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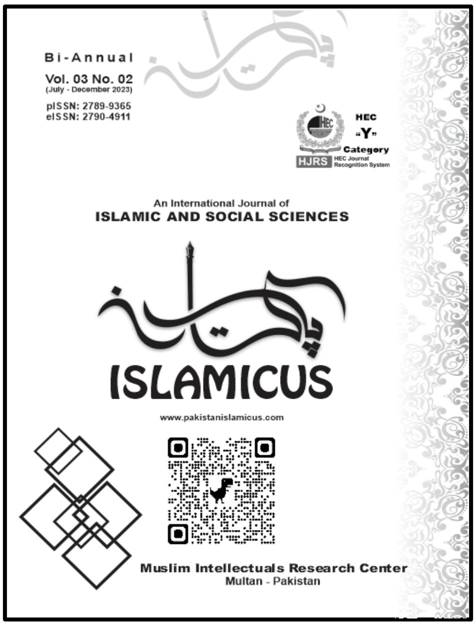

TOPIC

NEXUS BETWEEN ECONOMIC GROWTH, ENERGY CONSUMPTION AND ENVIRONMENTAL DEGRADATION: EMPIRICAL EVIDENCE FROM ECONOMIC COOPERATION ORGANIZATION COUNTRIES

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Abstract

Environmental sustainability is the most important concern all over the world due to low carbon emissions. A sufficient study has been conducted about the factors that influence carbon emissions in various regions of the world, whereas ECO (Economic Cooperation Organization) countries have yet to have such literature. The goal of this study is to examine the impact of economic growth, energy consumption, trade openness, gross capital formation, and urban population on carbon dioxide emissions using panel methods. Panel data we used in this research from 1993-2019 for nine economic cooperation organisation economies. We use the different panel unit root, Cross-sectional dependency, and panel Waterland tests, especially FMOLS and DOLS. The various Panel Unit Root test outcomes demonstrate that, at 1st difference, all variables are stationary. Panel cointegration techniques like (Westerlund) verify that the entire set of variables is cointegrated. In the end, FMOLS and DOLS findings reveal that all variables, including economic growth, consumption of energy, urban population, trade openness, and urban population, have a favourable and statistically significant effect on emissions of carbon dioxide (CO2). However, gross capital formation has no statistically significant impact on emissions of carbon dioxide. The research outcome of this study helps every relevant stakeholder, particularly practitioners, environmentalists, and researchers, in developing applicable policies for the sustainability of the environment, like in the reductions in carbon dioxide emissions in the Economic Cooperation Organization.

Keywords: Carbon Emission, Energy Consumption, GDP, FMOLS, DOLS and ECO Countries.

Introduction

The natural environment as a whole is the most important factor in sustaining economic activity. “It plays a crucial role in the supply of assets and raw materials (such as timber, water, and minerals), requires the input of raw materials for the manufacturing of goods and services, and indirectly provides the output provided by the ecosystem, which includes water purification, flood risk management, carbon sequestration, and nutrient cycling).” Jamil and derbali,2016. For today and generations to come, natural resources are required for economic growth and expansion.

Environmental degradation is one of the biggest challenges facing the world today. Human health, the ozone layer, biodiversity, air superiority, natural resources (such as water, forests, and soil), and the economy as a whole are all negatively affected by it. Among the factors that have an effect on environmental degradation, the increasing trend of worldwide emissions of carbon dioxide is the main movement related to the growth of energy demand. In 2017, 2.1 per cent increase in worldwide demand for energy, up from 0.9 percent in 2016, with a typical increase of 0.9 per cent during the previous five years. Global electricity demand is growing at a considerably faster rate (3.1%) than overall energy demand. China and India, both of the most heavily populated regions, are experiencing 70 percent economic growth.

Furthermore, energy demand is another major problem, as is increasing population and urbanisation (Zhang et al., 2017), which is even more important to prevent fast disturbances and worldwide climate change. Energy is vital for daily activities as well as the total economy's social, economic, and environmental growth. It can be tough to collect, transport, or consume everyday items without the use of energy. As a result, an investigation shows that a lack of energy reduces the productivity of different sectors of society, including transportation and social life (Yildirim, 2017). The worldwide climate is under threat as a result of the rising use of energy. This has resulted in long-term droughts, increasing sea levels, and greater heat waves, all of which have had serious adverse effects on the environment. However, individuals have concluded that human activities are coming to an end. Carbon dioxide (CO2) and other greenhouse gases are increasingly being emitted into the atmosphere (Michie, 2015). Similarly, the desire for economic growth has resulted in environmental damage, which is typically an outcome of growth and industrial growth in both emerging and developed nations. The economic expansion of every economy is dependent on a variety of factors, some of which may have a negative impact on the environment, such as the harvesting of unstable resources, pollution, and climate change. According to Phimphanthavong (2013), rapid urbanisation and growth in the economy in many countries have resulted in a rise in the use of energy. As a result, the fundamental issue confronting many countries is that increased energy use, along with economic expansion, has resulted in a significant rise in carbon dioxide levels in the atmosphere. Additionally, as stated by Kasman and Duman (2015), a lot of energy is generated from fossil fuels such as coal, crude oil, and natural gas, which increases the release of carbon dioxide (CO2). This will also prove to scholars that carbon dioxide emissions are hidden and that findings may take several years to achieve (Colley et al., 2017).

