The Academic
International Journal of Multidisciplinary Research

An Online Peer Reviewed / Refereed Journal
Volume 4 | Issue 7 | July 2026
ISSN: 2583-973X (Online), SJIF IF(2026): 5.6
Website: www.theacademic.in

Determinants of CO_2 Emissions in BRICS Countries

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DOI : https://doi.org/10.5281/zenodo.22096079

ARTICLE DETAILS

Research Paper

Received: 22-06-2026

Accepted: 25-07-2026

Published: 21-08-2026

Keywords:

CO_2,

ABSTRACT

There are several factors those are affecting the level of CO_2 emissions. But with change in region and with respect to change in timing the determinants of CO_2 emission also varies. In our recent study it is tried to find out the factors which affects CO_2 emission in BRICS nations. The data is obtained from the World Bank's World Development Indicator. The range of data is taken from 1998 to 2014 for five variables CO_2 emission with KT, Electricity from Hydro Power, Merchandise trade, Per-capita GDP and Population of the five BRICS countries. Here it is used tools like descriptive statistics and GMM, Causality test, Graph to analyse the data and it is obtained there is upward trend of CO_2 emission of all the countries. Among the BRICS countries the growth of CO_2 emission is highest for the China compared to other countries. All the four factors like population, GDP per-capita, Merchandise trade affect positively to the CO_2 emission whereas the electricity production from hydropower plays significantly negative role in increasing the level of Co2 emission. The result obtained from GMM estimation indicate that when LGDP and LPPL increase by 1% then CO_2 increases by .087% and .130% respectively and one unit increase in EPH, decreases the CO_2 emission by .0028 % and one unit increase in MT will increases the

CO_2 emission by .002% and 1 % increase in co2 in previous year leads to .863% increase in CO_2emission. From the Granger causality test it is found that all the four factors cause the CO_2 emission.

INTRODUCTION

The world's ecology is being impacted by human activity on a special scale. Human activity is the cause of the gathering of several greenhouse gasses which causes depletion of ozone layer in the atmosphere (Spangenberg, 2007). Environmental disasters caused by humans are the most common occurrence, according to historical data. For example, due to terracing for rice farming in China which caused a huge deforestation during early 800 B.C., and during the Roman Empire, anthropogenic activity greatly contaminated the land and water surrounding Rome (Kula, 1998). Ehrlich and Holden (1971) developed a formula known as IPAT. This formula, which shows the effects of anthropogenic environment, confirms that overall effect of Environment (I) which is the product of affluence (A), technology (T) and the population (P), (Commoner et al., 1971). Following the Industrial Revolution, which began in theduring 18th century, ecological shortages became apparent as the world's population grew rapidly. Boulding (1966). According to Boulding, the spaceship's waste and shortage issues will get worse as the population and economic activity grow (Kula, 1998). The effect of economic activity on CO2 discharge has grown in importance during the last thirty years, both domestically and globally. However, because of the rise in mass production, which causes widespread environmental damage and CO2 emissions (Ghouali Yassine Zakarya et al. 2015). It is a crucial member of the GHG family.

Global organization i.e. the World Economic Forum (WEF) and the United Nations (UN) are constantly working to lessen the detrimental effects of global warming which is caused by the climate change on the economy and society at large. One of the key ways to offset greenhouse gasses (GHG) in this context is the COP3 of the United Nations Framework Convention on Climate Change (UFCCC) i.e the Kyoto Protocol. To tackle greenhouse gasses (GHG), which leads to climate change, was the goal of the 1997 Kyoto Protocol, which targeted to eliminate 5.2% of GHG discharge between 2008 and 2012 compared to 1990 levels. In 2005, this became operative. Despite the fact that the BRICS nations which consists country like Brazil, China, Russia, India and South Africa joined that Kyoto Protocol to lower emissions, environmental issues persist due to the region's recent economic expansion. (Yassine Zakarya Ghouali et al., 2015). The IEA analysis estimates that air pollution causes 6.5 million lives annually, and if immediate steps is not taken, the number of deaths may rise dramatically in the upcoming years to come. Furthermore,

