International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2021, 11(6), 353-364.

The Impact of Financial Development on Decarbonization Factors of Carbon Emissions: A Global Perspective

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Received: 24 June 2021 **Accepted:** 13 September 2021 **DOI:** https://doi.org/10.32479/ijeep.11872

ABSTRACT

In order to limit the adverse effects of climate change, the carbon dioxide emissions should be controlled. These toxic emissions are associated with the energy sector like coal, oil, natural gas, which produce air pollution and it has to be reduced. Reductions can be brought about by using appropriate technologies and policy initiatives. Financial development has been an important factor, which influences the decision on carbon emissions. This study attempts to study the relationship between financial development and carbon emissions, based on the least square of NLS and ARMA method and the data, based on 10 developed countries and five developing countries, during the study period of 10 years from 1st April 2010 to 31st March 2019. The study employed the Kaya identity IPAT model, unit root test and co-integration test. The variables of GDP per capita and carbon dioxide (CO_2) emissions were used as a measure of economic financial development and the status of environmental degradation.

Keywords: Carbon Dioxide Emissions, Financial Development, Urbanization, GDP Per Capita, Climate Change, STIRPAT Model
JEL Classifications: P44, Q40, Q48, Q54

1. INTRODUCTION

Stabilizing climate change entails reducing net emissions of carbon dioxide (CO_2) to zero. The latest scientific data inform us that we need to reach zero net emissions by 2100, to stabilize climate change around the 2°C target above the preindustrial temperature that has been agreed by governments as the maximum acceptable amount of warming. Relaxing the target to 3°C would require little difference in the policies needed but 2°C target would require more aggressive, earlier action. Positive emissions in some sectors and some countries can be offset, to some extent, through natural carbon sinks and negative emissions in other sectors and countries. The report of the Intergovernmental Panel on Climate Change (IPCC) presents the consensus view of 830 scientists, engineers, and economists from more than 80 countries and it was formally endorsed by the governments of 194 countries.

In the 2015 Paris agreement on climate change, the world's nations agreed to limit the increase of global mean temperatures to well below 2°C and make efforts to limit temperature increases to 1.5°C above pre-industrial levels. This desirable limit was to be reflected in country level emission pledges, known as Nationally Determined Contributions (NDCs). The first worldwide common efforts, to control and to stabilize the concentration of greenhouse gases (GHG) in the atmosphere, took place in the Earth Summit at Rio De Janerio in 1992, where many countries agreed on the United Nations Framework Conventions on Climate Change (UNFCCC). The objective of this convention was to "achieve stabilization of greenhouse gas concentration in the atmosphere, at a level, that would prevent dangerous anthropogenic interference with the climate system". They should be achieved within "a time-framework sufficient to allow ecosystem to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner".

The UNFCCC was followed by an agreement, for fixing internationally accepted emission reduction targets, commonly known as the Kyoto Protocol. Targets are common, with differentiated responsibilities of the parties. Parallel to the Paris Agreement and Kyoto Protocol, the UN developed 17 Sustainable Development Goals (SDGs), agreed to by 193 countries in 2015. Particularly, Goal 7 of Sustainable Development Goals seeks to "ensure universal access to affordable, reliable, sustainable and modern energy services by 2030".

In this study, an attempt has been made to analyze the relationship between financial development and decarbonization factors of carbon emissions, for the sample of 10 developed countries and five developing countries, using the variables of CO_2 emissions, GDP per capita, urbanization, population and industrial value added.

The rest of this paper is arranged as follows: Section 2 provides a review of literature. Section 3 describes the empirical strategy and collection of sample data. The results are discussed in Section 4. The conclusion is presented in Section 5.

2. LITERATURE REVIEW

In this study, an attempt has been made to briefly review the literature, which is the work already undertaken by earlier researchers, relating to the topic under study.

Manta et al. (September 2020), in the paper entitled, **"**The Nexus between Carbon Emissions, Energy Use, Economic Growth and Financial Development: Evidence from Central and Eastern European Countries"**,** estimated the nexus between carbon dioxide emissions, energy use, economic growth, and financial development for ten Central and Eastern European Countries (CEEC), over the 2000-2017 period, starting from the theory of Environmental Kuznets Curve (EKC). This paper emphasizes the importance of reducing the CO_2 emissions and establishes the long-run co-integration relationships among CO_2 emissions, energy use, GDP and financial development, using the panel FMOLS and the cross-sectional dependence regression. Since the variables were co-integrated, the Vector Error Correction Model (VECM) was used, to identify short-term and long-term causal relationships. In the long run, the levels of CO_2 emissions and energy use did not have any influence on the economic growth (GDP and GDP^2). The results revealed that by using environment-friendly policies, the national economy in the long run or short run, would not be compromised and hence the government can implement green policies, to control energy demand, in order to reduce the energy use.

Jain (2020) examined, "Drivers of Change in India's Energy-related Carbon dioxide Emissions during 1990-2017". The author found that India was striving to achieve its climate mitigation goal of reducing the greenhouse gas (GHG) emission intensity, in the economy, by 33-35% by 2030, from 2005 levels. The energy-related CO_2 emissions, in an economic region, change due to a shift in the scale of intensity and structure of activities in the region. The analysis of Kaya factors revealed that while there was decoupling between energy use and GDP growth since late 1990s, the decarbonisation of the energy supply was not yet significant. The decomposition of the aggregate changes indicated that during 1990-2005, the increase in emissions, due to population effect and income effect was offset by energy intensity effect such that the net increase in emissions was not significant. The increase in emissions, in 2005-2010, was significantly high since all the factors contributed to the increase in emission during this period. The offset by energy intensity was observed during 2010-2015, which was pronounced during 2015-2017. The study also confirmed that the changes in the carbon intensity of energy did not show a clear trend of decarbonization of the energy supply, even until 2017.

Qian et al. (2020), in the paper entitled "Analysis of CO_2 Drivers and Emissions Forecast in a Typical Industry-Oriented County, China", examined the main drivers of CO_2 emissions and reported that predicting their trend to be the key to promoting low-carbon development. Global average surface warming by the end of the 21^{st} Century, is projected to depend mainly on the cumulative effect of CO_2 emissions. In this study, they used the LMDI method, proposed by Ang, to analyze energy-related drivers of CO_2 emission, which can be decomposed into six types: population, per capita GDP, industrial structure, energy intensity, energy structure and carbon emission coefficient. This study adopted the five scenario analysis, to predict the energy-related CO_2 emissions, changing in each scenario and to determine whether there was a possibility of reaching peak CO_2 during the study period. The study concluded that the decomposing drivers optimized the economic development mode while adjusting the energy structure, which was the key to slowing down CO_2 emissions in the study period. GDP was the most influential factor, driving CO_2 emissions, from 2010 to 2017, playing a long-term, direct, and dominant role. Reducing the proportion of secondary industry and increasing the proportion of green industries, emerged as the main factor, capable of inhibiting CO_2 emissions.

