

Research Article

THE DECOUPLING DILEMMA: ANALYZING THE CO₂ DELTA WITH INDIA'S GROWTH AND NATIONAL ACTION PLAN ON CLIMATE CHANGE

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ABSTRACT

The relentless rise in global CO₂ emissions driven by rapid economic expansion poses one of the most pressing challenges to climate stability and sustainable development. Despite technological advances and policy efforts, CO₂ emissions continue to increase, reaching new records in recent years and threatening the achievement of Paris Agreement targets. This study investigates the relationship between economic growth as measured by Gross Domestic Product (GDP) and CO₂ emissions. The primary objective is to examine the nature and strength of this relationship, exploring whether economic expansion inevitably leads to higher emissions or if decoupling is observable in certain contexts. Using a comprehensive dataset from reliable sources, the analysis employs Pearson and spearman correlation coefficients, trend comparisons and detrended Wilcoxon signed-rank test to understand the effect of NAPCC.

INTRODUCTION

The strong relationship between the economic growth (typically presented in the form of GDP) and the carbon dioxide emissions has long intrigued and sometimes bothered economists and environmental scientists. As economies perform well and the GDP is at a higher point, the CO₂ emissions are also likely to increase. The reason is that growth has generally implied a large-scale increase in the consumption of fossil fuels to energize factories, illuminate cities, transport products. These two have been inseparable over the years. In the recent past, however, the situation has begun to change in most of the richer nations. The growth of GDP in some countries such as the United States, European Union and even in some areas of East Asia, is accompanied by the emission levels levelling or even declining- a phenomenon known as decoupling. It is occurring due to the improved energy efficiency, the reduction of coal use in favor of natural gas and renewable energy, the rising service-based economy, and such policies as carbon taxes and emissions trading systems.

Subject selection:

This paper examines the fact that economic growth or the growth in gross domestic product, and carbon dioxide emissions have always been inextricably linked but with the current developments, this phenomenon has begun to take some really interesting twists. Throughout the history of the world, as the economic growth took off and people became rich, the emissions began to escalate too, with a large portion of the increase being in the number of coals, oil, and gas being burnt to run factories, houses, cars, and all the other things in the world. However, during the recent decades, several of the rich world countries started defying that ancient trend. They are living to see their economies continue to grow- creating employment, increasing living standards, and their CO₂ emissions are either level or even declining.

Importance of the subject:

One of the most significant issues of environmental economics and sustainable development today is the relationship between the economic growth of a country in terms of Gross Domestic Product (GDP) and the emissions of CO₂. In its most basic form, it poses a direct question that is simple but desperate: are we able to continue to become wealthier without destroying the planet? The trend has long been evident: as economies grow, they develop a tendency to burn fossil fuels, run more industries, and deforest more areas all of which release more carbon dioxide into the atmosphere. This strong connection between growth and emissions has been a significant contributor to climatic change and global warming. It is the reason why researchers continue to revisit this relationship. The Environmental Kuznets Curve (EKC) is one of their major concepts under testing. It is a good idea that does not imply that the level of emission must continue increasing with the increase in wealth of any nation. In fact, the opposite is true, the pollution is greatest in the first years of the development, but after the people get to the point where they have a specific income level, the societies start investing in cleaner technologies, stricter regulations, and more efficient methods of doing things- and even as the economy grows, so do the emissions. It is important to know whether or not this turning point does materialize and in what circumstances to make practical policies to save people and environment.

REVIEW OF LITERATURE

Balogh and Jambor (2017) examined the data of 168 countries during 1990 to 2013 to determine the true causes of CO₂ emissions on a global scale. They discovered through an advanced statistical procedure that there was considerable evidence in favor of the Environmental Kuznets Curve concept. Some of their most remarkable results were rather self-explanatory: going one way to renewable energy or nuclear energy significantly reduces emissions, whereas going the other way to coal in this respect only exacerbates the situation. Liberalization of international trade and increased tourism has the effect of moving the emissions upwards. Surprisingly, the conversion of farmlands into a more productive land actually makes CO₂ more, despite overall decline in agricultural advancement. On the positive aspect, the foreign direct investment and the more robust financial system not only reduce the emissions, but it is contrary to the general belief that the rich nations simply plough their pollution in the other countries.

