy sources. Similarly, Pao and Fu (2013) provided evidence supporting the feedback causation between renewable energy and GDP in Brazil over the period 1980-2010. Shahbaz et al. (2015) evaluated the relationship between renewable energy usage and production by utilizing a multivariate framework that considered factors such as capital and labor forces. Analyzing data from Pakistan between 1972 and 2011, they identified a bidirectional link between renewable energy and production. In a study covering OECD member countries from 1990 to 2008, Ohler and Fetters discovered a positive feedback relationship between various forms of renewable energy and gross domestic product.

Ben Jebli and Ben Youssef (2014) authors of a Tunisian research covering the years 1980-2010, investigate the relationships between various forms of energy, including renewable and nonrenewable forms of energy, as well as commerce and economic expansion. The findings point to the existence of a unidirectional nexus that connects renewable energy with the gross domestic product as well as international commerce. They suggest that Tunisia should encourage the use of renewable energy, devise a strategy for maximizing the benefits it receives from the innovation exchange in renewable energy that takes place during the importation of capital goods, and succeed in the formation of renewable energy businesses that are geared toward exportation.

The transfer of technology, primarily facilitated through international trade and finance, is widely recognized to have a significant impact on the adoption of renewable energy sources (Razzaq et al., 2023). Numerous empirical studies have explored the cause-and-effect relationship between economic growth and the increased utilization of renewable energy (Moriarty and Honnery, 2012; Simionescu et al., 2020; Hao et al., 2021). Additionally, other research has investigated the causal link between economic expansion, renewable energy usage, and carbon dioxide (CO_2) emissions. Consistently, these studies have concluded that the adoption of renewable energy plays a vital role in fostering economic growth, and vice versa. Furthermore, adopting an energy strategy that aims to increase the share of renewable energy in overall energy consumption has proven to be an effective approach in reducing greenhouse gas emissions (Sharma et al., 2021; Chien et al., 2022). To explain the rise in gross domestic product (GDP), it is possible to include additional factors, such as international trade, in the production function. These variables may encompass capital, labor, and the utilization of renewable energy sources.

Several studies have delved into the relationships among energy consumption, international trade, and overall output (Kumaran et al., 2020). Lean and Smyth (2013) focused on investigating the dynamic link between economic growth, electricity output, exports, and pricing in Malaysia. Their Granger causality tests revealed a unidirectional causation, indicating that increased economic development leads to higher electricity generation. Employing a multivariate model, Lean and Smyth (2013) further explored the causal relationship in Malaysia between production, electricity consumption, exports, labor, and capital. They found a bidirectional causation between production and power usage, suggesting the need for Malaysia to invest in electrical infrastructure and implement laws promoting energy conservation to reduce unnecessary electricity consumption. Also, Narayan and Smyth studied the feedback effects among energy usage, exports, and GDP in a sample of Middle Eastern nations. Sadorsky (2009) investigated the commerce and energy consumption relationship for eight Middle Eastern countries using panel cointegration methods. In the short term, Sadorsky observed a Granger causality running from exports to energy consumption, as well as a bidirectional causality between imports and energy consumption. In the long term, he noticed that an increase in total exports and imports affected the demand for energy. In a separate study focusing on seven South American countries, Sadorsky

demonstrated a long-term causal relationship between international trade and energy usage. His analysis led to the conclusion that environmental regulations aimed at reducing energy consumption would also impact trade.

