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The Impact of Carbon Dioxide Emissions on the Economic Growth of India and China

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Abstract- The goal of this study was to look at the effects of CO2 emissions on India's and China's economic growth. CO2 emissions appear to be increasing in both India and China, according to preliminary data analysis. In addition, both countries' carbon emissions from electricity and heat production have recently decreased, while India's reduction has been greater than China's. India's CO2 emissions from the use of gaseous fuels are also higher than China's. China, on the other hand, emits more CO2 than India from manufacturing and building. The findings also revealed that while both India and China's carbon intensity increased over time, China's was higher. Carbon emissions have a negative and significant relationship with India and China's economic growth, according to the results of correlation and regression research. We conclude that lowering carbon emissions is crucial for the country's well-being based on these findings. As a result, the government should come up with environmentally friendly measures for reducing carbon emissions. Environmental protection is a long-term process that necessitates constant planning, government laws, and public and private sector cooperation.

KEYWORDS- Economic growth, Carbon Dioxide Emissions, Carbon emissions trends,

I. INTRODUCTION

Over the last few decades, researchers have focused their efforts on the relationship between economic growth and carbon dioxide emissions. Many governments have significant issues, including ensuring stable economic growth and environmental protection. The threat of climate change is being exacerbated by rising carbon dioxide emissions. Developed countries utilise a lot of energy, which results in carbon dioxide emissions, hence pollution is closely tied to economic development and growth. Environmental deterioration has been identified as a significant issue in the process of economic development. Because air pollution has a direct impact on human health and economic performance.

A. An Overview of Economic Growth in India and China

India's economy was in shambles at the time of independence. She was in charge of the development of a foreign country rather than her own as a colony. The government, which is in charge of agricultural and industrial progress in general, refused to play even a little role in this. In contrast, the world saw rapid progress and expansion in agriculture and manufacturing in the half-century leading up to India's independence, thanks to the states' active participation. The British government never made any significant changes to benefit the social sector, limiting the economy's ability to produce.

B. Objectives of the Study

The objectives of the study are as follows;
To analyze the trends in CO2 emissions in India and china.
To analyze the impact of CO2 emissions on the economic growth of India and china.

C. Hypotheses of the Study

The trend in CO2 has remained static over the time.
There is no impact of CO2 emissions on the economic growth of India and China.

II. REVIEW OF LITERATURE

This section provides a summary of the literature review, which covers research papers on the relationship between carbon dioxide and economic development in India and china other nations. It discusses the variables studied, as well as the methodology and econometric models employed to back up the claim of a link between variables.

Alam (2019) [1] looked into the effects of economic development on environmental quality. Economic development and environmental degradation were measured using GDP per capita and CO2 emissions.

Makarabbi et al., (2017) [2] used data from the World Bank Development Indicators and World Energy Statistics databases from 1978 to 2015 to look at the long-term and causative relationship between CO2 emissions, GDP per capita, energy consumption, and FDI.

Kasperowicz (2015) [3] used a panel data approach to look at the relationship between CO2 emissions and economic growth in 18 EU Member countries.

Heidari et al. (2015) [4] looked studied the association between economic development, CO2 emissions, and energy consumption in five ASEAN countries from 1998 to 2008

Lacheheb, M. (2015).[5] Economic growth and carbon dioxide emissions: Investigating the environmental Kuznets curve hypothesis in Algeria. International Journal of Energy Economics and Policy, 5(4), 1125-1132.

Farhani and Rejeb (2012) [6] looked at the link between energy consumption, GDP, and CO2 emissions in 15 MENA nations using data from 1973 to 2008. In the short run, there is no causal link between GDP and energy consumption, or between CO2 emissions and energy consumption, according to the findings of this study. In the long run, however, there is a one-way causality from GDP and CO2 emissions to energy consumption.

Xiongling (2016) [7] showed that in the long run economic growth and CO2 emissions are balanced. The findings revealed that long-term economic development can help to decrease environmental degradation.

Ghosh et al., (2014) [8] examined the causal relationship between GDP, CO2 emissions, and energy consumption for Bangladesh. The study made use of time series data from 1972 to 2011.

Misra, Kaumudi. (2019). [9] examined the relationship between India's economic growth and carbon emissions for the period 1970-2012. The metrics chosen to understand this relationship were GDP (a proxy for economic growth) and CO2 emissions.

