

FDI, GDP, and CO₂ Emission: ARDL Bound Cointegration Relationship Examination

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Abstract: *The study tries to evaluate empirically, the relationship between foreign direct investment (FDI) and environmental impact with GDP in India using annual data over the period 1980-1981 to 2017-18. The genuine effect on the earth, in any case, might be bigger because CO₂ emission is one of the numerous contaminations produced by financial exercises. In any case, CO₂ is a worldwide air toxin, our finding has some broad ramifications for the worldwide condition too, with India has risen as the fourth most noteworthy in the worldwide positioning of CO₂ emissions by the turn of this century. The Autoregressive Distributed Lag (ARDL) Bound Test after which the cointegration and causality tests were analyzed. The error correction models were also predictable to scrutinize the short-run dynamics. The Granger causality test finally deep-rooted the presence of unidirectional causality which long runs from GDP and CO₂ to foreign direct investment. The error correction estimates confirmed that the Error-Correction Term is statistically significant and has a negative sign, which confirms that there isn't any problem in the long-run equilibrium relationship between the independent (GDP & CO₂) and dependent variables (FDI). The study concluded that FDI had a long-run relationship with GDP and CO₂ emission.*

Keywords : *Foreign Direct Investment, Gross Domestic Product, CO₂ Emission, Indian Economy, ARDL Cointegration Analysis, etc.*

I. INTRODUCTION

The inflows of Foreign Direct Investment (FDI) has expanded quickly during the late 1980s and 1990s in pretty much every area of the world rejuvenating the long and argumentative discussion about the expenses and the advantages of FDI inflows (Pao & Tsai, 2011). The positive advantages of FDI to the accepting host nation incorporate capital, aptitude and innovation move, showcase access and fare advancement. This paper analyzes the two and the most significant advantages and expenses of foreign direct investment in the Indian setting: GDP growth and environmental corruption (Zhang & Zhou, 2016). Economic hypothesis gives us numerous reasons why FDI may bring about improved growth execution of the host nation ("Fdi, Growth and The Environment: Evidence from India on CO₂ Emission during the Last Two Decades," 2009). In any case, there is no all-inclusive understanding among the empiricists about the positive relationship between FDI inflows and economic growth (TokeSAidt & PeterSJensen, 1938). While a few investigations watch a positive effect of FDI on economic growth, others distinguish a negative connection

between these two factors (V.G.R. Chandran & Chor Foon Tang, 2013).

Most FDI has gone to south India, In the north, FDI is situated around Delhi, Haryana, and Punjab (Hoffmann, Lee, Ramasamy, & Yeung, 2005). Koreans have liked Tamil Nadu. They are one of the enormous financial specialists for making autos, family unit contraptions and telephones (Hitam & Borhan, 2012). They have observed Tamil Nadu be fairly a perfect area. In any case, it is northern India, except the more unfortunate expresses, that need foreign financial specialists more. Tamil Nadu has a better framework and work power, however, environmentally it is as poor as different states. All over India, there are the issue of environmental corruption and trash transfer issues. (Peng, Tan, Li, & Hu, 2016) (Shao, Yang, Yu, & Yu, 2011) India is producing 1,00,000 metric huge amounts of trash each day — a colossal measure of strong waste. One can see piles of trash close Delhi in Gazipur which as of late fallen because of gas implosion, executing few individuals. Strong waste administration will be a fantastic issue later on. Stink from spoiling trash is an exceptionally off-putting factor for voyagers and potential foreign financial specialists. In the capital city consistently, photos of uncollected trash lying in the city show up in the papers (Borhan, Ahmed, & Hitam, 2012). These stops of strong waste breed infections, which we are for the most part subject to; we are living with the danger of dengue, viral fever and stomach diseases every day (Zakarya, Mostefa, Abbes, & Seghir, 2015). This isn't the situation of individuals living in other Emerging Economies where individual's live overall sound lives (Blanco, Gonzalez, & Ruiz, 2013). Likewise like in the propelled nations, we are encountering worry in enormous naps living in India. The study tries to evaluate empirically, the relationship between foreign direct investment (FDI) and environmental impact with GDP in India using annual data over the period 1980-1981 to 2017-18.