Numerous nations have recently struggled to produce a lot energy as possible to meet energy demand while also implementing policies to reduce GHG (greenhouse gas emissions) in the atmosphere. The current trend in energy supply and consumption is environmentally, economically, and socially unstable, and associated with energy, carbon dioxide emissions will rise by two-quarters by 2050, resulting in increased oil demand, raising security concerns in nations that produce oil unless critical and long-term initiatives implemented (Apergiset al., 2010). As a result, numerous researchers and developers have debated the socioeconomic importance of energy demand. In this manner, it suggests that growing economies ought to be careful of using energy-efficient techniques and multiple forms of renewable energy. Besides, nations that are developing will face more challenges in the short and long run as they increase carbon dioxide emissions due to increased energy consumption because actual output and usage of energy are heavily reliant on each other as a trade-off (Shahbaz et al., 2016).

Environmental degradation is defined as the use of resources such as water, air, and soil that degrade the earth or its environment (Rinkesh, 2017). In other words, anything humans do that is hazardous to the environment or harms wildlife, and natural ecosystems causes environmental damage. This is one of today's greatest challenges because a clean environment is critical to the survival of humans and all kinds of life on the earth. The deterioration of ecosystems has resulted in the decline of many land and sea animal and plant species as a result of biodiversity loss (Thapa, 2012). The primary challenges associated with environmental degradation are pollution of the air and water, smog, the rapid destruction of forests, destruction of the ozone layer, and loss of aquatic life. As reported by Seton and Exet (2015), carbon dioxide (CO2) emissions are a valuable source of Greenhouse emissions because they decline as well as harm the atmosphere. Several variables contribute to environmental pollution, including economic growth, openness in trade, population, and use of energy. Emissions of carbon dioxide (CO2) from energy consumption in developing nations have risen dramatically over the reporting period. Likewise, gases like methane, chlorofluorocarbons, and carbon dioxide will increase GHG (Greenhouse Gas Emissions) and worsen global warming. Global warming has resulted in more shortages, erosion of soil, and floods, along with more substantial pore water levels and ozone layer loss (Ekpoh and Bassey, 2016).

The goal of the current study is to investigate the impact of energy consumption, economic growth, trade openness, urban population, gross capital formation, and gross urban population on carbon dioxide emissions in selected nine ECO economies.

Our contribution to the literature on energy economics has three components. “First, this would be the first study that will investigate the role of energy consumption on carbon dioxide emissions while utilising the latest available data from (Economic Cooperation Organization) ECO countries. Secondly, this study will moreover contribute to the role of GDP (economic growth), urbanisation, capital formation, and trade openness in clarifying CO_2 carbon emissions. Thirdly, the most important contribution of the present study is that to achieve the above-mentioned objectives, we will use the latest panel data and methods”. This research will generate policies and suggestions for improving environmental quality. The recommended policies will be valuable to policymakers and regulatory organisations in ECO countries in order to enhance the environment, based on the findings of the present research.

The remaining portion of the paper is arranged as follows: "Section 2 provides a literature assessment on the link between GDP, energy indicators, and environmental degradation (CO2 emissions). Section.3: Research methodology. Section 4 presents the empirical findings. Section 5 has concluding remarks.

Literature Review

“A lot of research has been done on economic growth, carbon dioxide emissions, and energy utilisation. Nevertheless, economic theories fail to establish a strong link between economic growth, energy use, and carbon emissions. In the energy economic literature, it has been thoroughly proven that economic growth, energy consumption, and carbon dioxide emissions have an impact. Different models were used in empirical studies that focused on different economies and time periods. In the upcoming sections, we will examine previously published research on the effects of economic growth, carbon emissions, and energy consumption.”

Empirical Literature

A study conducted by Saboori et al. (2017) "employed the JC (Johansen Co-integration) test to analyse the relationship between GDP (economic growth), oil consumption, and environmental degradation (CO2) in three Asian nations from 1980 to 2013. The study's findings revealed a one-way relationship between GDP and oil consumption in South Korea, Japan, and China.

In the same way, Acer et al. (2017) investigated the relationship between environmental degradation and energy sources (oil, coal) in OECD nations. There are two phases in the research. The first phase was covered by OPEC's shocks to the oil price. Concerns about energy safety and Cold War planning were the main focus of OECD's oil policy during this period. Environmental policies are being implemented by the other OECD nations in phase two. Oil and coal perform differently in development due to these various time periods.

Iskaet al. (2017) utilised the ARDL (Auto-regressive distributed lag) method to validate the association between the variables. As a result, international trade, tourism expenditures, economic growth, and financial system growth all had a favourable impact on Greece's carbon dioxide emissions. The Greek economy, including tourism, was emphasised as a key area that has long-term negative environmental effects for Greece. The link between economic growth, environmental degradation (carbon dioxide), industrialisation, and energy use has long-run symmetry, as stated by Owusu et al. (2017). Economic expansion and power consumption increase carbon dioxide emissions by 7 to 20%, as revealed by the VC (variance decomposition) findings.