Alam (2019) studied the "Economic Development and CO_2 emissions in India". The study examined the impact of economic development on the quality of environment in India. GDP per capita and CO_2 emissions were used, to measure economic development and environmental degradation respectively. It predicts inverted U-shaped relationships between indicators of various types of environmental degradation and economic development. The author analyzed the long-run linkages between CO_2 emissions, GDP per capita and industrial value added and found the dynamic adjustment between the first differences of the variables, specifically the impact of growth in GDP per capita and industrial value added on CO_2 emissions, in India, from 1980 to 2014. The time series econometric techniques such as, Augmented Dickey-Fuller (ADF) unit root test for stationarity, Johansen co-integration test for detecting long-run relationship and Vector Error Correction Model (VECM) for checking the validity of long-run relationship were applied. The study found the impact of economic development on the quality of environment in India. Growth in GDP per capita was found to be negatively related to CO_2 emissions in India. But with no change in GDP per Capita, CO_2 emissions went up, with rise in industrial value added.

Jiang and Ma (2019), in the paper entitled, "The Impact of Financial Development on Carbon Emissions: A Global Perspective", discussed financial development, as an important factor influencing carbon emissions. In this study, they examined the relationship between financial development and carbon emissions based on a generalized method of moments and the data from 155 countries. The study divided the sample countries into two groups: developed countries, and emerging market and developing countries. They investigated the influence of different aspects of financial development on carbon emissions, by adopting a series of proxy variables of financial development. The authors examined the stationarity of the first-order difference of the variables and the results indicated that all the unit root tests were significant, at the 1% level, which implied that all the variables were integrated at an order of one. The results of the regression showed that financial development did have a positive effect on carbon emissions, as the coefficients were positive and significant at the 1% level. In other words, financial development could increase carbon emissions from a global perspective, and they concluded that the results of the study remain valid for the sub-group of emerging market and developing countries also. The empirical results indicated that financial development had no obvious influence on carbon emissions for developed countries.

Yazdi and Dariani (2019), in the paper entitled, "CO_2 Emissions, Urbanization and Economic Growth: Evidence from Asian Countries", empirically examined the dynamic causal relationship between CO_2 emissions, energy consumption, economic growth, trade openness and urbanization, for the period 1980-2014, using causality tests for Asian countries. CO_2 emissions from energy consumption had increased significantly in newly industrialized countries, since the 1990s, compared with industrialized countries. Urbanization is a dynamic moderation phenomenon on the social and economic capability of the rural areas (agrarian economic base) rather than on urban areas (industrial economic base). In order to construct panel cointegration test, it was important to allow for as much heterogeneity as possible among the individual members of the panel. To investigate the existence of a long-run equilibrium relationship between CO_2 emissions and the regressors, the study employed the newly established Pooled Mean Group (PMG) estimator for dynamic heterogeneous panels developed. The authors found that low CO_2 emissions were associated with high openness in the long run. In particular, they found that high openness was associated with low CO_2 emissions in the long run, but only to a certain level of openness. In other words, there was a turning point towards an openness beyond which greater openness may generate high CO_2 emissions.

Shearer et al. (2017), in an article entitled, "Future CO_2 Emissions and Electricity Generation from proposed Coal-fired Power Plants in India", reported that with its growing population, industrializing economy and large coal reserves, India represents a critical unknown in global projections of future CO_2 emissions. The study assessed the proposed construction of coal-fired power plants in India and evaluated their implications for future emissions and energy production in the country. The high emission intensity reflects the large fraction of electricity generated from coal in India and the targeted intensity decrease by 2030, will almost certainly require drastic reductions in the fraction of electricity being generated by coal. The study found that combined with already operating fossil-based plants, India's proposed coal plants would preclude a 33-35% reduction in the country's 2005 electricity emissions intensity by 2030, if the coal plants are utilized at a capacity factor of 65% or higher.

3. MATERIALS AND METHODS

3.1. Materials

The paper proposes to analyze the problem of decarbonization factors of CO_2 emissions and their impact on financial development during the study period. The influence of financial development on carbon emissions is still under debate, in both the theoretical and empirical research, which reflect the complexity of their relationship which cannot be readily detected or described. To reduce the carbon emissions will affect the financial development and economic growth. The theoretical research reveals that the financial development has both positive and negative effects on carbon emissions and the empirical research reflects that the influence of financial development on carbon emission varies across countries and regions. The present study proposes to examine the unit root test and co-integration test, by using CO_2 emissions and financial development variables, during the study period.

The need for study was Climate change can be considered a systematic risk that affects the financial industry, as it affects all sectors of the global economy. The important damages produced by the physical outcomes of climate change and their direct connection with the accumulation of CO_2 emissions, stimulated the international authorities to take remedial measures, in the conference in Paris in December 2015. The Paris agreement proposed to limit the increase in global average temperatures, to below 2°C, which would be above pre-industrial levels and to strive for restricting the temperature rise to 1.5°C. This aim was to be reflected in country-level emission pledges, known as Nationally Determined Contributions (NDCs).

The objectives of the analysis is to study the relationship between financial development and decarbonization factors of CO_2 emissions during the study period and to study the climate change and measures to reduce carbon dioxide emissions. The present study tested the following null hypotheses: H1: There is no relationship between financial development and decarbonization factors of CO_2 emissions during the study period and H2: There is no relationship between climate change and carbon dioxide emissions. In this study the main objective was to find the impact of financial development on decarbonization factors of carbon emissions during the study period. The sample consisted of top ten developed countries and five developing countries, as presented in Table 1.

3.1.1. Reasons for choosing developed and developing countries

A developed country is a sovereign state, with a developed economy and technologically advanced infrastructure, compared to other nations.

Several factors determine whether or not a country is developed, such as the human development index, political stability, gross

Table 1: List of sample countries

S.No	Developed countries	Developing countries
1	Norway	Argentina
2	Switzerland	Guyana
3	Ireland	India
4	Germany	Brazil
5	Hong Kong	China
6	Australia	
7	Iceland	
8	Sweden	
9	Singapore	
10	Netherlands	

Source: world population review.com and borgenproject.org

domestic product (GDP), industrialization, and freedom. The Human Development Index was developed by the United Nations, to measure human development in a country. HDI is quantified by looking at a country's human development, such as education, health, and life expectancy. HDI is set on a scale from 0 to 1, and most developed countries have a score above 0.80. HDI can be used to determine the best countries to live in, as those who are more developed, typically have a higher quality of life. The United Nations Development Report 2019 Statistical Update ranks each country in the world, based on its HDI ranking. The following list includes the sample ten developed 10 countries.