Energy is very necessary to the continued growth and development of countries (Kumaran et al., 2020). In particular, energy derived from fossil fuels has been the component that has seen the greatest demand all across the globe. The growing demand for energy-intensive activities in both developed and emerging countries, along with wasteful practices in affluent nations (particularly in the Gulf countries), raises two major concerns. First, it leads to the depletion of easily accessible energy resources, primarily oil. Second, it contributes to the pressing issue of global warming, driven by the rapid increase in greenhouse gas emissions like carbon dioxide (CO2) and methane. These two interconnected problems hold significant implications for the world's future. Given the global nature of these energy-related challenges, it is crucial to prioritize the management and utilization of renewable energy resources. The term "renewable energy" refers to power that comes from sources such as the sun, the wind, geothermal heat, tides and waves, biomass, wood, and other organic waste (Martins et al., 2022). Renewable energy, in contrast to traditional forms of energy, does not pollute the environment, is completely safe, and cannot be depleted. As a result, it is rapidly expanding all over the globe, and according to predictions, it will eventually displace a significant number of traditional forms of energy component. Currently, it holds the top spot in terms of the total proportion of energy consumption. In China, for instance, the amount of electricity generated by wind power has just surpassed the amount of electricity produced by nuclear power plants (Martins et al., 2023).

3. DATA AND METHODOLOGY

3.1. Data

This study's aim is to evaluate the possibility of an intertemporal relationship between FDI, industrial value added, carbon emissions, the consumer expenditures of governments, and international trade. To empirical estimate the relationship among the variables of the study, the data is taken from world development indicators ranges from 2001 to 2022. The authors of the study have taken 58 developing countries and find out the long run estimates to provide evidence of the relation among the variables of the study that are trade openness, FDI, renewable energy, carbon emissions, industrial value added, GDP per capital (to eliminate the effect of population size), govt. final consumption. The description of variables, their abbreviations and measurement units are given in Table 1.

3.2. Descriptive Analysis

It is standard practice to start the analysis of data with a descriptive analysis since doing so helps researchers and analysts to have a better knowledge of the structure and patterns existing in the data before going on to more extensive studies. This is one reason why descriptive analyses, presented in Table 2, are often used as a starting point for data analysis. Statistics that assess central tendency give insight into the values that are most representative of the whole collection of information by indicating which values fall into that category (Hassan et al., 2023; Kayani et al., 2019; Kayani et al., 2023). The three metrics of central tendency that are employed the most often are the mean, the median, and the mode. The mean is the most common. For the purpose of characterizing the variability or spread of the data, statistics that are known as dispersion statistics are used such as range, the variance, the standard deviation. In compared to a normal distribution, skewness and kurtosis are both assessments of the extent to which the data are concentrated in the tails; however, skewness represents the asymmetry of the data distribution (Kaur et al., 2018). The importance of descriptive analysis cannot be overstated when discussing the acquisition of first insights into a dataset, the identification of outliers and patterns, as well as the determination of the overall shape and features of the distribution of the data. On the other hand, it does not entail verifying hypotheses or developing projections about the population; as a result, it is subject to a number of constraints. When doing more complicated analyses and drawing larger generalizations, it is usual practice to make use of inferential statistics and predictive modeling.

Table 1: Description of variable of study

Variable names	Abbreviations	Measurements
Trade openness	TRDE	Trade index
Foreign direct Investment	FDINV	Foreign direct investment, net inflows
Renewable energy	RENCON	Renewable energy consumption (percentage of total final energy consumption)
Carbon emissions	COEMSN	CO_2 emissions (kt)
Industrial value added	INDVADD	Industry (including construction), value added (percentage of GDP)
GDP per capita	GDPPCAP	GDP per capita (current US$)
Government expenditure	GCONEXP	General government final consumption expenditure (current US$)

GDP: Gross domestic product

4. RESULTS

4.1. Correlation Matrix

A correlation matrix is a square matrix that displays the correlations between multiple variables. It is commonly used in statistics and econometrics to investigate the relationships among different variables within a dataset. The correlation coefficient, a statistical measure, quantifies the strength and direction of the linear relationship between two variables. Researchers assess the statistical significance of correlation coefficients through hypothesis testing, comparing the calculated P-values with a predetermined significance threshold, typically set at 0.05. If the P-value is lower than the significance level (0.05), researchers reject the null hypothesis, concluding that there is a statistically significant relationship between the variables. On the other hand, if the P-value is greater than the significance threshold, researchers fail to reject the null hypothesis, indicating that there is no significant correlation between the variables. The probabilities presented in Table 3 are likely associated with hypothesis testing, enabling researchers to draw meaningful conclusions about the relationships between the variables based on their statistical significance (Hasan et al., 2022).