Research conducted by Koçak and Şarkgüneşi (2017) explored the link between renewable energy use and economic growth in nine black sea and Balkan economies from 1990 to 2012 using the panel causality method. The study's findings demonstrated that there is a long-term bidirectional relationship between renewable energy consumption and economic growth and that renewable energy consumption has a favourable impact on economic growth.

Similarly, Miyak (2017) employed the system Generalized technique (GMM) and PMG technique to analyse the relationship between economic growth, renewable and nonrenewable consumption of energy consumption, and carbon emissions of carbon on a panel of 42 industrialised countries from 2002 to 2011. Nonrenewable energy consumption has a negative impact on economic growth in developing countries, as indicated by the findings. In the long term, the utilisation of renewable energy improves economic growth.

Fully modified OLS estimation methods were used by Ajide (2018) to examine the relationship between the use of energy, emissions of CO2, and growth of GDP in the Group of Eight G8 from 1960 to 2015. Energy consumption and carbon dioxide emissions play a crucial role in economic growth. However, the way is totally opposite, as evidenced by empirical research. While the first has had a positive impact on economic growth, the latter has had the opposite effect. Long-term associations are also generated, but the causality direction is not the same."

Danial et al. (2018) investigated the link among emissions of CO_2 and the growth of GDP in five EU-5 (European Union) economies during 1985-2016, namely (France, Germany, Spain, Italy, and the United Kingdom). A carbon emissions function was utilised by them to calculate the EKC (environmental Kuznets curve) phenomenon, which defines the relationship between carbon dioxide emissions and economic growth. Five European Union regions have an N-shaped link among carbon dioxide emissions and GDP, as exposed by the study's result. Trade openness, economic growth, and renewable energy use all have a useful impact on emissions of CO_2, whereas the use of renewable energy, natural resources, and energy innovation all enhance the quality of the environment.

Işk (2019) “employed the ECK (Environmental Kuznets Curve) theory to investigate the greatest levels of carbon dioxide (CO2) emissions, real GDP, renewable energy, fossil fuel energy usage, and population for the ten US nations from 1980 to 2015. The finding was also investigated using penal estimate via cross-sectional dependency. The study's findings indicated that the EKC hypothesis was only valid in Michigan, Illinois, Florida, and Ohio. Interestingly, despite the fact that Texas is a significant oil-producing state, the negative effects of fossil energy consumption on CO2 emission levels are not statistically seen.

Ahmad et al. (2019) “investigated the impact of non-renewable energy, renewable energy, trade openness, and urbanisation on emissions of carbon in selected South Asian regions from 1990 to 2014. The panel FMOLS (Fully Modified Ordinary Least Squares) approach was utilised to conduct the investigation. The findings revealed that non-renewable energy was favourably connected to carbon dioxide emissions, although renewable energy was adversely related to emissions of carbon dioxide.

Tong et al. (2020) “investigated the relationship between economic growth, energy consumption, and carbon dioxide emissions in the E7 countries from 1965 to 2017. A bootstrap ARDL (Autoregressive Distributed Lag) bound test using SB (Structural Bricks) was used in the investigation. The study's findings revealed that there is no co-integration between economic growth, energy consumption, and carbon dioxide emissions. Furthermore, Jumlu and Husam(2020) used an ARDL (Autoregressive Distributed Lag) bound test to analyse the relationship between economic growth, energy consumption, urbanisation, and carbon emissions (CO2) in MINT economies from 1993 to 2017. The findings also revealed a long-term association between energy consumption, economic growth, and emissions of carbon dioxide (CO2) and urbanisation in all MINT nations.

Philip et al. (2020), To study asymmetric cointegration among variables, applied the NARDL model to explore the asymmetric relationship between economic growth, energy consumption, and carbon dioxide emissions in fifteen nations from 1971 to 2014. They also employed an asymmetric causality technique to determine the causal relationship between variables.

Granger causality test results revealed that the variables are inextricably linked. The outcome proved that there is a symmetric relationship between economic growth, energy use, and carbon dioxide emissions in both the short and long term. Fixed effect, Pooled OLS regression, Granger Causality and Panel cointegration techniques are applied by Osobajoet al. (2020) to analyse the influence of economic growth, energy use, and CO2 emissions on 70 nations from 1994 to 2013. The use of Granger causality results showed that there is a bidirectional correlation between population, capital stock, and economy with carbon dioxide emissions, but energy consumption is unidirectional. In the same way, the cointegration test showed that there is a long-term link between energy utilisation, GDP, and CO_2 emissions. Likewise, Dabachi et al. (2020) investigated the causal associations among economic development, energy use, energy intensity, energy price, and carbon dioxide emissions in OPEC African nations from 1970 to 2018 using simultaneous equation methods. They employed second-generation approaches to investigate the stationarity and cointegration relationship between the variables. The study's conclusions showed a causal link among energy pricing and economic growth, energy use, and CO2 emissions. To sustain sustainable energy utilisation in OPEC African countries, energy policy must determine the causality between economic growth and energy consumption, as per research.