The world economy is changing every day, due to trade investments, inflation and emerging economies make a greater impact than ever before. Improvements in these economies have been due to significant government reforms within these countries as well as the administration of international aid, through financial and infrastructural efforts. These are the sample five fastest developing countries.

The variable of the study was CO_2 emissions, and selected five control variables were financial development, trade openness, urbanization, population growth, and industrial structure. The sample selection and details of the variables, used in the study, are presented in Table 2.

All the variables were extracted from the World Development Indicators database of the World Bank, except for the financial development (FD1) variable, which was sourced from the International Monetary Fund (IMF) database. All the variables were transformed into the natural logarithms, except for FD1 and population growth (POP), as they were already dimensionless or ratio indexes.

3.1.2. Appendix: The introduction of the Index, proposed by Svirydzenka (2016) (FD1)

The comprehensive index of financial development, proposed by Svirydzenka, is one of the proxy variables of financial development. This index is constructed by using six sub-indexes, concerning the depth, access, and efficiency of financial institution and financial markets. Table 3 presents the frame work of this index.

The dataset of the panel of 15 countries was collected during the years from 1st April 2010 to 31st March 2019. Sample countries were into two groups: ten developed countries and five developing countries. The tools used for this study were descriptive statistics, correlation matrix, panel unit root test, and cointegration and regression analysis. The mean is the average of the data, which is the sum of all the observations divided by the number of observations. The standard deviation is the most common measure of dispersion, or how spread out the data are about the mean.

Table 2: Variables

Variables	Symbol	Measurable indicator
Carbon emission	CE	Carbon dioxide emissions (metric tons per capita)
Financial development	FD1	A comprehensive index proposed by Svirydzenka
Financial development	FD2	Domestic credit to the private sector (% of GDP)
Financial development	FD3	Domestic credit to the private sector by banks (% of GDP)
Financial development	FD4	Market capitalization of listed domestic companies (% of GDP)
Financial development	FD5	Total value of traded stocks (% of GDP)
Trade openness	TRADE	Total import and export (% of GDP)
Urbanization	URBAN	Urban population (% of total population)
Population growth	POP	Population growth (%)
Industrial structure	IVA	Industrial value added (% of GDP)

Table 3: Framework, proposed by Svirydzenka (FD1)

Aggregate Index	First-level sub-index	Second level sub-index
Financial Development (FD1)	Financial Institutions (FI)	1. Depth (FID) 2. Access (FIA) 3. Efficiency (FIE)
	Financial Markets (FM)	1. Depth (FID) 2. Access (FIA) 3. Efficiency (FIE)

Source: IMF website

$$Std\ Deviation = \sqrt{Variance} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(X_i - \overline{X})^2}$$

Skewness is the measure of asymmetry in a probability distribution. It can either be positive, negative or undefined. Positive Skew — this is the case when the tail on the right side of the curve is bigger than that on the left side. Under these distributions, mean is greater than the mode. Negative Skew — this is the case when the tail on the left side of the curve is bigger than that on the right side. Under these distributions, mean is smaller than the mode.

The most commonly used method of calculating Skewness is:

$$Skewness = \frac{3(Mean - Median)}{Std\ Deviation}$$

3.2. Methodology

3.2.1. Drivers of CO_2 emissions

CO_2 emissions were divided into four driving factors, following the Kaya identity, which is generally presented in the form:

Kaya identity:

$$C = P\ (G/P)\ (E/G)\ (C/E)$$

Where:
C = CO_2 emissions; P = population
G = GDP E = primary energy consumption

The identity expresses, for a given time, CO_2 emissions as the product of population, per capita economic output (G/P), energy intensity of the economy (E/G) and carbon intensity of the energy mix (C/E).

Because of possible non-linear interactions between terms, the sum of the percentage changes of the four factors, e.g. (Py-Px)/Px, will not generally add up to the percentage change of CO_2 emissions (Cy-Cx)/Cx. However, relative changes of CO_2 emissions in time can be obtained from relative changes of the four factors as follows:

Kaya identity: relative changes in time:

$$Cy/Cx = Py/Px\ (G/P)\ y/(G/P)\ x\ (C/E)\ y/(C/E)\ x$$

Where x and y represent two different years.

The Kaya decomposition is presented as:

CO_2 emissions and drivers

$$CO_2 = P\ (GDP/P)\ (TES/GDP)\ (CO_2/TES)$$

Where:
C = CO_2 emissions; P = population; GDP/P = GDP/population
TES/GDP = Total primary energy consumption per GDP
CO_2/TES = CO_2 emissions per unit TES
GDP in 2015 USD, based on purchasing power parities.

The Kaya identity can be used to discuss the primary driving forces of CO_2 emissions. For example, it shows that globally, increases in population and GDP per capita have been driving up trends in CO_2 emissions, more than offsetting the reduction in energy intensity. In fact, the carbon intensity of the energy mix is almost unchanged, due to the continued dominance of fossil fuels, particularly coal in the energy mix, and to the slow uptake of low-carbon technologies.

However, it should be noted that there are important caveats in the use of the Kaya identity. Most important, the four terms on the right-hand side of equation should be considered neither as fundamental driving forces in themselves, nor as generally independent from each other.

Carbon emission is the release of carbon into the atmosphere. To talk about carbon emissions is simply to talk of greenhouse gas emissions; the main contributors to climate change. Since greenhouse gas emissions are often calculated as carbon dioxide equivalents, they are often referred to as "carbon emissions" while discussing global warming or the greenhouse effect. Since the industrial revolution, the burning of fossil fuels has increased, which is directly related to the increase of carbon dioxide levels in our atmosphere and thus the rapid increase of global warming.

Carbon intensity is a measure of how much carbon is being emitted per unit of GDP. A country, with low carbon intensity, is running its economy more cleanly than one with a high carbon intensity, either due to energy efficiency or a high percentage of renewables and/or nuclear power in its energy mix. But a country, with low carbon intensity and large economy, could still emit more overall CO_2 emissions than a country with a high carbon intensity and small economy. An individual country's carbon intensity can also fall while its emissions rise overall, if its economic growth outstrips the reduction in emissions per unit of GDP. Carbon intensity is a measure of how efficiently countries use their polluting energy resources, such as coal, oil and gas.

Pedroni's Cointegration Test, formulated by Pedroni (1999; 2004), and introduced seven test statistics that test the null hypothesis of no cointegration in nonstationary panels. The seven test statistics allow heterogeneity in the panel, both in the short-run dynamics as well as in the long-run slope and intercept coefficients. Unlike regular time-series analysis, this tool does not consider normalization or the exact number of cointegrating relationships. Instead the hypothesis test is simply the degree of evidence or lack thereof, for cointegration in the panel among two or more variables. The seven test statistics are divided into two categories: group-mean statistics that averages the results of individual country test statistics and panel statistics that pools the statistics along the within-dimension. Nonparametric (ρ and t) and parametric (augmented Dickey–Fuller [ADF] and v) test statistics come within both groups.

