

Do Foreign Investments Harm Or Heal? An Empirical Study Of FDI And CO₂ Emissions In India

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Abstract

Foreign Direct Investment (FDI) has become a primary source of capital formation in various countries around the world. Its significance lies in the profound impact it has on the economies of host nations. "FDI not only plays a crucial role in the economic development of a country but also contributes to technological advancement and job creation. However, despite its positive contributions to economic growth, the increase in FDI inflows has sparked debates about their potential effects on environmental quality. Some researchers argue that countries experiencing industrialisation, economic development, and an inflow of foreign investments may also witness a rise in CO₂ emissions, which can be particularly harmful to emerging nations."

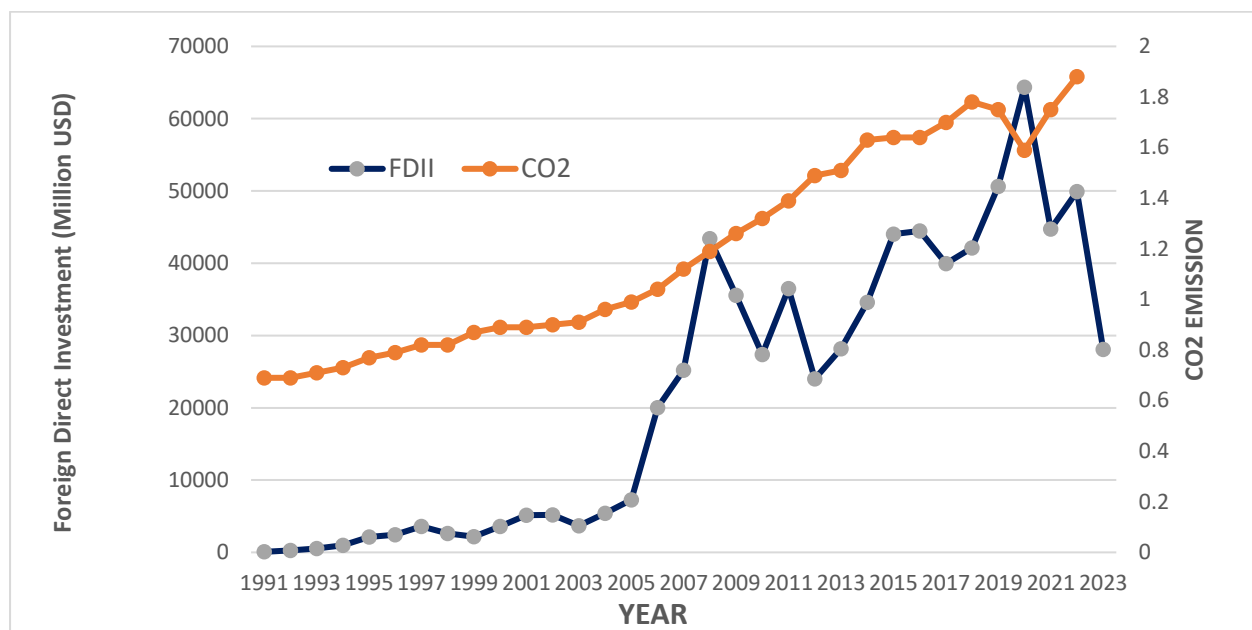
This research tries to investigate how foreign direct investments affect the CO₂ Emissions in India over the period of 1991- 2023. The study was conducted using the Autoregressive Distributed Lag (ARDL) method, which has shown that foreign direct investments reduce Carbon emissions in India in the long run.

Keywords: Foreign direct Investment (FDI), India, Carbon Emissions, Economic Growth, ARDL

