An Empirical Analysis of Carbon Emissions in International Trade and Economic Growth for E7 Countries

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ABSTRACT

This study investigates the relationships among Carbon Emissions (CO_2), Energy Use (EU), Broad Money (BM), Renewable Energy Consumption (REC), Gross Domestic Product (GDP), Domestic Credit to the Private Sector (DCPS), and Imports (IMP) and Exports (EXP) in the E7 countries – Brazil, China, Indonesia, India, Mexico, Russia, and Turkey – using the stepwise least-squares method. By analysing panel data from 2009 to 2023, the research explores the short- and long-term impacts of economic growth, domestic credit to the private sector, and imports and exports on carbon emissions for E7 countries. The findings reveal that in the long run, the economic growth of GDP, imports and domestic credit to the private sector have significant positive effects on carbon emission, indicating that as an individual country's economic growth increases, it will increase its carbon emissions with the help of innovative technologies, industrialization, urbanization and renewable energy sources. The study concluded that the E7 Countries are emerging economies and also concentrate on decarbonization goals and strategies. With this E7 or emerging economies, China and India are the second and third-largest emitters in the world. The study suggests that the emerging countries should concentrate on economic growth for a green environment, Net-Zero goals and objectives, and follow the policies to attain carbon neutrality and net-zero carbon emission in the emerging economies.

Keywords: Economic Growth, Carbon Emissions (CO_2), Imports, Exports, Energy Use
JEL Classification: Q430, Q54, F1

1. INTRODUCTION

The growing every year global temperature has risen by somewhat more than 1°C, or almost 2°C Fahrenheit, during the Industrial Revolution. The yearly global temperature has risen by 0.2°C, or 0.36° Fahrenheit, every 10 years over the past 40 years (https://www.nrdc.org/stories/global-warming-101). At the 21st Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015, 196 countries adopted the Paris Agreement. The Paris Agreement seeks to keep global warming to 1.5°C and to keep it far below

2°C. As part of the Paris Agreement, nations submitted Nationally Determined Contributions (NDCs) outlining their strategies for reducing emissions in order to achieve the global temperature target (Joshi and Chen, 2020). According to a United Nations Development Programme survey, 86% of people worldwide support global cooperation in addressing the situation, and popular demand for climate action is rising dramatically. Many nations, companies, and communities have set more aggressive targets to phase out fossil fuels as a result of this demand for change. The term "climate adaptation" describes how we are defending our natural systems and societies against current or impending

climatic dangers (https://www.nrdc.org/stories/climate-change-progress#opportunities). Increased carbon emissions, mostly from human activities like burning fossil fuels, are the main cause of climate change. The globe warms as a result of the accumulation of greenhouse gases in the atmosphere brought on by these emissions.

The main greenhouse gas causing this warming is carbon dioxide (CO_2). Significant changes in weather patterns, sea levels, and ecosystems are being brought about by this warming, which may pose threats to biodiversity, food security, and human health. Carbon emissions are mostly caused by burning fossil fuels (coal, oil, and natural gas) for energy, industrial operations, deforestation, and agriculture. Greenhouse gases like CO_2 are released into the atmosphere as a result of these emissions (United Nations, n.d.). Global temperatures rise as a result of these gases' ability to trap heat. The amount of CO_2 in the atmosphere has risen by 50% over pre-industrial levels due to human emissions (Climate Change: Atmospheric Carbon Dioxide, 2025). The fundamental reason for selecting E-7 countries is that these countries are major emerging economies in the world and have shown significant development in the past two decades. According to Price, Waterhouse, and Coopers (PWC), the gap between E-7 and G-7 countries is closing, and the economic growth of E-7 might surpass that of G-7 by the year 2032. Over the next 40 years, the projected annual growth of E-7 countries is expected to be at a rate of 3.5% as compared to 1.6% for the G-7 countries.

The present study examines the analysis of carbon emissions in international trade and economic growth for the E7 from 2009 to 2025. The basic reason for selecting E-7 countries is that these countries are key growing economies in the globe and have shown tremendous development in the last two decades. Price, Waterhouse, and Coopers (PWC) claims that the E-7's economic growth may overtake the G-7's by 2032 and that the gap between E-7 and G-7 nations is narrowing. The G-7 countries are predicted to grow at a rate of 1.6% over the next 40 years, whereas the E-7 countries are predicted to grow at a rate of 3.5% (Safi et al., 2020). The data for this study have been extracted from the World Bank database from 2011 to 2025 for E7 nations like Brazil, China, India, Indonesia, Mexico, Russia, and Turkey. One significant reason for establishing specific selection criteria when studying the relationship between carbon emissions and international trade in E7 countries, that emerging economies.

1.1. Energy Efficiency
The need for housing, appliances, and industries is growing as urbanization soars. Over 70% of India's yearly energy use is already accounted for by buildings and industries. Increasing energy efficiency will be essential to reducing pollution, increasing energy availability, and saving energy, given India's expanding economy. Overall energy consumption and emissions can be decreased by increasing the energy efficiency of buildings, transportation, and industries. A key component of decarbonization initiatives is the energy sector. Businesses can find inefficiencies and areas for improvement with the use of precise energy usage measurement. For instance, the International Energy Agency (IEA) estimates that by 2040, advances in global energy efficiency could cut energy use by 12% (CarbonAnalytics, 2024). Trade-related

carbon emissions account for a large share of world emissions and are essential to the sustainable growth of the entire global economy. Analyzing how international trade influences carbon emissions, especially for major international trade participants, is directly tied to reducing carbon emissions and greenhouse gas (GHG) emissions. Carbon emissions and international trade are strongly related, and an increase in trade volume may lead to an increase in emissions overall (Zhao et al., 2023).

Logistics, transportation, and shipping emissions—all of which are connected to carbon emissions—are greatly impacted by the global trade environment. International trade can improve economic growth, revenue, and production efficiency for countries with abundant natural resources, but resource exploitation has a natural negative impact on the environment. Most studies show that positive (negative) impacts on imports or exports reduce CO_2 emissions and vice versa. The different effects of imports and exports on carbon emissions have recently come to light. Increasing international trade supports the sustainable growth of the world economy. A major part of the global economy is international trade (Zhao et al., 2023). Most economic activity, including international trade, will probably need to change to make the shift to a low-carbon economy. It will become more and more necessary for businesses to reduce greenhouse gas (GHG) emissions to be efficient and competitive. Reducing carbon emissions from both the manufacturing and transportation stages will be necessary to decarbonize economic activity.

The Carbon emissions are impacted by international trade in several ways, both positively and negatively. Theoretically, the impact of trade on the environment is unknown since various mechanisms that pull in opposing directions are at work, and the significance of each mechanism's part is influenced by various conditions (WTO, 2013). Therefore, the issue of how trade affects GHG emissions and carbon emissions overall is empirical. There are several ways that international trade might increase emissions. Carbon emissions expand as a result of increased production, transportation, and consumption of products and services brought about by trade openness. This is frequently called the "scale effect" of trade (Antweiler, Copeland and Taylor, 2001; World Trade Report 2022: Climate change and international trade).

There are several ways that international trade might reduce emissions. According to Antweiler, Copeland, and Taylor (2001), trade can reduce emissions by promoting changes in production practices that cut emissions per unit of output, a phenomenon known as the "technique effect." Cleaner technology, such as carbon-friendly technologies that might not be available in the importing nations, is made easier to access and implement through international trade. Public desire for a cleaner environment may rise as a result of open trade's increased economic growth and per capita income (World Trade Report 2022: Climate change and international trade).

