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# FDI, Carbon Emissions, and Sustainable Inclusive Development in India: An Analysis Using the Environmental Kuznets Curve

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**Business Finance and Economics Department Jai Narain Vyas University, Jodhpur FDI, Carbon Emissions, and Sustainable Inclusive Development in India: An Analysis Using the Environmental Kuznets Curve**

**Abstract**

Foreign Direct Investment (FDI) has been crucial in driving India's economic growth through industrial expansion and job creation, but it also raises concerns about environmental sustainability due to increased carbon emissions. This research examines the relationship between FDI, carbon emissions, and India's pursuit of sustainable and inclusive development, using the Environmental Kuznets Curve (EKC).The EKC suggests that while economic growth initially leads to environmental degradation, later stages of development may bring improvements as cleaner technologies are adopted. The dual role of FDI is highlighted, where it can initially increase emissions but also foster long-term innovation and greener practices. Policymakers must balance attracting FDI with promoting environmental sustainability and ensuring that growth benefits all sections of society, particularly vulnerable populations.

## 1.1 Introduction

Foreign Direct Investment (FDI) has played a pivotal role in shaping India's economic growth, fueling industrial expansion, technological advancement, and job creation. However, as India continues to attract substantial foreign investments, concerns regarding the environmental impact of this economic expansion have become increasingly prominent. One of the most pressing issues is the rise in carbon emissions, driven by heightened industrial activity and energy consumption. Balancing the benefits of FDI with the need for environmental sustainability poses a significant challenge, especially as India strives to meet its

climate commitments. The link between FDI inflows and carbon emissions is crucial for designing policies that can ensure sustainable growth. As India progresses economically, there is a growing need to align foreign investment strategies with environmentally conscious practices, fostering a development path that is both inclusive and environmentally sustainable.

### 1.2. Review of Literature

Kumar Nagesh (2005)[1] explores the post-liberalization impact of FDI on India's economic growth, particularly in sectors like manufacturing, services, and technology. The study highlights that FDI contributes positively to GDP growth by enhancing capital formation and facilitating the transfer of advanced technologies. Despite these benefits, the uneven distribution of FDI benefits across regions and sectors is a notable concern. Similarly, Prasanna N. (2010)[2] examines the role of FDI in boosting India's export capacity, finding that FDI facilitates access to global supply chains and advanced technologies, thereby enhancing export performance. The research emphasizes that foreign firms, through FDI, enable Indian industries to improve productivity and compete globally, particularly in sectors like textiles and automobiles. However, the uneven distribution of FDI benefits across states and industries remains a challenge.

More recent studies, such as those by Sudhakar P. and Valmurugan R. (2023)[3], examine the link between FDI and stock market performance. Their regression analysis reveals that FDI positively influences the Bombay Stock Exchange (BSE) index and contributes significantly to GDP growth by boosting industrial development and technological advancement. This study underscores the importance of a supportive policy environment for maximizing the benefits of FDI and maintaining financial stability. Similarly, Usha Srivastava (2023)[4] investigates FDI inflows and their impact on India's GDP using regression analysis in SPSS, confirming a significant positive correlation between FDI and GDP growth. The study highlights that FDI has sector-specific benefits, particularly in manufacturing and services, and emphasizes the importance of policies that support FDI's positive economic effects, despite regional disparities in benefit distribution.

Tripathi Vinita et al. (2015)[5] provide a more detailed econometric analysis of FDI's influence on macroeconomic variables using the Vector Autoregressive (VAR) model and Johansen cointegration test. Their findings show long-term relationships between FDI and key economic indicators, with FDI Granger-causing several macroeconomic variables. This study also uses impulse response analysis to demonstrate how shocks to FDI affect macroeconomic performance over time, offering a nuanced understanding of FDI's role in economic growth.

### 1.4. Objectives of the Study:-

1. Analyze the relationship between FDI inflows and carbon emissions in India's sectors.
2. .Examine how policy frameworks influence the FDI-carbon emissions relationship.
3. Evaluate the impact of FDI-driven technological advancements on carbon emission reduction.
4. Explore the socioeconomic effects of FDI on marginalized communities and environmental quality.

### 1.5 Research Methodology

The research methodology employed in this study involves regression and correlation analysis to examine the relationship between Foreign Direct Investment (FDI) and carbon emissions in India from 2000 to 2022-2023. The Environmental Kuznets Curve framework is applied to assess the hypothesis that economic growth, initially associated with higher emissions, may lead to improvements in environmental quality as development progresses. This comprehensive approach facilitates a robust understanding of how FDI influences carbon emissions while considering the dynamics of economic growth and environmental sustainability.