Summary of Literature Review

Even when applying similar methodologies, the results are mixed. This could be because of discrepancies in the variables utilised, the transformations performed, the sample period, and/or the panel of countries analysed. However, using new databases, it will be interesting to investigate the relationship between economic growth and carbon emissions.

III. RESEARCH METHODOLOGY AND DATA SOURCES

If the investigation's superstructure, or research technique, is unscientific, improper, or erroneous, the analysis and conclusion may be invalid, scientific, and appropriate. In general, research technique refers to a methodical and logical approach to solving a research topic. The tools, methodologies, and statistical analysis pattern used in this study have been detailed in length below, keeping in mind the study's aims.

A. Sources of Data

The information for this study was gathered from secondary sources. The secondary data was used to explore the influence of CO2 emissions on India and China's economic growth and to examine the trends in CO2 emissions in India and China. The following sources were used to compile the data for this study:

Books and journals

World Development Indicators, World Bank.

B. Methods Used for Analyzing and Interpreting Data

Correlation Analysis; Karl Pearson's coefficient of correlation was use d to determine the relationship between CO2 emissions and economic growth (GDP) in India and China. The coefficient of correlation was calculated using the formulas below:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{n\sum x^2 - (\sum x)^2\, n\sum y^2 - (\sum y)^2}}$$

• Pooled Ordinary Least Square Model: Since our data consists of both the cross-sectional and time-series features, we pooled time series and cross-sectional dimension together and estimated a grand function. A regression model in which pool all observations together without keeping in mind the time and cross-sectional dimensions, is known as pooled OLS model. Therefore, we specified the following for our pooled OLS model to examine the impact of CO2 emissions on the economic growth of China and India.

$LGDPit = \alpha + \beta CO2it$

Where,

LGDPit = log of GDP (economic growth) of country i at time t.

CO2it = CO2 emissions in country i at time t.

α = intercept

β = slope (change)

IV. DATA ANALYSIS AND RESULTS

A. Trends in CO2 Emissions

This section goes through the different aspects of carbon emissions.

B. Trends in CO2 Emissions (kg per 2015 US$ of GDP)

Table 1 and Fig. 1 demonstrate that CO2 emissions in India decreased between 1990 and 2006 but CO2 emissions increased during the next three years. However, barring the years of 2003 and 2004, China CO2 emissions continued to show a declining trend till 2108. India's CO2 emissions have been decreasing since 2010. This was largely due to the acceptance of Kyoto Protocol commitments, which require governments to limit greenhouse gas emissions and demonstrate their commitment to climate action.

Table 1; Trends in CO2 Emissions (kg per 2015 US$ of GDP)

YEAR	CO2 emissions (kg per 2015 US$ of GDP – India)	Average Annual Growth (AGR)	CO2 emissions (kg per 2015 US$ of GDP - China)	Average Annual Growth (AGR)
1990	1.21		2.11	
1991	1.29	6.84	2.05	-3.05
1992	1.27	-1.61	1.88	-8.04
1993	1.25	-1.17	1.81	-4.09
1994	1.24	-1.14	1.67	-7.50
1995	1.24	0.14	1.68	0.59
1996	1.21	-2.55	1.52	-9.61
1997	1.23	1.64	1.42	-6.55
1998	1.18	-3.72	1.36	-4.20
1999	1.17	-1.09	1.23	-9.49
2000	1.17	0.14	1.20	-2.12
2001	1.13	-3.21	1.17	-2.65
2002	1.13	-0.26	1.16	-1.05
2003	1.08	-4.62	1.22	5.31
2004	1.07	-0.83	1.29	5.39
2005	1.03	-3.03	1.31	1.99
2006	1.02	-1.23	1.29	-1.94
2007	1.04	2.20	1.22	-4.88
2008	1.08	3.37	1.15	-6.10
2009	1.11	2.12	1.12	-1.98
2010	1.08	-2.14	1.12	-0.76
2011	1.08	0.46	1.12	-0.01
2012	1.11	2.78	1.06	-4.74
2013	1.08	-3.13	1.03	-3.27
2014	1.09	1.15	0.95	-7.30
2015	1.02	-6.82	0.88	-7.18
2016	0.95	-6.20	0.83	-6.56
2017	0.94	-1.29	0.79	-4.55
2018	0.93	-0.70	0.76	-3.55

