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A Global Outlook of Economic Expansion and Environmental Degradation: An Empirical Study

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Abstract- The study initiated with the questioning about the relation among economic growth, energy use in industries and environmental pollutants of countries in the world. This research work uses cubic function for which data collected in both time series and cross section the panel econometric models such as pooled OLS, unit root tests, co-integration, ADL models were used. This study measures the relationship between CO_2 emissions, energy consumption and economic growth. The research advocates that the correlation among CO_2, energy consumption and economic development in major countries of the world on both co-integration and individual cross-country results. The study also recombed on the lower time period as well as long term relation embrace environmental protection plan such as re-usable sources, greenery development as directed by United Nations Framework Convention on Climate Change and other Environmental agencies in the world and vis versa to control on carbon emissions in coming years.

Keywords: Industrial energy use, environmental pollutants, economic growth, CO_2 emissions, panel data models, Environmental Kuznets Curve

1 INTRODUCTION

The present study to cross checks the countries in world has taken proper step to reduce their carbon emission level or not, even after conducted two major important meetings. The first meeting was held at Kyoto protocol summit, Japan in 1997 recommended the governments of all over the countries try to reduce their carbon emission level at least 5% by 2008 -12 which was equal to 1990s. Another important meeting conducted in 2016, in December at Paris, where France has taken the decision to reduce at least 2% carbon emission in the present level. In this aspect the study tries prove whether the countries in the world work on to reduce their carbon level or not.

This concept was derived because the countries in the world have the compulsion to increase their economic position so that they can become economically strong. To become economically strong each and every country are bound to use their industrial energy resources such as petroleum, crude oil, coal and lignite, natural gas and electricity. Suppose the country widely use their industrial energy sources, one hand they can improve economically well but on the other hand they are producing more environmental pollutants by carbon dioxide emissions which will lead to a gradual increase in the overall temperature of the earth's atmosphere and a change in global or regional climate patterns. Owing to increase the carbon emission especially, it leads to decline the environmental quality [1] and it promotes the natural disasters like flood, tsunami etc. Industrial development helps to increase in the amount of goods and services produced per head (economic growth) of the world leads to environmental degradation over a period of time.

The growth of any country through the development of industries was deals with utilization of various energy resources and natural sources and which will lead to environmental deprivation by refuse the energy material. The decay of the natural world and the impact of human activity on its environment around the world come to a dangerous condition which will not only impact on the current generation but for future generations also. This environmental substandard quality leads natural disasters in all over the world and got greater attention towards it. Now moral sense has developed around to make better economic development without any harm to environment and this also become a topic of discussion among researchers to investigate it in coming time.

Declining environmental quality is because of increasing discharge of CHGs (greenhouse gases) especially CO_2 (carbon dioxide) emissions by the various industries. This put together it further dangerous and making it more serious about our environment and social welfare at its usual state. Because, environmental degradation of the sea level is expected to increase 20ft more by 2021 as per the forecasting. Suppose a gradual increase in the overall temperature of the earth's atmosphere by 3^o to 4^o Celsius it will be the caution of unexpected natural calamities like food, drought etc. which will have impact on almost 350 million people around the world. The greater degree of greenhouse gases discharge is warning the global warming condition in regular nature.

Apart from these two meetings at the world level, another meeting held at Japan (June 2016) with Group Seven (G7) countries are discussed the ways to reduce greenhouse gases emissions. Considering all these efforts, the countries in the world are trying to reduce greenhouse gases emissions (GHGs) especially carbon dioxide emissions (CO_2) in regard as to improve the environmental quality. Hence this may be a small piece of work to estimate the association among carbon dioxide emissions, energy consumptions and economic development of countries in the world in respect with all the continents. Since it is understood that the carbon dioxide emission (CO_2) is the

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major threat to decline the environmental quality which may also promote natural disasters. Hence, it may prove that there may be a close relationship between carbon dioxide emissions (CO_2), energy utilization and economic growth. Considering the above facts, the present study tries to check the relationship between CO_2 emission, energy use and economic growth and also recommend the countries that will be the most carbon emitted countries in the world.

Banerjee and Murshed [2] found real GDP and FDI relationship with emission variable and a highly valid unidirectional causality relationship was found from energy consumption, FDI, GDP, and economic openness to CO_2 emissions by Rai, Bembey and Sarfare [3]. Ganda [4] also work on short and long run association through EKC, among economic development, energy uses and carbon emission which validate the EKC, in energy and primary coal consumption in the long-run. The bi-directional relationship of carbon emission found by Ganda [5] with trade and energy consumption. This is also supported by Sunde [6] showing decrees in energy uses badly affect economic growth in short and long run this as well supported by Iyke [7]. Whereas Environmental Performance Index neither increase nor decrease with the incremental changes in GDP growth rate [8]. Hassan [9] found that the disclosure by companies who has poor environmental measures in the carbon intensive group was significantly higher than similar disclosures made by either better or poor environmental performers.

The whole paper is organized as follows; section 1 gives brief introduction about the relationship between carbon emission, energy use and economic development. Section 2 provides the earlier works conducted so far all over the world. Section 3 discusses materials and methods of Environmental Kuznets Curve (EKC) hypothesis and panel unit root models. Section-4 gives empirical results of CO_2(carbon dioxide) emissions, energy consumption and economic development inter relationship. Section-5 provides concluding remarks of this research.

2 Literature Review

As per the earlier studies there are ***three approaches*** have done so far relating carbon dioxide emissions, energy use and economic development in line with *Zang, X. P and Cheng, X. M* [10] *and Ghosh, S* [11]. It started with focusing on deterioration of the environment and economic growth by attempting to identify the factors of Environmental Kuznets Curve (EKC) i.e. different types of curve were produced by the hypothesis while identifying the relation between carbon dioxide emission, usage of energy and economic advancement. *Sun, J. W* [12] measured CO_2-EKC hypothesis in the countries with peak energies and found the inverse effect with a curve of U-shape against per capita GDP. *Halicioglu, F* [13] analyzed the relationship between emissions produced by CO_2, consumption of energy, domestic income and foreign trade during the period of 1960 to 2005 through time series data of Turkey. Based on the results he found that EKC hypothesis did not hold good.