(Khoshnevis Yazdi & Dariani, 2019) narrowed on such factors as fast urbanization, economic growth, energy consumption, and population shifts affecting CO₂ emissions in a group of Asian countries. They have applied panel data and the STIRPAT model, which is a convenient tool to analyze human-environmental impacts, and more advanced tests of long-term relationships and causality. Their discovery was relatively simple, namely, the problem of fast-paced urbanization is a significant contributor to the increased levels of CO₂ throughout the region. The rise in economic growth and increased energy consumption also drives the rise in emissions, albeit the impact varies by countries, some countries are more affected by the impact of the same based on their position in the urbanization process. Ultimately, however, the researchers emphasized the fact that Asian nations should indeed focus more on intelligent city planning, transition to greener energy, and development of policies that will allow the economies to expand without littering the environment, and to address the problem of climate change directly.

(Aye & Edoja, 2017) carefully examined in a study the impact of economic growth on CO₂ emissions in 31 developing nations, and they used an ingenious dynamic panel threshold model to identify non-linear effects. What they found interesting was that, at low-growth level (below a specific level of income), the trend was to increase the economy; hence it is possible that we get reduction of emissions, perhaps due to the initial gains in efficiency or changes in economic organization. However, after that, as the growth increases, additional growth initiates a sharp increase in the emissions, and the effect is even more pronounced in the high-growth regime. These findings actually make one feel that balancing a developing country that attempts a sustainable future is really a challenging task and they also allude to the need to leap onto cleaner technologies and energy transitions at the early stages in order to avoid becoming stuck on a dirty and high-emission path.

(Olubusoye & Musa, 2020) examined the relationship between the economic growth and the carbon emissions in 43 African nations in terms of income levels and solid panel methods such as the ARDL model, Mean Group and Pooled Mean Group estimators. They were having the mainstream Environmental Kuznets Curve concept-that the higher the growth, the higher the emissions, but at some point, the reverse takes hold, as nations become better-off, emissions begin to decline--and the result again was inconclusive, that the curve works in some groups of incomes, but in total, the connection tends to be positive or ambiguous, in large part due to the high use of fossil fuels and more structural problems. The conclusion is obvious, it is

incredibly hard to help many African economies develop without deteriorating the environment, and that is why the study urges more specific activities in changing to renewables and constructing really sustainable ways of development in order to achieve improved climate outcomes on the planet.

(India: NAP Process Country Case Study, n.d.) provide an effective overview of the way India is addressing climate adaptation. Although the country does not have a National Adaptation Plan used by others, it uses the National Action Plan on Climate Change (NAPCC) which was initiated in 2008 as well as state-level plans (SAPCCs) to lead the way. The NAPCC incorporates eight macro national missions among them five missions that focus on adaptation to vulnerable regions such as water, agriculture, Himalayas and forests with an objective of establishing some form of resilience, intended particularly to the poorer population, and pursuing benefits in economy and environment. These lead to the promises of India under the Paris Agreement like reduction of emission intensity (emissions per unit of GDP) by 33-35% by the year 2030 over the year 2005 and increasing the carbon sinks by planting more forests.

Objectives:

- To understand the trend of CO₂ emissions of the countries of Asia.
- To understand the change in GDP and CO₂ emissions of India
- To examine the correlation between India's GDP and CO₂ emissions
- To know the decadal changes in GDP and CO₂ emissions
- To know the effects of NAPCC in India

Hypothesis:

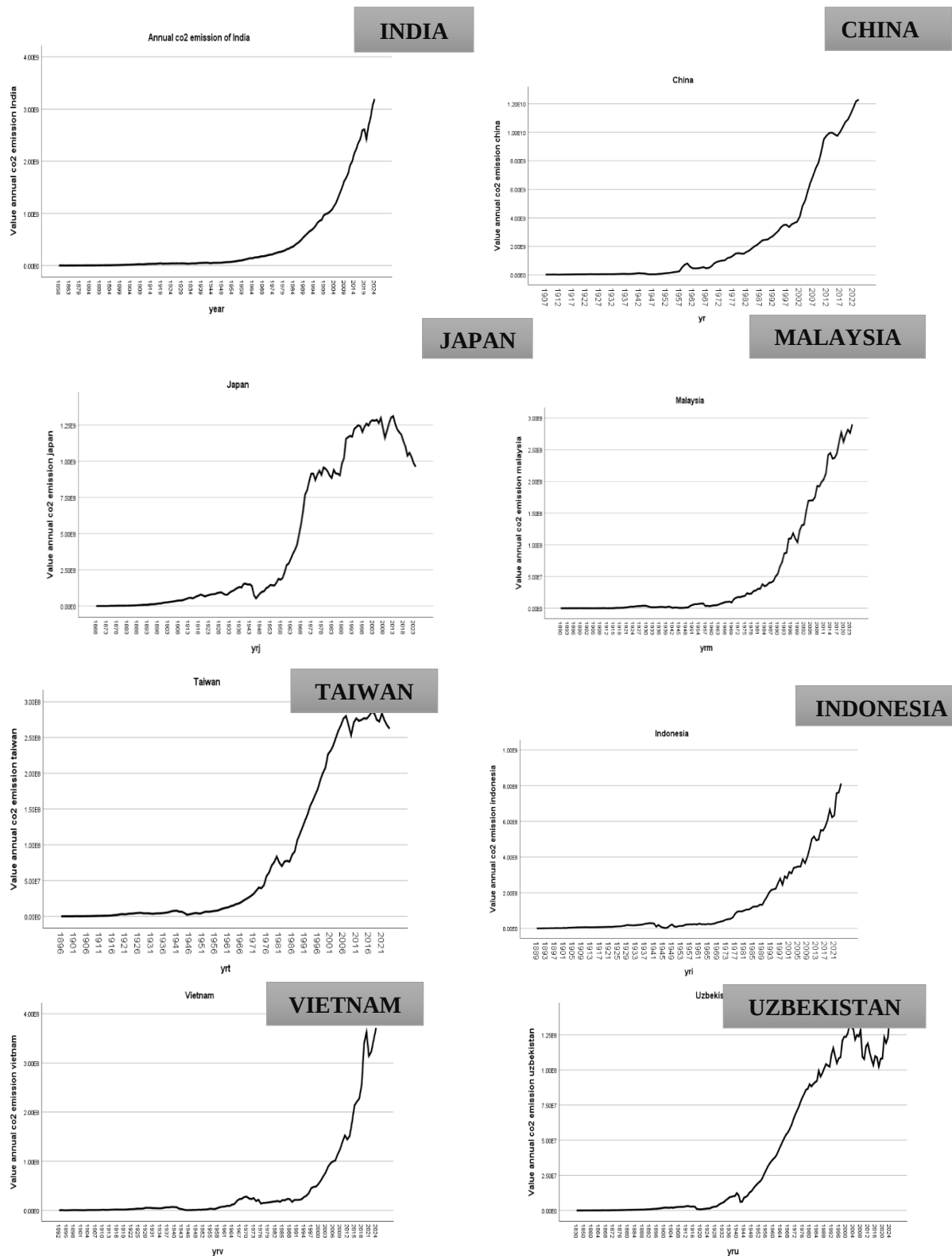
H₀: There is no significant correlation between GDP and CO₂ emissions of India.

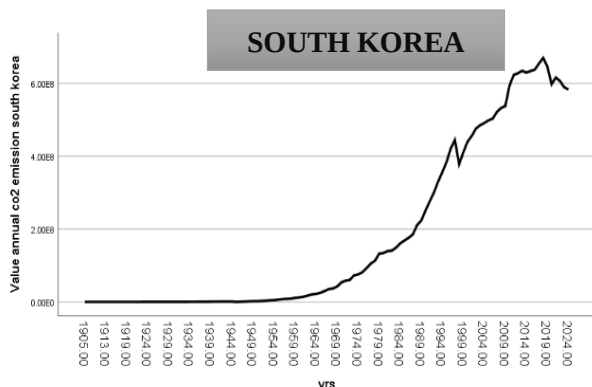
H₀: The Median of first-differenced CO₂ emissions is the same pre and post NAPCC.

METHODOLOGY

Quantitative data are analyzed using statistical software (e.g., SPSS ver.25) to perform correlation and regression analysis and detrended Wilcoxon signed-rank tests. These analyses were helped identify the relationship between CO₂ emissions and GDP.

ANALYSIS

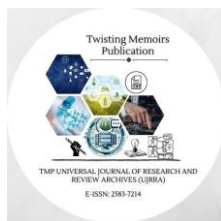




According to the statistics of ‘Our World in Data’ of Carbon dioxide (CO₂) emissions from fossil fuels and industry. Land-use change emissions are not included., some Asian countries like Japan is seeing a downward trend in CO₂ emissions over the years. Countries like Taiwan, Uzbekistan and South Korea are seen to have reached the downward turning point. They seem to be in the transitionary phase where they are in a almost stagnant situation. Whereas CO₂ emissions in India, China, Malaysia, Indonesia and Vietnam has been continuously increasing over the years.