Regression analysis is a set of statistical methods, used for the estimation of relationships between a dependent variable and one or more independent variables. It can be utilized to assess the strength of the relationship between variables and for modeling the future relationship between them. Regression analysis includes several variations, such as linear, multiple linear, and nonlinear. The most common models are simple linear and multiple linear. Nonlinear regression analysis is commonly used for more complicated data sets, in which the dependent and independent variables show a nonlinear relationship. Regression analysis offers numerous applications in various disciplines, including finance.

The S.T.I.R.P.A.T. model is used to investigate the relationship between urbanization and CO_2 emissions. The S.T.I.R.P.A.T. model is based on the Influence, Population, Affluence and Technology (I.P.A.T.) model, developed by Ehrlich and Holdern (1971). The I.P.A.T. model relates environmental impact to population, affluence (per capita consumption) and technology. The I.P.A.T. identity (Eq.1) is often used as a basis for studying the role of the various factors, driving CO_2 emissions.

$$I = P \times A \times T \quad (1)$$

The I.P.A.T. model has been criticized as (1) being primarily a mathematical equation or accounting identity, which is not suitable for hypothesis testing and (2) assuming a rigid proportionality between the variables. In response, Diez and Rosa (1997) propose a stochastic version of I.P.A.T.

Thus, using this model as the basis, Dietz and Rosa (1997) proposed the S.T.I.R.P.A.T. model in which α represents the constant term and P, A and T are the same as that in Eq. (1), b, c, and d represent the elasticity of environment impacts with respect to P, A, and T, respectively, e_i is the error term and the subscript i denotes the country, 'I' represents an impact, typically measured in terms of the emission level of a pollutant, 'P' denotes population size, 'A' represents a society's affluence and 'T' is a technology index. In order to examine the factors affecting environmental change, the I.P.A.T. model is simple, despite its limitations.

$$I_{i}t = \alpha_i P\beta_{it} A_{it} T\, i^{t\delta_i}{}_{t} e_{it}$$

In Eq. (2), countries are denoted by the subscript i (I = 1. N) and the subscript t (t = 1… T) denotes the time period. Country – specific effects are represented by α_i and e_{it} represents the random error term. Taking natural logarithms of Eq. (2) provides a convenient linear specification for panel estimation. When all variables are in natural logarithms, the estimated coefficients can be interpreted as elasticities.

Panel unit root tests are superior to time series unit root tests. Therefore, this study employed panel unit root tests, as found in Im et al. (IPS) (2003) and Levin Lin and Chu (LLC) (2002). Panel unit root tests are similar to unit root tests performed on a single series. The ADF model for panel data may be expressed as:

$$=\rho_{i\gamma} Y_i^{tt}\ {}^{\iota}\in^{\delta}{}_i \Delta Y_{it} + \chi_{it}{}^{\beta}{}_{+} \in_{it}$$

Where y it is the series of interest being i= 1, 2… N cross-section units over periods t=1, 2,…, T, x it represents a column vector of exogenous variables, including the fixed effects or individual trends, qi is the mean-reversion coefficient, q is the lag length of the autoregressive process and it ε it a idiosyncratic disturbance, assumed to be a mutually independent. If qi < 1, y it is said to be weakly (trend) stationary and if qi= 1, then y it presents a unit root. Two natural assumptions may be made about qi in the ADF model for panel data. First, it is assumed that the persistence parameters are common across countries, so that qi ¼ q for all i. Using this assumption, and Levin et al. (2002) approach (both testing for a null hypothesis of a unit root against the alternative without unit root) and the Hadri (2000) approach (which tests the nullity of unit root against the alternative hypothesis), can be applied. Second, qi is freely varying across units, allowing for individual unit root processes.

The case of ADF and PP tests was proposed by Maddala and Wu (1999) and Choi (2001) and the IPS test was proposed by Im et al. (2003). The three of them test the null hypothesis of a unit root against the alternative hypothesis of some individuals without unit roots.

4. EMPIRICAL RESULTS

Statistics on carbon dioxide emissions, financial development FD1, trade openness, urbanization, population and industrial value added, are presented in Table 4. All the variables were transformed into natural logarithms, except FD1 and population. The mean value of carbon emissions reported the highest value at 4.308 and the financial development variable recorded a lower value of 0.637. The value of standard deviation, at 1.692, was high. Regarding FD1 variable, mean and standard deviation were highly influenced by each other. The minimum value of population was negative at −1.900 and the maximum value of carbon emissions was 6.111. All the variables reported skeweness value to be negative that is, skewed to the left tail and the peak on right side. In kurtosis, the variable of FD1 at 0.058, was Platykurtic. i.e $k<0$. Kurtosis was lesser than that of the normal distribution. The population variable recoded kurtosis value at 5.670 i.e. $k>0$ and hence leptokurtic, with a high degree of peakedness.

Correlation is a statistical measure, that describes how two variables are related and indicates that as one variable changes in value, the other variables tends to change in a specific direction. All the variables of carbon emissions, financial development, trade openness, urbanization, population and industrialization were converted into natural logarithm.

Table 5 presents the correlation matrix, when all the correlation coefficients of each of the variables, were <0.6897. The relationship between trade openness and FD1 reported high growth correlation of 0.6897. When financial development (FD1) increased, the other variable of (TRADE) total import and export (% of GDP) also increased. The industrialization and urbanization reported negligible correlation because there was no relationship between the movements of the two variables. The coefficient correlation of carbon emissions and industrialization revealed no relationship between each other.

