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A Study on the Economic Impact of Greenhouse Gases in India

Saradha A★

Assistant Professor, PG & Research Department of Economics, Ethiraj College for Women, Chennai, TN, IND.

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ABSTRACT

According to the report of Jayanta Basu states that the carbon emissions in India are projected to increase by 6% while the United States is expected to experience a 1.5% increase, and the rest of the world may see a 1.7% increase. Conversely, China's emissions are anticipated to decrease by 0.9%, and the European Union is expected to see a reduction of 0.8%. From 2000 to 2021, India witnessed a threefold increase in emissions from the coal sector, reaching 1.80 gigatonnes (gt) of CO_2 equivalent. Similarly, emissions from the oil sector doubled to 0.62 gt, gas emissions increased from 0.04 to 0.13 gt, and cement emissions rose from 0.05 to 0.15 gt (Jayanta Basu, Down to Earth, November 11, 2022). In 2021, the construction sector emitted approximately 10 gigatonnes of CO_2 into the atmosphere (Global Status Report for Buildings and Construction 2022). Among the top 10 emitters globally (China, US, EU, India, Russia, Japan, Germany, Iran, Saudi Arabia, and South Korea), India's emissions continue to exhibit significant growth. The release of greenhouse gas emissions into the atmosphere poses a greater risk to human health. The focus of the present study is to investigate the CO_2 emissions in India over a specific period and their impact on economic growth.

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1.0 INTRODUCTION

The main cause of global warming are the greenhouse gases emitted by mankind. The greenhouse gases emitted in a country is the cause for global warming in another country which in turn depresses economic growth (Delworth *et al.,* 2016). The huge economic losses due to warmer temperature resulted in the decrease in agricultural yields, reducing labour productivity and also a decrease in industrial output. There exists a direct relationship between emission of greenhouse gases such as carbon dioxide, methane, nitrous oxide and economic loss of a nation.

India, with a population of approximately 1.3 billion, holds the distinction of being the second most populous country globally. In terms of Gross Domestic Product (GDP), India ranks sixth worldwide, just behind the UK, and stands as the fastest-growing major economy globally. Projections

★ *Corresponding author's e-mail:* saradha_a@ethirajcollege.edu.in (Saradha A)

indicate that India's population is expected to surpass China's and become the world's largest by 2025, reaching its peak at around 1.7 billion by 2060. In terms of carbon dioxide emissions, India contributes 7% to the global burden, and its per capita emissions are around 40% of the global average. While the United States leads as the largest emitter, responsible for 14% of emissions, India ranks as the fourth highest emitter of carbon dioxide globally (Basu, 2022).

Coal power plants, rice paddies, and cattle are the primary contributors to India's carbon dioxide (CO_2) emissions. Notably, India's CO_2 emissions are increasing at a more rapid pace compared to other significant energy-consuming countries.

1.1 Carbon Footprint

The total amount of carbon dioxide and its equivalents emitted due to various anthropogenic activities are referred to as Carbon footprint (CF). "Carbon footprint is defined as a measure of the impact of human activities on the environment in terms of the amount of greenhouse gases produced. The total greenhouse gas emissions from various anthropogenic activities from a particular region are expressed in terms of carbon dioxide equivalent, which indicate the carbon footprint of that region" (Andrew, 2009).

1.2 Objectives of the Study

- To examine the economic impact of greenhouse gas emissions in India.
- To find the major sources of carbon emissions in India.
- To analyse the relationship between GDPs per capita and carbon emissions in India.

1.3 Hypothesis

- **H_1:** GDP per capita was significantly correlated with carbon emissions in India

2.0 METHODOLOGY

The study is based on secondary data collected from various reports and journal articles. The data was then analysed and interpreted.