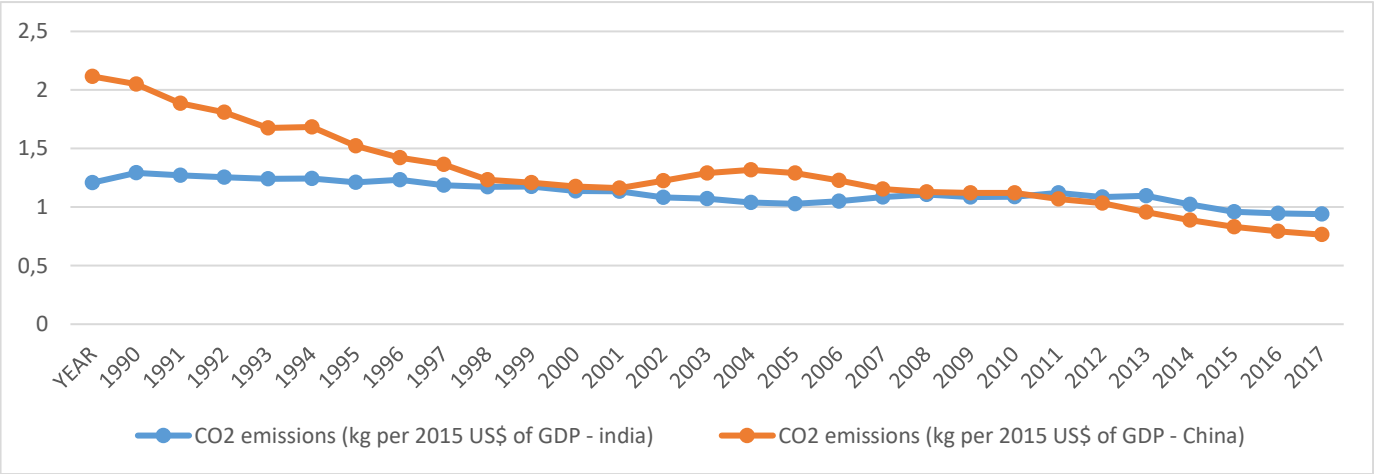

Figure 1; Trends in CO2 Emissions (kg per 2015 US$ of GDP)

C. Trends in CO2 Emissions (metric tons per capita)

Table 2 and Figure 2 exhibit CO2 emission patterns (metric tonnes per capita) Table 2 and Figure 2 demonstrate that CO2 emissions (metric tonnes per capita) in case of India were below one metric tonnes per capita up to 2005. On the other CO2 emissions of China fluctuated between 2 metric tonnes to four metric tonnes during the period of 1990-

2005.After 2005, CO2 emissions in both the countries continued to show an upward trend The year 2009 saw the highest average growth rate in CO2 emissions of India while the year 2013 recorded highest growth rate in the CO2 emissions of China. Following that, the rate of rise in CO2 emissions (metric tonnes per capita) dropped slightly in case of India, with emissions remaining in the range of 1.50 to 1.70 metric tonnes per capita in between 2012 and 2017. However, CO2 emissions per capita in case of China continued to rise even after 2013 and were higher than that of India throughout the study period.

Table 2; Trends in CO2 Emissions (metric tons per capita)

YEAR	CO2 emissions (metric tons per capita - India)	AGR	CO2 emissions (metric tons per capita -China)	AGR
1990	0.64		1.91	
1991	0.68	6.25	2	4.71
1992	0.69	1.47	2.07	3.5
1993	0.7	1.44	2.24	8.21
1994	0.72	2.85	2.31	3.125
1995	0.76	5.55	2.56	10.82
1996	0.79	3.94	2.51	-1.95
1997	0.82	3.79	2.54	1.19
1998	0.823	0.36	2.6	2.36
1999	0.87	5.71	2.51	-3.46
2000	0.889	2.18	2.64	5.17
2001	0.887	-0.22	2.77	4.92
2002	0.9	1.46	2.97	7.22
2003	0.91	1.11	3.42	15.15
2004	0.96	5.49	3.95	15.49
2005	0.99	3.125	4.46	12.91
2006	1.04	5.05	4.9	9.86
2007	1.12	7.69	5.3	8.16
2008	1.18	5.35	5.43	2.45
2009	1.28	8.47	5.79	6.62
2010	1.34	4.68	6.33	9.32
2011	1.43	6.71	6.89	8.84
2012	1.5	4.89	7.03	2.03
2013	1.53	2	7.28	3.55
2014	1.64	7.18	7.21	-0.96
2015	1.641	0.06	7.12	-1.24
2016	1.648	0.42	7.07	-0.70
2017	1.71	3.76	7.17	1.41