Table 2: Descriptive analysis

Variables	Mean	Median	Maximum	SD	Skewness	Kurtosis	Jarque Bera
TRDE	121.782	68.688	732.398	155.447	2.548	8.349	3015.812
COEMSN, M	17.277	0.0162	7780	357	2.978	4.424	10.727
GCONEXP, B	47.1	4.300	2760	206	1.323	1.310	0.0553
GDPPCAP	3383.618	2495.005	15,974.64	2918.893	1.427	4.839	637.134
RENCON	41.635	37.265	98.34	28.669	0.295	1.828	95.205
FDINV, B	21.7	0.005	10700	459	2.196	4.629	0.0113
INDVADD	100,963.400	70,416.17	658,106.7	100,504.1	1.828	6.967	1607.948

TRDE: Trade openness, COEMSN: Carbon emissions, GCONEXP: Government expenditure, GDP: Gross domestic product, GDPPCAP: GDP per capita, RENCON: Renewable energy consumption, FDINV: Foreign direct investment, INDVADD: Industrial value added, SD: Standard deviation

Table 3: Correlation matrix

Probability	RENCON	TRDE	INDVADD	GCONEXP	GDPPCAP	FDINV	COEMSN
RENCON	1.00						
TRDE	−0.36 (0.0015)	1.00					
INDVADD	−0.49 (0.0000)	0.58 (0.0056)	1.00				
GCONEXP	−0.42 (0.0023)	0.90 (0.0017)	0.57 (0.0038)	1.00			
GDPPCAP	−0.48 (0.0020)	0.49 (0.0075)	0.95 (0.0099)	0.51 (0.0065)	1.00		
FDINV	−0.22 (0.0010)	0.22 (0.0000)	0.53 (0.0001)	0.16 (0.0047)	0.55 (0.0011)	1.00	
COEMSN	−0.48 (0.0100)	0.82 (0.0031)	0.46 (0.0067)	0.90 (0.0077)	0.39 (0.0045)	0.27 (0.0002)	1.00

TRDE: Trade openness, COEMSN: Carbon emissions, GCONEXP: Government expenditure, GDP: Gross domestic product, GDPPCAP: GDP per capita, RENCON: Renewable energy consumption, FDINV: Foreign direct investment, INDVADD: Industrial value added

Table 4: Panel unit roots tests

Variables	Levin, Lin and Chu t*	Im, Pesaran and Shin W-statistic	ADF - Fisher's Chi-square	PP - Fisher's Chi-square	Order
TRDE	−2.480	−1.474	125.597	115.436	Level
INDVADD	−14.112	−13.756	412.070	556.251	1st
GCONEXP	−9.377	−9.028	299.628	485.983	1st
GDPPCAP	−14.542	−14.112	420.563	767.678	1st
FDINV	−10.610	−13.514	428.296	1111.250	1st
COEMSN	−9.706	−10.145	322.188	851.588	1st
RENCON	−8.282	−10.703	336.328	820.705	1st

TRDE: Trade openness, COEMSN: Carbon emissions, GCONEXP: Government expenditure, GDP: Gross domestic product, GDPPCAP: GDP per capita, RENCON: Renewable energy consumption, FDINV: Foreign direct investment, INDVADD: Industrial value added, ADF: Augmented Dickey-Fuller, PP: Phillips-Perron