according to the World Health Organization (WHO) 2019, an extra 250,000 deaths year between 2030 and 2050 may caused by the air pollution. One of the main reason of climate change is carbon dioxide (CO2) emissions (Cagler 2020, Cai et al 2020). Global CO2 emissions rose from 9420,523 kt in 1960 to 35,998,929 kt in 2016, according to the World Bank. (Caglar and others, 2022). Since CO2 is the main factor that of greenhouse gas family which may leads global warming, so regulating it has become a crucial intergovernmental task. These BRICS nations are using non-renewable resources as source of energy to increase their income growth, which has resulted in larger carbon emissions (Talukdar and Misner 2001).

In recent years, academics and the media have emphasized much more attention to the BRICS nations. These nations differ from each other in terms their diversified of language, diversified culture, different background and economic activity structure. They have one common characteristic, that is the BRICs' economic development has significantly outpaced that of the other top industrialized nations. They maintained to outperform other countries even after the economic crisis that began in 2007. In 2009, China's economy grew by 8.1%, Brazil's remained stable, India's increased by 5.9%, and Japan's shrank by up to 6%. Russia was the group's worst performance, declining by 7%. and the 2015 prediction, which projects that all of these nations' economy would grow faster than the average of developed economies, raises interest in these nations even more. (Yassine Zakarya Ghouali et al., 2015). Since the BRIC nations are the biggest among rapidly expanding emerging economies, they have a far greater impact on the global economy than any other smaller developing country (Pao and Tsai 2010).

This study essentially focuses on and examines some of the variables that contributed to higher CO2 emissions in the six BRICS nations—Brazil, Russia, India, China, and South Africa—which were established in 2009.

REVIEW OF LITERATURE

(Ang, 2008) studied the long run correlation between Malaysia's GDP, energy usage and CO2 discharge. The findings show in long run direct relationship exist between CO2 dischage and uses of energy and with GDP. He discovered that in the long-term elasticity of GDP in relation to energy use and CO2 emissions is 0.548 and 0.238. The Granger causality test **(Clive Granger 1969)**

shows there exist a long-term unidirectional cause and effect relation between the GDP and energy use. Additionally, he discovered a weak causal connection between long-term economic growth with CO2 emissions. Nevertheless, neither the EKC hypothesis nor the FDI effects and transportation energy use on emissions of CO2 were examined in this study.

(Pao and Tsai 2010) tried to analyse the key factors influencing emissions, looked at the dynamic cause and effect connection between CO_2 emissions, foreign direct investment (FDI), energy consumption and economic growth in the BRICS countries and they discovered a strong bidirectional causal relationship between CO2 emissions and FDI. In the long term, Pao and Tsai discovered unidirectional causality from output to emissions, energy use, and FDI and a bidirectional causality between emissions, energy consumption, and FDI. They discovered there has a unidirectional causal connection between real output and emissions and consumption of energy , respectively.

(Niu et al., 2011) in their study used panel -data methodologies ,to investigate the long-term link between energy use, GDP, and CO2 for eight Asia-Pacific nations , which includes developing nations such as Thailand, and Indonesia ,China along with India. Additionally, he discovered a long-term correlation between CO2 discharge and the energy use sources like coal and oil in emerging countries but, they were unable to identify any long run correlation between the effects of electricity and natural gas on CO2 discharge. The study also found that energy use, particularly in emerging countries, is the primary reason of CO2 emissions. By creating an individually fixed variable coefficient of the model linking per capital energy consumption and emission of CO2 , the study also examined for each nations differently. The coefficients of energy consumption to CO2 emissions for Indonesia and Thailand are 3.11 and 3.44, respectively. Similar to industrialized nations, such as Thailand (2.08) and Indonesia (2.03), the relationship between per capital GDP and per capita CO2 emissions is more than one or unity. In nations like Thailand and Indonesia, the coefficients of energy usages and GDP on CO2 discharge are relatively high. According to the Granger causality test results, there has a long term causal connection between CO2 emissions with respect to GDP and energy consumption in developing nations. However, their investigation also shows there has a short-term unidirectional cause and effect connection between energy usage and CO2discharge.(Park and hong 2023)