He, C and Sandberg, R[12] studied EKC used time series data to study the hypothesis in Canada during the period 1948 to 2004 and did not succeed to find the evidence of EKC hypothesis. *Fodha, M and Zaghdoud, O [15]* measured relationship based on EKC hypothesis, between emissions like CO_2, SO_2 which are toxic in nature and real GDP for Tunisia during 1961-2004 and found that there is a relation of EKC hypothesis with SO_2 not CO_2. It was also found in that there is a long run equilibrium relationship between emissions and Gross Domestic Product.

Dinda, S et al.[16] analysed the link between a suspended specific substance (spm) i.e. Using a quadratic income formula, researchers compared per capita national income with solids, liquids that could be spread by air, and sulphur oxide emissions (SO_2) from 1979 to 1990 and found no evidence of the EKC hypothesis. M. Galeotti and colleagues [17] use the cubic function of OECD and non-OECD nations using two separate data sets to investigate the relationship between per capita CO_2 emissions and the EKC hypothesis. i.e. for energy data period was 1960 – 1998, for CO_2 emission data period is 1950 – 1997 and found the evidence of EKC only for OECD countries.

Canas, A et al.[18] Using a cubic function, researchers looked at the EKC hypothesis for 16 industrialised countries from 1960 to 1998 and discovered an inverted U-shaped EKC association. *Perman, R and Stern, D. I* [19] the EKC hypothesis was tested in 74 countries and found no evidence of the EKC hypothesis between per capita sulphur dioxide emissions and per capita income quadratic function. Azomahou, T et al.[20],the applicability of the EKC concept was discovered in 100 countries between 1960 and 1996. Other research examined larger data sets as well and discovered evidence of EKC hypothesis Bertinelli, L and Strobl, E [21], Taskin, F and Zaim, O [22].

The second method focuses on the link between energy usage and economic growth. J. Kraft and A. Kraft [23] investigated the causal link between energy use and economic growth in the United States. The studies like *Yu, E. S. H and Choi, J. Y* [24], *Ferguson, R et al.* [25], *and Toman, M and Jemelkova, B* [26], emphasized the lack of a clear relationship between energy usage and economic growth. Lee, C. C. [27] used panel econometric tools to examine the relationship between energy use and economic growth in 11 major industrialized countries and discovered that there is a bi-directional relationship between energy use and economic growth in the United States, a uni-directional relationship in France, Italy, and Japan, and no relationship in the remaining countries.

The third strategy, which looked at the relationship between carbon dioxide emissions, energy consumption, and economic development, incorporated the first two approaches [28], Using a quadratic econometric model, researchers looked at energy use and economic development in France from 1960 to 2000 and discovered that there is a long-run relationship between CO_2 emissions, energy consumption, and economic development. The researchers discovered a bi-directional link between the factors as well. For the period 1975–2005, *Jalil, A. and Mahmud, S. F.* [29] investigated the interlinkages between CO_2 emissions, energy usage, real GDP, and foreign commerce in China and discovered that there is a long-term relationship between the variables.

The link between real GDP and CO_2 emissions was discovered to be unidirectional. Using the cubic function of GDP, Shafik, N, and Bandyyopadhyay, S [30] discovered the presence of a link between CO_2 emissions and real GDP, and showed that macroeconomic variables such as trade and debt had an impact on the environment. Grossman, G. and Krueger, A. [31] and Panayotou, T. [32] investigated the association between SO_2 and NO_2 and macroeconomic variables such as per capita GDP, trade intensity, and population, and discovered substantial links between environmental deterioration and these variables. Using a quadratic relationship, Selden, T. M., and Song, D. [33] discovered a definite association between SO_2, NO_2, and CO_2 on Turkey's per capita GDP. N. Shafik [34] investigated the link between environmental quality, per capita income, and other factors such as endowment, income, technology, and policy.

Heil, M. T., and Selden, T. H. [35] collected data from 132 nations between 1950 and 1992 to determine the relationship between international commerce and pollution. Increased trade intensity results in higher CO_2 emissions in low-income countries and lower CO_2 emissions in high-income nations, according to the findings of the study using the cubic function, Cole, M. A. [36] investigated the relationship between pollution and trade among industrialised countries and discovered that trade openness is highly connected to pollution. Similar study also done by Akbota and Baek [37] at Kazakhstan which shows that a lower level of earning increases carbon dioxide (CO_2) but at a high level decreases it.

S. Ghosh [38] used econometric models to analyse the causal relationship between CO_2 emissions, energy consumption, economic development, real investment, and employment in India from 1971 to 2006. According to the findings, there is no correlation between the variables, although there is a bi-directional association between economic progress and CO_2 emissions. Halicioglu, F [39] identified a bi-directional association between carbon dioxide emissions and income in Turkey using a quadratic function to determine the relationship between CO_2 emissions, per capita energy consumption, per capita income, and trade openness. M Hussain et al. [40] investigated the relationship between carbon dioxide emissions, per capita energy consumption, and economic growth in Pakistan using data from 1971 to 2006 and discovered that the variables have a long-term relationship with a bi-directional relationship between CO_2 emission and energy consumption. Similar study also done by Sharmin and Tareque [41] to look the effect of globalization, urbanization, industrialization and development on carbon dioxide(CO_2) emissions per capita at Bangladesh.