4.2. Panel Unit Root Tests

Panel data, often referred to as longitudinal data or cross-sectional time series data, are made up of observations taken on a variety of subjects spanning a number of time periods (such as individuals, organizations, or countries). Cross-sectional time series data and longitudinal data are additional terms for panel data. Unit root tests can handle such panel datasets because of an enhancement known as panel unit root tests. These experiments provide room for the potential of both individual- and time-specific effects. The Levin et al. (2002), Test, often known as the LLC Test, extends the Augmented Dickey-Fuller (ADF) test for panel data. It considers data patterns that are unique to both people and historical periods. The Im et al. (2003) Test is another well-known panel unit root test that builds on the ADF test's basis. When utilizing this strategy, it is feasible to have cross-sectional dependence and different autoregressive coefficients across individuals. The Fisher-type tests, such as the Fisher-type ADF and Fisher-type PP (Phillips-Perron) tests, include data from person-specific unit root tests to produce a panel test. These tests are referred to as Fisher-type Panel Unit Root Tests. The Fisher-type Fisher-type PP (Phillips-Perron) test is another illustration of a Fisher-type test. When choosing the best panel unit root test, one must take into account the specifics of the data as well as the current study topic. Researchers should carefully analyze the test's underlying assumptions as well as its ramifications before applying the test to their panel datasets. The results of panel unit root tests based on below tests are reported in Table 4.

4.3. Kao Residual Cointegration Test

The cointegration or longrun relationships among the variables used in the study is examined by Kao Residual Cointegration test and their estimates are provided in Table 5. It reveals that we may be able to reject the null hypothesis of No Cointegration and can conclude that there exists Cointegrating relationship among the variables.

4.4. Panel ARDL Results

The Panel Autoregressive Distributed Lag (ARDL) test is a method that is used in order to conduct an investigation into the nature of the long-term connection that exists between the variables that are included in a panel dataset. This investigation is carried out with the intention of determining whether or not the connection is significant. It extends the ARDL approach, which is generally used for time series data, to panel data, in which observations are obtained for multiple entities spanning various time periods. generally, the ARDL technique is used for time series data. Analysis of time series data is a common use of the ARDL modeling language. In order to determine whether or not there is a long-term connection between the variables that make up the panel as a whole, a Panel ARDL test is performed. This test involves first estimating an ARDL model for each individual

Table 5: Kao residual cointegration test

Null hypothesis: No cointegration				
Test name	*t*-statistic	Probability	Residual variance	HAC variance
ADF	3.508398	0.0002	0.009684	0.011346

ADF: Augmented Dickey-Fuller

Table 6: Panel autoregressive distributed lag long runa and short run results

Variable	Coefficient	SE	*t*-statistic	Probability*
Long run equation				
RENCON	0.041593	0.025520	1.629793	0.1036
FDINV	0.026716	0.007885	3.388294	0.0007
GDPPCAP	0.600915	0.084770	7.088795	0.0000
INDVADD	0.212074	0.063590	3.335034	0.0009
GCONEXP	0.325041	0.041056	7.917037	0.0000
COEMSN	−0.401211	0.034733	11.55142	0.0000
Short run equation				
COINTEQ01	−0.235114	0.045497	−5.167647	0.0000
D (TRDE [−1])	0.068958	0.023889	2.886657	0.0040
D (RENCON)	−0.028342	0.247231	−0.114637	0.9088
D (FDINV)	0.028054	0.022460	1.249074	0.2120
D (GDPPCAP)	0.926336	0.143123	6.472323	0.0000
D (INDVADD)	0.232891	0.113965	2.043534	0.0413
D (GCONEXP)	−0.263599	0.080770	−3.263563	0.0011
D (COEMSN)	0.121992	0.111926	1.089928	0.2761
C	2.344569	0.454546	5.158048	0.0000

GDP: Gross domestic product, TRDE: Trade openness, COEMSN: Carbon emissions, GCONEXP: Government expenditure, GDPPCAP: GDP per capita, RENCON: Renewable energy consumption, FDINV: Foreign direct investment, INDVADD: Industrial value added, SE: Standard error

entity that makes up the panel in its own right, and then combining the results of these separate estimations in order to perform the test. The purpose of this test is to determine whether or not there is a long-term connection between the variables that make up the panel. In many cases, the model formulation will incorporate both the lagged values of the dependent variable as well as the lagged values of the independent variables.