(Hossain, 2011) studied the connection between CO2 discharge, urbanization, and economic energy usages and trade openness, growth for cluster of nine recently industrialized nations, including Thailand, Malaysia, and Philippines. findings indicate that energy usages and growth ,income have a substantial long-term effect on CO2 emissions in Thailand and Philippines, not for the nation Malaysia. There is exist no long-term causal connection between income, energy use, and emissions of CO2 , according to the Granger causality test **(Clive Granger 1969)** results. But, there has a short-term causal connection between CO2 emissions and income.

(Ghouali Yassine Zakarya et al., 2015) used panel data analysis method to analyse the link between CO2 discharge , FDI, energy usages and economic growth in the BRICS . It was discovered that FDI influence economic growth positively but there has no positive influence on emission of CO2 in these nations. The also indicate that GDP, FDI net inflows and total primary energy consumption, are significant determinates that eventually raise CO2 emissions. Furthermore, a long run and short-term direct unidirectional causal link among the variables was discovered.

(Shahbaz et al. 2016) used quarterly data from 1991 to 2015 to examine what is the connection between GDP and biomass energy consumption for the BRICS economies. The Trade openness in the production function was considered in the study. The Johansen cointegration analysis the variables listed was employed in the investigation. They discovered that within the tested period, trade and capital stock buildup demonstrated substantial statistical prove to boost GDP growth in BRICS nations . The relationship between international trade and economic growth is also demonstrated by the Granger causality test **(Clive Granger 1969)** based on VECM. From a policy perspective, the study indicated that biomass energy was a major force behind BRICS countries' sustainable development.

(Caglar et al., 2022) Using WDI data from 1990 to 2018, investigated how trade openness, environmental complexity index, natural resources percentage of GDP, GDP, and PPP investment in energy affect CO2 emissions in BRICS countries. They discovered due to trade openness, higher emission values, and more use of natural resources for agriculture activity and various mining purpose, negatively affect environmental quality in BRICS countries and GDP may have a favorable effect on CO2 emissions. ECI (Economic Complexity index) has a substantial and detrimental effect on emissions. They discovered that economic growth has a favorable impact on CO2 emissions for the BRICS countries, with a 1% increase in ECI resulting in emissions reductions of − 0.0557 (− 0.065%).

RESEARCH GAP

Many studies ignore Electricity Production from Hydroelectric Sources (% of total), Merchandise Trede (% of GDP), when analysing BRICS nations .So the problem of omitted variable biasness will arise. So in our study we will examine the impact of these variables both theoretically and empirically, we will analyse the role of these variables on Co2 discharge in BRICS nations.

OBJECTIVE

- To study Trends of CO2 emissions BRICS nations.
- To analyse the some of the Determinant’s of Co2 Emission in BRICS nations.

DATA AND THE METHODOLOGY

This is study based on various secondary data which is collected from Various internet sites such as World Bank's Development Indicator, Magazine, Scholarly Article.

In this study we have used annual data collected for BRICS countries on their CO2 Emissions(kt), Electricity Production from Hydroelectric Sources (% of total), GDP per Capita (Constant 2015 U$$), Merchandise Trede (% of GDP), Population (Total) over the period of 1998 to 2019 From world Development Indicator.CO2 emission is measured in Kilo ton. Electricity Production from Hydroelectric Sources and Merchandise Trade is measured by % GDP and we measured GDP per capita in US Dollar at 2015 prices and we measured the Population in total term.

To analyse the data different Statistical software such as STATA, MS Excel is used.