In the transition to lower-carbon fuels such as biofuels, hydrogen, or renewable electricity, increasing the efficiency of aircraft, vehicles, and vessels, phasing out high-carbon vehicles, and enhancing system-wide operational efficiency—including through the use

of vehicle-sharing and efficient route planning—are some of the main decarbonization pathways for international transportation. The remaining part of carbon emissions from international transit could be neutralized by carbon trading and emerging technologies like carbon capture, utilization, and storage, if it is not possible to completely reduce transportation-related carbon emissions at the source (World Trade Report 2022: International trade and climate change).

The remainder of this paper is structured as follows. In Section 2, a literature review is given. In Section 3, the methodology and data used in this paper are described in this section. Section 4 presents the empirical findings. In Section 5, the discussion and conclusions are provided.

2. LITERATURE REVIEW

In this study, a determination was made to quickly review the literature, which is the previous research done by other researchers related to the current field of research. An overview of the selected topic has been presented.

In an article entitled "Financial Instability and Consumption-based carbon emission in E-7 countries: The role of Trade and Economic Growth" by Adnan Safi, Yingying Chen, Salman Wahab, Shahid Ali, Xianrong Yi and Muhammad Imran. The study examines the effects of financial instability on consumption-based carbon emissions for the E-7 group of countries for 1995-2018. This study makes use of advanced econometric techniques to check for unit root test, cointegration, and short-and long-run estimation. The results for slope heterogeneity use the Pesaran and Yamagata (2008) method, showing that there is a problem of heterogeneity. And also, the results for the cross-sectional dependency test use the Pesaran (2015) method indicate that there is a cross-sectional dependency between the panels with significant test statistics values. The high dependency among the panel variables suggests that a variety of differences in one country affect others.

The paper entitled "Energy Consumption and GDP in developing countries: A cointegrated panel analysis" by Lee (2005). It aims to empirically re-examine the long-run co-movement and the causal relationship between energy consumption, GDP, and real capital stock in a multivariate model using time series data for 18 developing countries from 1975 to 2001. The author analysed statistical tools like panel unit root tests, heterogeneous panel cointegration tests, and a panel-based error correction model. To investigate whether there is fairly strong evidence in favour of the hypothesis that long-run and short-run unidirectional causalities run from energy consumption to GDP, but not vice versa. The results of the panel FMOLS estimates indicate that the coefficients of EC are statistically significant at the 5% level, with a positive effect. The results found that the elasticity of energy consumption and capital stock with respect to GDP is significantly smaller than one, but the growth effect of energy consumption is larger than that of capital stock. It implies that energy is an important ingredient for economic development. The author concluded that high energy consumption tends to have high economic growth.

Kang (2021) examined "CO_2 Emissions Embodied in International Trade and Economic Growth: Empirical Evidence for OECD and Non-OECD Countries." Based on the EKC hypothesis, this study used panel data for OECD and non-OECD countries from 2005 to 2015 to examine the relationship between CO_2 emissions represented in global commerce and economic growth. Granger causality was used in this study to examine the causal relationship between the estimated variables. Using the idea of a pollution refuge, it measured the position of importers and exporters of CO_2 emissions in global trade. In particular, for both total and non-OECD countries, the author found evidence of an inverted U-shaped link between CO_2 emissions and economic growth. This suggests that while CO_2 emissions in trade balances rise during the early phases of economic development, they fall after the income turning point. The results of the study revealed that they are struggling to prevent CO_2 emissions and shift the responsibility for environmental pollution to other nations. As a result, there is a global discussion about how much economic development affects the production and consumption of environmental pollutants and whether or not this trend should continue. The author concluded with their conclusion that whereas developing or less economically developed countries can be relatively net exporters of CO_2 emissions, industrialized nations can be relatively net importers of CO_2 emissions.

The article entitled "CO_2 emissions, economic growth, energy consumption, trade and urbanization in new EU member and their countries: A panel data analysis" by Kasman and Duman (2014). This research aims to investigate the EKC hypothesis for the panel of new EU countries and member nations from 1992 to 2010. To examine the dynamic relationship between carbon emissions, energy consumption, income, trade openness, and urbanization. The testing procedure consists of the following steps. In the first step, the stationarity properties of the time series variables are examined using alternative panel unit root tests. If these variables are non-stationary, the second step is to test whether there is a cointegrating techniques. The test results indicate that most statistics are statistically significant, and therefore, the null hypothesis of no cointegration can be rejected at conventional levels, suggesting that the variables are cointegrated. The results revealed that indicate a positive and significant relationship between the variables of emissions per capita and real income, suggesting that higher income leads to higher emissions. The results found that the coefficients of squared per capita real GDP are negative and significant, indicating a non-linear relationship between per capita real GDP and per capita carbon emissions in the sampled countries. The paper concludes that there was a bidirectional Granger causality relationship between their variables among the carbon dioxide emissions, energy consumption, and GDP, suggesting that the amount of carbon dioxide emissions in the sampled countries will not decrease in the near future if their economic outputs continue to increase.

The study entitled, "The Impact of Fintech and Economic Development on Carbon Emissions in Mobile Money Economies" by Vanitha and Thangaiyarkarasi (2025). Achieving green and low-carbon goals requires innovation, which propels industrial change and upgrading. Many nations actively support the expansion of

FinTech in order to increase the financial services sector's ability to innovate. In the area of a low-carbon, green economy, this will undoubtedly aid in the growth of industry and technology. This study investigated the relationship between fintech in mobile money economies and carbon emissions (CO_2). The study used statistical tools for the Generalised Linear Model (GLM) and unit root using the variables fintech, carbon emissions, domestic credit to the private sector, foreign direct investment, GDP, and trade. In a 10-year period, from 2013 to 2022, the study used statistical tools for the Generalised Linear Model (GLM) and unit root test. The results of the study demonstrated that fintech has a beneficial impact on carbon emissions and will help financial institutions create a green economy and promote the low-carbon economy in order to fulfill the goals of the Paris Agreement. According to the study's findings, the most effective financial technique for lowering carbon emissions (CO_2) globally is fintech, or financial technology.

Thangaiyarkarasi and Vanitha (2021) published a paper titled "The impact of financial development on decarbonization factors of carbon emissions: A global perspective." Carbon dioxide emissions should be reduced in order to mitigate the negative effects of climate change. Coal, oil, and natural gas are examples of the energy sector's harmful emissions that contribute to air pollution and must be minimized. The use of suitable technologies and regulations can result in reductions. One significant component influencing the decision on carbon emissions has been financial development. Using data from ten industrialized countries and five developing countries over a 10-year period, from April 1, 2010, to March 31, 2019, this study aims to investigate the relationship between financial development and carbon emissions using the least square of NLS and ARMA approach. The unit root test, co-integration test, and Kaya identity IPAT model were used in the investigation. Carbon dioxide (CO_2) emissions and GDP per capita were utilized as indicators of environmental degradation and economic financial development, respectively.

Vanitha and Thangaiyarkarasi (2024) published a study titled "The Impact of Carbon Emission and Energy Factors on Climate Change in BRICS Countries." Human activity is the primary source of climate change and global warming, mostly as a consequence of burning or combustion. The use of fossil fuels has raised carbon emissions as a result of the Industrial Revolution's advancement. In the fields of economics, it is one of the primary issues caused by climate change. This study's primary goal is to investigate how climate change affects energy and carbon emissions in the BRICS countries during a 20-year period, from 2003 to 2022. The study examines the connection between GDP, energy factors, and carbon emissions. Granger causality between all variables is analyzed using econometric methods. Energy factors include the variables of energy use, electric power consumption, access to electricity, and renewable energy consumption. The empirical findings demonstrate that raising GDP ultimately leads to a low-carbon economy by lowering carbon emissions. standard correlation between GDP per capita and CO_2 emissions per capita. From 1990 to 2008, both metrics seem to have increased; however, GDP per capita continued to rise while CO_2 emissions started decreasing in parallel with the global economic crisis (Jambor and Balogh, Determinants of CO_2 emission: Aglobal evidence, 2018). As a result of rich nations agreeing to lend money to developing nations, these nations should improve their infrastructure and technologies for adaptation and mitigation, especially by implementing sustainable resilience to the effects of climate change, improving their ability for natural disasters, and shifting to sustainable, low-carbon economies.