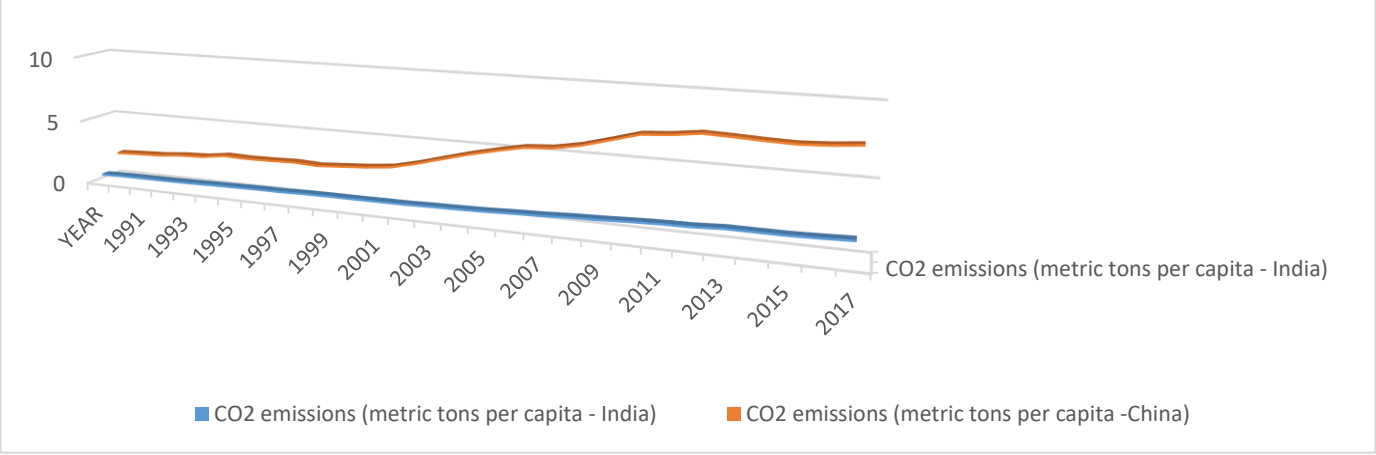

Figure. 2; Trends in CO2 Emissions (metric tons per capital)

D. CO2 Emissions from various Sectors

Figure 3 show trends in CO2 emissions from electricity and heat production (% of total fuel combustion). Figure 3 show that India's carbon emissions from electricity and heat production were higher than that of China during 1990-2010 period. However, post 2010, CO2 emissions from electricity and heat production of both the countries almost showed the same trend. Carbon emissions from electricity and heat production ranged between 50% in 1993 to about 57% in 2004. The CO2 emissions from electricity and heat production were highest for China and India in the year 2003 and 2004 respectively. The carbon emissions from electricity and heat production started declining from 2010 in both the countries, although, the decline was higher in case of India than China This analysis shows that CO2 emissions from electricity and heat production in recent times contribute in more or less in same magnitude to greenhouse gases in both the countries.

