Global Warming in Interaction with Domestic and foreign Investment: The Indian Case Study

I. Abstract:

Human actions have a substantial impact on the global environment. The depletion of the ozone layer due to the use of chlorofluorocarbons and the threat of global warming due to the accumulation of "greenhouse gases," carbon dioxide and methane that is released in agriculture, energy production, and transportation are few prominent illustrations of damages to the environment. The advent of these unprecedented repercussions of human activities on a global scale eventually directs to a complex economic policy in the world. Hence, the policies to promote economic growth, equity, trade, and technological change to have a significant impact on the global environmental scenario.

Purpose: In this respect, the current study concentrates on the financial activities by a country, specifically, India, in relation to the global warming. The major financial activities in a country are based on domestic as well as foreign investment. The source of the domestic financial investment activities, known as Domestic Investment (DI), considered here are investment in plant, machinery, and equipment purchase. While the source of foreign investment is specified as Foreign Direct Investment (FDI).

Methodology: The study applies Auto Regressive Distributed Lag (ARDL) model to find the co-integration between the three variables. Further, the long run impact of domestic investment and short run impact of FDI on carbon dioxide emission are found to be present.

Finding: The study finds significant environmental impact of domestic and foreign investment in India.

Implication: Further, the study provides important policy implication by suggesting reducing the usage of carbon emission through fossil fuel to improve long run sustainable development in India.

Key Words: Domestic Investment, Foreign Direct Investment, Carbon Dioxide Emission, Auto Regressive Distributed Lag Model, India

II. Introduction:

Gross Domestic Product (GDP) is considered one of the most important indicators of a country's economic performance and is used to measure its overall economic health and growth. It takes into account all final goods and services produced by households, businesses, and governments, including investments, consumption, and exports. Investments play a crucial role in increasing the GDP and thus the economic health of the country.

Investment plays a crucial role in the GDP of a country. Investment refers to the spending on capital goods, such as machinery, buildings, and infrastructure, which are used to produce goods and services in the future. It is a key driver of economic growth because it contributes to the creation of new businesses, the expansion of existing businesses, and the development of new technologies. This, in turn, leads to increased production and employment, which can lead to higher GDP. In addition, investment can lead to increased productivity and efficiency, which can also contribute to higher GDP. When firms invest in new technology or equipment, they can produce more goods and services with the same number of resources, which can lead to lower costs and increased profits. Therefore, investment is a critical component of GDP, and a country must attract and promote investment to drive economic growth and development.

For a country, investment can accrue from either domestic or foreign sources.Domestic investment (DI) refers to the investment made by individuals, businesses, and the government within the country's borders, aimed at expanding productive capacity, creating employment opportunities, and increasing economic activity. Foreign investment refers to investment in domestic businesses of a country by a foreign investor, Zhu , et al (2016). Investment from foreign sources could include portfolio and direct investment. While portfolio investment is aimed to generate returns for investors by investing in financial assets like stocks and bonds, direct investment aims at getting substantial interest in local businesses.

Both DI and FDI enable businesses to invest in new equipment, machinery, or infrastructure, to produce more goods and services with greater efficiency, leading to increased output and higher GDP. Shahbaz, et al (2019), posit that both DI and FDI create jobs, which leads to increased consumer spending, and in turn, stimulates demand and further economic growth. This leads to a multiplier effect, where increased investment leads to increased economic activity and a higher GDP.

An increase in GDP indicates the development of a country which is reflected by a rise in the standard of living, enhanced infrastructure, augmented access to various social and medical

facilities, and a general sense of well-being of citizens. While GDP is an essential measure of economic activity, it does not capture all aspects of well-being, such as environmental quality & sustainability, carbon emissions, income distribution, and quality of life.

India initiated a policy of liberalization, globalization, and privatization in 1991 intending to increase its GDP and thus achieve economic development. This new Industrial Policy not only unshackled the domestic markets from quotas and licenses but also opened the gates for investors across the globe to invest in India. This led to a surge not only in DI but also FDI which had a multiplier effect and resulted in increased productivity and efficiency, better infrastructure, and access to social and health facilities culminating in an increase in the GDP. Along with the surge in national GDP, there also has been a spurt in carbon dioxide (CO2) emissions in the country. While an increase in CO2 emissions indicates the growth of the economy, it also indicates the potential degradation of climate quality.