II. IMPORTANCE OF THE STUDY

Frequency in the water bodies and the outcome is that our oceans, lakes, and streams are contaminated to such an extent that it has crossed threat levels, murdering fish and other amphibian animals. Water contamination is extremely genuine (Gholipour Fereidouni, 2013).

It is such a difference to create nations where you can see clean waterways and lakes and drink

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water from the tap (Osabuohien, Efobi, & Gitau, 2013). The guilty parties are the destitute urban nearby bodies which dump crude sewage into waterways and production lines are dumping modern waste into streams with relinquishing (Žižmond, 2014). It is horrendous to see the Yamuna being decreased to a channel which stinks to the high sky in the late spring. Same is the situation with the Ganges. Enormous measures of cash-filled the cleaning of the Ganges have not yielded noteworthy outcomes in improving the nature of water (Matthew & Robert, 2009). China with a lot quicker economic growth in the past is confronting pretty much similar issues however is combating environmental contamination on a war balance (Aliyu, 2005). It has hindered its GDP growth and cleans its environment.

III. THE OBJECTIVE OF THE STUDY

The study makes an effort to evaluate empirically, the impact and relationship between foreign direct investment (FDI) and environment (CO₂ emission) with GDP in India.

IV. PERIOD OF THE STUDY

The study used annual data over the period from 1980-1981 to 2017-18.

V. HYPOTHESIS

The following is the hypothesis structured for scrutinizing the objective of the study:

H₀: FDI does not have any significant relationship with GDP and CO₂ emission in India.

H₁: FDI had a significant relationship with GDP and CO₂ emission in India.

VI. THE METHODOLOGY OF THE STUDY

The empirical examination depends on exact in demeanor and the information reachable in the RBI yearly report and Ministry of account joint measurable proclamation was consummate. Auxiliary information utilized for the examination of the exploratory study. FDI and different economic growth markers information were gathered from the Indian nation measurable yearly report and RBI yearly reports from its sites. And all extra required data have been made from different scholarly journals and literature.

The Autoregressive Distributed Lag (ARDL) Bound Test after which the cointegration and causality tests were analyzed. The error correction models were also predictable to scrutinize the short-run dynamics. The Granger causality test finally deep-rooted the presence of unidirectional causality which long runs from GDP and CO₂ to foreign direct investment.



Source: Author's contribution

VII. REVIEW OF LITERATURE

Table no.1: The collected reviews of literature related to the study

Literature	Variables & Methodology	Result
(Baek & Koo, 2008) (Bakhsh, Rose, Ali, Ahmad, & Shahbaz, 2017) (Peters & Hertwich, 2008)	The cointegration analysis and VEC model, short- and long-run relationships among FDI, economic growth, and the environment in China and India.	The cointegration analysis and VEC model are applied to examine the short- and long-run associations among FDI, economic growth, and the environment in China and India.
(Zomorodi & Zhou, 2016) (Hajilary, Shahi, & Rezakazemi, 2018) (Yi & Song, 2011)	Environmental Kuznets Curve (EKC) and Pollution Haven Hypothesis (PHH) in determining the relationship between environmental quality and the economic growth of a country.	Results have demonstrated that no unmistakable end can be resolved as the job of EKC and PHH differs crosswise over economies, anyway both the speculations are more if there should arise an occurrence of creating nations.
(Danish, Wang, & Wang, 2018) (Hoffmann et al., 2005) (Merican, Yusop, Mohd Noor, & Siong Hook, 2007)	ARDL model and VECM, the Granger causality approach draw an inference that importation technologies mainly supply to CO ₂ emission in the long run in China.	The legislature of China needs to extend contribution to R&D for higher mechanical quality and licensed innovation rights the executives limit, which will be positive for the insurance of the environment.