Table 1

year	annual CO ₂ emission India (in tonnes)	GDP (in Rs. Crores)	% change in GDP	% change in CO ₂
1950	60942560.00	10085		
1951	63805724.00	10721	6.31	4.7
1952	67249430.00	10522	-1.86	5.4
1953	68607650.00	11452	8.84	2.02
1954	72306530.00	10834	-5.4	5.39
1955	78693850.00	11030	1.81	8.83
1956	81618800.00	13140	19.13	3.72
1957	91617590.00	13536	3.01	12.25
1958	95801250.00	15086	11.45	4.57
1959	101436020.00	15895	5.36	5.88
1960	111320210.00	17407	9.51	9.74
1961	120399360.00	18445	5.96	8.16
1962	132579760.00	19826	7.49	10.12
1963	142438960.00	22774	14.87	7.44
1964	139483200.00	26563	16.64	-2.08
1965	153696700.00	28016	5.47	10.19
1966	159371420.00	31711	13.19	3.69
1967	159557100.00	37133	17.1	0.12
1968	174070540.00	39324	5.9	9.1
1969	177411300.00	43298	10.11	1.92



1970	181723860.00	46249	6.82	2.43
1971	191964860.00	49523	7.08	5.64
1972	203037040.00	54591	10.23	5.77
1973	209096030.00	66428	21.68	2.98
1974	215854050.00	78426	18.06	3.23
1975	234209710.00	84221	7.39	8.5
1976	244749840.00	90751	7.75	4.5
1977	258962060.00	102796	13.27	5.81
1978	263149940.00	111371	8.34	1.62
1979	276285000.00	122155	9.68	4.99
1980	291714430.00	145370	19	5.58
1981	314969280.00	170805	17.5	7.97
1982	325383070.00	191059	11.86	3.31
1983	352204860.00	222485	16.45	8.24
1984	361568800.00	249268	12.04	2.66
1985	397601120.00	281330	12.86	9.97
1986	426318050.00	314816	11.9	7.22
1987	455354720.00	357861	13.67	6.81
1988	491700100.00	424531	18.63	7.98
1989	540661900.00	487684	14.88	9.96
1990	577986560.00	569624	16.8	6.9
1991	615388160.00	654729	14.94	6.47
1992	655423550.00	752591	14.95	6.51
1993	677262100.00	865805	15.04	3.33
1994	714042800.00	1015764	17.32	5.43
1995	760480200.00	1191813	17.33	6.5
1996	823602200.00	1378617	15.67	8.3
1997	857975740.00	1527158	10.77	4.17
1998	875783360.00	1751199	14.67	2.08
1999	961193860.00	1952036	11.47	9.75
2000	987065100.00	2102375	7.7	2.69
2001	1001198400.00	2281058	8.5	1.43
2002	1032750340.00	2458084	7.76	3.15
2003	1068397950.00	2765491	12.51	3.45
2004	1134611000.00	3242209	17.24	6.2
2005	1195393300.00	3692485	13.89	5.36
2006	1293321500.00	4293672	16.28	8.19
2007	1393485200.00	4986426	16.13	7.74
2008	1490366500.00	5630063	12.91	6.95
2009	1613327600.00	6477827	15.06	8.25
2010	1678529500.00	7784115	20.17	4.04

2011	1765694800.00	9009722	15.74	5.19
2012	1926986400.00	10113281	12.25	9.13
2013	1995337200.00	11355073	12.28	3.55
2014	2148052000.00	12467959	9.8	7.65
2015	2231817500.00	13764037	10.4	3.9
2016	2352540200.00	15253714	10.82	5.41
2017	2425721900.00	17090042	12.04	3.11
2018	2595227100.00	18899668	10.59	6.99
2019	2611174700.00	20103593	6.37	0.61
2020	2422732000.00	19854096	-1.24	-7.22
2021	2675778000.00	23597399	18.85	10.44
2022	2831131600.00	26949646	14.21	5.81
2023	3062756400.00	29535667	9.6	8.18
2024	3193478100.00	33068145	11.96	4.27

Source: <https://ourworldindata.org/> CO₂-emissions

<https://rbi.org.in/Scripts/AnnualPublications.aspx?head=Handbook%20of%20Statistics%20on%20Indian%20Economy>