As per a report by National Oceanic and Atmospheric Administration (NOAA)'s Global Monitoring Report, the average atmospheric carbon dioxide was 414.73 ppm globally despite the decreased economic activity due to the COVID-19 pandemic (Lindsey, 2022). These levels of CO_2 emissions show an increase of 2.58 ppm over 2021 amounts and indicates one of the highest annual increases. India being a rapidly developing country has witnessed a surge not only in investments but also in CO_2 emissions post-1991. While investments are necessary to boost the Indian GDP, it is equally important to preserve the climate quality and limit the CO_2 emissions to preserve the environmental quality and ensure the sustainable development of India.

Therefore, this study in its current form aims to identify the relationship between investment in CO_2 emissions in India from 1994 to 2019. Post implementation of the new industrial policy, the time frame chosen for this study indicates a normal economic period without the pandemic shock. The results of the study will help to understand the relationship dynamics between DI, FDI, and CO2 emissions and thus chart a future roadmap for India's sustainable economic development.

The rest of the paper is organized is as follows. The next section evaluates the literature, followed by a section capturing data description and its analysis, the final section includes the conclusion and policy implications.

III. Literature Review:

Economic development has been an area of interest for researchers and policymakers worldwide. Research has been conducted not only to identify the variables leading to economic progress and development but also to identify the effects of this progress. Specific studies have been conducted to understand the impact of FDI specifically on the GDP of nations. Besides identifying the economic and social impacts of growth, studies have increasingly focused on the non-economic effects of GDP surge specifically on climate change. Focusing on either a single nation or a group of nations, this research have employed varied statistical techniques.

Todorović & Kalinović, (2023) showed that exports of goods and services make the largest contribution for middle-income countries, while research and development expenditures for high-GDP countries. The panel data regression further revealed that FDI was not statistically significant for the observed countries and the middle-income economies have stunted growth due to lesser investment in research and development. Similarly, Leimbach, Kriegler, Roming, & Schwanitz(2017) proposed a method of GDP scenario building based on the fact that in a highly fragmented world, where technological and knowledge spillovers are low, human capital and technological advancement have a relatively small impact on growth, and per capita income varies widely around the globe. Using the socio-economic pathways for five factors, the GDP projections thus developed provided crucial input for the integrated assessment of global change in climatic conditions.

Elboiashi, Noorbakhsh, Paloni, & Azémar(2009) discovered that while the effect of FDI is positive on DI and GDP in the long run, it is negative in the short- run. The study further indicated that though DI plays an important role in GDP, FDI is more effective than promoting growth in Tunisia, Morocco, and Egypt from 1970 to 2006. The study employed Vector Correction Model, Granger causality test, Impulse response function, and variance decomposition analysis to unearth these relationships. Using the cross-country data from 1970 to 1985, Balasubramanyam, Salisu, & Sapsford, (1996) discovered that while FDI was useful in export-promoting regimes but had less impact in import-substituting countries. Ross & Fleming(2023)explored the impact of Chinese FDI via the Belt and Road initiative on the economic growth of 22 host countries and discovered that while in general FDI had a positive impact on host countries' economic growth, the Chinese FDI hurt these countries.

Specifically studying the low and middle-income group countries, Ram & Zhang (2002) and Apergis , et. al (2023) discovered that though FDI improves the GDP of these countries, it

does not lead to the general well-being of the population as measured by access to education. On the other hand, Li & Liu (2005) discovered that FDI promotes economic growth directly as well as indirectly. Applying the single and simultaneous equation method on panel data for 84 countries, this study indicated that while FDI and the technology gap have a major negative influence on economic growth in developing nations, FDI and human capital have a strong beneficial impact, Gyamfi (2022).

Shah, et al.(2022) examined the relationship between human mortality, FDI, renewable energy consumption, and air pollution in China from 1998 to 2020. Using the non-linear ARDL approach, the research suggested that renewable energy consumption and mortality rates are affected by FDI inflows, and there exists a one-directional causality running from renewable energy and pollution to mortality. The study further suggested that though FDI inflows should be boosted in China due to their positive impact, it is equally important to adopt and extensively use renewable energy to bring down air pollution and human mortality rates.