### 1.6. Hypothesis:-

**Hypothesis 1:** Higher Foreign Direct Investment (FDI) in India significantly increases carbon emissions.

**Hypothesis 2:** Increased FDI significantly reduces carbon emissions, significantly aligning with the Environmental Kuznets Curve

### 1.7. Findings

FDI in India has been instrumental in driving economic growth and fostering development. Over the years, the nation has drawn significant foreign investment from various countries. The following table offers an overview of FDI inflows in India from 2000 to 2022-2023.

**Table 1:-Relationship Between Foreign Direct Investment and Carbon Dioxide Emissions in India (FDI in US Million Dollars, CO2 in Metric Tons)**

| Years | Foreign Direct Investment (US Million Dollars) | Carbon Dioxide Emissions (in Metric Tons) |
|---|---|---|
| 2000 | 891.103 | 4028 |
| 2001 | 906.085 | 6130 |
| 2002 | 935.917 | 5035 |
| 2003 | 960.281 | 4322 |
| 2004 | 1029.552 | 6051 |
| 2005 | 1076.249 | 8961 |
| 2006 | 1149.22 | 22826 |
| 2007 | 1267.965 | 34843 |
| 2008 | 1366.261 | 41873 |
| 2009 | 1460.526 | 37745 |
| 2010 | 1558.149 | 34847 |
| 2011 | 1657.113 | 46556 |
| 2012 | 1797.049 | 34298 |
| 2013 | 1850.005 | 36046 |
| 2014 | 2021.829 | 45148 |
| 2015 | 2053.715 | 55559 |
| 2016 | 2076.318 | 60220 |
| 2017 | 2192.488 | 60974 |
| 2018 | 2300.207 | 62001 |
| 2019 | 2287.71 | 74391 |
| 2020 | 2109.749 | 81973 |
| 2021 | 2323.888 | 84835 |
| 2022 | 2516.967 | 71355 |

**Source:-International Energy Agency (IEA) DatabaseCO2 Emissions, Energy Investments, World Energy Outloo**

The table presents the relationship between carbon dioxide emissions (measured in metric tons) and Foreign Direct Investment (FDI) inflows (measured in millions of US dollars) for the years 2000 to 2022. Over the observed period, there has been a general increase in both carbon dioxide emissions and FDI inflows, highlighting significant growth in economic activity, which often correlates with industrialization and energy consumption.

In the early 2000s, carbon dioxide emissions started at 891.1 million metric tons in 2000, accompanied by FDI inflows of $4,029 million. By 2022, carbon dioxide emissions reached 2,516.97 million metric tons, while FDI increased substantially to
$71,355 million. This sharp rise in both emissions and investment indicates that FDI may have contributed to economic expansion, leading to greater industrial output and energy use, which in turn drove up emissions levels.

A significant trend in the data is that from 2006 onward, FDI inflows experienced a sharp surge, especially between 2006 and 2007, when FDI more than tripled, increasing from $22,826 million to $34,843 million. This rise in investment coincided with a continuous increase in carbon dioxide emissions, suggesting that FDI may have fueled sectors with high energy demands, thus contributing to greater emissions.

In certain years, such as 2019 and 2020, a decrease in carbon dioxide emissions is observed, despite continuous growth in FDI. This could be attributed to global economic shifts, such as the impact of the COVID-19 pandemic, which disrupted industrial activity and temporarily reduced emissions. By 2021, both carbon dioxide emissions and FDI inflows rebounded, with emissions rising to 2,323.89 million metric tons and FDI inflows reaching $84,835 million. This trend underlines the complex interplay between economic growth, foreign investment, and environmental impact over time.

**Table2:-Descriptive Statistics of Foreign Direct Investment and CO2 Emissions in India (2000-2022)**

| | N | Range | Minimum | Maximum | Sum | Mean | | Std. Deviation | Variance | Skewness | | Kurtosis | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Statistic | Statistic | Std. Error | Statistic | Std. Error |
| FDI | 23 | 1625.864 | 891.103 | 2516.967 | 37788.980 | 1642.99913 | 112.767495 | 540.813905 | 292479.680 | -.028 | .481 | -1.505 | .935 |
| CO2 | 23 | 80806 | 4029 | 84835 | 920018 | 40000.78 | 5451.820 | 26146.008 | 683613755.632 | .055 | .481 | -1.077 | .935 |
| Valid N (listwise) | 23 | | | | | | | | | | | | |