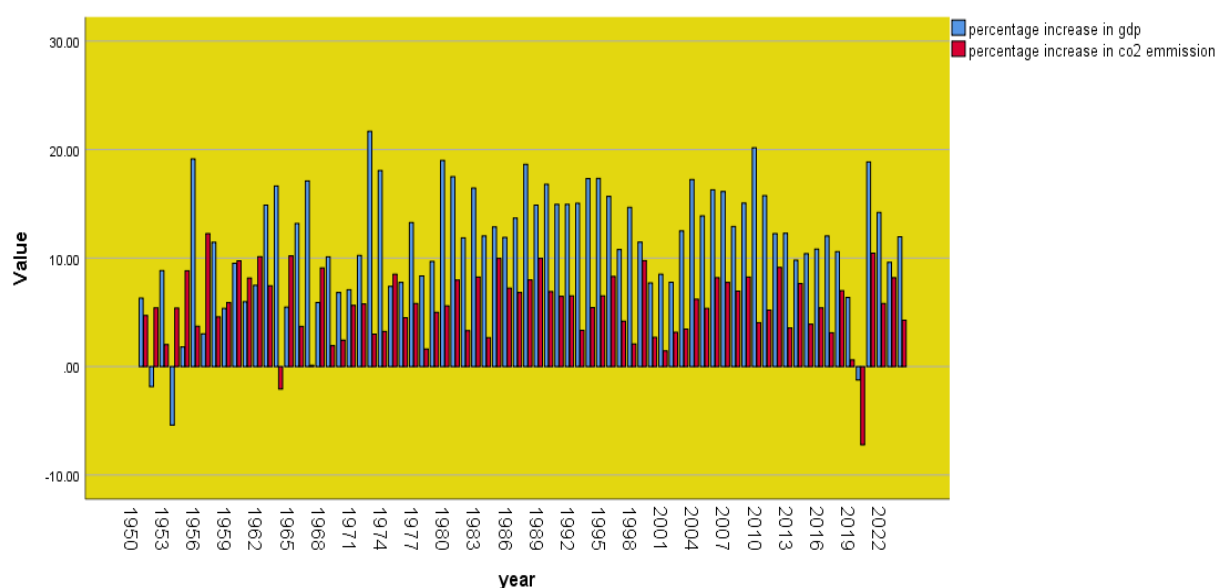


Figure 1

The above table and graph depict annual CO₂ emissions in India (in tonnes) and GDP of India (in Rs. Crores). It also reveals percentage change in CO₂ emissions and GDP. It shows that there has been a constant increase in both GDP and CO₂ emissions, though the percentage change differs from year to year. There has been a positive percentage change in GDP and CO₂ emissions throughout these years, with an exception of some years. There has been an increase in CO₂ emissions despite reduction in GDP in 1954, which is due to the inefficient use of energy, industrial activities and inefficient technologies. In 2020 there has been a reduction in both CO₂ emissions and GDP, which is mainly due to COVID-19 pandemic which led to

lockdown, economic slowdown and decreased industrial activity.