Abdullah (2020) “conducted research on EC (energy consumption), GDP, and CO2 emissions in eight emerging economies from 1998 to 2011. The geographical interaction of surrounding economies was determined using spatial simultaneous equations using random effect panel data. The study's findings indicated bidirectional causation between environmental pollution and gross domestic product, along with EC and CO2 emissions. Further, Chihoho et al. (2020) used fixed and random effect regression models to assess the influence of per capita real income and energy consumption on CO2 emissions in BRICS nations from 1989 to 2016. Based on the study's findings, economic growth and energy consumption have a favourable influence on carbon dioxide (CO2) emissions in the BRICS states. Similarly, Chontanawat (2020) used Granger causality and cointegration approaches to investigate the dynamic relationship between economic production, energy usage, and carbon dioxide emissions in ASEAN economies from 1971 to 2015. The findings revealed a long-term connection. Furthermore, the Granger Causality conclusion indicates that energy consumption and economic development are connected to emissions of carbon dioxide. The results of the research give useful information on policy implementation. The goal of policies is to minimise or save energy use, which will benefit from reducing carbon dioxide emissions without having a significant impact on output.”

Research Methodology

Theoretical Framework of The Study

This part contends theoretical and conceptual portions related to the links between energy use, economic growth, and carbon emissions for 9 selected (Economic Cooperation Organization) nations by way of the STIRPAT "(Stochastic Impacts by Regression on Population, Affluence, and Technology) framework proposed by Dietz and Rosa (1997) and York et al. (2003). Ehrlich and Holdren (1971) created the "STIRPT" model, which is based on IPAT "(influence, population, and technology)". The IPAT model correlates environmental impact (I) with population size (P), per capita consumption (A), and degree of technology (T). The IPAT status might be classified as follows in order to analyse the influence of several factors impacting carbon dioxide (CO2) emissions:

$$“I = P \times A \times T“$$

Dietz and Rosa (1994) pointed out two drawbacks of the IPAT model: first, it is mainly a mathematical equation, which is not ideal for hypothesis evaluation, and second, it assumes tight ratios among variables. To address these main drawbacks, Dietz and Rosa (1997) presented the following random version of the IPAT framework:

“Iit=βoPβ1itAitβ2 Tβ3iteit”

T can be connected with various environmental elements in addition to A and P (York 2007). Previous studies have employed various agents to demonstrate the influence of technology or human activities on the environment. Shi (2003), for example, utilised the number of services and trade in GDP, whereas Poumanyvong et al. (2012) use urbanisation to symbolise technology and grass capital to reflect wealth. The Stochastic Impacts by Regression on Population, Affluence, and Technology model considers the contributions of all variables, including carbon dioxide emissions, energy consumption, economic growth, trade openness, urban population, and gross capital formation. As a result, the STIRPAT theory analyses the carbon dioxide emissions components.

Figure 1: The Conceptual framework of the study

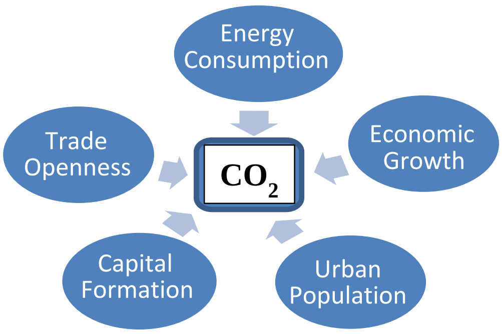

Figure 2 highlights the relationship as it proceeds toward the independent variables of energy consumption, gross domestic product (GDP) capital formation, trade, and population, whereas the dependent variable is carbon dioxide emissions (CO_2).

Methodology and Data

Panel data variables are utilized in the present paper from 1993 to 2019 for selected Economic Cooperation Organization (ECO) countries: "Azerbaijan, Iran, Kazakhstan, Kyrgyz Republic, Pakistan, Tajikistan, Turkey, Turkmenistan, and Uzbekistan. The time period chosen is determined by the availability of data for each variable. Carbon dioxide emissions are measured in metric tons per capita that act as dependent variable alongside energy consumption (kg of oil equivalent per capita), economic growth (GDP per capita current US$), urban population growth (annual%), gross capital formation (% of GDP), and trade openness (Exports + Imports / GDP) acting as independent variables. The information was gathered from numerous sources. The data set was compiled using the World Bank database, World Development Indicator (2020), and International Energy Agency (2020) data for nine ECO (Economic Cooperation Organization) nations. For investigating the relationship between energy consumption, economic growth, and environmental degradation (CO_2), econometric models based on multiple linear regressions (MLR) are designed and assessed for selected (Economic Cooperation Organization) ECO economies."2016 (Jamal and Derbali)."

"$CO2_{it} = \alpha_0 + \alpha_{1i}GDP_{it} + \alpha_{2i}EC_{it} + \alpha_{3i}UR_{it} + \alpha_{4i}TO_{it} + \alpha_{5i}GCF_{it} + \mu_{it}$ "

Carbon dioxide (CO_2) is an endogenous variable in the aforementioned econometric model, whereas GDP, EC, UR, GCF, and TO are exogenous variables, with the error term represented by ε_{it}

GDP = Gross Domestic product (current US$)

EC= energy consumption (kg of oil equivalent per capita)

GCF= Gross capital formation (% of GDP)

TO= trade openness (Exports + Imports / GDP)

UR= urban population (annual %)

μ = Error Term

All independent variable projected coefficients are written as aji, where j = 1... 5 subscript i = 1... 9 indicate nation / region, index, t = 1... 27 indicate time period.