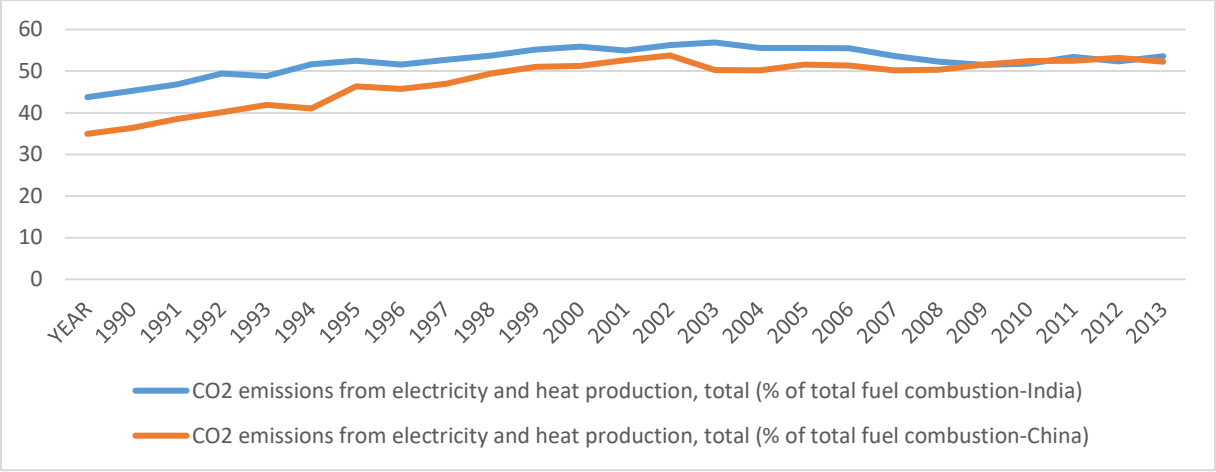

Figure 3; Trends in CO2 Emissions from electricity and heat production

E. CO2 emissions from gaseous fuel consumption (% of total)

Figure 4 show trends in CO2 emissions from gaseous fuel consumption (% of total). Figure 4 show that India's CO2 emissions from gaseous fuel consumption were very higher than that of China throughout the study period (except the year 2016). India's CO2 emissions from gaseous fuel consumption fluctuated in the range of 3% to 6% of the total while that of China fluctuated in the range of 1% to 3. The CO2 emissions from gaseous fuel consumption were highest for India and China in the year 2010 and 2016 respectively. This analysis shows that as compared to China, India's CO2 emissions from gaseous fuel consumption contribute more to greenhouse gases.

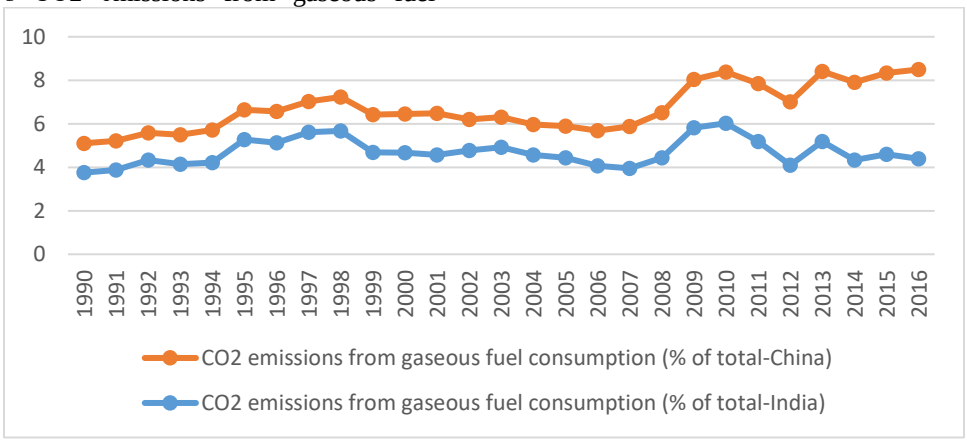

Figure. 4: CO2 emissions from gaseous fuel consumption

F. CO2 emissions from liquid fuel consumption (% of total)

Table 5 shows trends in CO2 emissions from liquid fuel consumption. Table 5 show that India's carbon emissions from liquid fuel consumption initially showed an upward trend up to 2001. Thereafter, its carbon emissions from liquid fuel consumption show a declining tendency and the carbon emissions from liquid fuel consumption were lowest in the year 2012. From 2012, the carbon emissions from liquid fuel consumption again showed an upward trend and increased up to 30% of the total emissions. On the other hand, barring few years, China's carbon emissions from

liquid fuel consumption declined throughout the study period. China's carbon emissions from liquid fuel consumption only make up about 14% of its total emissions. Thus, we can say that the carbon emissions from liquid fuel consumption are lower from China than from India

Table 5; Trends in CO2 emissions from liquid fuel consumption

YEAR	CO2 emissions from liquid fuel consumption (% of total-India)	CO2 emissions from liquid fuel consumption (% of total-China)
1990	28.14269947	15.20970824
1991	27.42431044	15.47738123
1992	29.8620847	15.96694336
1993	28.6651751	16.22450489
1994	28.94368777	15.34278425
1995	29.2078455	15.19069731
1996	31.33181262	16.67407709
1997	29.75141002	17.84853192
1998	31.32863199	17.31742259
1999	31.57686558	18.96483624
2000	32.30822915	19.41385193
2001	31.24800059	18.70957624
2002	28.84309591	17.16292307
2003	28.92551142	16.48866263
2004	27.30510012	16.39608636
2005	26.36911228	14.62194761
2006	26.0985909	13.98137429
2007	25.12832266	12.9425258
2008	28.33125004	13.49423545
2009	28.99761847	12.34323595
2010	24.87568819	12.90900609
2011	23.42731508	12.12274847
2012	22.81065096	12.35339812
2013	23.44776165	12.43506201
2014	23.90953947	12.77528287
2015	27.87231748	13.51582901
2016	29.72391649	13.61682903