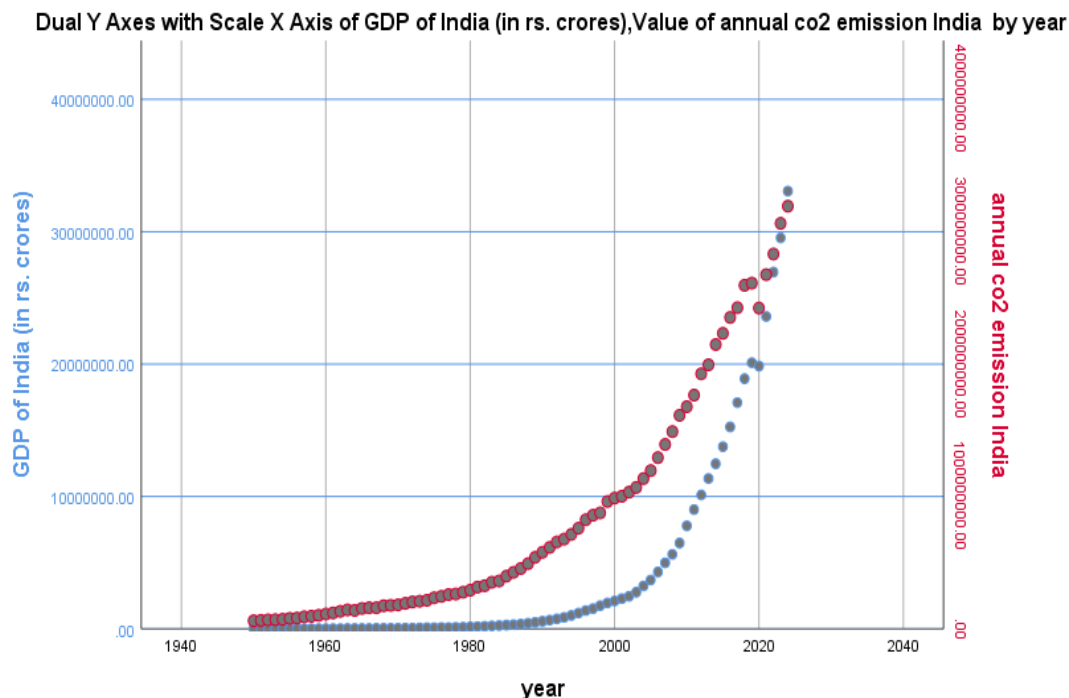


Figure 2

The graph displays the historical data for India's Gross Domestic Product (GDP) and its annual carbon dioxide (CO₂) emissions from approximately 1950 to 2040. Throughout the observed period, India's GDP has exhibited a steady upward trajectory. The growth remained fairly moderate until the mid-1990s, it then gained substantial momentum, marking a transformative wave of economic expansion. CO₂ emissions also show a general increasing trend. The emissions track the GDP growth closely, suggesting a strong correlation between economic activity and carbon emissions which has been supported by the correlation test below.

Table 2

Correlations				
			Annual emission CO ₂ India	GDP of India (in rs. crores)
Spearman's rho	annual CO ₂ emission India	Correlation Coefficient	1.000	1.000**
		Sig. (2-tailed)	.	.000
		N	75	75
	GDP of India (in rs. crores)	Correlation Coefficient	1.000**	1.000
		Sig. (2-tailed)	.000	.
		N	75	75
**. Correlation is significant at the 0.01 level (2-tailed).				

H0: There is no significant correlation between GDP and CO₂ emissions of India.

H1: There is a significant correlation between GDP and CO₂ emissions of India.

The Sig. value is <0.01, indicating that there is a significant correlation between GDP and CO₂ emissions of India. The value correlation coefficient is 1.000. This indicates a perfect positive correlation, meaning that as India's GDP increases, its annual CO₂ emissions also increase proportionally.

$y = 394913513.850 + (107.030) \times$
where; y= CO₂ emissions in tonnes

x= GDP in Rs. Crores

Regression analysis which explains 88.3% (adjusted R square) changes in CO₂ emissions in India due to GDP during the years 1950-2024 reveals that a unit change in GDP causes 107.030 units increase in CO₂ emissions.

Decadal changes:

Table 3

Decade	avg. CO ₂	avg. GDP	Correlation coefficient	adjusted R square	Δin CO ₂ due to unit Δin GDP
1951-1960	83245705.4	12962.3	0.967	0.928	6321.468
1961-1970	154073220	31333.9	0.967	0.928	1999.308
1971-1980	238902296	90563.2	0.987	0.971	1088.689
1981-1990	424374846	326946.3	0.996	0.992	684.661
1991-2000	792821707	1319208.7	0.996	0.99	252.214
2001-2010	1290138129	4361143.0	0.992	0.983	132.057
2011-2020	2247528380	14791118.5	0.963	0.918	67.454
2021-2024	2940786025	28287714.3	0.987	0.962	57.052

Table shows average CO₂ emissions and average GDP during various years. Average CO₂ emissions were 83245705.4 tonnes during the decade 1951-61, which increased to 2247528380 Tonnes in in 2011-20 and to 2940786025 tonnes in 2021-24. Similarly average GDP was Rs. 12962.3 Crores during the decade 1951-60, which increased to Rs. 1319208.7 crores in 1991-2000 and to Rs. 28287714.3 Crores in 2021-24.

The table also shows the value of correlation coefficient during different decades and all the values are close to 1 (ranging from approximately 0.967 to 0.996), which indicates a very strong positive correlation between the two variables. As GDP increases, CO₂ levels also tend to increase significantly.

The values of adjusted R square are consistently high, suggesting that GDP is a very strong predictor of CO₂ emission levels across these decades.