Econometric Methodology

The listed below econometric procedure are applied to panel data.

- Panel Unit Root Tests
- Cross Section Dependency

- West land Panel Co-integration

Panel Unit Root and Panel Co-Integration Tests

The panel unit root is a test used to find out whether or not the data is stationary. In this latest panel data analysis, one element root of the panel variable is identified to the concerned proportion. While the test meets the CD (cross-sectional dependency) Pesaran, (2004) requirement for adequate unit root and cointegration, it can alleviate cross-section dependence challenges." The application of CADF (cross-section Augmented Dickey-Fuller) panel unit root evaluation (Pesaran, 2007) is effective among current cross-section vulnerabilities because it is particularly dominating in the presence of cross-section outcomes.

Cross Sectional Dependency Test

Before conducting a panel data evaluation, researchers should investigate cross-sectional dependency as the most crucial diagnostic approach. The following tests are employed in this context: the LM test of Breusch and Baltagi (1980), the LM and CD test of Pesaran (2004), and the scaled LM test with bias corrected of Baltagiet al. (2012). This CD test's primary objective is to determine the impact and shock of one country on another.

West Lund Panel Co-Integration Test

Panel co-integration approaches have recently received a lot of concentration, especially in empirical literature, for their primary goal of determining if there is a long-run link between the crucial variables of time series dimension T and cross-sectional dimension N. In this work, we apply the relatively new co-integration approach devised by Wester lund (2007) to investigate the long-run relationship. The advantage of this unique co-integration test is that it is not constrained by familiar components and solves CD (Cross-sectional Dependence) difficulties by bootstrapping the serious value of the t-statistics. “Wester lund (2007) used four assessments to determine the co-integration of variables. Wester lund co-integration test dimensions are Ga (among categories), Gt (between groups), Pt (among panel), and even Ga and Gt numerical correlation statistical test null suggestion, which means that there will be no co-integration integral panel series corresponding to co-integration in a single cross-sectional unit. In the case of a recommendation of cointegration for the wall panels, Pt, Pa, the test for lack of co-integration in the partial summaries of all panel sectors."

Empirical Results

This part analyzes the empirical implications of the entire inquiry while providing all the potential answers to the experimental research. Experimental and practical applications discuss in this section. The estimated outcomes from this study are checked in the concluding discussion of the results generated.

The results in Table 1 represent the descriptive analysis of the study's variables. The average and standard deviation of CO2 emissions are determined to be 4.794 and 4.013, respectively, with a minimum and maximum of 0.29 and 15.64, and 1804.8 and 1368.10 are similar figures for energy consumption, with a lowest of 279.00 and a highest of 5190.0. Additionally, the minimum and maximum standards for GDP are 138.42 and 1389, respectively, with averages of 29.77 and standard deviations of 3295.05. Gross capital creation has an average value of 27.14 and a standard deviation of 9.96, while trade openness has an average value of 71.76 and a standard deviation of 33.82. The urban population's average and standard deviation are, respectively, 1.85 and 1.03. With the exception of urban population, all indicators in the economies of the Economic Cooperation Organization are favorably skewed. The allocation is skewed to the right, with more observations to the left, according to the values of skewness. The Economic Cooperation Organization's variables' values for the Kurtosis statistic show that all of the variables are paltry-kurtic.

Table: 1 Descriptive statistics

	Mean	Max value	Min value	Std.Dev	Skewness	Kurtosis	Obs
CO_2	4.79	15.64	0.29	4.01	0.90	2.89	243
EC	1804.	5190.	279.00	1368.10	0.89	2.80	243
GDP	2977.	1389	138.42	3295.05	1.38	3.91	243
TU	71.76	181.59	25.30	33.82	0.93	3.35	243
UR	1.85	3.77	-1.71	1.036	-1.19	4.73	243
GCF	27.14		9.01	9.962	0.93	4.00	243

Note: “this descriptive statistics table summarizes of all variables used in this thesis. We used yearly panel data of nine ECO (Economic Cooperation Organization) countries (Azerbaijan, Iran, Kazakhstan, Kyrgyz Republic, Pakistan, Tajikistan, Turkey, Turkmenistan, Uzbekistan) from 1993-2019”.

The correlation matrix between all variables is displayed in table 2. Correlation matrix has two purposes, to demonstrate the link among the variables, and to emphasize multicollinearity issues. Multicollinearity is present when the correlation coefficient value of the variables is greater than 80 percent. “Multicollinearity occurs when one or multiple variables are connected to one another”. Estimate which variable will effect on dependent variable also difficult (Kopo, 2004). The model's specified variables show that multidimensional issues exist. Our estimation findings agree with earlier research.

As shown in Table 3, there is a statistically significant positive correlation between carbon dioxide and energy consumption, Carbon Dioxide and economic growth, and Carbon Dioxide and gross capital formation, whereas there is a statistically significant negative correlation between emissions of carbon dioxide and population urbanization and trade openness. Furthermore, Table 2 demonstrates that none of the variables indicate multicollinearity.