Keeping in mind that the Panel ARDL test, just like any other statistical test, involves assumptions, and those assumptions, in order to give relevant results, need to be met. Among these presumptions is the notion that there would be no serial correlation and that the model will have a stable state. If model deviate even slightly from these presumptions, you run the risk of producing estimates that are either biased or inconsistent. In conclusion, the Panel ARDL test is an efficient approach for performing an investigation into the nature of the long-term connection that exists between the variables that make up a panel dataset. The results drawn from Table 6 may be used to draw conclusions about the significance of the long-term connection between the variables. It gives researchers the ability to draw meaningful inferences on the presence or lack of a stable long-run equilibrium across the whole panel, all while taking into account the individual heterogeneity and dynamics of the individuals in the study.

It is possible for renewable energy to have a major and diverse influence on trade, with both good and negative repercussions depending on a variety of elements and settings. It is possible for countries that have an abundance of renewable energy resources, such as solar, wind, hydro, and geothermal power, to become net exporters of clean energy (Ibrahim and Ajide, 2021; Usman et al., 2021). This may result in the establishment of new export markets and a rise in the number of trade possibilities, both of which can have a beneficial influence on the balance of trade and economic growth of a nation. It is possible for a nation to become less reliant on the importation of fossil fuels by increasing its use of renewable energy sources (Ali and Kirikkaleli, 2022). When governments work to increase their energy independence, they make themselves less vulnerable to the price swings of fossil fuels and the geopolitical conflicts that might impact conventional energy imports. This makes it possible for these nations to improve their energy security.

Both the nation that is the recipient of Foreign Direct Investment and the nation that is the provider of FDI may experience many beneficial effects related to trade as a result of FDI. The nation that hosts the foreign investors often benefits from the introduction of cutting-edge technology, specialized managerial knowledge, and industry best practices (Liu et al., 2022). This sharing of information and technology has the potential to increase the host nation's productivity and efficiency, which in turn may lead to the production of products and services of a better quality that are more appealing to consumers in other countries. Foreign direct investment has the potential to assist nations in expanding their product ranges.

Because it measures the contribution of industries to the gross domestic product (GDP) of a country after taking into account the inputs that are used in intermediate production, the industrial value added has a considerable influence on international commerce. IVA and commerce have a convoluted and intricate interaction with one another (Ge et al., 2022; Kang et al., 2022). Our findings provide empirical support for the hypothesis that a high IVA in certain sectors might lessen a country's dependence on foreign goods imported from other nations. When a country has healthy industries that generate goods and services with high value added, that country may be able to replace some of its imported products with ones that are produced locally. This has the potential to result in a favorable trade balance while also reducing trade deficits.

Spending by the government may have an effect on trade in a variety of ways, including directly as well as indirectly. The magnitude of these impacts is influenced not only by the kind of the money spent by the government but also by the circumstances of the economy as a whole (Ahmad et al., 2022; Işık et al., 2021). If government spending on trade facilitation measures, such as modernizing customs, providing training on trade-related topics, and simplifying trade procedures, is successful in lowering trade barriers and other bureaucratic obstacles, then this results in increased efficiency in customs clearance and smoother trade processes, which is to the benefit of both importers and exporters. Spending by the government that contributes to overall economic growth might have an indirect effect on trade. When the economy is doing well, consumers are more likely to spend more money, which results in a higher demand for products and services across the board, both domestically and globally.