Based on the earlier studies it is understood that the studies conducted to measure the relationship between carbon emissions, energy use and economic growth with one of the approach or all three approaches. But no study found to measure the relationship between carbon emissions, energy use with sector wise. Since the study found research gap and tries to fill the gap, by taking energy use sectors like petroleum, coal and lignite, natural gas and electricity for the present study. This may be helpful the countries can understand their level of carbon emissions specifically in sector wise. With this they can also take necessary steps to reduce their carbon emissions based on the particular sector.

3 Methods

The prime aim of this research work is to study underling inter-relationship among CO_2 (carbon dioxide) emissions, energy uses, economic growth of countries around the world. The study used third approach i.e. measuring the relationship between carbon dioxide emissions, energy consumption and economic growth. Hence the secondary objectives of the study are framed in the following manner:

1. To test the environmental Kuznets curve (EKC) hypothesis for carbon emission.
2. To study the inter-relationship between environmental pollution and economic growth
3. To explore the inter-relationship among carbon emissions, energy consumption economic growth.

The variables taken for this study are CO_2 (carbon dioxide) emission per-capita which is measured in metric tons per capita CO_2 (carbon dioxide) uses, per capita Gross Domestic Product is used as representative for economic developmental position of the country (GDP), and various modes of energy uses by sectors like petroleum products is measured million ton (PET), natural gas is measured billion cubic meters (NGAS), coal and lignite is measured million ton (CL) and also electricity is measured terawatt hour (ELET) have been used in natural logarithm form. The necessary data has been collected for countries in the world from global statistical year book 2016 over the period of 1990 to 2016.

Present research work uses cubic function which was earlier applied by ***Fodha, M and Zaghdoud, O* [15].** Because data collected for this study in both time series and cross section the panel econometric models such as pooled ordinary least square, unit root tests, co-integration, autoregressive distributed lag models were used.

4 Results and Discussion

4.1. Environmental Kuznets Curve (EKC) Hypothesis

Since this research work follows the model used by ***Fodha, M and Zaghdoud, O* [15]** to measure the carbon emissions of countries in the world. To measure this relationship the study used to apply the following equations;

Where – carbon dioxide emissions / capita, - energy consumption of different kind of sectors like - petroleum is measured in million tons of oil, - is measured by metric tons is measured billion cubic meters, is measured terawatt hours and GDP / capita, gross domestic product representative of economic growth. Where δ_0 is a constant and δ_1, δ_2, δ_3, and δ_4 are the slope parameters. From the model it presumes that larger level of energy uses will leads to higher economic growth and also leads to high CO_2 (carbon dioxide) emissions, then $\delta_1 > 0$ as per the above equation. As per Environmental Kuznets Curve hypothesis, the higher economic growth will produce higher carbon emissions. Then the above equation tries to find out the relationship between carbon emissions, energy consumption and economic growth of countries in the world.

If $\delta_2 > 0$, $\delta_3 < 0$, $\delta_4 > 0$, it produces a N – shape curve
If $\delta_2 < 0$, $\delta_3 > 0$, $\delta_4 < 0$, it produces inverted N – shape curve
If $\delta_2 < 0$, $\delta_3 > 0$, $\delta_4 = 0$, it produces an U – shape curve
If $\delta_2 > 0$, $\delta_3 < 0$, $\delta_4 = 0$, it produces an inverted U – shape curve

The Environmental Kuznets Curve (EKC) hypothesis clarifies that N – Shape curve indicate that when the earning level of country is gradually improve, the environmental quality initially moves towards declining side and later on improves and thereafter tensed to weak. For inverted N-shape curve shows the nations' earning levels increases moderately, quality of environment first enhance and subsequently it declines and at last it improves. Likewise for U – shape curve the national income in lower levels the quality of environment will enhance, when the income level is high, environmental quality declines. Inverted U – shape curve shows that when income at soaring level, quality of environment declines, whereas the income levels are low the quality of environment enhance.

Table 1
Results of Environmental Kuznets Curve hypothesis

Variables	EU					GDP	GDP²	GDP³
	PET	NGAS	CL	ELET	TOT			
European Union	.5045 (.0000)	.1904 (.0000)	.2847 (.0000)	-.0558 (.0371)	.7581 (.0000)	-.0750 (.0000)	.0375 (.0000)	-.0250 (.0000)
Commonwealth Independent Countries	.2128 (.0000)	.3087 (.0000)	.1934 (.0000)	.1373 (.0002)	.7887 (.0000)	-.0604 (.0000)	.0302 (.0000)	-.0201 (.0000)
North & Latin America	.6806 (.0000)	.2083 (.0000)	-.0100 (.2765)	.1474 (.0000)	.8326 (.0000)	-.0225 (.0000)	.0112 (.0000)	-.0075 (.0000)
ASIA	.2317 (.0008)	.0609 (.0836)	.3875 (.0000)	.1932 (.0071)	.6656 (.0000)	.0106 (.0002)	-.0053 (.0002)	.0035 (.0002)
Pacific	.4687 (.0000)	.2689 (.0000)	.2882 (.0000)	.5251 (.0002)	.7662 (.0000)	-.4298 (.0000)	.2149 (.0000)	-.1432 (.0000)
Africa	-.0046 (.9523)	.0224 (.4813)	.0931 (.0000)	.5027 (.0000)	.3552 (.0000)	.0494 (.0002)	-.0247 (.0001)	.0164 (.0000)
Middle East	.4643 (.0000)	.4459 (.0000)	-.0140 (.1665)	.0868 (.0068)	-.1388 (.0556)	.0730 (.0000)	-.0710 (.0002)	.0669 (.0000)

From the analysis of EKC hypothesis it was observed that all the continents are showing more than 0 except Middle East countries, showing more energy usage led to enhance the country's economic growth also increase level of carbon dioxide release. For Middle East nations it shows high energy use leads to increase their economic growth but they have not emitting high carbon dioxides. It was also observed that European Union, Commonwealth independent countries, North- America and Latin-America and pacific supports inverted N-shape EKC hypothesis. Thus, indicate that these national income level increases moderately, quality of environment first enhance and further it declines and their after it improves. The study also found that Asia, Africa and Middle East countries supports N-shape EKC hypothesis. Thus, it indicates the income level of these countries enhancing gradually, the quality of environment first declines and improve their after and then moves to weak subsequently. Because of this the quality of environment in these nations will have inconsistency all the time and also the environmental quality is substandard in any point of time. So, it can be summarized that these nations produce and discharge more CO_2 (carbon dioxide) so that the erosion of quality of environment high. These nations should take appropriate policy measures to decreases the level of CO_2 (carbon dioxide) especially Asia, Africa and Middle east countries in an immediate effect.