Table.2 Correlation Matrix

Correlation Prob.	**"CO2**	**EC**	**GDP**	**GCF**	**UP**	**TO"**
CO_2	1					
EC	0.777*	1				
GDP	0.531*	0.508*	1			
GCF	0.446*	0.497*	0.274*	1		
UP	-0.173*	-0.109	0.110	0.110	1	
TO	-0.015	-0.023	-0.225*	0.123	-0433*	1

Self-Estimation

Note: "Asterisks * and ** indicate significance level at 5% and 10% correspondingly".

In the table 3 illustrates the outcome of the cross-sectional dependency test. "The null hypothesis is rejected in this scenario if the probability value of the Pesaran(2004), CSD statistic is less than the significant threshold; null hypothesis indicates that there is no CSD (Cross-Sectional Dependence).Although a p-value greater than the significance level indicates that the null hypothesis is accepted, the alternative hypothesis is rejected. Furthermore, the results of CSD statistics, as well as the equivalent probability value of the Pesaran (2004) Cross-Section Dependency test, reveal that there is no cross-sectional dependency at 1% of all common significance levels, implying that the null hypothesis is rejected. As a result, there is a strong signal of cross-sectional dependency in the data. CD concerns are addressed later in the study with the use of a proper panel unit root test by data degrading". The cross-sectional dependency test evaluated a country's influence and shock on another.

Table.3 Cross Sectional Dependence Test

Variables	**LM_P**	**LM_S**	**LM_{BC}**	**CD**
CO_2	**374.45***	**39.88***	**39.71***	**5.54***
EC	**423.47***	**45.56***	**45.49***	**2.68***
GDP	**832.06***	**93.81***	**93.64***	**28.81***
GCF	**132.12***	**11.32***	**11.15***	**1.99***
UP	**124.82***	**10.46***	**10.29***	**2.27***
TO	**397.30***	**42.58***	**42.40***	**2.16***

Note: "Asterisks * and ** indicate the presence of horizontal section dependency among economies at the significance level at 1% and 5% correspondingly".

Initially, in the current study, we used several Panel approaches to test for stationarity in panel data. Table 04 displays the results of several Panel Unit Root testing. “The Panel Unit Root tests are well-known for determining whether or not data is stationary using t-statistics and p-values. The stationarity of data is based on the null and alternative hypothesis; if the data is non-stationary, it indicates that the unit root exists in the research variables, which is known as the null hypothesis. In this study, we used the Im-Pesaran and Shin (IPS) exam (2007), as well as the FADF (Fisher Augmented Dickey Fuller) test, as well as a second generation test that included CIPS and CADF. All Unit root tests demonstrate that all variables are stationary at the first difference. All of these tests were applied one by one to all of the research variables, which included carbon emissions (CO2), GDP growth, energy consumption, trade openness, capital formation, and urban population. The results of these tests revealed that all of the variables are not stationary at the level, which suggests that unit root isn't present. After applying the first difference, which states that alternative hypotheses are accepted while the null hypothesis is rejected, all variables are stable. The results show that all variables, including carbon emissions (CO2), energy consumption, GDP growth, trade openness, urban population, and capital formation, are stationary at the first difference, as shown in Table. 04. all of these tests as such, Pesaran and Shin W-state, Fisher-ADF, CIPS, and CADF, provided the same result: chosen variables are stationary after taking into consideration the first difference. These many panel unit root tests can produce the same results, increasing the consistency and validity of these tests.

Table.4 Unit Root Test

	IPS		**ADF**		**CIPS**		**CADF**	
	In level	In 1st Diff	In level	In 1st Diff	In level	In 1st Diff	In level	In 1st Diff
“CO2	0.494	-7.32*	24.90	109.97*	-3.302 *	- 5.49*	-2.78*	-4.28*
EC	-1.78**	- 6.67*	33.43**	106.67*	-3.79*	-5.53 *	-2.87*	-4.00*
GDP	0.74	-3.11*	9.91	41.16*	-2.33***	-4.39*	-2.54*	-3.60*
TO	-0.93	-5.30*	39.63**	76.04*	-1.44	-3.48*	-1.81	-3.15*
UR	-1.73**	-5.29*	29.15	80.76*	-2.21	-4.77*	-1.97	-3.34*
GCF	-1.99**	-4.79*	35.83**	70.13*	-2.24**	-4.07*	-2.85*	-2.90* “

Note: “The asterisks *, ** and *** specify a 1, 5 and 10% statistical significance level respectively.”

In the beginning the stationarity of every variable in the current investigation is checked. The results of many Panel Unit root tests show that every variable in the research are stationary at the 1st difference. The punitive unit root was applied once the measure of panel co-integration was met since all variables were stationary at the first difference. “Furthermore, the Panel cointegration method is used to assess the stationarity of the chosen variables. In this work, we applied the Westerlund Panel co-integration approach, which was proposed by WesterLund (2007), to confirm long-term connection among the variables in current exams. The key advantage of this new Cointegration test is that it is not constrained by common factors and solves CD (Cross-Sectional Dependency) difficulties by bootstrapping the t-statistic critical values. Westerlund (2007) used four tests to examine the association between variables. Determine the results of four panel co-integration tests in Table 05. We reject the null hypothesis at the 5% level, which implies that if the probability value is larger than 5%, there is no co-integration, whereas less than 5% indicates that co-integration exists. As a result, a substantial association appears to exist between GDP growth, energy use, and CO2 (carbon emissions).