(Dogan & Seker, 2016) (Perkins & Neumayer, 2008) (Inglesi-Lotz & Dogan, 2018) (MacDermott, 2009)	Renewable and non-renewable energy, real income, and trade openness on CO ₂ emissions in the EKC model for the EU over the period 1980-2012 by employing panel inference practice vigorous to cross-sectional dependence.	The Dumitrescu-Hurlin non-causality approach demonstrates that there is bidirectional causality between the sustainable power source and carbon discharges, and unidirectional causality running from genuine pay to carbon outflows, from CO ₂ emanations to non-sustainable power source, and from exchange receptiveness to CO ₂ discharges.
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Source: Author's contribution

VIII. DATA ANALYSIS

Autoregressive Distributed Lag (ARDL) Bound Cointegration Test

Autoregressive Distributed Lag (ARDL) model assumes an essential job when comes a need to dissect an economic situation. In an economy, change in any economic factors may acquire change another economic factor past the time. This

adjustment in a variable isn't what reflects quickly, however it conveys over future periods (Wong, 2018).

H₀: $\pi_x = \pi_y = 0$ (There is no long-run levels relationship)

H₁: $\pi_x \neq 0$; and $\pi_y \neq 0$ (There is a Long run levels relationship exist)

$$\Delta FDI_t = \alpha + \beta_1 \cdot FDI_{t-1} + \beta_2 \cdot GDP_{t-1} + \beta_3 \cdot CO2_{t-1} + \sum_{i=0}^p \alpha_{1i} \Delta FDI_{t-i} + \sum_{i=0}^p \alpha_{2i} \Delta GDP_{t-i} + \sum_{i=0}^p \alpha_{3i} \Delta CO2_{t-i} + \varepsilon_t \quad (1)$$

Where,

- α = Constant
- Δ = $1 - L$ is the Difference Operator
- β = FDI Integrators
- FDI = Foreign Direct Investment
- GDP = Gross Domestic Product
- CO₂ = Emission of CO₂ is the Energy Sector
- p = Optimum lag length
- t = Time gap
- ε = Error

Econometric examination of long-run relations has been the focal point of much hypothetical and exact research in economics. For the situation where the factors in the long-run connection of intrigue are pattern stationery, the general practice has been to de-pattern the arrangement and to display the de-trend arrangement as stationary disseminated slack or autoregressive disseminated slack (ARDL) models. Estimation and surmising concerning the long-run properties of the model are then done utilizing standard asymptotic typical hypothesis (Pesaran, 1997).

The ARDL Bound Cointegration Test (1,0,1)

Table no.2: Result of Ordinary Least Square of ARDL (1,0,1) Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.	Statistics	
FDI(-1)	0.52	0.15	3.47	0.00	R-squared	0.89
GDP	0.01	0.01	2.45	0.02	Adjusted R-squared	0.88
CO ₂	126189.60	68999.39	1.83	0.08	S.E. of regression	44100000
CO ₂ (-1)	-147887.00	72819.11	-2.03	0.05	Sum squared residual	68000000
					Mean dependent variable	82400000
					S.D. dependent variable	13000000

Source: Computed

Interpretation:

The table no.2 shows the result of the estimated equation of the ARDL (1,0,1) model. The R² value is 89% which impulse that the available data was fit for the model. Probability value for all the independent variable is less than the 0.05 with a significant level of 5%. The study rejects the null hypothesis,

therefore, FDI had a significant relationship with GDP and CO₂.

Model 1: The restricted constant and no trend case.



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Model 2: The unrestricted constant and no trend case.

Model 3: The restricted linear trend and unrestricted constant case.

Model 4: The unrestricted constant and unrestricted linear trend case.

Table no.3: The Result of ARDL Bound Cointegration Test (1,0,1)