The study paper entitled, "The Impact of Economic Growth and Population to Reduce Carbon Emission in Developed Countries" by S. Vanitha, Thangaiyarkarasi, N and P. Srinivasan. One of the most significant concerns facing the modern world is climate action, which has long-term social and psychological, personal, economic, and demographic impacts. As the industrial revolution has advanced, the use of non-renewable energy has led to an increase in carbon emissions, which are the main driver of climate action and global warming in the economic world. The purpose of this study was to ascertain the correlation between population (POP), Gross Domestic Product, Industrial Value (IV), and carbon emissions (CO_2) in developed nations over 10 years, from January 1, 2010, to December 31, 2020. This study looked at how population growth and CO_2 emissions affect economic growth in developed countries. In the context of climate change, GDP and CO_2 emissions were utilized as measures of economic growth and environmental deterioration, respectively. Granger causality was used across all variables in statistical techniques for econometric analysis. Granger causation found that while industrialization increased carbon dioxide emissions over time, when GDP per capita increased, carbon dioxide emissions could decrease. Economic expansion is seen in rich nations as essential to achieving goals and giving developing nations financial support. All of the cointegrated variables were shown to have a long-term connection.

3. MATERIALS AND METHODS

3.1. Materials

In the current context, the study proposes to analyse the problem of achieving net-zero emissions targets, which is extremely important. But it is also important to remember that the goals must align with the needs of climate justice. The problem of a "double-whammy" arises when emerging nations face severe developmental challenges in addition to the climate crisis. Therefore, in order to reach the ultimate goal of net zero emissions, nations that can invest more in the fight against climate change could assist underdeveloped nations. The primary objective of several global climate policies has been to limit the increase in the average global temperature to 2°C or 1.5°C. Net-zero emission objectives are the most current efforts at simplifying the climate change issue in the context of these climate policies. The Paris Agreement's shared but differentiated responsibilities (CBDR) principle must be followed, even though Nations with lower incomes have a major role to play in reaching these goals (Vcansupport, 2021b). This research focuses on an empirical analysis of the carbon emissions associated with international trade and economic growth in E7 countries. The connection between financial instability, international trade, economic growth, and carbon emissions in these countries remains ambiguous. While carbon emissions tend to rise with economic growth, the influence of factors such as financial instability,

technological advancements, and exports on these emissions is not thoroughly comprehended. This study aims to investigate the effects of these variables on carbon emissions, providing valuable insights for policy development that seeks to mitigate emissions while fostering economic progress.

The need for study was the Paris Climate Agreement, which was created in 2015 with the goal of reducing global warming by <2°C. The E-7 economies have set targets to reach carbon neutrality, or net-zero carbon emissions, similar to the rest of the world. Sea level rise, extreme weather events, and ecosystem damage are just a few of the serious and permanent effects of climate change that will result from exceeding these thresholds. India has made the decision to reach carbon neutrality by 2070, while China, Indonesia, and Russia have pledged to do it by 2060. In the same way, Turkey has established a goal to become carbon neutral by 2053, while Brazil and Mexico have set a target for 2050. Jiang et al. (2023). This research investigates the environmental consequences of economic expansion and trade within E7 nations, analysing the influence of financial volatility, technological advancements, and other economic factors on carbon emissions. It emphasizes the necessity for policymakers to access data that enables them to make well-informed choices regarding the equilibrium between growth and environmental sustainability. Furthermore, the study highlights measures that can mitigate carbon emissions while fostering economic development, intending to advance eco-friendly technologies in emerging markets.

The objectives of the analysis are to examine the influence of carbon emissions on international trade and energy use for the E7 countries, to analyse the impact of carbon emissions on economic growth for the E7 countries, and to summarise the findings, suggestions, and conclusions. The present study tested the following null hypotheses: H1: There is no impact of an empirical analysis of carbon emissions on international trade and energy use for the E7 countries, and H2: There is no impact of carbon emissions and economic growth for E7 countries. The E7 Countries were selected as samples for

Table 1: The list of E7 Countries

S. No.	Country Name
1	Brazil
2	China
3	India
4	Indonesia
5	Mexico
6	Russia
7	Turkey

Source: https://www.igi-global.com

this study. The sample was selected for the E7 Countries from the website www.worldbankindicators.com. The sample selection of E7 Countries is shown in Table 1.

The main source of data for this study is Secondary Data. The data were collected from www.worldbankindicators.com. The sample Variables are shown in Table 2. This study aims to choose carbon dioxide emissions (CO_2) as the dependent variable and other variables of international trade (imports and exports), energy use, renewable energy consumption, broad money, domestic credit to the private sector, gross domestic product, as the independent variables. All the variables were transformed into natural logarithms, as the variables were already dimensionless or ratio indexes. This study covers a period of 15 years from 1st January 2009 to 31st December 2023.

3.2. Methodology
3.2.1. Augmented Dickey-Fuller test (ADF)
The Augmented Dickey-Fuller (ADF) test is a statistical test used to determine whether a unit root is present in a time series dataset. A unit root suggests that a time series variable is non-stationary, meaning its mean and variance change over time, and it does not revert to a constant mean over time. The presence of a unit root can indicate that the series has a trend. The ADF test is commonly applied in econometrics and finance to test for the stationarity of a time series, which is an essential assumption in many statistical modeling techniques. The null hypothesis of the ADF test is that the time series has a unit root, indicating it is non-stationary. The alternative hypothesis is that the series is stationary. The test statistic is compared to critical values from a Dickey-Fuller distribution to determine whether to reject the null hypothesis.

3.2.2. Stepwise least squares method
Stepwise least squares regression is a statistical method used for model selection and variable selection in linear regression analysis. It involves iteratively adding or removing predictor variables from a regression model based on certain criteria until an optimal model is achieved.

$$m = N\ \Sigma(xy) - \Sigma x\ \Sigma y\ N\ \Sigma(x2) - (\Sigma x)2$$

Stepwise regression is a statistical technique for fitting regression models in which an automated process selects the predictive variables. A variable is added to or subtracted from the set of explanatory variables in each stage according to a predetermined criterion. This typically takes the shape of an F-test or T-test sequence that is run forward, backward, or combination. There

Table 2: List of variables

S. No.	Name of the variables	Symbols	Measurable indicators
1	Carbon Emission (Dependent Variables)	CO_2	CO_2 Emissions (Metric Tons Per Capita)
2	Energy Use (Independent Variables)	EU	Energy Use (kg of oil equivalent) per $1,000 GDP (Constant 2017 PPP)
3	Renewable Energy Consumption (Independent Variables)	REC	Renewable energy consumption ($of total final energy consumption)
4	Broad Money (Independent Variables)	BM	Broad money (% of GDP)
5	Gross Domestic Product (Independent Variables)	GDP	GDP per capita (constant 2015 US$)
6	Domestic Credit to Private Sector (Independent Variables)	DCPS	Domestic credit provided by financial sector (% of GDP)
7	Import (Independent Variables)	IMP	Import of goods and service (cons2015 U$$)
8	Export (Independent Variables)	EXP	Export of goods and service (constant 2015 U$$)

Source: Data collected from www.worldbankindicators.com

have been calls to either completely abandon stepwise model building or, at the very least, ensure that model uncertainty is accurately reflected by using prespecified, automatic criteria along with a more complex standard error of variance. This is due to the common practice of fitting the final selected model, followed by reporting estimates and confidence intervals without adjusting them to take the model building process into account.