**Source:- Author's compilation**

The descriptive statistics table provides a comprehensive overview of the Foreign Direct Investment (FDI) and carbon dioxide (CO2) emissions data. Both variables have a sample size of 23, indicating a consistent dataset. FDI ranges from a minimum of 891.103 million dollars to a maximum of 2516.967 million dollars, with a mean of approximately 1642.999 million dollars and a standard deviation of 540.814, suggesting significant variability in investment levels. Conversely, CO2 emissions exhibit a broader range, from 4029 metric tons to 84835 metric tons, with a mean of 40000.78 metric tons and a standard deviation of 5451.820, highlighting substantial fluctuations in emissions over the observed period. The skewness values for both variables are close to zero, indicating a relatively symmetric distribution,

### 1.7.1. Correlation Analysis

**Table 3:-Correlation Analysis: FDI and Carbon Dioxide Emissions**

| | CO2 | FDI |
|---|---|---|
| **CO2** | **1** | **.937**** |
| **Sig. (2-tailed)** | | **.000** |
| **N** | **23** | **23** |
| **FDI** | **.937**** | **1** |
| **Sig. (2-tailed)** | **.000** | |
| **N** | **23** | **23** |

**Source:-Author's compilation**

#### 1.7.1.(A) Correlation Results

The correlation analysis reveals a strong positive association between CO2 emissions and Foreign Direct Investment (FDI), with a Pearson correlation coefficient of 0.937. This indicates a statistically significant relationship at the 0.01 level (2-tailed), supported by a p-value of 0.000. With a sample size of 23 for both variables, the results suggest that higher levels of FDI are closely linked to increased CO2 emissions.

### 1.7.2. Regression Analysis

**Table 4:-Impact of Foreign Direct Investment on CO2 Emissions: A Regression Analysis**

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .937[a] | .878 | .872 | 9364.369 |

a. Predictors: (Constant), FDI

**Source:- Author's compilation 1.7.2.(A) Model Summary**

The regression analysis demonstrates a strong relationship between Foreign Direct Investment (FDI) and CO2 emissions. The model's R value is 0.937, indicating a high degree of correlation between the independent variable (FDI) and the dependent variable (CO2). Additionally, the R-Square value of 0.878 suggests that 87.8% of the variability in CO2 emissions can be explained by the changes in FDI. This high percentage highlights the model's strong explanatory power. The adjusted R-Square, which accounts for the number of predictors in the model, is 0.872, further confirming the model's robustness. The standard error of the estimate is 9364.369, reflecting the average deviation of the observed CO2 values from the regression line.

**Table 5:-Impact of Foreign Direct Investment on CO2 Emissions: A Regression Analysis (Anova)**

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 13197983102.808 | 1 | 13197983102.808 | 150.505 | .000[b] |
| | Residual | 1841519521.105 | 21 | 87691405.767 | | |
| | Total | 15039502623.913 | 22 | | | |

a. Dependent Variable: CO2

b. Predictors: (Constant), FDI

**Source:- Author's compilation**

The ANOVA results show a statistically significant relationship between FDI and CO2 emissions, with an F-statistic of 150.505 and a p-value of 0.000. The model explains most of the variation in CO2 emissions, with a large regression sum of squares compared to the residual sum of squares.

**Table 6:-Impact of Foreign Direct Investment on CO2 Emissions: A Regression Analysis (Coefficients)**

**Coefficients**

| | | Unstandardized Coefficients | | Standardized Coefficients | t-statistics | Sig. |
|---|---|---|---|---|---|---|
| Model | | Beta | Std. Error | Beta | | |
| 1 | (Constant) | -34409.324 | 6371.913 | | -5.400 | .000 |
| | FDI | 45.289 | 3.692 | .937 | 12.268 | .000 |

a. Dependent Variable: CO2

**Source:- Author's compilation**

The coefficients table shows a strong positive relationship between FDI and CO2 emissions. The unstandardized coefficient (B) of 45.289 indicates that for each unit increase in FDI, CO2 emissions rise by 45.289 units, with a standardized coefficient (Beta) of 0.937. The intercept is -34,409.324, representing predicted emissions when FDI is zero. Both FDI and the constant are statistically significant at the 0.01 level, with t-statistics of 12.268 and -5.400, and p-values of 0.000, confirming the significant impact of FDI on CO2 emissions.