2.1 Review of Literature

In recent decades, India's CO_2 emissions have risen dramatically due to the country's rapidly expanding industrial sector and population. As carbon dioxide and other pollutants continue to build up in the atmosphere, they contribute to global warming, which raises sea levels and disrupts weather patterns, making natural disasters more likely and having devastating financial and social consequences (Varun and Tyagi, 2021). The IEA Data Browser for 2021 estimates India is responsible for 2.3 billion metric tonnes of CO_2 emissions, or 6.8% of world emissions. India's fossil fuel-based CO_2 output in 2016 was 2,533,638,100 metric tonnes. With a population of 1,324,517,249 in 2016, India's per capita CO_2 emissions are at 1.91 tonnes, representing an increase of 3.6% from 2011 (IEA, 2022). Smith *et al.,* (2021) in their article found that the impact of fossil fuel consumption and GDP is smaller for the emerging economies. Global GHG emissions had risen steadily over a century. In various sub sectors, electricity generation, land use management, transport and aviation there is a consistent increase in the growth of emissions in India.

3.0 GLOBAL CARBON BUDGET

According to the Report of Global Carbon Project (2022), the emissions from fossil fuels, excluding carbonation, have shown a significant increase over the years. From 6.95 billion tonnes in the year 2000, these emissions have risen to 10.13 billion tonnes in 2021, indicating a substantial 31.4 percent increase. Additionally, the report highlights that atmospheric growth has experienced a 49 percent increase between 2000 and 2021. The combined effect of "rising fossil emissions, emissions from land use change, atmospheric growth, ocean sink, land sink, and cement carbonation sink has resulted in an imbalance in the carbon budget over the years."

Table 1

Global Carbon Budget (values in billion tonnes)

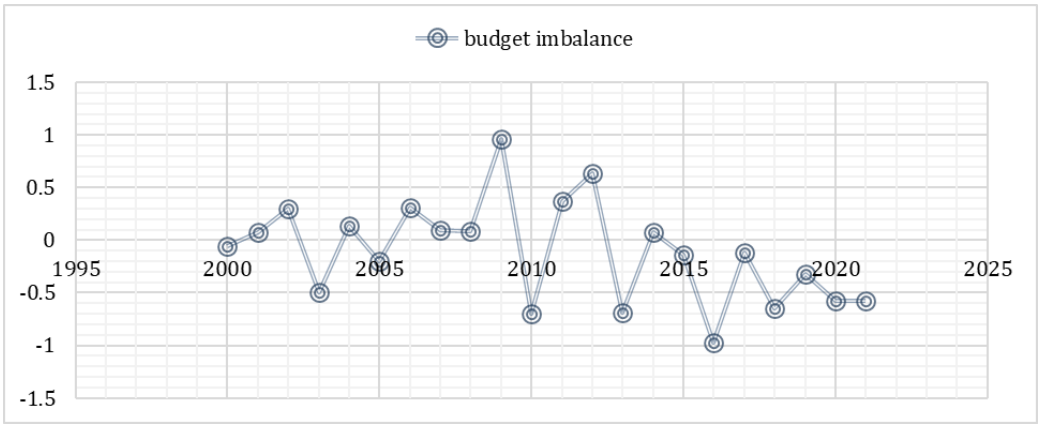
Year	Fossil emissions excluding carbonation (1)	Land-use change emissions (2)	Atmospheric growth (3)	Ocean sink (4)	Land sink (5)	Cement carbonation sink (6)	Budget imbalance (7)
2000	6.95	1.40	2.66	1.91	3.75	0.09	-0.06
2001	7.01	1.29	3.93	1.82	2.38	0.09	0.08
2002	7.17	1.41	5.03	2.17	0.99	0.09	0.30
2003	7.55	1.54	4.86	2.31	2.31	0.10	-0.50
2004	7.82	1.46	3.29	2.27	3.47	0.11	0.14
2005	8.08	1.29	5.25	2.33	1.88	0.12	-0.20
2006	8.35	1.38	3.76	2.43	3.11	0.13	0.31
2007	8.60	1.21	4.50	2.36	2.71	0.14	0.10
2008	8.76	1.27	3.78	2.38	3.63	0.14	0.09
2009	8.61	1.37	3.36	2.54	2.99	0.15	0.96
2010	9.11	1.32	5.14	2.51	3.32	0.16	-0.70
2011	9.41	1.35	3.57	2.55	4.11	0.17	0.37
2012	9.55	1.32	5.12	2.62	2.32	0.18	0.64
2013	9.64	1.26	5.20	2.65	3.56	0.18	-0.69
2014	9.71	1.34	4.33	2.78	3.66	0.19	0.08
2015	9.70	1.47	6.27	2.85	2.01	0.20	-0.14
2016	9.70	1.24	6.03	2.98	2.69	0.20	-0.97
2017	9.85	1.18	4.55	2.85	3.56	0.20	-0.12
2018	10.05	1.14	5.03	2.95	3.65	0.21	-0.65
2019	10.12	1.24	5.44	2.99	3.04	0.21	-0.32
2020	9.62	1.11	4.99	3.00	3.11	0.22	-0.58
2021	10.13	1.08	5.23	2.88	3.45	0.23	-0.58