Table 6 shows the CO_2 emissions in Metric Tons (MT), for the period 1st April 2010-31st March 2019. CO_2 emissions are widely considered to play a significant role in contributing to global warming. Global warming has adverse effect on

Table 4: Descriptive statistics

Variable	Mean	SD	Min	Max	Skweness	Kurtosis
CE	4.308	1.692	0.000	6.111	−1.799	2.140
FD1	0.637	0.275	0.150	0.980	−0.736	0.058
TRADE	4.172	1.377	0.000	6.093	−1.591	3.267
URBAN	4.271	0.387	3.273	4.605	−1.589	1.330
POP	0.893	0.530	−1.900	2.700	−0.249	5.670
IND	2.843	0.847	−0.511	3.643	−2.305	5.025

CE denotes carbon emissions. FD1 denotes financial development. TRADE denotes trade openness. URBAN denotes urbanization. POP denotes population and IND denotes industrialization or industrial value added

Table 5: Correlation matrix of the variables

Variable	CE	FD1	TRADE	URBAN	POP	IVA
CE	1					
FD1	0.2737	1.0000				
TRADE	0.2529	0.6897	1.0000			
URBAN	0.1477	0.5966	0.6888	1.0000		
POP	0.0750	0.1352	0.1598	0.1972	1.0000	
IVA	−0.0594	0.2915	0.0000	−0.2382	0.0442	1

Source: Computed with EViews. CE denotes carbon emissions. FD1 denotes financial development. TRADE denotes trade openness. URBAN denotes urbanization. POP denotes population and IND denotes industrialization or industrial value added economic activities, with increased weather variability and loss of biodiversity. Over the past few decades, the level of CO_2 in the atmosphere, had continued to rise. China is the largest CO_2 emitter, with 3.39% in 2019. China is the fast developing economy, with new technologies, to improve their financial position. India is the third largest emitter of carbon emission, with 1.6% in 2019. It recorded lower percentage when compared to the previous year (2018) at 5.41%. Iceland and Germany reported the lowest carbon emissions in 2019 at −5.38 and −6.49%. Developing countries like Argentina and Brazil, reported negative values of carbon emissions at −2.69 and −0.38%.

Table 7 presents the carbon dioxide emissions and per capita, of developed and developing countries, for the period 1st April 2010-31st March 2019. Australia was ranked ninth in CO_2 emissions per capita, at 2.85% because the economy was dominated by the service sector, contributing about 63% of its GDP and employing about 79% of its workforce. Australia is also part of the Asia-Pacific Economic Cooperation (APEC), G20, the Organization for Economic Cooperation and Development (OECC), and the World Trade Organization (WTO). The value of CO_2 emissions had increased from negative per capita emissions of −2.7% in 2010.

India occupies the 103rd rank because it is the second most populated country in the world. In India, the people widely use motor vehicles like car, scooter, bike etc., and it creates more pollution to the environment. The biggest challenge to limit carbon dioxide, is faced by developing economies because of their thrust for rapid economic growth. Due to rapid growth, there is a tendency to generate more CO_2 emissions. In 2019, India reported 0.51% of carbon emissions per capita because the income level of population went down due to the pandemic of Covid-19.

Table 8 presents the carbon emissions intensity, for both developed countries and developing countries. Carbon Intensity is a measure of how much carbon is being emitted per unit of GDP. Rankings are given to carbon intensity value for each country, each year. China recorded the 13th rank, among 180 countries. China is the world's second-largest economy but its per capita income is relatively low compared to other high-income countries. Ireland was awarded

Table 6: CO_2 Emissions in Metric Tons (MT) for the period 1st April 2010 to 31st March 2019

CO_2 Emissions Metric Tons in Percentage (%)											
Year/Country	**Rankings**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Developed countries											
Norway	56	4.48	−2.96	−1.51	−1.5	1.03	3.04	−1.21	7.24	0.29	−1.36
Ireland	64	−0.91	−10.21	1.88	−3.53	−0.53	4.46	4.51	−3.11	−0.92	−3.84
Germany	6	6.09	−3.29	1.5	2.32	−4.81	0.78	0.51	−1.79	−3.25	−6.49
Hong Kong	58	−8.84	8.57	−1.16	2.54	4.14	−8.3	1.81	−1.46	−0.17	−2.03
Australia	15	−1	−0.58	−0.1	−1.07	−2.25	1.78	1.94	0.63	0.38	4.17
Iceland	129	−3.24	−2.69	2.03	3.56	−1.25	2.01	0.65	4.83	2.03	−5.38
Sweden	57	12.77	−7.99	−6.39	−4.11	0.17	0.23	1.07	−0.69	−1.76	2.69
Singapore	51	8.88	5.29	−1.06	0.94	−2.59	−1.72	1.17	2.56	−1.12	1.32
Netherlands	31	6.37	−6.34	−1.98	−0.69	−4.35	4.48	−0.3	−1.49	−2.45	−3.4
Developing countries											
Argentina	27	2.9	4.26	2.93	−1.72	3.93	1.38	−0.12	−3.08	−0.55	−2.69
Guyana	144	1.79	3.17	74.31	25.74	−8.89	2.92	7.22	−17.59	1.09	2.3
India	3	5.25	5.52	7.65	3.39	8.09	2.55	1.26	4.46	5.41	1.6
Brazil	14	13.21	4.64	7.61	4.77	4.93	−5.68	−6.38	1.86	−3.48	−0.38
China	1	9.34	9.57	2.33	2.54	1.15	0.16	0.19	2.05	2.25	3.39

Source: www.knoema.com

Table 7: CO_2 emissions per capita for the period 1st April 2010 to 31st March 2019

CO_2 emissions per capita in percentage (%)											
Year/Country	**Rankings**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Developed countries											
Norway	31	3.22	−4.17	−2.78	−2.76	−0.21	1.86	−2.24	6.22	−0.61	−2.23
Ireland	42	−0.91	−10.21	1.88	−3.53	−0.53	4.46	4.51	−3.11	−0.92	−3.84
Germany	32	6.19	−3.34	1.33	2.07	−5.08	0.51	0.25	−2.03	−3.47	−6.66
Hong Kong	50	−9.38	7.95	−1.73	1.93	3.48	−8.94	1.01	−2.29	−1.03	−2.84
Australia	9	−2.7	−2.17	−1.6	−2.47	−3.6	0.39	0.56	−0.71	−0.92	2.85
Iceland	21	−4.53	−3.62	1.37	3.09	−1.68	1.46	−0.02	4.03	1.2	−6.16
Sweden	63	11.85	−8.72	−7.12	−4.85	−0.6	−0.53	0.31	−1.42	−2.47	1.97
Singapore	29	6.55	3.22	−2.85	−0.75	−4.15	−3.26	−0.4	1.01	−2.54	0.01
Netherlands	27	6.01	−6.64	−2.28	−0.99	−4.63	4.18	−0.59	−1.77	−2.72	−3.67
Developing countries											
Argentina	67	1.84	3.17	1.85	−2.75	2.87	0.36	−1.1	−4.01	−1.48	−3.58
Guyana	100	1.67	2.82	73.39	24.91	−9.52	2.23	6.56	−18.07	0.52	1.74
India	103	3.83	4.14	6.3	2.13	6.81	1.36	0.1	3.29	4.25	0.51
Brazil	93	12.11	3.64	6.61	3.81	4.01	−6.48	−7.15	1.07	−4.2	−1.09
China	37	8.72	8.95	1.76	1.98	0.62	−0.33	−0.27	1.62	1.85	3.02

Source: www.knoema.com

the 164th rank because the carbon emission intensity value was negative at −3.84, in 2019. Singapore and India reported low carbon intensity value of 1.32 and 1.6 for the year 2019. Singapore is the ninth-most developed high-income nation in the world and one of the world's most competitive economies in the world when it comes to the economy. Today, service and manufacturing are the two main sectors of Singapore's strong economy. India has a large well-skilled workforce that has contributed to its fast-growing and largely diverse economy.