Table.5 West Lund Panel Co-integration test

Statistic	Value	Z-value	P-value
Gt	-3.66	-2.11	0.01
Ga	-10.40	2.88	0.99
Pt	-12.20	-3.86	0.00
Pa	-11.07	1.53	0.93

Note: significant level at 5%

As a result, all variables are cointegrated conform that by Panel Westerlund (2007). In the current study, there is cointegration between all of the variables that were selected. After that, long run correlations among the entire variables, such as energy consumption, economic growth, trade, formation of capital, urban population, and environmental degradation, must be discovered. In addition, the Fully Modified Ordinary Least Squares (FMOLS) approach is used to identify long-term relationships.

Table 06 summarizes the influence of economic growth and energy use on carbon emissions in selected ECO (economic corporation organization) nations. The FMOLS econometric results confirmed that GDP growth and energy utilization among urban populations are statistically significant at a 1% significance level, but trade openness is statistically significant at a 5% significance level, while gross capital formation is statistically insignificant.

Energy consumption has a long-run positive relationship with carbon emissions (CO2); for every 1% increase in energy usage, carbon emissions (CO2) rise by 0.0031 percent. "Because emerging economies tend to employ wasteful manufacturing resources, this outcome is predicted. Oganesyan (2017), Ang (2007, 2009), and Halicioglu (2009) all found a positive relationship between energy use and carbon emissions. Similarly, GDP has a statistically significant beneficial influence on carbon emissions. As a result, for every one percent increase in wealth, carbon emissions (CO2) climb by 0.0014 percent. This leads to the conclusion that the growth in economic activity is associated to increases in per capita income, which has worsened carbon emissions in the sample of Economic corporation organization economies studied. As a result, CO2 emissions will exacerbate the environmental impact of global warming and climate change. The current study findings depend on the outcomes of Yang et al. (2018) and Wang et al. (2017). Additionally, FMOLS results demonstrate a positive but statistically insignificant influence of grass capital production on carbon emissions (CO2) in the case of ECO nations. This shows that gross capital has no effect on CO2 emissions. This finding backs with Satrovicet al.'s (2020) findings. Furthermore, trade openness has a large and beneficial influence on carbon emissions (CO2); for every one percent increase in trade openness, carbon emissions rise by 0.024 percent. More energy is required for the production of products and services, while more goods are required for trade openness. The major reason for the decrease in CO2 emissions is an increase in transportation demand. According to Economic Cooperation Organizations, the great majority of energy produced by traditional fuel sources such as oil, gaseous gasoline, and coal has a positive impact on carbon dioxide emissions." Our findings are consistent with the results reported by Hossain (2011). Our findings are consistent with the results presented by Jebli and Youssef (2015) and Halicioglu (2009). in the same way, the urban population coefficient has a significant and positive influence on carbon emissions. Carbon emissions increase by 0.31 percent for every one percent increase in urban population in nations that are members of the Economic Cooperation Organization. This finding supported the findings of Lin et al. and Pata (2018).

Table.6 Fully Modified OLS (FMOLS)

Variable	Coefficients	Std-Error	T-Statistic	Probability
EC	0.003	0.000	6.374	0.000
GDP	0.001	3.498	4.083	0.000
TO	0.007	0.006	0.181	0.231
UR	0.002	0.002	0.508	0.012
GCF	0.315	0.102	2.065	0.002
R^2 0.990				
Adj: R^2 0.980				

Note: author self-estimations

Table 7 shows the results of DOLS "(Dynamic Ordinary Least Squares) estimation of CO2 emissions as the dependent variable. The outcomes of fully modified ordinary least square are comparable to the outcomes of dynamic ordinary least square. The DOLS results also confirmed that energy consumption, economic growth, and urban population are statistically significant at a 1% significance level, while trade openness is statistically significant at a 5% significance level, but gross capital formation is not statistically significant."

Table.7 Dynamic OLS (DOLS)

"Variable	Coefficients	Std-Error	T-Statistic	Probability
EC	0.0027	0.004	6.374	0.000
GDP	0.0002	6.877	4.083	0.000
TO	0.0031	0.017	0.181	0.856
UR	0.003	0.006	0.508	0.013
GCF	0.453	0.219	2.065	0.043"
R^2 **0.997**				
Adj: R^2 **0.981**				

Note: Author self-Estimations

In the end, the pairwise granger causality approaches were used to determine the link presented by Dumitrescu and Hurlin (2012). Table 08 labels outcome of casualty testing. The results of the casualty test revealed that there is one way casualty between carbon emissions and energy consumption, with the casualty running from energy to CO2. Our findings are consistent with those of Feki and Ali (2014).Additionally, two way relations exists between GDP growth and carbon emissions, but one way causality exists between gross capital and emissions of carbon dioxide, with the casualty direction running from GCF to emissions of CO2. In similar way unidirectional casualties among urban populations and carbon dioxide emissions the direction of causation runs from urban population to carbon emissions; there seems to be unidirectional causality between trade openness and carbon emissions; and causality runs from carbon dioxide emissions to trade.