4.2. Panel unit root test

Economic data series study needed approach of the unit root test to transform non-stationarity data to stationarity to stay away from false or misleading result in regression modelling. Economic data series of non-stationarity data, panel unit root test with differencing the data series is better. The model for standard panel unit root test is as follows:

Here coefficient of is equal to one(1) and Where = 1, 2, ….., N showing the N different individual items used in the panel. In this study the data is balanced panel having equal unit of years and nations the study adopts common as well as unit specific trends are measured for models uphold by LLC, and IPS. These tests follows ADF (Augmented Dickey Fuller) principle i.e. static or presence of unit root as null hypothesis and non-stationarity or absence of unit root as alternative hypothesis.

Table 2(a) and 2(b) represents the analysis of LLC, IPS respectively for the countries in the world, panel unit root test through to examine the stationarity and combination properties of the chosen variables. The study reveilles that all the continents are showing non-stationarity at level and stationarity in first differences except Middle east countries and Commonwealth independent countries. They show that mix of stationarity. So, this shows that those continents show non-stationarity at level and stationarity at first difference, the panel cointegration test is applicable. Those continents represent mixture of stationarity process, panel Auto Regressive Distribution Lag (ARDL) test is applicable to measure the long run and short run interrelationship between these variables.

Table 2 (a)
Panel Unit root test of LLC

Continent	CO2	PET	NGAS	CL	ELET	GDP
LEVEL						
European Union	1.0409 (.8510)	-.4694 (.3194)	1.0067 (.8430)	-.1597 (.4365)	2.8767 (.9980)	3.3481 (.9996)
Common wealth Independent Countries	-2.7510 (.030)	-3.9405 (.0000)	-1.1586 (.1233)	-2.4533 (.0071)	-3.9617 (.0000)	-3.9821 (.0000)
North America & Latin America	1.1336 (.8715)	.7656 (.7780)	-.4869 (.3131)	-.3036 (.3807)	1.1521 (.8754)	.5872 (.7215)
ASIA	-.4883 (.3126)	-2.2547 (.1121)	-.7013 (.2416)	1.4643 (.9284)	-1.50901 (.0656)	1.4356 (.9245)
Pacific	2.3677 (.9911)	-1.0878 (.1383)	2.3920 (.9916)	1.6461 (.9501)	1.9388 (.9737)	3.0801 (.9990)
Africa	.2584 (.6020)	-1.3436 (.0895)	1.1626 (.8775)	1.6669 (.9522)	2.2172 (.9867)	2.1445 (.9840)
Middle East Countries	-1.8340 (.0000)	-.0199 (.4920)	-9.4919 (.0000)	2.1043 (.9823)	-4.2779 (.0000)	-.2201 (.4129)
DIFFERENCE						
European Union	-11.9820 (.0000)	-1.1602 (.0000)	-9.3969 (.0000)	-12.6866 (.0000)	-7.6582 (.0000)	-6.3365 (.0000)
Common wealth Independent Countries	-4.3304 (.0000)	-4.8075 (.0000)	-6.2706 (.0000)	-4.4624 (.0000)	-3.4600 (.0003)	-3.2381 (.0006)
North America & Latin America	-6.6070 (.0000)	-7.1504 (.0000)	-6.7178 (.0000)	-1.8668 (.0000)	-4.5679 (.0000)	-5.0221 (.0000)
ASIA	-4.1446 (.0000)	-5.5171 (.0000)	-5.1913 (.0000)	-4.1838 (.0000)	-3.6035 (.0002)	-3.2588 (.0006)
Pacific	-2.6665 (.0038)	3.0602 (.0011)	-3.4283 (.0003)	-3.3491 (.0004)	-1.9388 (.0263)	-1.3680 (.0856)
Africa	-4.4278 (.0000)	-4.3147 (.000)	-4.4085 (.0000)	-6.8687 (.0000)	-2.3267 (.0100)	-2.0825 (.0186)
Middle East Countries	-7.7353 (.0000)	-3.5641 (.0002)	-9.1604 (.0000)	-5.1617 (.0000)	-3.1322 (.0009)	-4.6302 (.0000)
Pacific	2.1301 (.9834)	-1.3923 (.1819)	.4269 (.6653)	2.2130 (.9866)	3.1583 (.9992)	3.0218 (.9987)
Africa	.1148 (.5457)	-.5441 (.2932)	1.3014 (.9034)	.8591 (.8049)	2.1989 (.9861)	.8416 (.8000)
Middle East Countries	-6.2657 (.0000)	.0021 (.5009)	-5.6502 (.0000)	1.3756 (.9155)	-2.9020 (.0019)	.5857 (.7210)