In this paper, the research is focused on objectives, that is to examine the influence of carbon emissions on international trade and energy use for the E7 countries and to analyse the impact of carbon emissions on economic growth for the E7 countries based on panel data of E7 or emerging countries for the period of 15 years. Considering the above research objectives and following the general practice on this topic. Thus, the following model was developed for our empirical analysis:

$$CO_{2it} = f\ (EU_{it}, REC_{it}, BM_{it}, GDP_{it}, DCPS_{it}, IMP_{it}, EXP_{it}) \qquad (1)$$

The empirical model of the study implies that Carbon Emissions (CO_2) are a function of Energy Use (EU), Renewable Energy Consumption (REC), Broad Money (BM), Gross Domestic Product (GDP), Domestic Credit to the Private Sector (DCPS), Import (IMP), and the Export (EXP) in E7 countries or Emerging nations. The model in equation (1) can be rewritten in log-form as follows in equation (2):

$$\log CO_{2it} = \alpha 0 + \alpha_1 \log EU_{it} + \alpha_2 \log REC_{it} + \alpha_3 \log BM_{it} + \alpha_4 \log GDP_{it} + \alpha_5 \log DCPS_{it} + \alpha_6 \log IMP_{it} + \alpha_7 \log EXP_{it} \qquad (2)$$

Where the sub-index 'i' refers to countries and 't' refers to the different years. Where $\log CO_2$ is the natural logarithm of Carbon Emissions, logEU is the natural logarithm of Energy Use, logREC is the natural logarithm of Renewable Energy Consumption, logBM is the natural logarithm of Broad Money, logGDP is the natural logarithm of Gross Domestic Product (GDP), logDCPS is the natural logarithm of Domestic Credit to the Private Sector (DCPS), logIMP is the natural logarithm of Import (IMP), and logEXP is the natural logarithm of Export in E7 countries or Emerging nations. The study was limited to 15 years and based mainly on secondary data. Considering the study's limitations, it is important to acknowledge that the analysis is based on data available up to 2023. This study used certain limited statistical tools, including Normality Descriptive, Correlation, ADF, and Stepwise Least Squares Method (STEPLS).

A measurement of the yearly emissions of carbon dioxide (CO_2), one of the six Kyoto greenhouse gases (GHG), from the waste, industrial, energy, and agricultural sectors, eliminating LULUCF. The IPCC's 5th Assessment Report (AR5) Global Warming Potential (GWP) parameters are used to standardize the metric to carbon dioxide equivalent levels. The term "energy use" refers to the utilization of primary energy prior to conversion to other end-use fuels. This is equivalent to the sum of domestic production, imports, and stock changes, less exports and fuels supplied to ships and aircraft involved in international transportation. The portion of final energy consumption that comes from renewable sources is known as renewable energy consumption. Broad money

(IFS line 35L. ZK) is the total amount of money that remains in banks; demand deposits that do not originate from the central government; time, savings, and foreign currency deposits of resident sectors that are not from the central government; bank and traveler's checks; and other securities like commercial paper and certificates of deposit.

Financial resources given to the private sector by financial corporations, such as loans, purchases of non-equity securities, trade credits, and other accounts receivable that create a claim for repayment, are referred to as domestic credit to the private sector. These claims include credit to governmental enterprises in certain nations. Monetary authorities, deposit money banks, and other financial corporations (including those that do not accept transferable deposits but do incur liabilities like time and savings deposits) are among the financial corporations. Finance and leasing firms, money lenders, insurance businesses, pension funds, and foreign exchange firms are a few examples of more financial corporations. GDP per capita will be determined by dividing the midyear population by the gross domestic product. GDP is the total gross value added by all local producers in the economy, except any subsidies that are not factored into the product value and any product taxes. It is computed without accounting for the depletion and deterioration of natural resources or the depreciation of manufactured assets. The data is always expressed in US dollars from 2015.

All commodities and other market services that are imported from the rest of the globe are valued at the same amount. The value of goods, freight, insurance, transportation, travel, royalties, license fees, and other services like financial, information, business, personal, government, and communication services are all included. They do not include transfer payments, employee remuneration, or investment income (formerly known as factor services). The information is in constant 2015 pricing and is stated in US dollars. The value of all goods and other market-related services provided to the rest of the world is represented by exports of commodities and services. They comprise the value of goods, freight, insurance, transportation, travel, royalties, license fees, and additional services including financial, information, business, personal, government, construction, and communication. Employee compensation, investment income (formerly known as factor services), and transfer payments are not included. The data is provided in US dollars and is based on constant 2015 pricing.

4. EMPIRICAL RESULTS

The summary statistics of CO_2 emissions, energy use, Renewable Energy Consumption, Broad Money, real per capita GDP, Domestic Credit to Private Sector, Export, and Import are presented in Table 3. All the variables were transformed into natural logarithms. The mean value of import reported the highest value at 9.8525 in IMP, and the REC variable recorded a lower value of 1.0364. The mean value at 8.8161 was the difference between the highest and lowest value; it revealed that renewable energy sources reduce carbon emissions through the help of importing goods and services from other countries. The maximum value of export was 12.3017, and the minimum value was 0.000

revealed at energy use, renewable energy consumption, broad money, domestic credit to the private sector, export, and import. The value of standard deviation at 4.0456 was high, which reveals that the value deviates from the average value. All the variables reported a skewness value to be negative, except carbon emission and energy use. The negative skewed showed in the left tail and the peak on the right side. In kurtosis, the variable of broad money and domestic credit to the private sector has a higher value at 10.5009 and 12.3476, indicating a long right tail of positive kurtosis of measures of dispersion, and the variables of export and import also have greater values of normal kurtosis, i.e., k > 0. Then, the other variables of carbon emissions, energy use, renewable energy use, and gross domestic product are less than those of the normal distribution, and hence, it is platykurtic. The descriptive results found that the mean values of imports and exports were 9.8525 and 9.8410, respectively. This indicates that the effect of international trade (trade openness) on carbon emissions in the E7 countries is complicated and varies by nation along with specific situation. It suggests that trade liberalization can enhance environmental quality (which could be through technology transfer), but it frequently raises emissions because of increased production and transportation dimensions.

The results of the correlation for the E7 Countries are shown in Table 4. The correlation between the variables applied in the E7 Countries. The variables of carbon emissions, energy use, renewable energy consumption, broad money, domestic credit to the private sector, gross domestic product, export, and import were transformed into logarithmic values. It measures the strength of the linear relationship between two variables. The variables of CO_2, BM, and domestic credit to private sector reveal a low positive correlation. When the variables of broad money and domestic credit to the private sector show a strong positive correlation

relationship between them, it reveals the values of 0.974 and 0.999, respectively. When compared to carbon emissions and broad money reveal the value of 0.2842, and carbon emissions with domestic credit to private sector revealed at 0.3022, it indicates a weak performance of the positive correlation relationship between their variables. The variable of carbon emissions compared with other variables of energy use, renewable energy consumption, gross domestic product, export, and import was revealed to have a negative correlation with their variables. It reveals a negative correlation, also known as inverse correlation. When one variable increases, the other variable also decreases.