For environment, the study incorporates the Carbon Emission in the developing economies which may affect the trade directly

or indirectly. In the study, the coefficient is found with negative sign revealing lower trade due to more carbon emission in the developing countries (Guo and Feng, 2021; Wang et al., 2022). Concerns about climate change and emissions of carbon could lead some nations to impose trade barriers and taxes on goods and services that are regarded as having a significant carbon footprint. This can make it more difficult and expensive for enterprises that operate in industries that rely heavily on carbon to export their products to particular markets, lowering the competitiveness of these businesses and perhaps leading to trade conflicts. Moreover, it is possible that there will be harsher rules or higher prices associated with transportation as a result of the efforts of countries and companies to minimize emissions (Wang and Zhang, 2021; Wang et al., 2022). This can result in an increase in the cost of commerce as a whole and may have an effect on the competitiveness of specific industries, in particular those that are highly dependent on global supply networks. Carbon emissions and the impact they have on climate change are becoming increasingly critical elements that influence the rules, regulations, and market dynamics that pertain to international commerce. Businesses who are able to adjust to these shifts and implement more environmentally friendly procedures may discover new opportunities, whereas companies that are highly dependent on carbon-intensive procedures may find that the global trade landscape presents them with obstacles.

5. CONCLUSION AND POLICY RECOMMENDATION

It is possible for nations to get into trade conflicts with one another if they establish laws favoring renewable energy. Trade restrictions, such as tariffs or non-tariff barriers, may be placed on renewable energy equipment and components, for instance, in order to safeguard local industries or in response to what is seen as unfair competition. It is possible that countries that primarily depend on conventional fossil fuel exports would face a reduction in demand as well as a fall in pricing as the worldwide adoption of renewable energy develops. This may have an impact on their economies as well as the trading links they have. In general, the effect that renewable energy has on international commerce is complicated and variable, since it is determined by factors like as a nation's energy resources, regulations, technical capabilities, and the dynamics of the global market. Although there is the possibility of gaining advantages in terms of energy security, economic expansion, and environmental sustainability, there is also the possibility of gaining problems in the form of trade conflicts and alterations in the old patterns of energy trade. To achieve the goal of maximizing the good benefits that renewable energy may have on commerce while reducing the possible negative implications, it is vital to have effective legislative frameworks as well as international collaboration.

The host nation may lessen its reliance on only a few main export commodities or goods if it is successful in attracting investments from a diverse range of companies and sectors. This would enable the country's export portfolio to be more robust to shocks from the outside world. The domestic economies in the panel under investigation are benefiting from the positive externalities that are created by FDI. When multinational corporations invest in a host nation, the economy of that nation as a whole, including its suppliers and industries, may stand to gain from the increased commercial prospects and knowledge spillovers. This may eventually result in the establishment of supplier connections and a local sector that is more competitive. The allocation of IVA among different sectors may also have an effect on the trade specialization of a nation. Some nations may choose to specialize in particular sectors that have a high value added, while others may choose to concentrate on areas that have a low value contributed. This has the potential to change the dynamics of international commerce as well as the patterns of worldwide supply chains. The contribution that the industrial sector makes to IVA may have more far-reaching repercussions for the expansion of a nation's economy. A robust industrial base has the potential to stimulate overall economic development, which may result in greater earnings, more consumer spending, and the growth of the middle class, all of which can further fuel domestic demand and trade.

The creation of trade policy, the negotiations of trade agreements, and compliance with international trade agreements may all be supported by government expenditures, which can be distributed via trade policy and negotiations. Trade policies and talks that are successful may unlock previously inaccessible new markets, lower existing trade barriers, and open up new avenues for commercial exchange. It is essential to keep in mind that the influence that governmental spending has on international commerce might look quite different depending on the efficacy of the spending, the relevance of the policies, and the state of the economy as a whole. Some kinds of government spending have the potential to favorably contribute to economic development and trade, whereas other forms of government spending could have unforeseen effects or lead to trade imbalances. A nation's involvement in international commerce may be supported and improved significantly via the use of strategic government spending that is both efficient and well-targeted.

In conclusion, while carbon emissions alone do not have a beneficial effect on trade, there are actions and policies connected to trade that may help to the reduction of carbon emissions and to sustainable development. These activities may help link commerce with environmental and climatic goals, so contributing to the development of a global economy that is more sustainable and resilient.

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