Table 2(b)
Panel Unit root test of IPS

Continent	CO2	PET	NGAS	CL	ELET	GDP
LEVEL						
European Union	2.3174 (.9898)	.5831 (.7201)	2.9060 (.9982)	-.6006 (.2740)	4.6718 (.9998)	4.1855 (.9899)
Common wealth Independent Countries	-1.2291 (.1095)	-2.3590 (.0092)	.36895 (.6439)	-1.1027 (.1351)	-2.5393 (.0056)	-3.3970 (.0003)
North America & Latin America	1.5300 (.9370)	.8533 (.8033)	.3636 (.6420)	.0104 (.5041)	2.3845 (.9915)	.6841 (.7531)
ASIA	.9445 (.8275)	-1.3125 (.1947)	1.0667 (.8569)	1.9272 (.9730)	1.8079 (.9647)	-.2587 (.3979)
Pacific	2.1301 (.9834)	-1.3923 (.1819)	.4269 (.6653)	2.2130 (.9866)	3.1583 (.9992)	3.0218 (.9987)
Africa	.1148 (.5457)	-.5441 (.2932)	1.3014 (.9034)	.8591 (.8049)	2.1989 (.9861)	.8416 (.8000)
Middle East Countries	-6.2657 (.0000)	.0021 (.5009)	-5.6502 (.0000)	1.3756 (.9155)	-2.9020 (.0019)	.5857 (.7210)
DIFFERENCE						
European Union	-8.0727 (.0000)	-6.5885 (.0000)	-8.4265 (.0000)	-7.3298 (.0000)	-8.3701 (.0000)	-5.4792 (.0000)
Common wealth Independent Countries	-2.1164 (.0172)	-2.5372 (.0056)	-3.4171 (.0003)	-1.6027 (.0545)	-5.9943 (.0000)	-5.6462 (.0000)
North America & Latin America	-4.5224 (.0000)	-3.1421 (.0008)	-5.3283 (.0000)	-8.4224 (.0000)	-5.6509 (.0000)	-3.6718 (.0001)
ASIA	-4.3793 (.0000)	-4.6689 (.0000)	-6.6844 (.0000)	-3.3984 (.0003)	-4.5965 (.0000)	-1.8318 (.0335)
Pacific	-1.3968 (.0812)	-2.7129 (.0033)	-1.7640 (.0389)	-4.0802 (.0000)	-2.6635 (.0039)	-4.0689 (.0000)
Africa	-3.6239 (.0001)	-3.0910 (.0010)	-4.4855 (.0000)	-3.8928 (.0000)	-2.3390 (.0097)	-5.5369 (.0000)
Middle East Countries	-6.4356 (.0000)	-2.8899 (.0019)	-7.2155 (.0000)	-2.7442 (.0030)	-4.3488 (.0000)	-3.1220 (.0009)

Figure in the parentheses are p – value to understand the significance level. IPS = Im, Pesaran, LLC = Levin, Lin, Chu.

4.3 Panel Co-integration test

The panel cointegration test applied to identify the time-based inter-relationship between CO_2 discharge, energy consumption and economic development of nations in the world, if possible, in this world. This part the famous Petroni co-integration tests is applied. Pedroni [42] cointegration test used to diversified panels, where in diversified angle coefficient, fixed effects and discrete particular deterministic movements are allowed. Here panel cointegration attempts to test the null hypothesis of no cointegration and the error, based on the panel information of Engle and Granger [43] statistics to test the distributions.

The Pedroni [42] panel cointegration regression is as follows

Where

Pedroni [44] evolved 7 cointegration statistics, in this the 1st is a type of non-parametric variance ratio statistics. The 2nd is a panel version non-parametric analogue to the well-known PP-rho stat. The 3rd statistics is also non-parametric, analogues to the PP – statistics. The 4th statistics corresponds to ADF statistics. All these 4 statistics are based on within dimensions. The remaining 3 statistics are support on a group mean approach, where the 1st one is comparable to the PP-rho statistics and remaining two are comparable respectively to the PP and ADF statistics. In this test any four statistics shows significant results, then it will be confirmed that they have long run relationship between the variable.

Table 3

Petroni Panel Co-integration test

Countries	Within-dimension				Between-dimension		
	P (v)	P (rho)	P (PP)	P (ADF)	G (rho)	G (PP)	G (ADF)
European Union	-.7665 (.7783)	1.9394 (.9738)	-5.9504 (.0000)	-6.1642 (.0000)	3.1553 (.9992)	-5.9679 (.0000)	-6.2846 (.0000)
North & Latin America	-.3292 (.6290)	-.0335 (.4866)	-5.5504 (.0000)	-5.5961 (.0000)	2.0781 (.9812)	-3.5267 (.0002)	-1.7262 (.0422)
Asian	-1.0852 (.8611)	1.9402 (.9738)	-.9878 (.1616)	-3.0312 (.0012)	2.5882 (.9952)	-.9852 (.1623)	-2.4827 (.0065)
Pacific	-1.6649 (.9520)	1.8532 (.9681)	-.6148 (.2693)	-3.0927 (.0010)	2.3176 (.9898)	-.3083 (.3789)	-2.5670 (.0051)
Africa	-1.2768 (.8992)	.5075 (.6941)	-1.9616 (.0249)	-1.9538 (.0254)	1.6227 (.9477)	-3.8803 (.0001)	-1.7273 (.0420)

Table–3 presents the analysis of panel co integration and it found that Latin America, European Union and North America, In this Africa rejected the null of no co-integration in most of the statistics and it concludes that they have long run relationship between carbon dioxide emissions, energy consumption and economic growth. Where the other continents like Asia and Pacific did not support the long run relationship between the variables. Since the continents have many countries, so an in-depth study would be feasible to understand the short run as well as long run by country wise.