The results of the unit root test for the E7 Countries are presented in Table 5. The sample variables of Carbon Emission, Energy Use, Renewable Energy Consumption, Broad Money, Gross Domestic Product, Domestic Credit to the Private Sector, Export, and Import were used in the study during the study period. For analysis, the unit root test, encompassing the ADF test and PP test statistics, was employed to determine the stationarity of the sample variable. It is to be noted that the statistical values of the ADF test the variables Broad Money this case has the lowest P-value 0.001, which is a strong indication that the null hypothesis is rejected. Similarly, the variables also exhibit low P-values of 0.0000, respectively, providing evidence for their stationarity. In an ADF test of t-statistics, all the variables are reported as negative values. The probability values of energy use, renewable energy use, broad money, and domestic credit to the private sector are less than the P-value of a significant level at 5%, which indicates the non-stationary and hence it has a unit root. And the other variables like carbon emissions, gross domestic product, export, and import are higher than the P = 0.05 level. In a Philips- perron test, the results of statistical values for all the variables are negative values. Accordingly, the probability value of energy use, renewable energy

Table 3: Results of descriptive statistics for E7 countries from 1st January 2009 to 31st December 2023

S. No.	Variables	Mean	Maximum	Minimum	Standard deviation	Skewness	Kurtosis
1	CO_2	3.0470	4.1225	2.4791	0.4996	0.9202	2.5867
2	EU	1.3701	3.7127	0.0000	1.5906	0.3148	1.1510
3	REC	1.0364	1.6990	0.0000	0.5293	−0.7551	2.5071
4	BM	1.7389	2.3578	0.0000	0.4572	−2.3933	10.5009
5	DCPS	1.6745	2.2893	0.0000	0.4002	−2.5440	12.3476
6	GDP	3.8024	4.1677	3.0626	0.2986	−1.1178	2.8576
7	EXP	9.8410	12.3733	0.0000	4.0409	−2.0327	5.1484
8	IMP	9.8525	12.3017	0.0000	4.0456	−2.0325	5.1480

Source: Data collected from www.worldbankindicators.com and computed using E-Views. CO_2 denotes Carbon Emission, EU denotes Energy Use, REC denotes Renewable Energy Consumption, BM denotes Broad Money, GDP denotes Gross Domestic Product, DCPS denotes Domestic Credit to Private Sector, EXP denotes Export, and IMP denotes Import

Table 4: Results of Correlation for E7 Countries from 1st January 2009 to 31st December 2023

S. No.	Variables	CO_2	EU	REC	BM	DCPS	GDP	EXP	IMP
1	CO_2	1.0000	−0.0972	−0.1773	0.2842	0.3022	−0.1281	−0.7558	−0.7577
2	EU	−0.0972	1.0000	0.2001	0.0806	0.0486	−0.0408	−0.0023	0.0034
3	REC	−0.1773	0.2001	1.0000	0.3719	0.3145	−0.3830	0.1095	0.1160
4	BM	0.2842	0.0806	0.3719	1.0000	0.9074	0.0640	−0.3651	−0.3631
5	DCPS	0.3022	0.0486	0.3145	0.9074	1.0000	0.1834	−0.3819	−0.3817
6	GDP	−0.1281	−0.0408	−0.3830	0.0640	0.1834	1.0000	−0.1895	−0.1940
7	EXP	−0.7558	−0.0023	0.1095	−0.3651	−0.3819	−0.1895	1.0000	0.9999
8	IMP	−0.7577	0.0034	0.1160	−0.3631	−0.3817	−0.1940	0.9999	1.0000

Source: Data collected from www.worldbankindicators.com and computed using E-Views. CO_2 denotes Carbon Emission, EU denotes Energy Use, REC denotes Renewable Energy Consumption, BM denotes Broad Money, GDP denotes Gross Domestic Product, DCPS denotes Domestic Credit to Private Sector, EXP denotes Export, and IMP denotes Import

consumption, broad money, domestic credit to the private sector, export, and import is revealed at a significant level of P < 5%. And the rest of the variables of carbon emission and gross domestic product, were a higher probability value of a significant level of 5%.

The Johnsen's Cointegration results are shown in Table 6 for the E7 Countries. The results show the cointegration equation with the variables of carbon emissions, energy use, renewable energy consumption, gross domestic product, broad money, domestic credit to the private sector, export and import. To compare the trace statistic and the maximum eigenvalue statistic to their respective critical values. The carbon emission value of trace statistics is 166.2695 greater than the critical value of 159.5297, which indicates that there exists a cointegration relationship between the variables. The other variable value of the trace statistic was lower than the critical value, which means to accept the null hypothesis. When the probability value of carbon emissions was revealed at 0.0203, which is less than the significance level of 0.05. The max-eigen statistic value of carbon emission 52.8889 exceeds a critical value of 52.3626, thus rejecting the null hypothesis. Thus, all the variables are cointegrated with each other. The other max-eigen statistic variables of EU, REC, GDP, BM, DCPS, EXP and IMP are less than the critical value, fail to reject the null hypothesis. The probability value of 0.0441 is less than the significance level of 5%. The import variable for the Trace statistic value of 1.9423 and the max-eigen statistic value of 1.9423 were the same.

The regression results of stepwise Least squares methods for Brazil from the year 2009 to 2023 are shown in Table 7. All variables are

expressed in natural logarithms. The study shows negative results for renewable energy consumption, domestic credit to the private sector, and imports, revealed at −0.0059, −0.0397 and −0.2591, respectively. It shows a significant negative relationship between CO_2 emissions and REC, CO_2 emissions and DCPS, and also CO_2 emissions and imports. To suggest that a unit increase in REC, DCPS and IMP in the Brazil countries reduces carbon emissions at −0.0059, −0.0397 and −0.2591. Further, the other variables of EU, BM, GDP, and EXP show a positive and significant relationship with a 1% increase, then the carbon emissions also increase by 0.0018, 0.0423, 1.6677 and 0.0064. Among all variables, only GDP has a statistically significant impact on the dependent variable, with a positive coefficient of 1.6677 and a P = 0.0435. This suggests that economic growth plays a substantial role in influencing carbon emissions. Other variables like EU, REC, BM, DCPS, EXP, and IMP have P-values well above 0.05, indicating they are not statistically significant in the model. The R-squared value of 0.8721 implies that approximately 87% of the variation in the dependent variable is explained by the model, while the adjusted R-squared of 0.7443 accounts for the number of predictors. A higher R-Squared suggests a better-fitting model for the study. The Durbin-Watson statistic of 2.1799 suggests no serious autocorrelation in the residuals.

The Table 8 presents the results of the least squares method for China from the period of 2009 to 2023. All the variables were transformed into natural logarithms. The study shows the relationship between domestic credit to the private sector and carbon emissions with −0.4240, suggesting that a one-unit increase in domestic credit to the private sector in China will reduce carbon emissions by −0.4240. Further, the variable of energy use, renewable energy consumption, broad money and GDP shows a significantly positive relationship with carbon emissions to reveal that a 1% increase in those variables increases carbon emissions in China by 0.0123, 0.0072, 0.3930, and 0.7288, respectively. The probability value of energy use and GDP were significantly less than the 0.05 level, as revealed at 0.0048 and 0.0000, and it suggests that the variables of energy use and GDP were statistically significant predictors of the carbon emissions. Then the other variables of probability value show that they were >5% or 0.05, which means the chances of error were high for that particular variable. The model has an R-squared value of 99%, indicating that the variability in the dependent variable is explained by the independent variables. The Adjusted R-squared value of 0.9745 suggests a good fit after adjusting for the number of predictors. The Durbin-Watson statistic of 2.2308 indicates that there is no significant autocorrelation.