In this research paper we tried to use panel data technique to investigate impact of Electricity Production from Hydroelectric Sources (% of total), GDP per Capita at (Constant 2015 U$$), Merchandise Trede as (% of GDP), Population (Total) on CO2 emission in BRICS countries. Here the dependent variable is CO2 Emission and all other variables are independent variables.

To check whether these variables are related to each other or not the Dumitrescu and Hurlin (2012)test and the Granger causality test **(Clive Granger 1969)** is used and Hadri test is used to check the problem Unit root and Kao LM test and test is used to check co-integration among variables or to check long run relations among variables.

RESULT ANALYSIS

Figure 1 depicts the trend of CO2 emission in BRICS Countries and the trend line more or less increasing in every BRICS country but the increasing trend is maximum in China in comparison of other BRICS countries. In South Africa the CO2 emission is least as compared to other BRICS countries the possible reason may be their GDP is less in compare of other countries.

Table 1 shows the descriptive statistics of BRICS countries and this shows average Co2 emission of BRICS countries is 2008955 with SD. Mean of EPH is 25.79 and SD is 28.58 (% total). The average GDP per capita income of BRICS counties is 5196.55 with SD 2767.24.The average Merchandise Trade to percentage of GDP is 37.35 with SD 13.35.

Figure 1

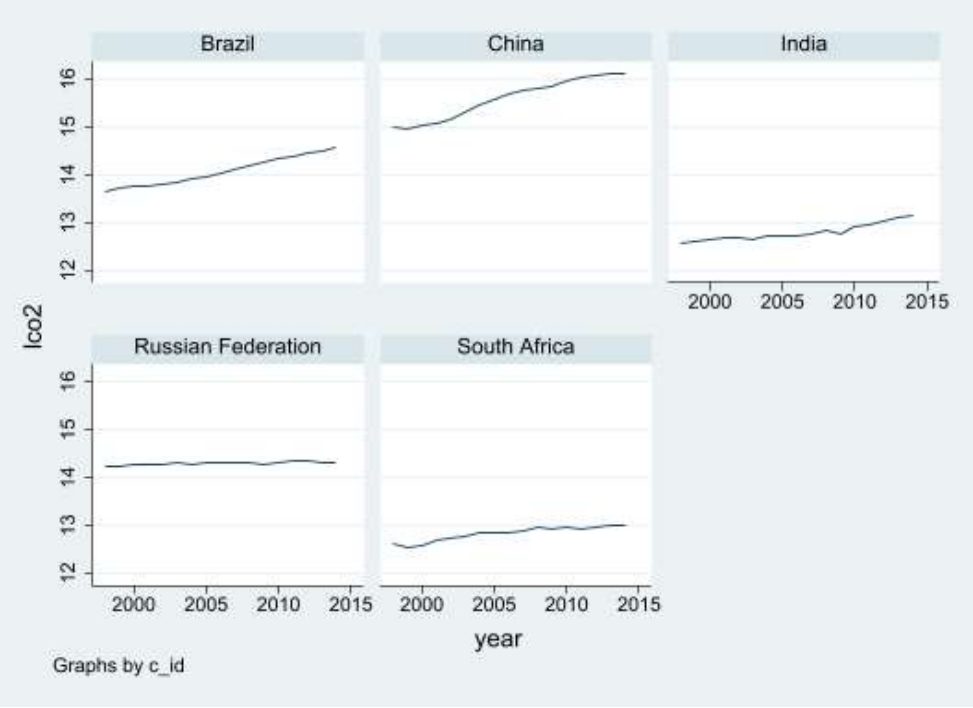

Table 1 Result of descriptive Statistics

Variable	Observations	Mean	SD	Min	Max
CO2	85	2008955	2507041	278270.9	10000000
EPH	85	25.79	28.58	.3	90.59
GDP	85	5196.55	2767.24	693.41	9621.52
MT	85	37.35	13.35	12.94	63.97
PPL	85	572000000	553000000	45900000	1370000000