Table 9 displays the results of the unit root test. The results of the LLC, Im, Pesaran and Shin unit root test, indicated that all variables were stationery at level or first difference. Hence for all variables, the null hypothesis of unit root was rejected after the first difference and the alternative hypothesis of panel unit root was accepted. ADF - Fisher Chi-square revealed the population prob.value to be 0.0002 and it was accepted, at significant level of 0.05%.

Table 10 presents the results of Pedroni cointegration and Kao Residual cointegration test. Pedroni is one of the most important and widely used tests of cointegration for panel data. The first four statistics are within-dimension based statistics and the rest are between-dimension based statistics. In group mean approach, the first statistics is analogous to the Phillips and Perron rho-statistics, Phillips and Perron t-statistics and the Augmented Dickey-Fuller t-statistics. According to the results of within-dimension of panel PP-statistics, probability value was 0.0000. But the statistics value was negative. Weighted statistics of Panel PP-statistics recorded negative value and hence reject the null hypothesis. According to group PP-Statistic, the probability value was 0.0000, at significant level of 5%. In Kao residual cointegration test of ADF t-statistics, the value was −0.055452 and the P-value was more than the significant level of 5%.

Table 11 presents the empirical results of the effect of financial development of the full sample on carbon emissions, with stepwise regressions. The results of the regression showed positive coefficients. The variable of carbon emissions was significant at the 1% level. The industrial value added variable recorded negative coefficient value of −0.0240 and the t-statistic value was −0.7776, but the probability value was at insufficient level. Financial development (FD1) variable was extracted from the International Monetary Fund working paper. Durbin-Watson stat. was greater than the value of two and it implied negative autocorrelation.

Table 12 presents the sub sample regression of carbon emissions, FD1, industrial value added, population, trade and urbanization, for developed and developing countries. The carbon emission of developed countries and developing countries was at significant level, and hence reject the null hypothesis. The probability value was 0.0000 for developed countries and 0.0006, for developing countries, at the significant level of 5%. The FD1 variable reported negative coefficient values of −0.0725 and −0.2840 for both groups. The R-squared value of 0.9787 and 0.9170 for

Table 8: CO_2 emissions intensity for the period 1st April 2010 to 31st March 2019

CO_2 emissions intensity in percentage (%)											
Year/Country	Rankings	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Developed countries											
Norway	111	4.48	−2.96	−1.51	−1.5	1.03	3.04	−1.21	7.24	0.29	−1.36
Ireland	164	−0.91	−10.21	1.88	−3.53	−0.53	4.46	4.51	−3.11	−0.92	−3.84
Germany	100	6.09	−3.29	1.5	2.32	−4.81	0.78	0.51	−1.79	−3.25	−6.49
Hong Kong	147	−8.84	8.57	−1.16	2.54	4.14	−8.3	1.81	−1.46	−0.17	−2.03
Australia	31	−1	−0.58	−0.1	−1.07	−2.25	1.78	1.94	0.63	0.38	4.17
Iceland	79	−3.24	−2.69	2.03	3.56	−1.25	2.01	0.65	4.83	2.03	−5.38
Sweden	168	12.77	−7.99	−6.39	−4.11	0.17	0.23	1.07	-0.69	−1.76	2.69
Singapore	150	8.88	5.29	−1.06	0.94	−2.59	−1.72	1.17	2.56	−1.12	1.32
Netherlands	99	6.37	−6.34	−1.98	−0.69	−4.35	4.48	−0.3	−1.49	−2.45	−3.4
Developing countries											
Argentina	72	2.9	4.26	2.93	−1.72	3.93	1.38	−0.12	−3.08	−0.55	−2.69
Guyana	74	1.79	3.17	74.31	25.74	−8.89	2.92	7.22	−17.59	1.09	2.3
India	39	5.25	5.52	7.65	3.39	8.09	2.55	1.26	4.46	5.41	1.6
Brazil	102	13.21	4.64	7.61	4.77	4.93	−5.68	−6.38	1.86	−3.48	−0.38
China	13	9.34	9.57	2.33	2.54	1.15	0.16	0.19	2.05	2.25	3.39

Source: www.knoema.com

Table 9: Panel unit root rest

Variables	Statistic	Levin, Lin and Chu t*	Im, Pesaran and Shin W-stat	Prob.**	ADF - Fisher Chi-square	Prob.**	PP - Fisher Chi-square	Prob.**
		Prob.**	Statistic		Statistic		Statistic	
CE	28.7049	1.0000	5.54785	1.0000	11.4459	0.9991	2.30375	1.0000
FD	−3.94049	0.0000	0.31345	0.6230	34.7142	0.2532	46.3851	0.0285
TRADE	−2.8506	0.0022	0.45989	0.6772	25.2274	0.6154	29.5081	0.3871
URBAN	−6.42902	0.0000	0.18006	0.5714	39.8587	0.0221	64.1545	0.0000
POP	−4.99122	0.0000	−2.7083	0.0034	64.8491	0.0002	69.7110	0.0001
IND	−3.70155	0.0001	−0.59357	0.2764	37.0995	0.1743	65.3930	0.0002

Source: computed in EViews. CE denotes Carbon emissions, FD denotes financial development, TRADE denotes trade openness, URBAN denotes urban population, POP denotes population growth and IVA industrial value added. ** Probabilities for Fisher tests are computed, using an asymptotic Chi -square distribution. All other tests assume asymptotic normality

Table 10: Pedroni residual cointegration test

Alternative hypothesis: common AR coefs. (within-dimension)				
	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	−0.849449	0.8022	−2.38168	0.9914
Panel rho-Statistic	2.917819	0.9982	3.500798	0.9998
Panel PP-Statistic	−5.840625	0.0000	−8.787449	0.0000
Panel ADF-Statistic	NA	NA	NA	NA
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	**Prob.**	**…**	**…**
Group rho-Statistic	4.672753	1.0000	…	…
Group PP-Statistic	−15.17831	0.0000	…	…
Group ADF-Statistic	NA	NA	…	…
Kao Residual Cointegration Test				
	t-Statistic	**Prob.**	**…**	**…**
ADF	−0.055452	0.4779	.	…

Source: Computed from EViews. v-Statistic is non-parametric variance ratio statistics, rho-statistics is panel version of a non-parametric statistics that is analogous to the familiar Phillips Perron rho-statistics, PP-statistics is Phillips and Perron test, and ADF is Augmented Dickey-Fuller test.