Table 5: Results of unit root test for E7 countries from 1st January 2009 to 31st December 2023

S. No.	Variables	Augmented Dickey-Fuller test statistics		Philips-Perron test statistics	
		Statistic	Prob.	Statistic	Prob.
1	CO_2	−2.0962	0.2467	−2.1620	0.2215
2	EU	−8.364	0.0000	−4.1864	0.0011
3	REC	−3.238	0.0206	−4.4319	0.0005
4	BM	−4.2145	0.0001	−4.0827	0.0016
5	GDP	−1.7437	0.4065	−1.7484	0.4041
6	DCPS	−3.1741	0.0244	−4.7217	0.0002
7	EXP	−2.7096	0.0758	−3.706	0.0053
8	IMP	−2.7134	0.0752	−3.6945	0.0055

Source: Data collected from www.worldbankindicators.com and computed using E-Views. CO_2 denotes Carbon Emission, EU denotes Energy Use, REC denotes Renewable Energy Consumption, BM denotes Broad Money, GDP denotes Gross Domestic Product, DCPS denotes Domestic Credit to Private Sector, EXP denotes Export, and IMP denotes Import

Table 6: Results of Johnsen Cointegration Test for E7 Countries from 1st January 2009 to 31st December 2023

S. No.	No. of variables	Eigenvalue	Trace statistic	Critical value	Prob.**	Max-Eigen statistic	Critical value	Prob.**
1	CO_2	0.4337	166.2695	159.5297	0.0203	52.8889	52.3626	0.0441
2	EU	0.2898	113.3806	125.6154	0.2179	31.8303	46.2314	0.6684
3	REC	0.2356	81.5504	95.7537	0.3147	24.9904	40.0776	0.7681
4	GDP	0.1961	56.5600	69.8189	0.3558	20.2984	33.8769	0.7357
5	BM	0.1491	36.2616	47.8561	0.3833	15.0147	27.5843	0.7471
6	DCPS	0.1081	21.2468	29.7971	0.3424	10.6421	21.1316	0.6829
7	EXP	0.0889	10.6047	15.4947	0.2370	8.6624	14.2646	0.3153
8	IMP	0.0207	1.9423	3.8415	0.1634	1.9423	3.8415	0.1634

Source: Data collected from www.worldbankindicators.com and computed using E-Views. CO_2 denotes Carbon Emission, EU denotes Energy Use, REC denotes Renewable Energy Consumption, BM denotes Broad Money, GDP denotes Gross Domestic Product, DCPS denotes Domestic Credit to Private Sector, EXP denotes Export, and IMP denotes Import

The results of the regression model for India are reported in Table 9. The coefficient of renewable energy consumption shows a significant negative relationship between carbon emissions with −0.1416 to suggests that a unit increase in renewable energy in India reduces carbon emissions by −0.1416%. Then the variable of broad money and imports showed a negative coefficient relationship

Table 7: Results of full regression stepwise least squares for Brazil from 1st January 2009 to 31st December 2023

S. No.	Variables	Coefficient	Standard error	t-Statistic	Prob.
1	EU	0.0018	0.0035	0.5265	0.6148
2	REC	−0.0059	0.0127	−0.4593	0.6600
3	BM	0.0423	0.2965	0.1428	0.8905
4	GDP	1.6677	0.6781	2.4593	0.0435
5	DCPS	−0.0397	0.2205	−0.1802	0.8621
6	EXP	0.0064	0.2392	0.0269	0.9793
7	IMP	−0.2591	0.379	−0.6835	0.5163
8	R-squared	---	---	---	0.8721
9	Adjusted R-squared	---	---	---	0.7443
10	Durbin-Watson stat	---	---	---	2.1799

Source: Data collected from www.worldbankindicators.com and computed using E-Views. CO_2 denotes Carbon Emission, EU denotes Energy Use, REC denotes Renewable Energy Consumption, BM denotes Broad Money, GDP denotes Gross Domestic Products, DCPS denotes Domestic Credit to Private Sector, EXP denotes Export, and IMP denotes Import

Table 8: Results of full regression stepwise least square for China from 1st January 2009 to 31st December 2023

S. No.	Variables	Coefficient	Standard error	t-Statistic	Prob.
1	EU	0.0123	0.0033	3.7141	0.0048
2	REC	0.0072	0.0086	0.8357	0.4249
3	BM	0.3930	0.2450	1.6038	0.1432
4	GDP	0.7288	0.0799	9.1171	0.0000
5	DCPS	−0.4240	0.1916	−2.2126	0.0542
6	R-squared	---	---	---	0.9836
7	Adjusted R-squared	---	---	---	0.9745
8	Durbin-Watson stat	---	---	---	2.2308

Source: Data collected from www.worldbankindicators.com and computed using E-Views. CO_2 denotes Carbon Emission, EU denotes Energy Use, REC denotes Renewable Energy Consumption, BM denotes Broad Money, GDP denotes Gross Domestic Products, DCPS denotes Domestic Credit to Private Sector, EXP denotes Export, IMP denotes Import

Table 9: Results of full regression stepwise least square for India from 1st January 2009 to 31st December 2023

S. No.	Variables	Coefficient	Standard error	t-Statistic	Prob.
1	EU	0.0065	0.0073	0.8992	0.3984
2	REC	−0.1416	0.4310	−0.3284	0.7522
3	BM	−0.5394	0.4198	−1.2848	0.2397
4	GDP	0.7874	0.2192	3.5923	0.0088
5	DCPS	0.7261	0.2241	3.2402	0.0142
6	EXP	0.1508	0.1542	0.9777	0.3608
7	IMP	−0.1006	0.1246	−0.8069	0.4462
8	R-squared	---	---	---	0.9893
9	Adjusted R-squared	---	---	---	0.9787
10	Durbin-Watson stat	---	---	---	2.2697

Source: Data collected from www.worldbankindicators.com and computed using E-Views. CO_2 denotes Carbon Emission, EU denotes Energy Use, REC denotes Renewable Energy Consumption, BM denotes Broad Money, GDP denotes Gross Domestic Products, DCPS denotes Domestic Credit to Private Sector, EXP denotes Export, IMP denotes Import

with carbon emissions with −0.5394 and −0.1006, to suggests that a unit increase in BM and IMP in India reduces carbon emissions by −0.5394 and −0.1006%, respectively. Then the other variables of EU, GDP, DCPS, and EXP show a positive and significant relationship with CO_2 to reveal that a 1% increase in these variables increases CO_2 in India by 0.0065, 0.7874, 0.7261 and 0.1508, respectively. The probability value of GDP and DCPS was less than the significance level of 0.05. Then the probability value of other variables of EU, REC, BM, EXP, and IMP were >5% or 0.05 significance level, which means the chances of error are high. For robustness, the R-square and the adjusted R-square values for 0.9893 and 0.9787, which are 99% and 97%. A higher R-squared indicates a better fit of the model. The Durbin-Watson statistic of 2.2697 indicators that there is no significant autocorrelation.

Table 10 presents the results of the regression for Indonesia from 2009 to 2023. The coefficient value for BM, DCPS, and IMP shows a negative relationship with the dependent variable of CO_2 emissions, with the value of −0.2866, −0.3331, and −0.2841 to suggest that a unit increase in BM, DCPS, and IMP in Indonesia countries reduces carbon emissions by −0.2866, −0.3331, and −0.2841%. The other variables of EU, REC, GDP and EXP show a positive coefficient; it significantly related to carbon emission, showing that a 1% increase in these variables also increases CO_2 by 0.029, 0.0354, 0.9433, and 0.6935, respectively. The probability value of all variables is greater than the significance level of 0.05. It means the chances of error are high in the regression results of probability values. The R-square value of 0.9642, which means that 96% of the variance in the dependent variable is predictable from the independent variable. It indicates a better fit of the model to the panel data. The Adjusted R-square value of 0.9285 suggests a good fit after adjusting for the number of predictors. The Durbin-Watson statistic of 2.2672 indicators that there is no significant autocorrelation.