G. CO2 intensity (kg per kg of oil equivalent energy use)

Carbon intensity, as noted before, is the ratio of carbon dioxide per unit of energy, or the amount of carbon dioxide emitted as a result of using one unit of energy in production. Emission intensities are also used to compare the environmental impact of different fuels or activities. The related terms - emission factor and carbon intensity - are often used interchangeably. Carbon dioxide emissions, largely by-products of energy production and use, account for the largest share of greenhouse gases, which are associated with global warming. Figure 5 show that the CO2 intensity (kg per kg of oil equivalent energy use) in case of India increased from 1.83 in 1990 to about 2.60 (kg per kg of oil equivalent energy use) in 2014 indicating that CO2 intensity increased by more than half times from 1990 to 2014. Similarly, CO2 intensity (kg per kg of oil equivalent energy use) in case of China increased from 2.49 in 1990 to about 3.24 (kg per kg of oil equivalent energy use) in 2014. Although, the carbon intensity of both India and China increased during the study period, but the data shows that carbon intensity of China is higher than that of India .

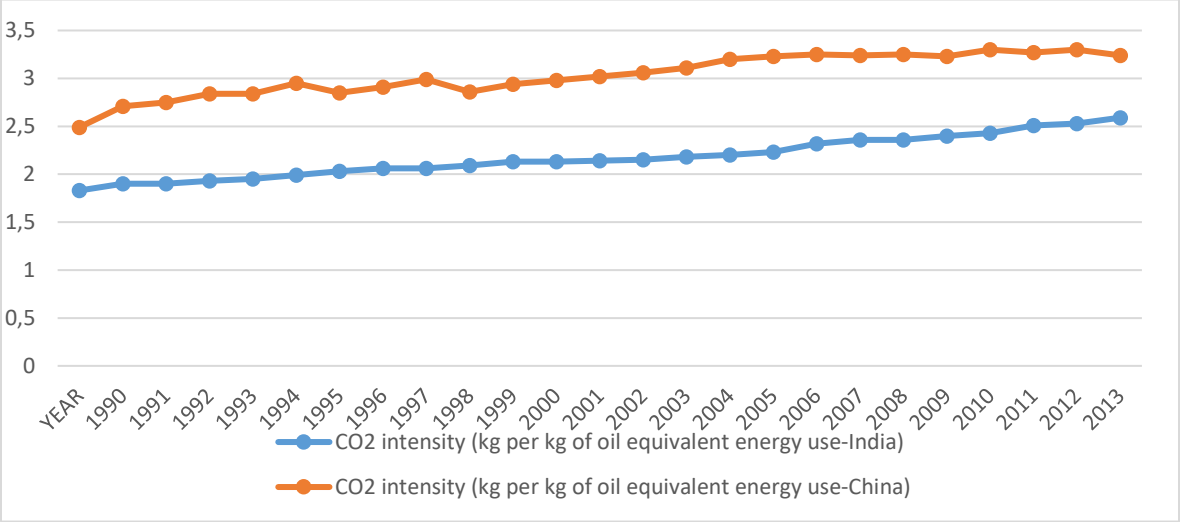

Figure 5.; CO2 intensity (kg per kg of oil equivalent energy use)

Correlation Analysis

This section presents results based on Karl Pearson's coefficient of correlation to determine the relationship between CO2 emissions and economic growth (GDP) in India. The findings reveal that CO2 emissions have a statistically significant negative association with economic growth.

Table 6; Results of Karl Pearson's Coefficient of Correlation

Variable	LGDP	LCO2
LGDP	1.0000	-
LCO2	-0.8412*	1.0000

* indicates significance at 1% level of significance, L signifies log the variable.

V. CONCLUSION

The goal of this research was to look into the effects of CO2 emissions on India's and China's economic growth. The data analysis clearly demonstrates that these factors are connected. We conclude, based on these data, that reducing carbon emissions is critical for the country's and people's well-being. As a result, the government should devise carbon-cutting strategies that are environmentally friendly. Environmental protection is a long process that necessitates ongoing planning, government regulations,
and public and industrial participation

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