Major studies have concentrated on relationship between investment and climate change conditions.Still, there is a dearth of recent research to discover and understand the specific relationship between domestic investment, FDI, and global warming. Discovering the interconnections between these variables in the short and long run shall not only lead to meaningful conclusions but shall suggest vital policy implications, Haq, et al (2022). Therefore, the study shall be employing the ARDL approach to seek insights into the synergies between domestic investment, FDI, and carbon emission as a proxy variable of global warming for the Indian economy.

Methodology

The logarithmic form of the data from 1994 to 2019 was used in this study. It is the net inflow of investment to acquire a long-term management stake (10 percent or more voting stock) in a business that operates outside of the investor's home country. FDI Equity capital, earnings reinvestment, other long-term capital, and short-term cash are all included in the balance of payments. Domestic investment proxied by Gross fixed capital formation (formerly gross domestic fixed investment) includes land improvements (fences, ditches, drains), plant, machinery, and equipment purchases, and the construction of roads, railways, schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Global warming proxied by carbon emission specifies direct emissions from fossil-

fuel combustion in manufacturing, heating, and transportation and power production for products and services are included for the variable specification.

The objectives of the study are listed as follows:

1. To discern the long-run cointegration among DI, FDI, and global warming in India.

2. To learn about the long-run impact of DI and FDI on global warming in India.

4. To deduce the short-run granger causality between DI and FDI on global warming in India.

To achieve the above objectives, this research aims to test the following hypotheses as listed below

- H_{01}: There is no long-run cointegration among DI, FDI, and global warming in India.
- H_{02a}: There is no long-run impact of DI on global warming in India.
- H_{02b}: There is no long-run impact of FDI on global warming in India.
- H_{03a}: DI does not granger cause global warming.
- H_{03b}: Global warming does not granger cause DI.
- H_{03c}: FDI does not granger cause global warming.
- H_{03d}: Global warming does not granger cause FDI.
- H_{03e}: FDI does not granger cause DI.
- H_{03f}: DI does not granger cause FDI.
- H_{04}: There exists no serial correlation in the data.

IV. RESULTS AND DISCUSSION

The descriptive statistics of the dataset are presented in Table (1) examining the summary of the data considered for the analysis.

Table (1): Summary of Statistics

Statistics	ln (CO2_EM)	ln (DI)	ln (FDI)
Mean	0.071990	11.46023	16.56427
Median	0.148224	11.55936	15.46886
Maximum	0.558771	11.90811	24.95963
Minimum	-0.526679	10.88337	10.49663
Std. Dev.	0.262297	0.351598	4.664126
Skewness	-0.327435	-0.240030	0.403875
Kurtosis	2.408763	1.465589	1.760711

Jarque-Bera	0.843283	2.800283	2.370656
Probability	0.655969	0.246562	0.305646
Sum	1.871730	297.9661	430.6709
Sum Sq. Dev.	1.719995	3.090525	543.8518
Observations (Years)	26	26	26

Source: Author calculations

From Table 1, FDI has maximum valuation of all the statistics. Also, the variables considered here are following normal distribution as the probability value of all the Jarque- Bera statistics are more than 0.05. The data are ranging for 26 years.

Next, unit root tests determine the order of integration. Augmented Dicky Fuller (ADF) and Phillips Perron (PP) were used to discover time series roots, as shown in Table (2) and Table (3).

Table (2): Summary of ADF and PP at Level

Variable Name	**ADF**		**PP**	
	t-Statistic	**Prob**	**t-Statistic**	**Prob**
ln (CO2_EM)	-2.522134	0.1225	-2.523032	0.1223
ln (DI)	-1.263081	0.6301	-1.228777	0.6454
ln (FDI)	2.337200	0.9999	2.259929	0.9999

** denotes the value as significant at five percent level
Source: Author calculations

The data in the study are checked with integration in different orders. Table 2 shows data integration of order zero, i.e., I (0). All the probability values are more than 0.50. Hence, data are not integrated to I (0).