INTRODUCTION

In recent years, India has emerged as a prominent player on the global economic stage by becoming one of the fastest-growing economies and an attractive destination for foreign direct investments (FDI). Traditionally viewed as a driver of economic growth, FDI is now recognised for its ability to enhance environmental sustainability. As the world faces the urgent challenges posed by climate change, India has pledged to achieve net-zero carbon emissions by 2070. This ambitious goal will require not only strong domestic policy reforms and significant investments in clean energy but also the strategic inflows of foreign capital, which can introduce green technologies, cleaner production methods, and international best practices. The inflow of Foreign Direct Investment (FDI) in India has exhibited a consistently positive and upward trend, playing a significant role in the growth of the Indian economy over recent years. FDI is recognised as a critical source for enhancing foreign exchange reserves, addressing trade deficits, and bridging gaps in revenue, management, and technical expertise. It serves as an effective tool for international economic integration, providing a combination of assets, including capital, technological proficiency, and market access (Khan & Masood, 2022). Foreign companies are increasingly investing in India to capitalise on competitive labour costs and to utilise favourable investment incentives, such as tax exemptions. Since the liberalisation of the economy in 1991, India's regulatory framework for foreign investment has undergone substantial improvements, positioning the country as one of the top ten most attractive destinations for inbound investment (Verma & Saluja, 2018). India's reliance on coal for energy and its rapid industrial growth have established it as one of the leading contributors to global CO₂ emissions. At present, the nation is responsible for approximately 7% of global CO₂ emissions. Additionally, India has also emerged as a pioneer in embracing renewable energy, setting ambitious goals aimed at reducing carbon intensity. This dual scenario raises critical questions regarding the influence of foreign direct investment on environmental degradation and India's potential role in alleviating these challenges. The "pollution halo hypothesis" and the "pollution haven hypothesis" serve as the theoretical basis for analysing the relationship between foreign direct investment (FDI) and carbon emissions in countries. The Pollution Halo Hypothesis posits that Multinational corporations (MNC's) from developed countries effectively transfer advanced technologies, superior management practices, and environmentally sustainable production methods to host economies, particularly in developing regions. This hypothesis asserts that foreign direct investment (FDI) not only facilitates technology transfer but also accelerates the adoption of cleaner production techniques, leading to significant environmental

improvements, such as reduced CO₂ emissions. However, for the halo effect to fully materialise, it is essential that the host economy possesses the capacity to assimilate these innovations and that robust regulatory incentives are in place to promote sustainable practices. The Pollution Haven Hypothesis posits that foreign direct investment (FDI) inflows may exacerbate CO₂ emissions, particularly in developing countries characterised by weaker environmental regulations. Multinational corporations are often inclined to relocate pollution-intensive industries to nations where compliance costs are comparatively low, leading to an increase in emissions within those host countries. Furthermore, the Scale Effect, which arises when FDI inflows stimulate heightened production and consumption, contributes to the escalation of emissions as energy demand intensifies, a significant portion of which is satisfied by fossil fuels. The graph below shows the comparison between foreign direct investment inflows (FDII) and carbon emissions (CO₂) in India.



Source: World Bank

In the early years from 1991 to 2000, both FDI and CO₂ emissions were relatively low, with modest growth. The increase in FDI was more pronounced compared to CO₂ emissions during this period. However, from the mid-2000s to the early 2010s, there was a significant increase in both metrics. The growth in FDI was particularly rapid, indicating increased foreign investments in India, which could be associated with economic liberalisation policies and a more favourable business environment. Concurrently, CO₂ emissions also increased, likely due to increased industrial activity and energy consumption driven by economic growth. The period from 2010 to 2023 shows a continued growth of both FDI and carbon emissions, albeit with some fluctuations, reaching its highest point in 2022. It is imperative to recognise that foreign direct investment (FDI) serves as a significant catalyst for economic growth. It provides essential financial resources that facilitate the implementation of environmental protection initiatives and the investment in cleaner technologies. These financial inflows not only promote economic development but also foster a sustainable future where environmental protection is prioritised alongside economic advancement.

LITERATURE REVIEW

Empirical studies investigating the intricate relationship between foreign direct investment (FDI) and carbon emissions (CO₂) have produced a tapestry of mixed results, shaped significantly by the unique contexts of host countries and regional dynamics. For example, Wang et al. (2022) delve into this relationship within Newly Industrialized Countries (NICs) using the Autoregressive Distributed Lag Pooled Mean Group (ARDL-PMG) approach. Their findings reveal that, in the long term, FDI—a catalyst for economic growth—alongside energy consumption and trade openness, exhibits a significant and positive correlation with carbon emissions in these nations, raising concerns about the environmental