Table 11: Results of the full sample regression

Variable	Coefficient	Std. Error	t-statistic	Prob.
L.CE	1.0063	0.0335	30.0413	0.0000
FD1	0.0219	0.1984	0.1105	0.9122
IVA	−0.0240	0.0309	−0.7776	0.4384
POP	0.0236	0.0524	0.4507	0.6531
TRADE	0.0423	0.0303	1.3981	0.1648
URBAN	−0.0450	0.0462	−0.9759	0.3312
R-squared	…	…	…	0.91033
Adjusted R-squared	…	…	…	0.906397
S.E. of regression	…	…	…	0.291386
Durbin-Watson stat	…	…	…	2.737537

Source: Computed from EViews. L.CE denotes Lag of carbon emission, FD1 denotes financial development1, TRADE denotes trade openness, URBAN denotes urbanization, POP denotes population growth, and IVA denotes industry value added

Table 12: Results of the sub-sample regressions

Variable	Developed countries		Developing countries	
	Coefficient	Prob.	Coefficient	Prob.
L.CE	1.0037	0.0000	0.6663	0.0006
FD1	−0.0725	0.0404	−0.2840	0.8277
IVA	−0.0073	0.4767	0.0608	0.5025
POP	0.0116	0.1258	−0.2930	0.6247
TRADE	0.0034	0.6536	0.4544	0.0885
URBAN	0.0050	0.7974	0.1373	0.3821
R-squared	…	0.9787	…	0.9170
Adjusted R-squared	…	0.9773	…	0.9048
S.E. of regression	…	0.0375	…	0.4986
Durbin-Watson stat	…	2.0437	…	2.1651

Source: Computed from EViews. L.CE denotes Lag of carbon emission, FD1 denotes financial development1, TRADE denotes trade openness, URBAN denotes urbanization, POP denotes population growth, and IVA denotes industry value added

independent variables could explain 97.87% and 91.70% true value of dependent variables.

Proxy variables of financial development, used for the regression analysis, were FD2-FD5. Generally, financial development is divided into the financial institution and the development of stock market (corresponding with indirect financing and direct financing respectively). FD2 and FD3 were used as proxy variables of the development of financial institution and FD4 and FD5, to be the proxy variables of the development of stock market. Table 13 presents the full sample regression of FD2 variable and the effect of carbon emissions recorded the significant probability value of 0.0000. The other developed and developing countries, coefficient and probability values were insignificant variables to each other. Durbin-watson statistics reported 1.3109 for the full sample, 1.2784, for developed countries and 1.4057, for developing countries, with no positive autocorrelation. R-Squared value of developing countries was 0.4523 and it implied that independent variables could forecast only 45.23% of true value of dependent variables.

Table 14 presents the full sample and sub sample regression of developed countries and developing countries, for the proxy variable of FD3. The coefficient variables of financial development FD3 and population revealed the negative effect values at −0.1662 and −0.1332, carbon emissions probability value at 0.0000 and the coefficient value at 0.9168, at significant level of 5%, 1% and 10%. IVA and urbanization variable indicated negative coefficient values to be −0.1469 and −0.0204. The probability value was insignificant because P-value was more than 5% level. The value of Durbin-Watson statistics was 1.2817, with 1.2416 for developed and 1.3081 for developing countries and they indicated positive autocorrelation.

Table 15 presents the full sample regression and the sub sample regression of developed countries and developing countries for the variables like carbon emissions, financial development FD4, industry value added, population trade and urbanization. The coefficients of FD4 and urbanization reported negative effect. The carbon emissions of full sample coefficient value was 0.8944 and the probability value was 0.0000, at significant level of 5%. R-squared and Adjusted R-squared values did not indicate the true value of 0.0895, 0.0754 and 0.056231. Durbin-Watson revealed positive autocorrelation because values were lesser than the value 2.

Table 16 presents the full sample and sub sample regression of developed countries and developing countries, with the financial development FD 5 variable and other variables. The carbon emissions variable of full sample regression was significant at 5% level, with coefficient value being 0.8115 and the probability value being 0.0000. The other sub sample regression of developed and developing countries reported insignificant values. Financial development and carbon emission reported no relationship between them and it recorded negative coefficient values of −0.2453, −0.8343 and −1.6107. Durbin-Watson statistics was less than the value of two i.e. they were 1.2820, 1.2286 and 1.3691, and it revealed positive autocorrelation under the regression model.

Table 17 presents the results of Static Panel Regressions of both developed and developing countries, with the variables of carbon emissions, Financial Development (FD1), industrial value added, population, trade openness and urbanization. All the probability values were insignificant because P-value was more than 5% level.

Table 13: Results of the full sample and sub-sample regression (explanatory variables: financial development variable two, FD2)

Variable	Full sample		Developed Countries		Developing Countries	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
L.CE	0.8926	0.0000	0.8468	0.2530	0.5099	0.2998
FD2	0.1822	0.2019	0.3321	0.0775	0.6705	0.1047
IVA	0.0329	0.8305	0.4821	0.1388	−0.3694	0.2929
POP	−0.0681	0.7989	−0.1748	0.5344	2.1699	0.1424
TRADE	−0.0115	0.9266	0.1404	0.6201	0.0456	0.9360
URBAN	−0.1841	0.4254	−0.7490	0.3038	−0.4094	0.3173
R-squared	.	0.2360	…	0.0853	…	0.4523
Adjusted R-squared	…	0.2064	…	0.0309	…	0.3821
S.E. of regression	…	1.5645	…	1.4844	…	1.7164
Durbin-Watson stat	…	1.3109	…	1.2784	…	1.4057

Source: Computed from EViews. L.CE denotes Lag of carbon emission, FD2 denotes financial development, TRADE denotes trade openness, URBAN denotes urbanization, POP denotes population growth, and IVA denotes industry value added

Table 14: Results of the full sample and sub-sample regression (explanatory variables: FD3)

Variable	Full sample		Developed countries		Developing countries	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
L.CE	0.9168	0.0000	0.6478	0.3758	0.5620	0.2407
FD3	−0.1662	0.5322	1.1042	0.0720	0.1798	0.8044
IVA	0.0789	0.6362	0.7045	0.0491	−0.1469	0.7312
POP	−0.1332	0.6109	−0.1314	0.6339	1.2072	0.5187
TRADE	0.0308	0.8116	0.2159	0.4424	0.1775	0.7604
URBAN	0.0999	0.7134	−1.6085	0.0960	−0.0204	0.9716
R-squared	…	0.2496	…	0.0896	…	0.4774
Adjusted R-squared	…	0.2194	…	0.0334	…	0.4067
S.E. of regression	…	1.5077	…	1.4400	…	1.6366
Durbin-Watson stat	…	1.2817	…	1.2416	…	1.3081