Source: Global Carbon Project (2022)

Note: 7 = ((1+2) - (3+4+5+6)) *i.e.,* "the budget imbalance is the sum of emissions (fossil fuel and industry + land-use change) minus (atmospheric growth + ocean sink + land sink + cement carbonation sink)." From table 1 it has been observed that there exists a budget imbalance over the period of time.

Figure 1

Budget Imbalance



Source: Computed from Secondary Data

Table 2

Consumption Emissions (values in Million Tonnes of carbon per year)

Year	India (1)	Percentage Increase in Consumption Emissions-India (2) Growth Rate (2) = (Yt+1 - Yt)/Yt	Asia (3)	Percentage Increase in Consumption Emissions- Asia (4) Growth Rate (4) = (Yt+1 - Yt)/Yt	World (5)	Percentage Increase in Consumption Emissions-World (6) Growth Rate (6) = (Yt+1 - Yt)/Yt
2000	247.17		2144.15		6946.95	
2001	249.22	0.822566407	2170.02	1.192154911	7005.47	0.835347236
2002	253.33	1.622389768	2290.3	5.251713749	7172.77	2.33243224
2003	267.76	5.389154467	2447.72	6.431291161	7546.83	4.956518167
2004	282.59	5.247885629	2578.35	5.066418446	7815.69	3.440003378
2005	299.03	5.497776143	2729.39	5.533837231	8082.59	3.302159333
2006	314.34	4.870522364	2873.97	5.030671858	8349.65	3.19845742
2007	346.29	9.226370961	3038.38	5.411107235	8599.01	2.899868706
2008	371.39	6.758394141	3209.41	5.32901686	8757.05	1.804717342
2009	416.43	10.81574334	3369.05	4.738427747	8614.64	-1.653116091
2010	430.56	3.281772575	3637.3	7.374975944	9105.99	5.395898744
2011	448.23	3.942172545	3967.97	8.333480344	9412.39	3.255283727
2012	496.84	9.78383383	4153.85	4.474884745	9554.11	1.483340677
2013	495.54	-0.262340073	4230.27	1.806504077	9639.52	0.886039969
2014	543.80	8.874586245	4291.88	1.435501459	9710.03	0.726156356
2015	580.21	6.27531411	4305.98	0.327451591	9704.85	-0.053375374
2016	602.88	3.76028397	4345.6	0.911726804	9695.47	-0.096746212
2017	624.75	3.50060024	4479.97	2.999350442	9851.73	1.586117362
2018	663.67	5.8643603	4679.82	4.270463394	10050.9	1.981613587
2019	673.45	1.452223625	4796.38	2.430166084	10120.79	0.690558741
2020	621.42	-8.372759164	4711.3	-1.805870991	9624.48	-5.156746131

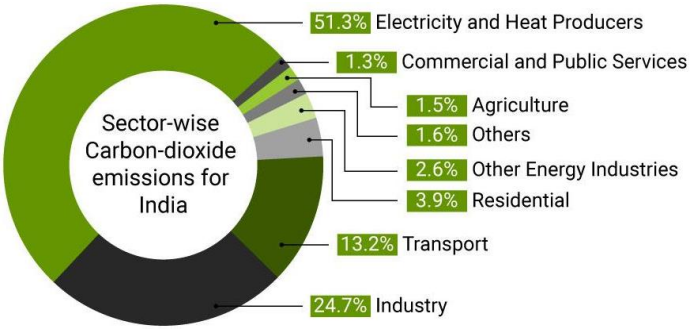
Source: Global Carbon Project (2022)