### 1.8 India's Evolution within the Environmental Kuznets Curve Framework

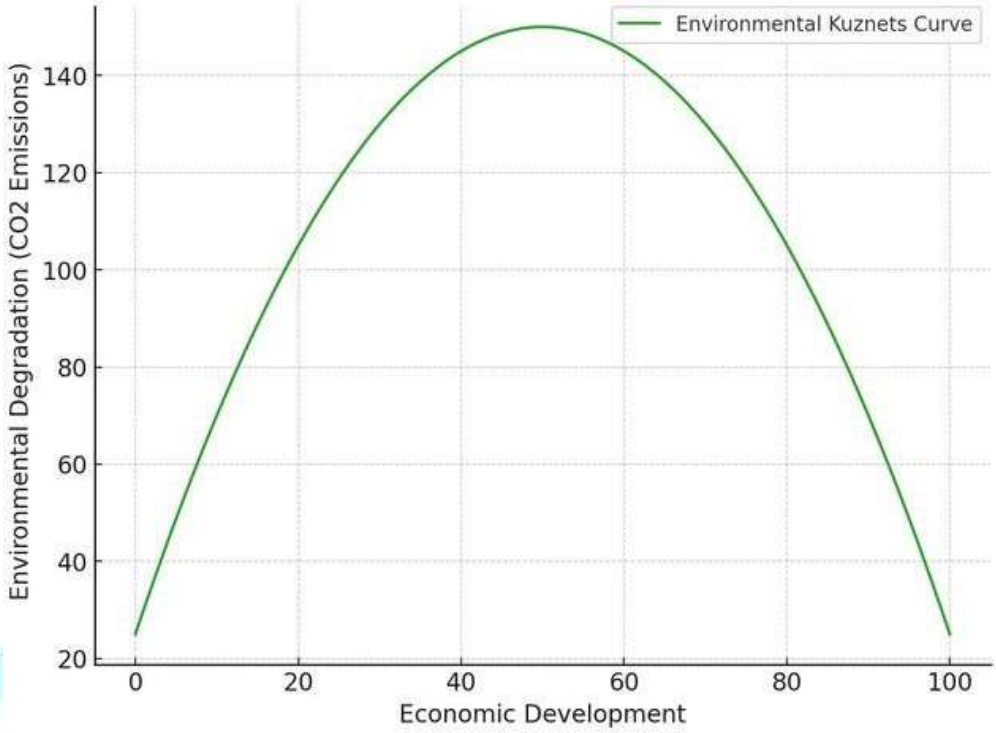


**Figure 1**:- **The Environmental Kuznets Curve: Relationship Between Economic Development and Environmental Degradation**

The Environmental Kuznets Curve (EKC) is a widely recognized hypothesis that explores the relationship between economic development and environmental degradation. It suggests that in the early stages of economic growth, environmental quality tends to worsen as industrialization increases, leading to higher pollution levels. This phase is characterized by rapid expansion in sectors such as manufacturing and energy production, which often rely on fossil fuels and contribute to rising carbon dioxide emissions, deforestation, and depletion of natural resources. However, as nations progress beyond a certain threshold of income and development, a turning point is reached where environmental consciousness, regulatory frameworks, and technological advancements begin to mitigate these negative effects. As a result, the curve follows an inverted U-shape, where environmental degradation initially rises but then declines with further economic growth.