According to Table 11 presents the result of Stepwise Least Square method, the coefficient for EU is 0.0018, indicating a positive relationship with the dependent variable with a P = 0.6148. The coefficient for REC is −0.0059, indicating a negative relationship with the dependent variable with a P = 0.6600. The coefficient for GDP is 1.6677, indicating a positive relationship with the

Table 10: Results of full regression stepwise least square for Indonesia from 1st January 2009 to 31st December 2023

S. No.	Variable	Coefficient	Standard error	t-Statistic	Prob.
1	EU	0.0029	0.0086	0.3407	0.7433
2	REC	0.0354	0.0221	1.5954	0.1546
3	BM	−0.2866	0.3144	−0.9114	0.3924
4	GDP	0.9433	0.4593	2.0537	0.0791
5	DCPS	−0.3331	0.2503	−1.3307	0.2250
6	EXP	0.6935	0.6577	1.0545	0.3267
7	IMP	−0.2841	0.4688	−0.6061	0.5636
8	R-squared	---	---	---	0.9642
9	Adjusted R-squared	---	---	---	0.9285
10	Durbin-Watson stat	---	---	---	2.2672

Source: Data collected from www.worldbankindicators.com and computed using E-Views. CO_2 denotes Carbon Emission, EU denotes Energy Use, REC denotes Renewable Energy Consumption, BM denotes Broad Money, GDP denotes Gross Domestic Product, DCPS denotes Domestic Credit to Private Sector, EXP denotes Export, and IMP denotes Import

dependent variable, with the P = 0.0435. The coefficient for DCPS is −0.0397, indicating a negative relationship with the dependent variables, with the P = 0.8621. The model has an R-squared value of 87%, indicating that the variability in the dependent variable is explained by the independent variables. The Adjusted R-squared value of 0.7443 suggests a good fit after adjusting for the number of predictors. The Durbin-Watson statistic of 2.1799 indicates that there is no significant autocorrelation.

The results of the regression model for Russia are reported in Table 12. The coefficient for EU is 0.002, indicating a negative relationship with the dependent variable, with a P = 0.8312. The coefficient for REC is −0.0717, indicating a positive relationship with the dependent variable, with the P = 0.8344. The coefficient for GDP is 0.9433, indicating a negative relationship with the dependent variable, with the P = 0.4249. The coefficient for REC is 0.0072, indicating a negative relationship with the dependent variable with a P = 0.4249. The coefficient for DCPS is 0.0542, indicating a negative relationship with the dependent variables with the P-value with a P = 0.9745. The model has an R-square value of 99%, indicating that the variability in the dependent variables is explained by the independent variables. The Adjusted

R-squared value of 0.7866 suggests a good fit after adjusting for the number of predictors. The Durbin-Watson statistic of 0.9474 indicates that there is no significant autocorrelation.

Table 13 presents the result of the Stepwise Least Squares method for Turkey from 1 January 2009 to 31 December 2023. All the variables were transformed into logarithms. The coefficients for EU, BM, DCPS, EXP, and IMP were a negative value of -0.0058, -0.2523, -0.4021, -0.1367, and -0.0492, indicating a negative relationship with the dependent variable. Then the t-statistic value of EU, BM, DCPS, EXP and IMP were also a negative value revealed at -0.9070, -0.6948, -0.9554, -0.3295, and -0.1194. The other coefficient values of REC, DCFS, and GDP were positive, but the probability value of these variables was revealed to be greater than the significance level of 5 per cent. The effect of the dependent variable on the independent variable was insignificant level. The R-square value of 0.9833 shows a higher value of 98 per cent, it seems to be fit for the model. And the adjusted R-Square value of 0.9389 suggests that 93 per cent good fit to the model. The Durbin-Watson statistic value was 3.4692, which shows that there is a negative autocorrelation.

The regression results of the stepwise least squares method are presented in Table 14 for the E7 Countries or the E7 economies. The coefficient value of domestic credit to the private sector and exports had a positive relationship with the dependent variable of 0.3033 and 0.9290, and the probability value of DCPS and exports was insignificant level because the P-value was more than 0.05 level of significance. The other variables of energy use, broad money, gross domestic product, imports and renewable energy consumption showed a significant negative relationship with carbon emissions to suggest that a unit increase in these variables in E7 countries reduces the carbon emissions by −0.0077, −0.0712, −0.7535, −1.0189 and −0.2483, respectively. The probability value of gross domestic product and renewable energy consumption is <5% or a 0.05 level of significance, which means the regression results are considerable and the variables are significant to each other. The R-squared value shows the

Table 11: Results of full regression stepwise least square for Mexico from 1st January 2009 to 31st December 2023

S. No.	Variable	Coefficient	Standard error	t-Statistic	Prob.
1	EU	0.0018	0.0035	0.5265	0.6148
2	REC	−0.0059	0.0127	−0.4593	0.6600
3	BM	0.0423	0.2965	0.1428	0.8905
4	GDP	1.6677	0.6781	2.4593	0.0435
5	DCPS	−0.0397	0.2205	−0.1802	0.8621
6	EXP	0.0064	0.2392	0.0269	0.9793
7	IMP	−0.2591	0.3791	−0.6835	0.5163
8	R-squared	---	---	---	0.8721
9	Adjusted R-squared	---	---	---	0.7443
10	Durbin-Watson stat	---	---	---	2.1799

Source: Data collected from www.worldbankindicators.com and computed using E-Views. CO_2 denotes Carbon Emission, EU denotes Energy Use, REC denotes Renewable Energy Consumption, BM denotes Broad Money, GDP denotes Gross Domestic Products, DCPS denotes Domestic Credit to Private Sector, EXP denotes Export, IMP denotes Import

Table 12: Results of Full Regression Stepwise Least Square for Russia from 1st January 2009 to 31st December 2023

S. No.	Variable	Coefficient	Standard error	t-Statistic	Prob.
1	EU	0.002	0.0090	0.2212	0.8312
2	REC	−0.0717	0.2095	−0.3425	0.7421
3	BM	−0.0096	0.0091	−1.0566	0.3258
4	GDP	0.6907	0.4734	1.4590	0.1879
5	DCPS	0.0099	0.0661	0.1502	0.8848
6	EXP	0.0392	0.1806	0.2170	0.8344
7	IMP	−0.0393	0.1817	−0.2162	0.8350
8	R-squared	---	---	---	0.8933
9	Adjusted R-squared	---	---	---	0.7866
10	Durbin-Watson stat	---	---	---	0.9474

Source: Data collected from www.worldbankindicators.com and computed using E-Views. CO_2 denotes Carbon Emission, EU denotes Energy Use, REC denotes Renewable Energy Consumption, BM denotes Broad Money, GDP denotes Gross Domestic Products, DCPS denotes Domestic Credit to Private Sector, EXP denotes Export, IMP denotes Import

Table 13: Results of Full Regression Stepwise Least Squares for Turkey from 1st January 2009 to 31st December 2023