Table (3): Summary of Unit Root Test by ADF and PP at First Difference

Variable Name	**ADF**		**PP**	
	t-Statistic	**Prob**	**t-Statistic**	**Prob**
ln (CO2_EM)	-5.446346	0.0002	-5.487188	0.0002
ln (DI)	-4.551705	0.0015	-4.578999	0.0014
ln (FDI)	-1.634137	0.4498	-4.097330	0.0044

** denotes the value as significant at five percent level
Source: Author calculations

Table 3 shows data integration of order one, i.e., I (1). All the probability values are more than 0.50. Hence, data are integrated to I (1).

At the next step, the study examines carbon emission as carbon consumption, domestic investment, and foreign direct investment (FDI). ARDL bound approach. According to Nkoro and Uko (2016), the ARDL model is a single equation model, and the current study uses India's growth rate as a dependent variable and export and FDI as independent variables. Table (4) explains why the ARDL model for variables is practical.

Table (4): Conditional Error Correction Model

Variable	Value of the Coefficients	t- Statistic	Probability
C	-0.602714	-2.874233	0.0110
LOG_CO2_EM (-1)	-0.203703**	-4.000464	0.0010
LOG_DI (-1)	0.110575**	3.576607	0.0025
LOG_DI (-1)	-0.013231	-0.750871	0.4636
D (LOG_CO2_EM (-1))	-0.279244	-1.457154	0.1644
D(LOG_DI)	0.012898	0.354373	0.7277
D(LOG_FDI)	-0.012349	-0.879795	0.3920
D(LOG_FDI (-1))	0.020257	1.723078	0.1041

** denotes the value as significant at a five percent level
Source: Author calculations

The conditional error correction model validates the ARDL model in research. Lagged carbon dioxide emission and domestic investment rate significantly affect India's carbon emission.

Long Run Analysis:

The principal step of analysing long-run association is to find out the cointegration between the datasets. The research in this next step finds out the long-run relationship among carbon emission, FDI and domestic investment by applying the ARDL model. The result of cointegration is summarised in Table (5).

Table (5): Result of Cointegration

Variable Specification		F- Statistic	I (0)		I (1)	
Dependent Variable	D(LOG_CO2_EM)	10.21397**	5%	3.1	5%	3.87
Independent Variables	LOG_DI LOG_FDI C		10%	2.63	10%	3.35

** explains the value is significant at five percent level
Source: Author calculations

Table (5) shows a positive cointegration value of 10.21397. Long-term, all three factors move together. The cointegration result exceeds both the tabular values of I (0) and I (1), which represent no and positive cointegration, respectively. The calculated value is greater than both tabular values, indicating long-term cointegration of the variables. It accepts H_{11}.Table 2 shows the model's long-term coefficient (6).

Table (6): Long Run Coefficient of ARDL

Variable Name	Coefficient	t-Statistic	Probability
LOG_DI	0.542822**	10.60410	0.0000
LOG_FDI	-0.064954	-0.811276	0.4291
C	-2.958783	-5.003219	0.0001

** explains the value is significant at five percent level
Source: Author calculations

After describing the cointegration finding, the research extracts the long-run coefficient to examine how domestic investment affects India's carbon emissions. Domestic investment growth boosts India's long-term carbon emission rate (0.542822). Domestic investment is crucial for long-term carbon consumption. Hence, the study accepts H_{12a}. On the other hand, Indian FDI has little long-term influence on carbon emissions. Thus, H_{02b} is accepted.

Short-Run Analysis:

The short-run ARDL model is justified by the short-run coefficients and the Error Correction Term (ECT) embedded in the model. The respective values are depicted in Table (7).

Table (7): Result of Error Correction Model

Variable Name	Coefficient	t-Statistic	Probability
D (LOG_CO2_EM (-1))	-0.279244	-1.741363	0.1008
D(LOG_DI)	0.012898	0.408752	0.6881
D(LOG_FDI)	-0.012349	-1.291301	0.2149
D (LOG_FDI (-1))	0.020257**	2.311360	0.0345
ECT	-0.203703**	-6.965367	0.0000

** explains the value is significant at five percent level
Source: Author calculations

The result depicted in table (7) proves that in the short run, there remains no causality between the variables. The ECT value is negative (0.203703) and significant (probability-0.000), which proves the long-run unidirectional causality from FDI and domestic investment to the carbon consumption.