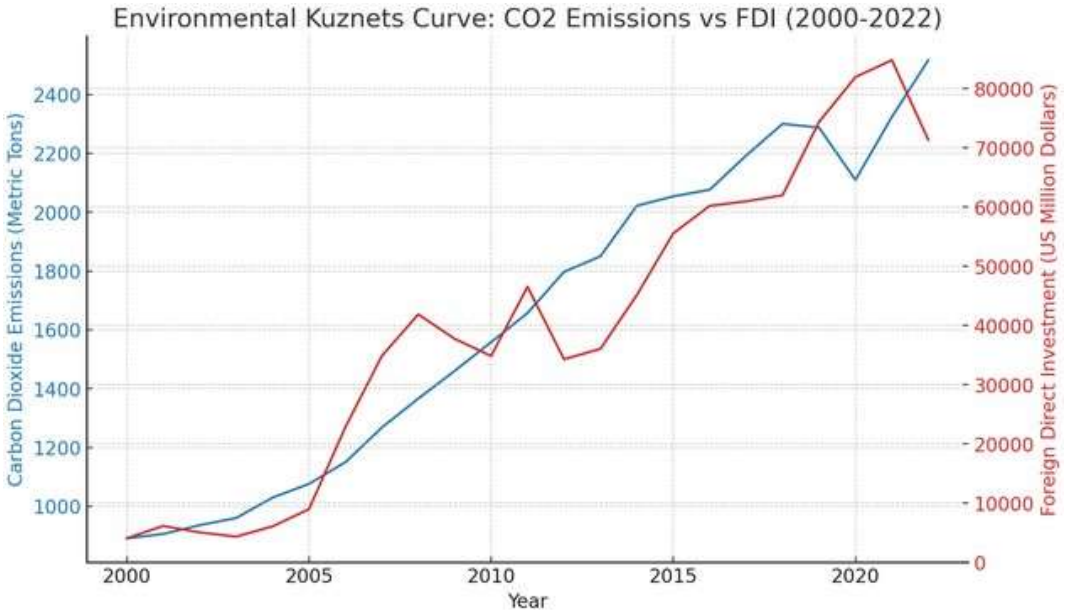


**Figure 2:-Environmental Kuznets Curve for India: Examining the Link Between Economic Growth and CO2 Emissions**

The Environmental Kuznets Curve (EKC) serves as a pivotal framework for understanding the complex relationship between economic development and environmental degradation. Initially proposed by Simon Kuznets, the EKC hypothesizes that as economies grow, pollution levels rise, reaching a peak before they begin to decline as nations adopt cleaner technologies and more effective environmental policies. This inverted U-shaped relationship suggests that wealthier nations tend to invest in sustainability and environmental preservation, ultimately leading to improvements in ecological conditions. In the context of India, however, the observed EKC trajectory has not followed this expected pattern, with both carbon dioxide emissions and foreign direct investment (FDI) showing a continuous upward trend from 2000 to 2022. This deviation raises critical questions about the country's development strategies, the impact of foreign investment on environmental sustainability, and the challenges India faces in balancing economic growth with environmental responsibility.

### 1.8.1. Factors Driving the Rising Trends of FDI and CO2 Emissions in India: Deviating from the Inverted U-Shaped Enviromnent Kuznet Curve

**1.8.1.(A) Development Stage**: India is still in a phase of rapid economic growth and industrialization, which typically results in increased pollution. The EKC suggests that environmental degradation will rise during early development stages due to the heavy reliance on fossil fuels, increased manufacturing, and lack of stringent environmental regulations. India's economy may not yet have reached the turning point where cleaner technologies and more efficient regulations significantly reduce emissions.

**1.8.1.(B) Late Adoption of Green Technologies**: For the EKC to show an inverted U-shape, economies need to adopt cleaner technologies and environmentally friendly policies at a certain stage of development. India, like many developing economies, might not have fully transitioned to greener technologies or renewable energy sources on a large scale, keeping emissions on the rise despite economic growth.

**1.8.1.(C) Economic Priorities**: Countries at certain stages of development often prioritize economic growth and infrastructure development over environmental concerns. In India's case, significant investment in sectors such as manufacturing, transportation, and energy production may still be driven by coal and other high- emission sources, which could delay the environmental benefits associated with economic growth.

**1.8.1.(D) Increased Foreign Direct Investment (FDI)**: The red line showing FDI increases suggests an influx of foreign capital, often targeted at industrial sectors that could contribute to rising emissions, especially if environmental regulations are not stringent enough to mitigate the environmental impact of these investments.

**1.9. Suggestions and Conclusions**

The analysis of the relationship between Foreign Direct Investment (FDI) and carbon dioxide (CO2) emissions in India from 2000 to 2022 reveals significant insights. The correlation analysis indicates a strong positive association between FDI and CO2 emissions, with a Pearson correlation coefficient of 0.937, underscoring that higher levels of FDI are closely linked to increased emissions. This relationship is further supported by the regression analysis, where the model explains 87.8% of the variability in CO2 emissions demonstrating a robust connection between these two variables.

The ANOVA results further affirm the model's significance, with an F-statistic of 150.505 and a p-value of 0.000, indicating that the impact of FDI on CO2 emissions is statistically significant. The unstandardized coefficient for FDI (45.289) suggests that for each additional million dollars of FDI, CO2 emissions increase by approximately 45.289 metric tons. This evidence highlights the potential environmental implications of continued foreign investment, especially in high-emission sectors. Given these findings, it is imperative for policymakers to consider strategies that align FDI with sustainable development goals. Implementing stricter environmental regulations and promoting cleaner technologies could mitigate the negative environmental impacts while still fostering economic growth. The trajectory of CO2 emissions in India calls for a balanced approach that encourages investment while safeguarding ecological integrity.

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