S. No	Name of the Variables	Coefficient	Standard. Error	t-Statistic	Probability
1	EU	−0.0058	0.0064	−0.9070	0.4313
2	REC	0.0833	0.1147	0.7258	0.5204
3	BM	−0.2523	0.3631	−0.6948	0.5372
4	DCPS	−0.4021	0.4209	−0.9554	0.4099
5	DCFS	0.4009	0.6863	0.5841	0.6002
6	GDP	1.2542	1.2861	0.9752	0.4014
7	EXP	−0.1367	0.4149	−0.3295	0.7634
8	IMP	−0.0492	0.4121	−0.1194	0.9125
9	R-squared	---	---	---	0.9833
10	Adjusted R-squared	---	---	---	0.9389
11	Durbin-Watson stat	---	---	---	3.4692

Source: Data collected from www.worldbankindicators.com and computed using E-Views. CO_2 denotes Carbon Emission, EU denotes Energy Use, REC denotes Renewable Energy Consumption, BM denotes Broad Money, GDP denotes Gross Domestic Products, DCPS denotes Domestic Credit to Private Sector, EXP denotes Export, IMP denotes Import

Table 14: Results of the regression of stepwise least square method for the E7 countries from 1st January 2009 to 31st December 2023

S. No.	Variable	Coefficient	Standard error	t-Statistic	Prob.
1	C	6.6983	0.4169	16.0665	0.0000
2	DCPS	0.3033	0.1678	1.8079	0.0738
3	EU	−0.0077	0.0179	−0.4289	0.6690
4	BM	−0.0712	0.1437	−0.4957	0.6213
5	GDP	−0.7535	0.1045	−7.2123	0.0000
6	IMP	−1.0189	0.4852	−2.1002	0.0384
7	REC	−0.2483	0.0665	−3.7344	0.0003
8	EXP	0.9290	0.4850	1.9155	0.0585
9	R-squared	---	---	---	0.7394
10	Adjusted R-squared	---	---	---	0.7200
11	S.E. of regression	---	---	---	0.2655
12	Durbin-Watson stat	---	---	---	0.7817

Source: Data collected from www.worldbankindicators.com and computed using E-Views. CO_2 denotes Carbon Emission, EU denotes Energy Use, REC denotes Renewable Energy Consumption, BM denotes Broad Money, GDP denotes Gross Domestic Products, DCPS denotes Domestic Credit to Private Sector, EXP denotes Export, IMP denotes Import

proportion of the variance in the dependent variable that is predictable from the independent variables. The R-squared value shows 0.7394 or 73% fit for the model. The value of Durbin-Watson revealed positive autocorrelation because the values are 0.7817, which is less than the value of 2.

The following are the major findings of the study. They are as follows:

The study found a long-term relationship among carbon emissions, energy use, renewable energy consumption, gross domestic product, broad money, domestic credit to the private sector, export, and import for the E7 Countries. The results of this study show that the mean value of export and import is higher than the other values. Mean value shows the average value of the data in the E7 Countries. The maximum value of 12.3733 and the minimum value of 0.000, and the difference between these highest and lowest values of 12.3733 show the range value of statistics. The standard deviation of imports shows the highest value of 4.0456, which explains how the deviations are from the average or mean value.

In the unit root test, the statistic values of the ADF test are negative, and the probability values of carbon emissions, gross domestic product, export and import are revealed greater than the significance level of 0.05; the series is non-stationary, which means there is a high probability that the observed result is due to random chance alone. In a Phillips-Perron test, the statistic values are negative, and the probability value of energy use, renewable energy consumption, broad money, domestic credit to the private sector, export and import are reported at the significant level is less than the 0.05 level, the series is stationary, which means the statistical properties, such as mean, variance, and autocorrelation, are constant over time.

The stepwise least squares regression results for developing economies or nations in the E7 group. The results of the regression analysis showed that the coefficient values for energy use, broad money, GDP, imports, and renewable energy consumption are all negative. This means that when the independent variable rises, the

dependent variable tends to fall. While the use of non-renewable energy contributes significantly to pollution, the use of renewable energy generally benefits the environment by lowering emissions.

In Mexico and Brazil, the independent variable of gross domestic product revealed a $P < 0.05$, which means that economic growth in an individual country will help reduce carbon emissions. In India, the fastest-growing economy and also the third-largest carbon emitter country, the gross domestic product and domestic credit to the private sector are less than the probability value of 0.05. China is the second-largest emitter in the world, and in that country, the variable of gross domestic product and energy use reveals a less significant level of probability value, 0.05%.

The paper suggests that Seven nations, which have the potential to become significant economic powers in the twenty-first century are referred to as the "Emerging 7," or E7 nations. Brazil, China, India, Indonesia, Mexico, Russia, and Turkey are some of these nations. The necessity for these nations to switch to more sustainable types of economic development in order to address the urgent environmental issues of our day has come to light more and more in recent years. Adoption of green energy technology and the encouragement of structural adjustments that facilitate its broad implementation are important components of this shift. Green energy sources like solar and wind can lower greenhouse gas emissions and other pollutants while simultaneously offering a dependable supply of electricity. Additionally, switching to green energy can help nations achieve their sustainability and climate goals while also allowing for new economic opportunities (Sarpong et al, 2023).

To satisfy growing energy demands without becoming more dependent on fossil fuels, E7 countries should prioritise investments in clean energy infrastructure and green technological innovation. The development of sustainable urban policy and low-carbon urban infrastructure is essential, given the rate of urbanisation. Additionally, urban areas can be used as green innovation hubs. Maintain international agreements (such as the Copenhagen Conference's pledge to reduce CO_2 emissions per GDP unit) and leverage cross-border collaboration to promote technology transfer and funding for sustainable development. According to the findings, achieving the Sustainable Development Goals (SDGs), particularly those on affordable and clean energy (SDG 7) and climate action (SDG 13), will necessitate a paradigm shift toward low-carbon energy sources that are more environmentally beneficial (World Trade Report 2022: Climate change and international trade).

The study examines relationship between carbon emissions in international trade and economic growth for the E7 countries or emerging nations. The study should focus on the scope for further research, which is in order to determine the actual carbon footprint of the E7 countries' domestic consumption relative to their exports and how this compares to industrialised countries, this study focuses on consumption-oriented emissions. The majority of research focuses on emissions that are produced contained within a nation's borders, or production-based emissions. Further research is required to determine how international trade and green

finance systems may help E7 nations adopt and transfer clean, low-carbon technology, as well as how successful these transfers are at lowering emissions. To assess the impact of particular policy measures on emissions, such as tradeable permit systems, carbon border adjustments, and environmental levies, more research is needed. In the context of international trade, further research is needed to evaluate the impact of particular policy instruments on the emissions trajectories of E7 countries, such as environmental taxes, carbon border adjustments, and tradeable permit systems. In order to identify focused mitigation measures, research may concentrate on particular energy-intensive industrial sectors (such as chemicals, metals, and textiles) that account for the majority of embodied emissions in E7 exports.

5. CONCLUSION

This study has to analyse the panel unit root test, the co-integration test, and the stepwise least squares method to test for the long-run and short-run relationships among variables such as CO_2 emissions, energy use, gross domestic product, domestic credit to the private sector, broad money, renewable energy consumption, imports, and exports. At the 2021 United Nations Climate Change Conference (COP26), a large number of governments, vehicle manufacturers, shippers and financial institutions signed the Glasgow Declaration on Zero-Emission Cars and Vans, committing to ensuring that new cars and vans being sold by 2035 in leading markets, and by 2040 for the rest of the world, would be zero-emission. In addition, 15 high-income economies signed a Global Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles to work together to increase sales of new zero-emission trucks and buses to 30% by 2030 and to 100% by 2040. In 2021, the International Road Transport Union (IRU), which represents the road transport industry in over 80 countries, launched a Green Compact to achieve carbon neutrality by 2050 (IRU, 2021) (World Trade Report 2022: Climate change and international trade.)

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