Table 2 GMM Regression Result

LCO2= C+β0(L1CO2L1) +β1EPH+ β2LGDP+ β3MT+ β4LPPL+Ut……..En 1

Where CO2 =Co2 emission and dependent variable (in kt unit)

CO2=CO2 emissions (kt) which is dependent variable

L1= Lag 1 of Co2

EPH=Electricity production from hydroelectric

sources (% of total

GDP=GDP per capita (constant 2015 US$)

MT=Merchandise trade (% of GDP)

PPL=Population, total

LCO2= -1.36+.863 (LCO2L1) + -.0028 EPH+.087 LGDP+ .002MT+.130 LPPL+Ut

GMM-One Step Estimation		
Variables	Coefficients	Standard Error
L1	.863***	.0338
EPH	-.0028 ***	.0007
LGDP	.087***	.026
MT	.002***	.0005
LPPL	.130***	.029
Constant	-1.36***	.348

Note: ***p < 0.01

Source: Estimations obtained from STATA 17 version software.

The result obtained from GMM estimation suggest that when LGDP and LPPL increase by 1% ,then CO2 increases the by .087% and .130% respectively and one unit increase in EPH, decreases the CO2 emission by .0028 % and one unit increase in MT will increases the Co2 emission by .002% and 1 % increase in co2 in previous year leads to .863% increase in Co2 emission.

Table 3 Granger non -causality test (Clive Granger 1969)

NULL HYPOTHESIS	W-Stat.	Zbar-Stat
EPH does not Granger-cause lco2(Asif et al 2022)	**3.2140**	**3.5007*** **
LGDP does not Granger-cause lco2. (Asif et al 2022)	**2.3507**	**2.1357*** **
MT does not Granger-cause lco2 (Asif et al 2022)	**2.8457**	**2.9183 *** **

LPPL does not Granger-cause lco2 (Asif et al 2022)	**2.4036**	**2.2193*** **

Source: Estimations obtained from STATA 17 version software.

This table shows us the causal relationship between CO2 and these independent variables at 1% level of significance and the result shows significant p value, hence we should reject our null hypothesis and accept there exist causality relationship between dependent and independent variable.

CONCLUSION

The result shows there is exist both direct and inverse link between dependent variable and independent variables. Some variables directly affectsCO2 emission in BRICS countries where as some inversely.

Variables like Total population, Merchandise Trade, GDP per capita and Lag of Co2 emission directly affect the CO2 emission and Variables Like EPH indirectly affects the CO2 emission in BRICS countries.

So, the Governments of these countries should try to take some more initiatives to increase electricity production from hydroelectric sources (% of total)

REFERENCES

- Ang JB. (2008). Economic development, pollutant emissions and energy consumption in Malaysia. Journal of Policy Modeling; 30:271–8.
- Asif Raihan, D. A. (2022). "Nexus between carbon emissions, economic growth, renewable energy use, and technological innovation towards achieving environmental sustainability in Bangladesh". *Cleaner Energy Systems*.
- Al-mulali, U. a. (2012). The impact of energy consumption and CO2 emission on the economic and financial development in 19 selected countries. *Renewable and Sustainable Energy Reviews*.
- Behnaz Saboori, S. G. (2024). "Rethinking diversification: Assessing the impact of energy concentration on climate change in rentier and non-rentier countries. *Energy Strategy Reviews*.
- Boulding, K.E. (1966). The economics of the coming Spaceship Earth'. In: Jarrett, H. (Ed.), Environmental Quality in a Growing Economy. Johns Hopkins University Press, Baltimore, MD.