The values of change in CO₂ emissions due to a unit change in GDP, decrease over time,

suggesting that the rate of increase in CO₂ emissions for a given increase in GDP may be slowing down in more recent decades. It decreased from 6321.468 tonnes in 1951-60 to 67.454 tonnes in 2011-20 and to 57.052 tonnes in 2021-24, this can be attributed to a number of measures of measures taken recently towards environment protection and conservation and the increasing awareness among the people.

National Action Plan on Climate Change (NAPCC)

India's first National Action Plan on Climate Change (NAPCC) was released on June 30, 2008. It outlines existing and future policies and programs addressing climate mitigation and adaptation. India is stepping up efforts to cut emissions(decarbonize) in non-power sectors. The revised National Green Hydrogen Mission targets annual production of 5 million tonnes of green hydrogen by 2030 to help decarbonize tough industries such as refining and fertilizers(*Policies & Action*, n.d.). NAPCC is the national approach that will see India decouple its economic development with greenhouse gas (GHG) emissions. It is constructed based on the idea that India will be following a low-carbon route though will not permit its individual GHG emissions to surpass those of the developed countries("National Action Plan for Climate Change," 2025).

Table 4

	avg. CO ₂	avg. GDP	Correlation coefficient	adjusted R square	Δin CO ₂ due to unit Δin GDP
Pre NAPCC (1992-2007)	964499162.5000	2266048.9375	.988	.975	172.233
Post NAPCC (2009-2024)	2345642812.5000	17207749.0000	.982	.961	58.594

The table compares the average CO₂ emissions and average GDP and correlation between CO₂ emissions and GDP before and after the implementation of the NAPCC policy. Pre NAPCC had average CO₂ emission of 964499162.5 tonnes and the correlation between CO₂ emissions and GDP was very strong (0.988), and a unit change in GDP led to a change of 172.233units in CO₂ emissions.

Post NAPCC shows average CO₂ emission of 2345642812.5 tonnes and the correlation remained strong (0.982), but the impact of GDP change on CO₂ emission change decreased substantially to 58.594 units.

This shows a 65.98 % reduction in change in CO₂ emissions due to unit change in GDP after NAPCC.

This suggests the policy effectively decoupled economic growth from CO₂ emission increases to a measurable extent; the results of detrended Wilcoxon signed-rank tests are:

Table 5

Ranks		N	Mean Rank	Sum of Ranks
fdiffpost – fdiffpre	Negative Ranks	2 ^a	8.50	17.00
	Positive Ranks	13 ^b	7.92	103.00
	Ties	0 ^c		
	Total	15		
a. fdiffpost < fdiffpre				
b. fdiffpost > fdiffpre				
c. fdiffpost = fdiffpre				

Table 6

Test Statistics ^a			
			fdiffpost-fdiffpre
Z			-2.442 ^b
Asymp. Sig. (2-tailed)			.015
a. Wilcoxon Signed Ranks Test			
b. Based on negative ranks.			

H₀: The Median of first-differenced CO₂ emissions is the same pre and post NAPCC.

H₁: The Median of first-differenced CO₂ emissions differs pre and post NAPCC.

As the Asymp. Sig. (2-tailed) value < 0.05, H₀ is rejected, and hence the Median of first-differenced CO₂ emissions differs pre and post NAPCC. This means that there has been a significant impact of NAPCC on CO₂ emissions.

However, there are 2 instances where the "post NAPCC" emissions were less than the "pre NAPCC" emissions (fdiffpost < fdiffpre) and there are 13 instances where the "post" emissions were greater than the "pre" emissions (fdiffpost > fdiffpre).

Higher number of positive ranks (13 vs 2) indicates a strong tendency for the CO₂ emissions to be higher even after the intervention than before.

Policy implications

The above results implies that even though there has been a significant reduction in CO₂ emissions with a unit change in GDP throughout these years, it is still insufficient.

Even after the implementation of NAPCC change in CO₂ emission is not in line with the anticipation. Hence, there is a need for a greater public awareness and more effective policy measures.

CONCLUSION

CO₂ emissions are continuously rising even after number of measures, driven largely by rapid industrialization and energy demand in economies, where emissions continue to rise alongside GDP growth. Absolute reductions still remain to be achieved in most of the emerging Asian countries and other developing countries of the world.

These findings affirm that in order to actually reduce emissions and ensure they continue to reduce, we must go all the way to renewables, alternatives that have less energy intensity and the development of efficient technology.

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