4.4. Panel Auto Regressive Distributed Lag Model (ARDL)

ARDL is a least square regression and it contains different lags of dependent and independent variables. ARDL can be applicable when mix of stationarity process of the variable. ARDL produce different lags of order to get accuracy of the results this can be named as strong regressors. Last square regression (LSR) used to estimate ARDL and for the used to present model research used the standard Akaike information criteria. The through ARDL can be expressed as

Conventional way to make an estimate of cointegrating relationships, such as Johansen's [45], Engle-Granger [43], Dynamic OLS, Fully Modified OLS, may acts as a variable in similar integration operations or either I (0) or I (1). This problem can be handled by the model developed by Pearsan and Shin [46], they suggested ARDL cointegration model it is applicable when the variables are mix of stationarity process. This model of ARDL depiction does not depend on uniformity of lag lengths, variables can have a different number of lags. There after the ARDL cointegration can be established with bound test to identify the inter-relationship among the variables.

Table 4

Auto Regressive Distributed Lag Model Results

Variables	Commonwealth Independent Countries (3,3,3,3,3,3)			Middle East Countries (4,2,2,2,2,2)		
	Co-eff	S.E.	Prob	Co-eff	S.E.	Prob
Long – run relationship						
PET	-.2502	.1057	.0267	.3773	.0259	.0000
C& L	.4297	.0932	.0001	.0249	.0293	.4010
NGAS	-1.6468	.4976	.0031	.3009	.0288	.0000
ELET	-5.1243	1.0546	.0001	.2310	.0234	.0000
GDP	-.4944	.1320	.0011	-.0021	.0003	.0000
Short – run relationship						
CO2	-.2558	.2258	.2689	.0451	.0543	.4117
PET	.0713	.0764	.3602	-.0487	.0783	.5375
C & L	.1487	.1284	.2588	-.0573	.0627	.3669
NGAS	.2424	.1394	.0955	.0435	.0501	.3900
ELET	-.4235	.1098	.0008	.1341	.0735	.0759
GDP	.0269	.2102	.8991	.0382	.0676	.5753
Cointg.	.0398	.0314	.2178	-.2311	.1652	.1698
C	-1.774	1.3760	.2101	.4205	.2967	.1644

The results of ARDL model presented in the Table-4, this result can be divided into two i.e. long term and short term relationship. The quality of being correct of ARDL model hold up the lags and this lag detail get from Akaike detail standards. Based on this study of long term relationship it can be identified that the null of no relationship can be rejected and accept there is a long term effect with energy use and carbon dioxide emissions. This shows that due to energy utilization the emission of carbon dioxide gases is high and also the effect will be in long term manner. Since the results supports significant relationship in concern with GDP in both the continents and found that there will be a long term effect in relation with GDP. This shows that the country can use energy for increasing their GDP and the same time they have direct impact with carbon dioxide emission. Short run relationship the result suggests that negative signalling variable and for long-run relationship remarkable value will be act towards only. In otherwise condition where negative signalling variable but not remarkable value indicate short-run relationship as well. The general model may be redacted through error term (Ut) for the further relationship. In the table-5 carbon dioxide emission and electricity consumption shows long term relationship and rest of the variables did not supports short term relationship for commonwealth independent countries. In case of Middle East countries petroleum and coal and lignite shows short term relationship. The overall model support based on co integrating term, that the variables are showing long term relationship and also short term relationship in case of Middle East countries.

Table 5(a)
Long-run and Short-run relationship for individual countries

Continent	Long – run						Short - run
	CO2	PET	NGAS	CL	ELET	GDP	ECM
A. European Union							
Belgium	-.3731 (.0002)	.1710 (.0000)	.1537 (.0001)	-.0375 (.0000)	.1191 (.0052)	-.2519 (.0007)	-.5644 (.0000)
Czeg Repub	-.2375 (.0003)	-.2236 (.0000)	.0594 (.0006)	-.1997 (.0001)	.6763 (.0006)	.4183 (.0001)	.1524 (.0000)
France	.6517 (.0049)	-.5114 (.0006)	-.1229 (.0014)	-.0862 (.0001)	-.0344 (.0268)	.0707 (.0104)	-.3079 (.0012)
Germany	-.5992 (.0000)	.5128 (.0000)	.1556 (.0000)	.2687 (.0000)	.0093 (.1199)	-.1377 (.0001)	-.6133 (.0003)
Italy	-.1359 (.0669)	-.0188 (.1959)	.0762 (.0014)	-.0373 (.0000)	-.0543 (.0272)	.4430 (.0015)	-.8790 (.0010)
Netherland	.3837 (.0082)	.0899 (.0006)	-.0918 (.0053)	-.1446 (.0000)	-.4566 (.0008)	-.0613 (.1548)	-.1819 (.0003)
Poland	-.1758 (.016)	-.0395 (.4285)	.2309 (.0002)	.2288 (.1577)	-.3803 (.2089)	.0866 (.5250)	-.0845 (.0000)
Portugal	-.3241 (.0025)	.1546 (.0061)	.0013 (.0005)	.0151 (.0030)	-.1868 (.4255)	.6874 (.0633)	-.0194 (.0575)
Romania	-.2753 (.0017)	.0442 (.0113)	.1222 (.0063)	.1473 (.0000)	.0176 (.1084)	.0515 (.0265)	-.0127 (.1787)
Spain	.0008 (.9084)	.3771 (.0000)	-.0298 (.0000)	-.0295 (.0000)	-.1287 (.0003)	-.2598 (.0041)	-.4883 (.0000)
Swedan	-.0849 (.0016)	-.1584 (.0020)	.0392 (.0008)	.3909 (.0000)	.6193 (.0025)	-.3470 (.0120)	-.1199 (.0001)
UK	.1830 (.0000)	-.7423 (.0000)	-.5095 (.0000)	-.2976 (.0000)	.5105 (.0000)	-.1653 (.0000)	-.2036 (.0000)
Norway	-.5224 (.0000)	.7238 (.0000)	.0896 (.0000)	.01990 (.0000)	-.1017 (.0000)	.6887 (.0000)	.2428 (.0000)
Turkey	-.2847 (.0035)	.1142 (.0018)	-.1956 (.0000)	.2328 (.0000)	-.0337 (.7390)	.2430 (.0006)	-.1120 (.0176)