Source: Computed from EViews. L.CE denotes Lag of carbon emission, FD3 denotes financial development, TRADE denotes trade openness, URBAN denotes urbanization, POP denotes population growth, and IVA denotes industry value added

Table 15: Results of the full sample and sub-sample regression (explanatory variables: FD4)

Variable	Full sample		Developed Countries		Developing Countries	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
L.CE	0.8944	0.0000	0.9083	0.3623	1.375221	0.5295
FD4	−0.2661	0.1859	0.0608	0.8668	−1.104051	0.4214
IVA	0.1532	0.3243	0.5482	0.2409	0.559548	0.364
POP	0.1835	0.5559	0.0336	0.9276	0.032687	0.9831
TRADE	0.3022	0.2612	0.2766	0.3676	0.250879	0.9121
URBAN	−0.1631	0.6245	−0.7561	0.5201	−0.215722	0.7931
R-squared	…	0.0895	…	0.0754	…	0.056231
Adjusted R-squared	…	0.0435	…	0.0020	…	−0.101063
S.E. of regression	…	1.5374	…	1.3705	…	1.926985
Durbin-Watson stat	…	1.2434	…	1.2006	…	1.226055

Source: Computed with EViews. L.CE denotes Lag of carbon emission, FD4 denotes financial development, TRADE denotes trade openness, URBAN denotes urbanization, POP denotes population growth, and IVA denotes industry value added

The following are the major findings of the study.

The relationship between GDP in Purchasing Power Standard and greenhouse gas emissions (in equivalent tonnes of CO_2) is an indicator of the level of eco-efficiency of an economy. A developing economy of China, was ranked first in CO_2 emissions. A lower relationship between two variables, that produce the lowest emissions into the atmosphere for every unit of wealth generated, will be the most efficient economy, with sustainable production patterns.

In order to identify the integration of the variables used in the study, four panel unit root test was employed: (1) Levin, Lin, and Chu "LLC" (2002); (2) Im. Pesaran, and Shin "IPS" (2003); (3) Augmented Dickey-Fuller (ADF); and (4) PP-Fisher Chi-Square. The results are reported in Table 10, for both developed and developing countries. The results revealed that the data were conclusively and consistently stationary in the first difference.

The three factors, that determine economic growth, are the accumulation of physical and human capital and productivity. Financial development is a multidimensional process. Important financial development takes place through banks, investment banks, insurance companies, mutual funds, pension funds and many other nonbank financial institutions.

Table 16: Results of the full sample and sub-sample regression (explanatory variables: FD5)

Variable	Full sample		Developed Countries		Developing Countries	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
L.CE	0.8115	0.0000	1.0170	0.1671	0.2882	0.5912
FD5	−0.2453	0.3142	−0.8343	0.1498	−1.6107	0.1252
IVA	0.2043	0.2246	0.6188	0.1028	0.7946	0.1160
POP	−0.0971	0.7159	−0.0596	0.8410	1.2179	0.3057
TRADE	0.1123	0.4739	1.0288	0.1599	0.1972	0.7248
URBAN	0.0452	0.8618	−1.0046	0.2164	0.8938	0.2001
R-squared	.	0.2323	…	0.0738	…	0.4483
Adjusted R-squared	…	0.2025	…	0.0187	…	0.3776
S.E. of regression	…	1.5682	…	1.4937	…	1.7227
Durbin-Watson stat	…	1.2820	…	1.2286	…	1.3691

Source: Computed with EViews. L.CE denotes Lag of carbon emission, FD5 denotes financial development, TRADE denotes trade openness, URBAN denotes urbanization, POP denotes population growth, and IVA denotes industry value added

Table 17: Results of the static panel regression

Fixed effect			Random effect	
Variable	Coefficient	Prob.	Coefficient	Prob.
L.CE	5.0548	0.5183	3.3562	0.1918
FD1	0.1117	0.9341	0.3108	0.7337
IVA	−0.0032	0.9792	−0.0957	0.3835
POP	−0.0054	0.9406	−0.0015	0.9826
TRADE	−0.2384	0.6000	0.2311	0.1998
URBAN	0.1569	0.9234	0.1274	0.8525

Source: Computed with EViews. L.CE denotes Lag of carbon emission, FD1 denotes financial development, TRADE denotes trade openness, URBAN denotes urbanization, POP denotes population growth, and IVA denotes industry value added.

The results of full sample and sub-sample regressions of developed and developing countries, with different proxy variables of financial development, revealed that the probability value was at significant level 5% and there was positive value. In other words, there was positive effect of financial development on carbon emission.

The suggestions of the study is Carbon dioxide emission are generated by two major sources. The burning of fossil fuels (oil, gas and coal) is responsible for two thirds of the emissions of carbon dioxide since the beginning of industrial revolution. The second cause is the conversion of land, mainly forests. North America and Europe are responsible for half of all carbon dioxide emitted since the beginning of the industrial revolution. They account for half of all emissions of carbon dioxide from human activities, leading to warming of the planet and other climate changes. The problem is compounded by an additional of two billion people, joining the world population during the same period. Society can become fully decarbonized by the end of this century, with the possible intervention of technologies to mitigate carbon dioxide emissions into the atmosphere.

The scope for further research are, a comparative study can be done for other macro-economic factors and financial development on CO_2 emissions, with the help of financial institutions and financial markets. The same study can be used to explore the relationship between individual sector wise and the same macroeconomic factors. Similar study can be applied to predict the future CO_2 emissions and macroeconomic factors for different period by using various analysis.

5. CONCLUSION

In this study, the drivers of energy-related CO_2 emissions, during 2010-2019, for developed and developing countries, were examined, using kaya identity framework. Research on drivers of energy-related CO_2 emissions can help countries to track their climate goals amid changing economic cycles, market forces and policy outcomes. Carbon dioxide is the most important greenhouse gas. Today the transport is responsible for about 23% of the global emission of carbon dioxide. In the present century, more than a billion people own a car. Greenhouse emissions, from vehicle transport sector, are growing faster than any other energy sector and over the past two decades, carbon dioxide emissions from transport have grown by 45%. The increasing use of energy, for technologies at work and home, is responsible for a rapidly increasing use of energy and the resultant CO_2 emissions. Majority of population lives in urban areas with the associated consumption of about 70% of the world primary energy. With the addition of 2.8 billion people, largely from developing countries, to join the world, higher energy consumption by 2050 would increase to new heights.

Economic growth, industrialization and urbanization should be thought of as a solution for environmental problems. However, it would be more optimal for developed and developing countries to follow higher economic growth path, along with policy responses influencing other socio-economic factors that would induce improvement in environmental quality. Policy measures involving inducements, incentives along with measures to spur economic growth, will ensure sustainable development path for developing countries.

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