Table *2* estimates the percentage increase in consumption emissions from the year 2000 to 2020. The table highlights that the consumption emission has decreased from 673.45 million tonnes

in 2019 to 621.42 million tonnes in 2020 in India on the whole and at the world level, it is found that there is a decrease in consumption emission from 10120.79 million tonnes in 2019 to 9624.48 million tonnes in 2020. The consumption emissions of India are 6.25% of the world emissions and 13.2% of the total Asia.

Figure 2

Sector-wise CO2 emission share in India



Source: CO_2 Emissions from Fuel Combustion, IEA 2021

It is evident from Figure *2* that electricity and heat producers are the major emitters of carbon dioxide contributing 51.3% in the year 2021, secondly the industrial sector (24.7%) and thirdly the transport (13.2%). For a country like India these three major sectors are the thriving force for economic growth. When these sectors flourish their contribution towards carbon emissions also increase simultaneously.

Table 3

GDP and CO_2 Emissions

Year (1)	GDP, PPP (constant 2017 international $) (2)	Annual CO_2 emissions (3)	Annual consumption-based CO_2 emissions (4)	GDP Per Capita (US $) (5)	Annual Growth Rate (%) (6)
1995	2028580241408	761449200	719422700	373.7665	
1996	2181728305152	825200830	768698560	399.9501	7.01
1997	2270084464640	858935100	803935400	415.4938	3.89
1998	2410475945984	876952060	820290050	413.2989	-0.53
1999	2623700729856	950950850	903167360	441.9988	6.94
2000	2724476747776	978103800	905620000	443.3142	0.3
2001	2855904477184	991731700	913154300	451.573	1.86
2002	2964542455808	1022175200	928201300	470.9868	4.3
2003	3197566976000	1058725300	981077200	546.7266	16.08
2004	3450907918336	1124517800	1035427800	627.7742	14.82
2005	3724338266112	1184926500	1095645600	714.861	13.87
2006	4024547409920	1258643300	1151740000	806.7533	12.85
2007	4332860473344	1356953100	1268807200	1028.3348	27.47
2008	4466602934272	1461518300	1360786000	998.5223	-2.9
2009	4817762123776	1611416200	1525794600	1101.9608	10.36
2010	5227155554304	1676495000	1577571600	1357.5637	23.2
2011	5501126967296	1778472600	1642312700	1458.1041	7.41
2012	5801290235904	1962594300	1820424000	1443.8824	-0.98
2013	6171766816768	2037415600	1815656000	1449.6105	0.4

2014	6629108482048	2187343000	1992492800	1573.8856	8.57
2015	7159188815872	2270766000	2125896400	1605.6054	2.02
2016	7750273204224	2383816000	2208969700	1732.5542	7.91
2017	8276934131712	2434868000	2289075200	1980.667	14.32
2018	8817665376256	2600446500	2431702800	1998.2591	0.89
2019	9174036512768	2626459400	2467512800	2072.2449	3.7
2020	8508757508096	2445012000	2276880600	1933.1011	-6.71

Source: Global Carbon Project (2022)

Based on the provided Table *3*, it is evident that in 2019, there was a rise in annual consumption-based carbon emissions, which can be attributed to an increase in GDP per capita. Conversely, when GDP per capita declines, consumption-based carbon emissions also decrease. Therefore, it can be inferred that there is a positive correlation between GDPs per capita and CO_2 emissions. This correlation has been statistically proven through correlation analysis.

- **H_1:** GDP per capita was significantly correlated with carbon emissions in India.