Table 5(b)
Common wealth Independent Countries

Continent	Long -run						Short- run
	CO2	PET	NGAS	CL	ELET	GDP	ECM
Kazakhstan	.3509 (.0524)	-.1530 (.0002)	-.1207 (.0001)	-.0205 (.6827)	-.5863 (.0019)	.5018 (.0005)	.0289 (.0000)
Russia	-.4332 (.0025)	.1018 (.0004)	.1805 (.0002)	.1374 (.0003)	-.1114 (.0594)	-.0166 (.0389)	.0002 (.0000)
Ukraine	-.7156 (.0002)	.1741 (.0000)	.5158 (.0000)	.5155 (.0000)	-.4284 (.0000)	.1353 (.0001)	-.0034 (.0000)
Uzbekistan	-.2253 (.0000)	.1625 (.0000)	.3941 (.0000)	-.0375 (.0000)	-.5679 (.0000)	-.5127 (.0000)	.1316 (.0000)

Table 5(c)
North America & Latin America

Continent	Long -run						Short- run
	CO2	PET	NGAS	CL	ELET	GDP	ECM
Canada	.0474 (.0002)	-.0150 (.1141)	.1029 (.0000)	.1252 (.0000)	.2725 (.0000)	-.0828 (.0015)	-.2792 (.0000)
United States	.1566 (.0000)	.1382 (.0003)	.2113 (.0000)	.1969 (.0000)	-.4437 (.0000)	.2888 (.0001)	-.1156 (.0000)
Argentina	.1112 (.0001)	-.1251 (.0016)	.1007 (.h0084)	.0267 (.0000)	-.0876 (.0087)	-.0228 (.0255)	-.3570 (.0028)
Brazil	-.0583 (.0052)	.0665 (.1358)	-.0181 (.0031)	-.0590 (.0004)	-.0114 (.2203)	.1513 (.0051)	-.0305 (.0000)
Chile	-.0689 (.0001)	.2312 (.0001)	.0543 (.0000)	.1082 (.0000)	.0739 (.0029)	.0427 (.0277)	.0561 (.0000)
Colombia	.1398 (.0063)	-.0105 (.2700)	-.0056 (.8145)	.0265 (.0069)	.0447 (.2542)	.0761 (.1739)	-.1693 (.0001)
Mexico	.1912 (.0000)	.9372 (.0001)	.0884 (.0005)	.0983 (.0000)	-.0200 (.0119)	-.6723 (.0000)	-.7382 (.0002)
Venezuela	.5843 (.0001)	-.2737 (.0066)	.1708 (.0017)	-.0100 (.0000)	-.5946 (.0104)	-.0665 (.2641)	-2.0842 (.0022)

Table 5(d)
ASIA

Continent	Long -run						Short- run
	CO2	PET	NGAS	CL	ELET	GDP	ECM
China	.5567 (.0341)	.1283 (.0000)	.1292 (.0000)	-.1203 (.0000)	-.1625 (.0140)	-.1204 (.0114)	-.0930 (.0000)
India	.3407 (.0121)	-.0389 (.0034)	.0161 (.0000)	.0934 (.0003)	-.1747 (.0004)	-.1680 (.0001)	-.2887 (.0000)
Indonesia	-.5199 (.1899)	.0187 (.0685)	.0541 (.0000)	-.0046 (.0097)	-.2259 (.0002)	.1285 (.0001)	-.0365 (.7893)
Japan	.8232 (.0381)	-.0676 (.0053)	.0916 (.0000)	.1840 (.0001)	-.0268 (.0458)	.1801 (.0021)	-.1379 (.0000)
Malaysia	.9231 (.2325)	.1597 (.0005)	-.1424 (.0026)	.0233 (.0000)	-.0247 (.0661)	-.4637 (.0047)	-.1799 (.1243)
South Korea	-.6651 (.1447)	.0464 (.0092)	-.0088 (.1820)	.0010 (.0790)	-.2821 (.0297)	-.1755 (.3140)	-.0607 (.1822)
Taiwan	-.3752 (.0047)	-.0027 (.0402)	.0471 (.0001)	-.0025 (.0000)	-.0422 (.0003)	.0547 (.0043)	-.0275 (.3452)
Thailand	-.1636 (.1316)	.0238 (.0013)	.0103 (.0000)	.2091 (.0000)	-.0448 (.0001)	.0454 (.0847)	-.2906 (.0821)

Table 5(e)
Pacific

Continent	Long -run						Short- run
	CO2	PET	NGAS	CL	ELET	GDP	ECM
Australia	-.2523 (.0000)	-.3419 (.0001)	.1610 (.0000)	.1272 (.0000)	-.2450 (.0002)	.3193 (.0042)	-1.0149 (.1245)
New Zealand	-.4535 (.0000)	.6048 (.0001)	.2315 (.0000)	.0593 (.0000)	-.3708 (.0009)	-.3118 (.0021)	-.1431 (.1632)

Table 5(f)
Africa

Continent	Long -run						Short- run
	CO2	PET	NGAS	CL	ELET	GDP	ECM
Algeria	-.1545 (.0034)	.2709 (.0003)	-.2594 (.0025)	.0094 (.0003)	-.0042 (.6585)	-.1250 (.1303)	.0172 (.0000)
Egypt	.0088 (.7467)	.3793 (.0111)	.1732 (.0112)	-.0167 (.0004)	-.3473 (.0439)	-.2714 (.4139)	-.0034 (.1857)
Nigeria	.0014 (.4226)	.0813 (.0312)	.0464 (.0092)	-.0073 (.0000)	-.0039 (.2798)	.0632 (.0034)	-.0138 (.0000)
South Africa	.4185 (.0000)	.2148 (.0000)	-.1197 (.0000)	.2805 (.0001)	-.3874 (.0000)	-.7165 (.0010)	-.1038 (.0014)