repercussions of such investments. In a contrasting exploration, Rafindadi et al. (2018) focus on the Gulf Cooperation Council (GCC) region and uncover enlightening insights. Their research suggests that foreign firms often showcase enhanced energy efficiency and embrace more environmentally sustainable production methods compared to their local counterparts. This highlights a potentially transformative benefit of FDI in fostering greener practices amidst a region grappling with environmental challenges. However, the findings of Ganda (2019) present an alternative perspective, noting a positive and significant relationship between FDI and carbon emissions, although this does not extend to the realm of greenhouse gases. His analysis endorses the Environmental Kuznets Curve (EKC) theory, positing that initial economic growth often leads to environmental degradation, followed by improvements at higher income levels as societies adopt cleaner technologies. Shifting the focus to China, the interplay between FDI and CO₂ emissions takes on a nuanced dimension. Zhang and Zhou (2016) investigate this relationship and conclude that FDI can facilitate emission reductions, resonating with the pollution halo hypothesis. However, they underscore that the impact of FDI is not uniform across the country, varying significantly by region. Simultaneously, Ye et al. (2021) add another layer to this discourse, suggesting that while FDI can indeed spur economic growth, it may paradoxically exacerbate carbon emissions. Nevertheless, they also point out its capacity to promote technological innovation that enhances energy efficiency, illustrating the complex duality of FDI's influence on environmental outcomes. Furthermore, the connection between economic growth and carbon emissions emerges as a crucial element in this discourse. Mikayilov et al. (2017) disclose that in Azerbaijan, the relationship between real GDP growth and CO₂ emissions is positive but insubstantial, with population growth exerting a more pronounced impact. Supporting this, Aye and Edoja (2017) reveal a U-shaped relationship, suggesting that economic growth can initially lead to a reduction in emissions in low-growth contexts, only to foster an increase in high-growth scenarios. This interconnectedness is further exemplified by the research of You et al. (2022), who unveil the intricate dynamics between CO₂ emissions and economic complexity across different income levels. Energy consumption is also portrayed as a pivotal factor in escalating CO₂ emissions. Shaari et al. (2021) affirm this notion, indicating that energy consumption plays a significant long-term role in driving emissions higher. Raihan et al. (2022) illustrate this in the Malaysian context, where a mere 1% increase in energy consumption is linked with a substantial 0.91% rise in CO₂ emissions, emphasising the direct impact of increased energy use on environmental deterioration. Additionally, Magazzino (2015) provides a compelling perspective by suggesting that fluctuations in CO₂ emissions can, in turn, influence energy consumption patterns within the Israeli economy, highlighting the bidirectional nature of these relationships. The trade openness adds an intriguing complexity to the narrative. Dou et al. (2021) argue that while trade openness generally promotes higher carbon emissions, the framework of the China-Japan-South Korea Free Trade Agreement emerges as a potential mitigatory force against this trend. They observe that while increasing imports can propel emissions upward, exports perform a crucial role in curtailing them, showcasing the intricate and often paradoxical interplay between trade and CO₂ output. In alignment with these findings, Akin (2014) suggests that while trade openness may initially lead to heightened emissions in the short term, it fosters the adoption of cleaner practices and technologies over the long run, indicating a transformative potential. In summary, the multifaceted impact of FDI, energy consumption, economic growth, and trade on carbon emissions unveils a rich tapestry of interconnected variables with varying repercussions based on regional and contextual specifics. The intricate interdependencies among these elements call for thoughtfully crafted policies that strike a delicate balance between fostering economic development and preserving environmental integrity. As we advance, a nuanced understanding of these relationships will be essential for devising effective strategies that promote sustainable growth while mitigating the impact of climate change across diverse global contexts."

Objective

To study the impact of Foreign Direct Investment Inflows on the CO₂ Emissions in India.