Long-Run Causality:

The ECT value shows that FDI and domestic investment cause long-term carbon consumption. Hence, economic shocks won't affect India's long-term stability. Any economy has a 20.37 percent chance of rebounding from short-term problems or external shocks.

Short-Run Causality:

The short-run directional causality is checked through the Granger Causality test, the results of which are depicted in table (8).

Table (8): Result of Granger Causality Test

Null Hypothesis Statement	F- Statistic	Probability
LOG_DI does not Granger Cause LOG_CO2_EM	1.84820	0.1698
LOG_CO2_EM does not Granger Cause LOG_DI	2.89093*	0.0664
LOG_FDI does not Granger Cause LOG_CO2_EM	0.27269	0.7626
LOG_CO2_EM does not Granger Cause LOG_FDI	0.68073	0.5116
LOG_FDI does not Granger Cause LOG_DI	1.06814	0.3526
LOG_DI does not Granger Cause LOG_FDI	3.23058**	0.0493

* Explains the value is significant at ten percent level
** Explains the value is significant at five percent level
Source: Author calculations

Table 8 proves the acceptance of $H_{13b}$and H_{13f}, there supporting the fact thatCarbon dioxide emission granger causes domestic investment, that, in turn, granger causes foreign direct investment in India. Rest of the hypotheses ($H_{03a,}H_{13c,}H_{13d,}$ andH_{13e}) get accepted proving the absence of granger causality among them.

The variables' lag values are associated. Hence, analysis must confirm no association. The study tests dataset autocorrelation using the Breusch-Godfrey Serial Correlation LM Test. Table 9 shows autocorrelation results.

Table (9): Breusch-Godfrey Serial Correlation LM Test

Null Hypothesis Statement	F- Statistic	Probability
There remains no autocorrelation in the model	1.621219	0.2504

** explains the value is significant at a five percent level
Source: Author calculations

Breusch-Godfrey Serial Correlation LM Test examines F-statistic (1.621219) and probability (0.2504). Hence, the study is free from autocorrelation, thus, acceptingH_{04}.

Throughout the course of time, as an economy becomes more developed and as the demand of energy continues to rise, the two factors work together to bring about the release of carbon dioxide. Investments, that remains as a part of growth, will generate and augment the usage of carbon dioxide. In this study, it is observed that both domestic and foreign investment play important roles to increase the level of carbon emission. Also, the carbon emission causes domestic as well as foreign investment to occur. In short, the need of carbon emission to foster the development in Indian economy is well proved. But, in future, to boost sustainable development in Indian economy, it is suggested to reduce the usage of carbon emission through fossil fuel (Yang, et. Al (2022)). This strategy will ultimately control the climate change to the reasonable and acceptable levels in the long run.

The broader policy related to the environment must encourage decisive low-emission economic growth for climate initiatives to be more effective. Carbon pricing weakens the low-emission investment signal as it encourages fossil-fuel-based economic growth. Investment, competition, trade, and tax policies have misalignments that need to realign to pro-growth reforms with low-carbon growth, such as guaranteeing a competitive power generation market. Hence, it is suggested to identify and address laws and regulations that strengthen the business case for investing and innovating in low-emission and climate-resilient infrastructure.

Climate resilience, especially infrastructure resilience, must include country and local infrastructure owners and operators who should choose the optimal measures on the investment in India. Also, the public sector must ensure that infrastructure investment is aligned with enhancing resilience to economic and climate-related shocks and catalysing private sector investment by establishing an enabling environment that enhances long run sustainable growth in the country.

V. CONCLUSION

This study proves the important contribution of domestic and foreign investment to affect the environment. International policy and environmental restrictions together need to be focused to support the concern of environmental damage created by the financial sectors of India in short and long run. In future, it needs to be examined how dependence on foreign investment in different industries affects greenhouse gas emissions, pollution, and land degradation in India. Also, the effect of domestic investment on sectoral implications needs to be investigated against human and environmental health. Besides, water pollution and deforestation rates need to be fixed in India, which coincides with the recent globalization of investment and commodities chains (Jorgenson, 2007)).

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