Model	Variable	Prob.	Variable	Prob.
Model:1 REST, CONSTANT	FDI(-1)	0.00	R-squared	0.90
	GDP	0.06	F-statistic	74.90
	CO ₂	0.05	Prob(F-statistic)	0.00**
	CO ₂ (-1)	0.04		
	C	0.23		
Model:2 CONSTANT	FDI(-1)	0.00	R-squared	0.90
	GDP	0.06	F-statistic	74.90
	CO ₂	0.05	Prob(F-statistic)	0.00**
	CO ₂ (-1)	0.04		
	C	0.23		
Model:3 REST, TRENT	FDI(-1)	0.00	R-squared	0.90
	GDP	0.05	F-statistic	59.92
	CO ₂	0.13	Prob(F-statistic)	0.00**
	CO ₂ (-1)	0.03		
	C	0.32		
	@TREND	0.35		
Model:4 CONST, TRENT	FDI(-1)	0.00	R-squared	0.90
	GDP	0.05	F-statistic	59.92
	CO ₂	0.13	Prob(F-statistic)	0.00**
	CO ₂ (-1)	0.03		
	C	0.32		
	@TREND	0.35		

Source: Computed

Note: **Significant at 5% level.

Interpretation:

The table no.3 shows the result of ARDL Bound Cointegration Test (1,0,1) models. In the above four models presents the F-statistic value of 59.92 and 74.90 which is greater than the table value. Probability value for all the independent variable is less than the 0.05 in all the four models with a significant level of 5%. Hence we reject the null hypothesis that there is no equilibrating relationship. The study found that the FDI had a significant relationship with GDP and CO₂.

ARDL - Error Correction Regression

The nearness of cointegration among Y and X makes it conceivable to research the short run [equilibrium or disequilibrium] connection among Y and X. In the short keep running there might be disequilibrium between real estimations of Y or X and long-run balance. An Error Correction Modeling looks at the nearness of balance or disequilibrium between short-run elements and long-run harmony (V.G.R. Chandran & Chor Foon Tang, 2013). Further, the gauge of negative error correction term in ECM

clarifies the degree of disequilibrium that can be killed at every period. At the end of the day, based on the size of the gauge of error correction term, [Sign is relied upon to be negative] the responsiveness of the adjustments in Y [or X] to the past deviations of real qualities Y [or X] from the long-run harmony can be comprehended (Rosner, 1989).

How rapidly disequilibrium can be amended [eliminated] relies upon the size and measurable noteworthiness of steady gauge of error correction term. On the off chance that the size is bigger, at that point, the extent of error correction will be bigger. Along these lines, the coefficient of the error correction term [b2] can be translated as the coefficient of the speed of alteration between short-run elements and long-run harmony esteems. The following model is used for testing the hypothesis.

$$FDI = C(1)*FDI(-1) + C(2)*GDP + C(3)* CO_2 + C(4)* CO_2 (-1) + C(5) + C(6)*@TREND$$

Table no.4: The result of Conditional Error Correction Regression Test

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4260000.00	425000.00	0.00	0.00
@TREND	352000.00	371000.00	0.00	0.00
FDI(-1)*	-0.51	0.16	-3.23	0.00
GDP**	0.02	0.01	2.08	0.05
CO ₂ (-1)	-50696.41	49917.68	-1.02	0.32
D(CO ₂)	117301.10	76004.20	1.54	0.13
Levels Equation				
GDP	0.03	0.01	2.11	0.04
CO ₂	-99834.64	106605.60	-0.94	0.36

Source: Computed

Note: * p-value incompatible with the t-Bounds distribution.

** Variable interpreted as $Z = Z(-1) + D(Z)$.

Interpretation:

Error-Correction Term is factually noteworthy and has a negative sign, which affirms that there isn't an issue over the long haul harmony connection between the autonomous and ward factors.

Formulated Equation

$$\text{Error Correction} = \text{FDI} - (0.0303 * \text{GDP} - 99834.6429 * \text{CO}_2)$$

From the table no.4 the study found that the conditional error correction regression test shows the GDP had the interrelationship with FDI at the p-value of 0.04 which is less than the difference at 5% level of significance. At the same time, FDI does not relate to environment condition with CO₂ emission (0.36) point of view it denotes a satisfactory convergence rate to equilibrium point per period. The result shows that FDI has not contributed much to the environment in India for the period 1980-1981 to 2017-18.