METHODOLOGY

This section provides an overview of the variables utilised and the econometric techniques applied in the analysis. "The primary objective of this study is to assess the impact of Foreign Direct Investment (FDI) inflows on CO₂ emissions in India. To achieve reliable findings, several additional explanatory variables

have been incorporated into the model. Data on CO₂ emissions, FDI, trade openness, energy consumption, and economic growth have been sourced from the World Bank database. The research utilises annual data from 1991 to 2023. The Autoregressive Distributed Lag (ARDL) method is employed to analyse both the long-run and short-run effects.

model specification

The impact of FDI on CO₂ Emissions has been assessed in this study. The nature of the link among the relevant variables is ascertained using the functional form that follows.

$$CO_2 = f(FDI, TRADE, GDPG, EC) \quad (1)$$

$$CO_2 = \beta_0 + \beta_1 FDI + \beta_2 TRADE + \beta_3 GDPG + \beta_4 EC + \varepsilon_t \quad (2)$$

Where CO₂ is Carbon emissions in India, FDI is the foreign direct investment inflows; TRADE indicates the degree of openness; GDPG demonstrates the economic growth of the country; and EC is energy consumption in India.

EMPIRICAL RESULTS AND DISCUSSION

ADF			PP		KPSS
Variables	t-Statistic	P-Value	t-Statistic	P-Value	P-Value
CO ₂	-3.441500	0.0178*	-1.377206	0.5809	0.290768*
Δ CO ₂	-0.355786	0.9030	-3.108357	0.0363*	
FDI	-2.293443	0.1801	-2.277501~	0.1850	0.298507*
Δ FDI	6.414016	0.0000*	6.703706	0.0000*	
GDPG	2.588993	1.0000	7.490716	1.0000	0.634756
Δ GDPG	-4.365786	0.0017*	-4.319267	0.0019*	
TRADE	-1.526245	0.5077	-1.526245	0.5077	0.184356*
Δ TRADE	-4.902782	0.0004*	-4.902782	0.0004*	
EC	0.124880	0.9613	1.238738	0.9977	0.307632*
Δ EC	-1.887657	0.3323	-4.760942	0.0006*	

Table 1. Unit Root Test

ADF, PP & KPSS TEST (Critical Value at 1% -0.739, 5% -0.463, 10% -0.347)

Notes: Δ denotes first differences, Significant at *5% Level

ADF, PP, and KPSS unit root tests are employed in this research to examine the stationarity of these variables. According to the findings in Table 1, Carbon Emissions, Foreign direct inflows, Economic Growth, Trade and Energy Consumption are stable at first difference. The ARDL model can be used in this research since none of the variables are stable at the second difference. The ARDL technique divides estimations into two steps. The first step is to see whether there is a long-run equilibrium connection between the variables or not. For that, we have used the bound F-test.

F-statistics	6.432760	
K	4	
Critical Bound Values		
Level of significance	Lower Bound (I(0))	Upper Bound (I(1))
10%	2.2	3.09
5%	2.56	3.49
1%	3.29	4.37

Table 2. Results of bounds testing

Table 2 illustrates the ARDL bound test's empirical findings. The study confirms a long-term effect between CO₂ Emissions, foreign direct investment inflows, Economic growth, Trade, and Energy consumption, as the F-value exceeds the upper bound value. In the second stage, the long- and short-term relation of Carbon emissions to independent variables is estimated.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FDI	-0.036230	0.014347	-2.525269	0.0197*

GDPG	-0.000004	0.000001	-3.582307	0.0018*
EC	0.004133	0.000288	14.36609	0.0000*
TRADE	0.002714	0.000961	2.824064	0.0102*
C	-0.610136	0.059954	-10.17673	0.0000*

Table 3. Log-run estimated Coefficients (Dependent variable: CO₂),
Significant at *5% Level

Long-term estimates are presented in Table 3. The long-run relationship coefficients reveal that foreign direct investment, economic growth, energy consumption and trade have a significant impact on the Carbon Emissions in India. The result showed that a 1 unit rise in the Foreign direct investment inflows reduces Carbon emissions by 0.036 units. Furthermore, the Economic Growth impact is marginally low, yet it is statistically significant. The output confirms a significant and long-term positive impact of the energy consumption on the Carbon emissions. With an increase of 1 unit value of energy consumption, the carbon emissions increase by 0.0041 units in India. With regard to trade openness, the results indicate that trade openness positively influences carbon emissions in India. With a 1 unit increase in trade, carbon emissions increase by 0.0027 units.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FDI)	-0.001955	0.002690	-0.726795	0.4754
D (FDI (-1))	0.008844	0.003199	2.764766	0.0116*
D(EC)	0.003641	0.000079	45.68627	0.0000*
ECM	-0.425534	0.061558	-6.912757	0.0000*