Table.8 Granger casualty PairWise

Null Hypothesis:			**W-Stat.**	**Probability**	**Outcomes**
EC	$\Rightarrow$	CO_2	2.729	0.010	
CO_2	$\Rightarrow$	EC	1.240	0.253	Unidirectional causality
GCF	$\Rightarrow$	CO_2	4.177	0.018	
CO_2	$\Rightarrow$	GCF	2.178	0.958	Unidirectional causality
GDP	$\Rightarrow$	CO_2	4.974	0.000	
CO_2	$\Rightarrow$	GDP	3.752	0.024	Bidirectional causality
UR	$\Rightarrow$	CO_2	5.348	0.000	
CO_2	$\Rightarrow$	UR	6.068	3.411	Unidirectional causality
TO	$\Rightarrow$	CO_2	2.351	0.875	
CO_2	$\Rightarrow$	TO	5.348	0.000	Unidirectional causality
GCF	$\Rightarrow$	EC	3.239	0.219	
EC	$\Rightarrow$	GCF	4.276	0.013	Unidirectional causality
GDP	$\Rightarrow$	EC	3.015	0.338	
EC	$\Rightarrow$	GDP	5.356	0.000	Unidirectional causality
UR	$\Rightarrow$	EC	5.919	8.043	
EC	$\Rightarrow$	UR	6.855	2.210	No causality

TO	⟹	EC	2.077	0.861	
EC	⟹	TO	6.322	7.396	No causality
GDP	⟹	GCF	6.557	1.647	
GCF	⟹	GDP	2.078	0.862	No causality
UR	⟹	GCF	2.712	0.554	
GCF	⟹	TO	2.104	0.868	No causality
TO	⟹	GCF	2.816	0.473	
GCF	⟹	TO	2.535	0.704	No causality
UR	⟹	GDP	5.061	0.000	
GDP	⟹	UR	5.445	0.000	Bidirectional causality
TO	⟹	GDP	2.431	0.800	
GDP	⟹	TO	6.729	5.740	No causality
TO	⟹	UR	3.501	0.122	
UR	⟹	TO	2.623	0.627	No causality

Note*: author self-estimations*

Conclusion and Policy Recommendations

Global warming has been discovered in developing economies, particularly in "Economic Cooperation Organization nations, as a result of large-scale economic expansion and population increases. As a result, carbon emissions have become a sensitive issue in these rising countries. The globe is currently experiencing technical advancement, but it is also suffering from environmental deterioration caused by many types of human and commercial activity. These causes include fast population increase, excessive use of ecologically harmful energy, and rapid industrialization, all of which have had a significant impact on our environment. In this study, we look at the impact of energy consumption and GDP growth on CO2 emissions for a group of nine countries within the Economic Cooperation Organization. We exploited secondary data over 27 years, from 1993 to 2019, to accomplish our aim. We picked carbon emissions as a dependent variable and maintained economic growth, energy consumption, urban population, trade openness, and gross capital formation as independent variables. In this study, we used panel unit root tests to determine the stationarity of the data. The findings reveal that, at first difference, all of the variables are stationary. We then used panel cointegration, as proposed by Westerlund (2007), to validate the long-run relationship between energy usage, economic growth, trade openness, urban population, capital accumulation, and environmental deterioration. Furthermore, the FMOLS and DOLS tests are used concurrently to observe long-run stiffness. Our estimation conclusions conform to those within the literature. In this research, the Westerlund panel cointegration test confirms the presence of a long-run connection among all study variables. Also, the econometric results of both the model's FMOLS and DOLS show an optimistic relationship between CO2 emissions and energy utilization, GDP growth, gross capital formation, trade openness, and urban population," whereas gross capital formation is statistically insignificant in the case of countries in the Economic Cooperation Organization.

This study's findings are all connected to earlier research. These studies clearly illustrate that energy consumption plays an important influence in the national production of both developing and advanced countries, as well as energy importing and exporting countries. Based on the findings of this inquiry, this subject needs greater respect in future exploration.

1. The outcomes of this study will assist all relevant stakeholders, including environmentalists, practitioners, and academics, in developing suitable policies for environmental sustainability, such as reducing carbon dioxide emissions in the Economic Cooperation Organization.
2. Economic Cooperation Organization countries must implement more energy-saving programs to reduce CO2 emissions. These countries should research ecologically friendly protection and energy-saving initiatives.
3. "The present research findings show that all of the variables, including energy use, national output, urban population, trade openness, capital creation, and carbon dioxide emissions, are cointegrated. As a result, when policymakers establish energy usage and economic growth policies at that time, they should take carbon emissions in certain economic company organization economies in mind."
4. To manage our country's emissions, further laws, systems, and policies must be acknowledged. Our findings indicate that energy usage is a variable that contributes to emissions of carbon dioxide (CO2). As a result, transportation vehicles must be managed and inspected to ensure that they do not emit dangerous carbon into the environment.

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