Table 5(g)
Middle East Countries

Continent	Long -run						Short- run
	CO2	PET	NGAS	CL	ELET	GDP	ECM
Iran	.1869 (.0000)	.0381 (.0014)	.0958 (.0001)	.1010 (.0001)	.1956 (.0020)	-.0811 (.0003)	-.5438 (.1124)
Kuwait	-.0761 (.0000)	.0939 (.0069)	.0700 (.0013)	-.0461 (.0255)	-.0141 (.8695)	.0009 (.0000)	-.3531 (.2415)
Saudi Arabia	.0497 (.0026)	-.2619 (.0002)	-.1044 (.0004)	-.2042 (.0000)	.3105 (.0001)	.2328 (.0004)	-.2593 (.1610)
UAE	.0198 (.0000)	-.0651 (.0000)	.1128 (.0000)	-.0798 (.0000)	.0444 (.0000)	.0025 (.0000)	.2317 (.0000)

Table 5(a), 5(b) , 5(c) , 5(d) , 5(e) , 5(f) and 5(g)- reveals that cross-country effect in relation with CO_2 (carbon dioxide) discharge, energy utilization and economic development of nations in the world. This result can find both the short term as well as long term relationships between the variables in regard to the countries in the world. For short term relationship, the error correction term shows negative indication with significant result then it will be treated as those countries have long-term inter-relationship. In contrast to the negative signalling showing variable but not remarkable value, it indicates those countries which have only short run relationships. In the case where if the term neither shows no negative nor significant or insignificant, those countries did not support both short-term and long-term inter-relationship. From this table it found that in European Union, majority of the countries have long term effect with CO_2(carbon dioxide) discharge, energy consumption and economic development, the countries like

Romania and Portugal short-term relationship. Whereas Norway as well as Czech Republic did not support either long-term nor short-term relationship. This table also found that energy use leads to economic growth in all the countries except Netherland, Poland and Portugal. These countries are using energy sources in different sector but they are getting most of the income from primary sectors rather than manufacturing sectors. In case of Commonwealth Independent Countries only Ukraine shows long term relationship between the variables and rest of the countries did not support either long term or short-term relationship. It is very interesting to look all the countries in the Commonwealth Independent group are getting economic growth through energy use only and also, they have the relationship between energy use and carbon emission. These countries might have taken necessary steps to reduce their carbon level in respect with the countries in the world. While North-America and Latin-American countries shows that they have long term relationship among CO_2(carbon dioxide) discharge, energy consumption and economic development except Chile, it did not support long term as well as short term relationship. From this group, the countries like Colombia and Venezuela using their energy widely even though they did not get high economic growth from manufacturing industries because these countries are producing high economic growth from service sectors especially tourism and allied sectors.

In the Asian subcontinent majority of the nations supporting short-term inter-relationship among the variables whereas the countries like China, India and Japan found to be long-term relationship. Since these nations mostly generating more carbon dioxide emissions by using energy sources most specifically in manufacturing industries. The countries like Thailand, Malaysia, South Korea and Indonesia are not emitting carbon dioxide by the use of energy sources. These are the countries famous for tourism and allied sectors, and they might have used less energy sectors only for their people's needs. To consider the Pacific region the countries like Australia and New Zealand did not support long term relationship between carbon dioxide emissions, energy consumption and economic growth and they found short term relationship only. Even Australia producing more thorium and uranium they are exporting to other countries and also, they use less energy sector for their region. This may be the reason they are showing short term relationship. Finally for the Middle East nations majority of them are found long-term relationship except UAE where it did not support any relationships. These Middle East countries is the major producer of Oil products and they are using more energy to produce the oil rather than use of manufacturing sectors. These countries are using less energy sources especially for the welfare of their countries. This may be the reason they have short term relationship.

5 Conclusion

The observed examination on the inter-relationship among CO_2(carbon dioxide) discharge, energy consumption and economic development of nations in the world. The result reveals that maximum level of energy uses will lead to improve the nation's economic development and higher level of CO_2(carbon dioxide) discharge in different continents of the world. This study found that it supports inverted N – shape relationship. Thus, it indicates that these countries income-level increases moderately, quality of environment initially improves and later it declines and later on it improves. The study also found that Asia, Africa and Middle east countries supports N-shape EKC hypothesis. So, it indicates that the income level of these nations is increasing gradually, the quality of environment initially declines and enhance their after and goes weak subsequently. Therefore, the quality of environment of these nations will have ups-and-downs all the time and also the quality of environment is inferior in any point-of-time. The observed modeling suggested that there exist long-term inter-relationship among CO_2(carbon dioxide) emissions, energy uses and economic development in most of the nations in the world based on both co-integration and individual cross country results. Some of the countries also found short-term relationship among the few nations and variables did not hold up any relationship. Those nations are supporting long-term relationship it is because of they are trying to increase their economic growth so that they are bound to run more manufacturing industries. For those who have found short term relationship they are using their energy sources only in the need area and other use they may go with renewable energy sources and also, they are adopting environmental safety measures to reduce their carbon dioxide level. Some of the countries did not find any relationship, thus it shows the use of energy sources only for the basic needs of the nation and for economic development, these nations may depend on primary sectors like Agricultural and Service sectors rather than manufacturing sectors. Those countries showing short-term as well as long-term relationship these nations must initiate measures of environmental safety such as sources which can be reusable, try to increase greenery like as per the direction of United Nations Framework Convention on Climate Change and other Environmental agencies in the world. Those who did not show any relationship, they also use environmental safety measures so that they may not produce more carbon emissions in future years.

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