Table 4

Correlation Analysis

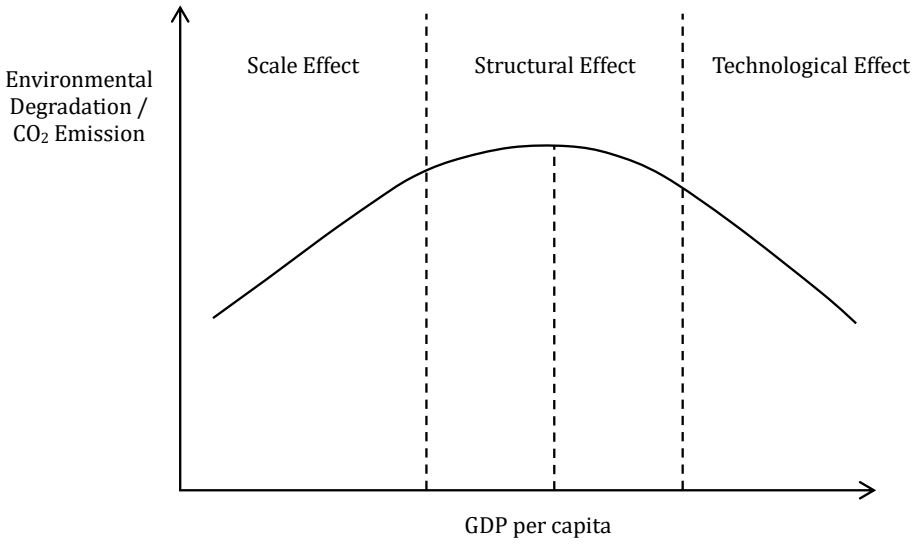
		CO_2 Emissions
GDP Per Capita	Pearson Correlation	0.975**
	Sig. (2-tailed)	0.000

Source: Computed from secondary data

The correlation analysis findings indicate a strong positive correlation (97.5%) between carbon emissions and GDP per capita in India. The p-value being less than 0.01 leads to the rejection of the null hypothesis at a one percent level of significance. Therefore, it can be concluded that the rise in GDP per capita in India is associated with an increase in carbon emissions (*refer* Table *4*). This relationship aligns with the Environmental Kuznets Curve (*see* Figure *3*), further supporting the observed trend.

Figure 3

Kuznets Curve



Source: The Earthbound Report

We have the GDP Per Capita in the X axis and CO_2 in the Y axis. Due to rapid industrialization the GDP per capita increases with a resultant increase in CO_2 emissions thus leads to Environmental degradation. This is clearly shown in Figure *3*.

3.1 Social Cost of Carbon

The economic cost related to climate damage that results from the emission of an additional tonne of carbon dioxide into the atmosphere is termed as the social cost of carbon and it is estimated in dollars. The social cost of carbon in India in 2022 was estimated to be around $90 per tonne of carbon dioxide (earth.org 2022) followed by the United States, where the economic costs of carbon emissions are estimated to be $50 per tonne. The social cost of carbon is highly expensive as global warming slows economic growth.

4.0 CONCLUSION

The global objective is to reduce emissions, which indicates progress in improving living conditions and reducing poverty. Due to the correlation between economic expansion and rising CO_2 emissions, reducing the CO_2 intensity of an economy may be accomplished by improving both energy efficiency and carbon efficiency. Energy efficiency concerns the energy used to generate a given gross domestic product (GDP) quantity. Similarly, a country's energy mix significantly impacts carbon efficiency, which is the amount of carbon dioxide (CO_2) released per unit of energy. When CO_2 emissions are reduced per unit of energy produced, energy efficiency rises.

It is the responsibility of the country to nurture Mother Earth and not to deplete. Economic growth can be achieved not by compromising on the quality of the environment but by protecting the environment without polluting it and giving it as pure as milk to the future generation.

4.1 Limitations

- The study is based on secondary data.
- The study focuses only on the impact of carbon emissions in India's economic growth.

4.2 Scope for Future Research

The study can be extended further to cross country comparisons. The recent statistics reveal that the social cost of carbon in India is high, and the government is taking a lot of initiatives to reduce it. Hence more research to be conducted in analysing the implications of policy decisions in reducing the carbon cost in India.

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