Table 4. Short-run estimated Coefficients,
Significant at *5% Level

The short-run results are summarised in Table 4. The estimated coefficients of the short-run relationship show that the lagged value of foreign direct investment inflow has a positive and significant effect on carbon emissions in India. With a 1 unit rise in foreign direct inflows, the carbon emissions rise by 0.0088 units. The coefficient value of energy consumption is 0.0036. It means that a 1-unit surge in the energy consumption increases carbon emissions by 0.0036 units. The ECM value presented above is -0.425534, which denotes the speed of Long-run adjustments towards convergence.

diagnostic tests

Test	P-value
Serial Correlation LM Test	0.1680
Normality test (Jarque-Bera)	0.44840
Breusch-Pagan Heteroskedasticity Test	0.1634

Table 5. Significant at *5% Level

The model is free from serial correlation, according to Breusch-Godfrey (LM) tests, as the significance level is higher than the 5% level. Furthermore, the given model is normally distributed as the significance value is more than 5% in the Jarque-Bera test. The Breusch-Pagan-Godfrey test for heteroskedasticity is

employed with the null hypothesis asserting constant variance within the model. Given the p-value of 0.1634, the null hypothesis can be accepted. Consequently, it can be inferred that the model exhibits homoskedasticity.

stability test

The cumulative sum of the recursive (CUSUM) test developed by (Brown et al., 1975) was employed to assess the long-run stability of the ARDL model. The results shown in Figure 1 indicate that the plot of the residuals remains within two pairs of straight lines, signifying stable carbon emission (CO_2) in India at a 5% critical bound during the period from 1991 to 2023. Given that we have established the presence of a long-run relationship in the ARDL model, it is important to acknowledge that the results illustrated in Figure 1 further corroborate this finding.