- Caglar, A. E., Zafar, M. W., Bekun, F. V., & Mert, M. (2022). Determinants of CO2 emissions in the BRICS economies: The role of partnerships investment in energy and economic complexity. *Sustainable Energy Technologies and Assessments*, *51*, 101907.
- Caglar AE. The importance of renewable energy consumption and FDI inflows in reducing environmental degradation: bootstrap ARDL bound test in selected 9 countries. J Cleaner Prod 2020;264:121663. https://doi.org/10.1016/j. jclepro.2020.121663.
- Cai Y, Sam CY, Chang T. Nexus between clean energy consumption, economic growth and CO2 emissions. J Cleaner Prod 2018;182:1001–11.
- Commoner, B., Corr, M., Stamler, P.J. (1971). The causes of pollution. Environment 13 (3), 2–19. Dean JM, Lovely ME, Wang H. (2009). Are foreign investors attracted to weak environmental regulations?. Evaluating the evidence from China. Journal of Development Economics; 90:1e13.
- D. Talukdar, and C. M. Meisner, "Does the private sector help or hurt the environment? Evidence from carbon dioxide pollution in developing countries," World Development, vol. 29, pp. 827-840, 200l.
- Heping Huang, M. Y. (2023). Impacts and mechanisms of heterogeneous environmental regulations on carbon emissions: An empirical research based on DID method. *Environmental Impact Assessment Review*.
- Hsiao-Tien Pao, C.-M. T. (2010). CO2 emissions, energy consumption and economic growth in BRIC countries. *Energy Policy*.
- Hossain MS. (2011.) Panel estimation for CO2 emissions, energy consumption, economic growth, trade openness and urbanization of newly industrialized countries. Energy Policy; 39:6991–9.
- Hong, J. P. (2013). Analysis of South Korea’s economic growth, carbon dioxide emission, and energy consumption using the Markov switching model. *Renewable and Sustainable Energy Reviews*.
- IEA, 2016. Small increase in energy investment could cut premature deaths from air pollution in half by 2040, says new IEA report. https://www.iea.org/news/ small-increase-in-energy-investment-could-cut-premature-deaths-from-airpollution-in-half-by-2040-says-new-iea-report
- Ishfaq Hamid, M. S. (2022). "Decarbonizationpathways: the roles of foreign direct investments, governance, democracy, economic growth, and renewable energy transition",. *Environmental Science and Pollution Research*

- Kivyiro, P. H. (2024). Carbon dioxide emissions, energy consumption, economic growth, and foreign direct investment: Causality analysis for Sub-Saharan Africa. *Energy*.
- Mert M, Caglar AE. Testing pollution haven and pollution halo hypotheses for Turkey: a new perspective. Environ Sci Pollute Res 2020;27(26):32933–43.
- Muhammad Shahbaz, G. R. (2016). Considering the effect of biomass energy consumption on economic growth: Fresh evidence from BRICS region. *Renewable and Sustainable Energy Reviews*.
- Niu S, Ding Y, Niu Y, Li Y, Luo G. (2011). Economic growth, energy conservation and emissions reduction: a comparative analysis based on panel data for 8 Asian Pacific countries. Energy Policy; 39:2121–31.
- Shahbaz M, Rasool G, Ahmed K, Mahalik MK. Considering the effect of biomass energy consumption on economic growth: fresh evidence from BRICS region. Renew Sustain Energy Rev 2016;60:1442–50.
- Sekanabo, D. (n.d.). Evaluating the Contribution of Renewable Energy on Economic Growth of Sub-Saharan Africa. *University of Rwanda*.
- Thuy Bui Minh, T. N. (2023). Relationship between carbon emissions, economic growth, renewable energy consumption, foreign direct investment, and urban population in Vietnam. *Heliyon*.
- World Bank, 2020. World development indicators online database. https:// databank.worldbank.org/source/world-development-indicators.
- Zakarya, G. Y., Mostefa, B. E. L. M. O. K. A. D. D. E. M., Abbes, S. M., & Seghir, G. M. (2015). Factors affecting CO2 emissions in the BRICS countries: a panel data analysis. *Procedia Economics and Finance*, *26*, 114-125.
- Zandile, Z. (n.d.). The Impact of Official Development Assistance and Capital Flight on Corruption and the Impact of Official Development Assistance, Capital Flight and Corruption on Economic Growth in Sub-Saharan African Countries. *Nelson Mandela University*