Long-Run Causality test using Bounds Test

(Engle, Granger, & Mar 2007) proposed an idea of causality dependent on expectation error: X is said to Granger-cause Y if Y can be figure better-utilizing past Y and past X than simply past Y. This is a minor rule, which, as expressed, extremely just reveals to us we can utilize an increasingly limited model for estimating Y. Be that as it may, Sims (1972) showed this was equal to a substantially more significant measure: that X fails to Granger- cause Y if and just if Y is econometrically exogenous in an X on Y dynamic relapse. With the assistance of this outcome, the "Granger-" in Granger-cause has now generally been disposed of so that "cause" all alone currently implies Granger-cause, and a homogeneity test normally alludes to a test for nonattendance of causality (in the correct setting) (Candelon, 2006). In this study added the test long-run causality test for the following:

$$\text{FDI} = 0.49 * \text{FDI}(-1) + 0.01 * \text{GDP} + 117301.07 * \text{CO}_2 - 167997.47 * \text{CO}_2 (-1) - 42644705238 + 351879788.307 * @\text{TREND}$$

Table no.5: The result of Bounds Test: Long Run Causality Test

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic K	4.36 2.00	10% 5% 3% 1% 10% 5% 1% 10%	Asymptotic: n=1000	
			4.19	5.06
			4.87	5.85
			5.79	6.59
			6.34	7.52
			Finite Sample: n=40	
			4.48	5.42
			5.39	6.44
			7.53	8.80
			Finite Sample: n=35	

		5%	4.52	5.48
		1%	5.46	6.57
			7.64	9.06
t-Bounds Test	-3.23	10%	-3.13	-3.63
t-statistic		5%	-3.41	-3.95
		3%	-3.65	-4.20
		1%	-3.96	-4.53

Source: Computed by author

Interpretation:

The result of Bounds Test: Long Run Causality Test shows the F-statistic value 4.36 is lesser than the I(0) and I(1) critical value bound. The study rejects the null hypothesis that there is no equilibrating relationship (Ray, 2012).

$$D(FDI) = -42644705237.96 + 351879788.3*@\text{TREND} - 0.50*(FDI(-1) - (0.03*GDP - 99834.64* CO_2 (-1)))$$

Furthermore, since the result reject the null and since have not included a constant or trend in the cointegration relationship with the FDI and CO₂ emission. It results there is a long-run relationship. From the table no.5, both the F-statistic (K) and t-Bounds test (t-statistic) show the long-run causality is there between the FDI and CO₂ in India in the study period.

IX. CONCLUSION

The study tries to evaluate empirically, the relationship between foreign direct investment (FDI) and environmental impact with GDP in India using annual data over the period 1980-1981 to 2017-18. The Autoregressive Distributed Lag (ARDL) Bound Test after which the cointegration and causality tests were analyzed. The error correction models were also predictable to scrutinize the short-run dynamics. The major findings of the study:

In ordinary least square Method, the study rejects the null hypothesis that there is no relationship between the variables and the empirical analysis on basis of Ordinary Least Square Method suggests that there is a positive relationship between foreign direct investment (FDI) and environment (CO₂) and GDP. Besides, whereas the Ordinary Least squares regression analysis can establish the dependence of either CO₂ on FDI or GDP.

The cointegration test long established that economic growth and foreign direct investment are cointegrated, indicating the existence of a long-run equilibrium relationship between the two as confirmed. The Granger causality test finally deep-rooted the presence of unidirectional causality which long runs from GDP and CO₂ to foreign direct investment. The error correction estimates confirmed that the Error-Correction Term is statistically significant and has a negative sign, which confirms that there isn't any problem in the long-run equilibrium relationship between the independent (GDP & CO₂) and dependent

variables (FDI). Their relative price denotes a satisfactory convergence rate to equilibrium point per period. The result shows that FDI has not contributed much to the Environmental protection in India for the period 1980-81- 2017-18, therefore, it is imperative for the government of India to take action for protecting environment form CO₂ emission. Moreover, despite the tremendous potential of FDI in environmental, it does not provide answers to all developmental problems as well as environmental problems. The public guiding principle needs to be in place to hold up the poorer segments of civilization. The role of FDI in this process is, under its impact on CO₂ and FDI with GDP. Finally, the study concluded that FDI had a long-run relationship with GDP and CO₂ emission.

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