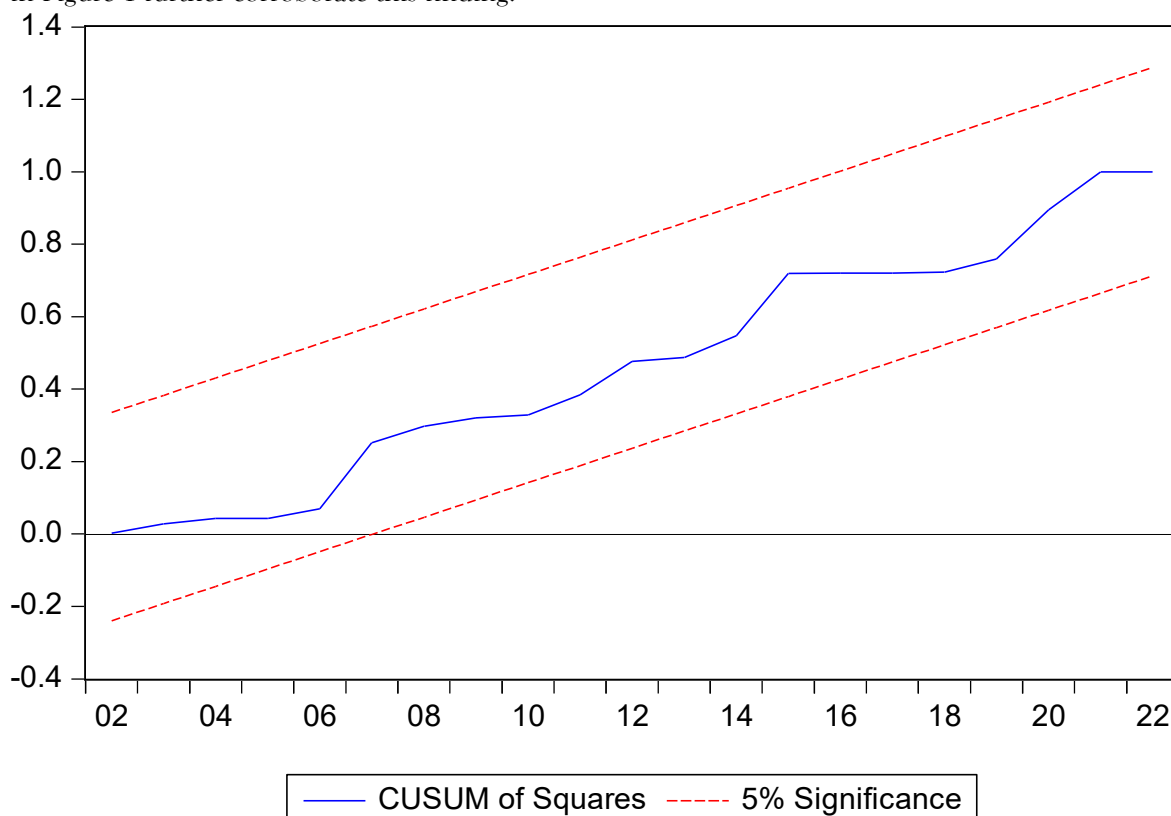


figure 1

CONCLUSION

The study investigates the relationship between carbon emissions (CO_2) and key economic indicators, including foreign direct investment (FDI), economic growth (GDP), trade openness, and energy consumption (EC) in India. The ARDL bound test results indicate a long-run equilibrium relationship between CO_2 emissions and the chosen economic factors, with the F-statistic value significantly exceeding the upper bound critical values at 5% significance level. In the long run, a 1-unit increase in FDI inflows is associated with a 0.036% reduction in CO_2 emissions. This implies that FDI, particularly when directed towards cleaner technologies or industries, can contribute to a reduction in emission levels. Economic growth (GDPG) has a marginal negative impact on emissions, with a 1 unit increase in GDP growth associated with a 0.000004 units reduction in emissions. This suggests that while economic growth is essential, its impact on emissions is minimal. Energy consumption and trade openness both have positive and significant impacts on CO_2 emissions. Specifically, a 1 unit increase in energy consumption leads to a 0.0041 unit increase in emissions, while a 1 unit increase in trade openness results in 0.0027 units increase in emissions. These findings highlight the need for sustainable energy policies and trade practices to mitigate the environmental impact of economic activities. In the short run, lagged FDI and energy consumption continue to influence carbon emissions. A 1 unit increase in lagged FDI inflows raises emissions by 0.0088 units, while a 1 unit increase in energy consumption leads to a 0.0036 unit increase

in emissions. The Error Correction Mechanism (ECM) value of -0.425 suggests that about 42.5% of the adjustment towards long-run equilibrium occurs within each period, indicating a relatively rapid convergence to the long-term relationship.”

implications

Firstly, there is a need to attract foreign direct investment (FDI) that specifically targets renewable energy, energy-efficient technologies, and sustainable industries. This strategic approach to FDI can significantly reduce carbon emissions while still fostering economic growth. Secondly, energy consumption has a notable impact on carbon emissions, so it is crucial to implement policies that promote energy efficiency. This can be achieved through incentives for the adoption of energy-efficient appliances, building standards, and industrial processes. Encouraging the use of renewable energy sources can also play a vital role in reducing the carbon footprint associated with energy consumption. Thirdly, trade policies should be designed to balance economic benefits with environmental sustainability. This could involve the implementation of carbon tariffs, green trade agreements, and other mechanisms to reduce the carbon footprint associated with trade activities. By doing so, India can continue to benefit from trade openness while minimising its environmental impact. Decoupling economic growth from carbon emissions is another key area of focus. This can be achieved through the adoption of renewable energy sources, carbon pricing mechanisms, and the promotion of low-carbon technologies. By implementing these measures, India can grow economically without a corresponding increase in carbon emissions. Regular monitoring and adjustment of policies are essential to ensure their effectiveness. Given that a significant portion of the adjustment towards long-run equilibrium occurs relatively quickly, policies may need to be reassessed and adjusted periodically to ensure they remain effective. This proactive approach can help maintain progress toward environmental goals. Lastly, raising public awareness about the environmental impact of economic activities can encourage individuals and businesses to adopt more sustainable practices. Public participation in environmental initiatives can drive the demand for green technologies and sustainable products, further supporting the country's efforts to reduce carbon emissions. In summary, the study underscores the importance of a multifaceted approach to environmental sustainability in India. By promoting green FDI, enhancing energy efficiency, implementing sustainable trade practices, decoupling growth from emissions, and engaging in regular policy monitoring and public awareness campaigns, India can achieve a balance between economic development and environmental protection.

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