Is Foreign Direct Investment a Cause of Environmental Degradation in Pakistan? An ARDL Approach to Cointegration

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Abstract

This study has investigated the empirical relationship between FDI and environmental degradation in Pakistan and 43 years of data is used in the study started from 1972 to 2014. Empirical tests show that there exist mix-cointegrating series, so ARDL bounds testing is applied to check the short-long run cointegration among the variables. Results concluded that FDI causes CO_2 emissions in long and short-run both. To check the direction of causality between variables, an ARDL Granger test is applied. It proved that FDI and CO_2 emissions have bidirectional causality and causing each other from both ways.

Keywords: Inflation, Environment, CO_2 emissions, FDI

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Globalization is increasing from past few decades and economies are closing to each other by removing trade barriers from their economies. Trade openness has increased the inflows of FDI in the countries. As the domestic investment is important for any economy, foreign direct investment is also important for the economic growth. Transnational corporations always introduce advance and efficient technology as compare to domestic firms, which becomes more competitive than local firms and hence boast the economic growth. Foreign direct investment positively benefits the host and home country with skilled capital, advance technology, access to the markets and export promotion.

Economic theory provides us with many reasons why FDI may result in enhanced growth performance of the host country (Abdouli & Hammami, 2015; Al-Mulali, 2012). However, there is no universal agreement among the empiricists about the positive association between FDI inflows and economic growth (Abdullah *et al.*2015; Bayar, 2014). While some studies observe a positive impact of FDI on economic growth, others detect a negative relationship between these two variables (Aitkin and Harrison, 1999). In a survey, Mello lists two main channels through which FDI may be growth enhancing: First, FDI can encourage the adoption of new technology in the production process through capital spillovers. Second, FDI may stimulate knowledge transfers, both in terms of labor training and skill acquisition and by introducing alternative management practices and better organizational arrangements (Mello, 1997).

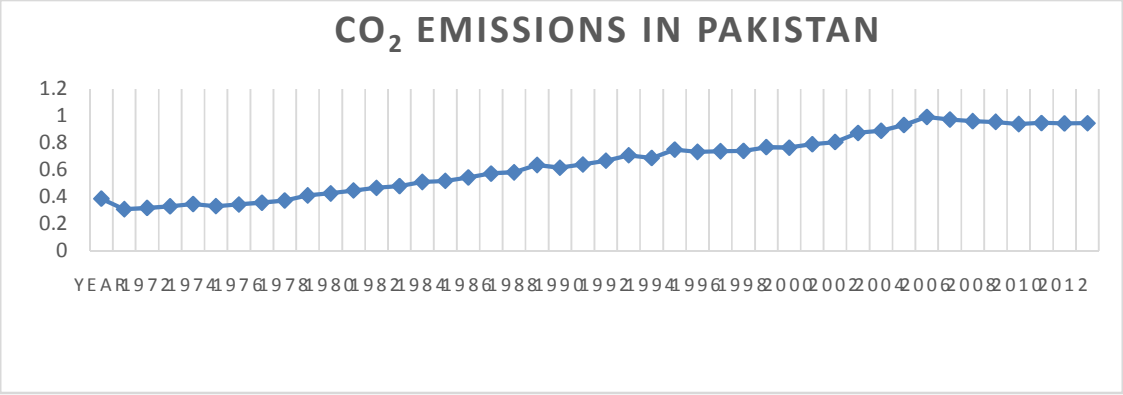
Developing countries always face the problem of low investment and high savings. Pakistan is also facing investment – saving gap, so, foreign direct investment fulfills this gap by injecting the investment in the economy that increase the economic growth (Ahmed & Long, 2013).FDI is a process of boosting the international economic system by increasing the

investment of inflows and outflows for the development. FDI inflows benefit the country because it does not emerge automatically. Investing economy benefits the home country by improving the infrastructure, technology and human capacities (Palat, 2011; Haider, 2012; Mahmood & Chaudhary, 2012).

FDI has also negative effects on the host country, like environmental degradation etc. CO_2 emissions are increasing in Pakistan yearly (see figure 1). On average 0.64 metric tons per capita CO_2 emissions are emitted from 1971 to 2014. The major reason for increasing CO_2 emissions is the rapidly increasing demand for energy in the industrial sector. Energy consumption is also increasing 13.5% yearly (Economic Survey of Pakistan, 2009). Also the use of gas, electricity, petroleum and crude oil is increasing 9.5%, 7.2%, 4.7%, and 7.2% respectively (Economic Survey of Pakistan, 2009). So use of all these things is polluting the environment.

This study has used the latest data set to find the impact of FDI on environment in long run and short run. Rest of the paper is organized in further 2, 3, 4, & 5 sections, literature review, data and methodology, empirical section, and conclusion respectively.

Figure 1. **CO_2 Emission in Pakistan**



Source: Author's calculations

Literature Review

Existing literature is given below in Table 1. Many research studies have found bidirectional causality between FDI and CO_2 emissions, Gu*et al.* (2013),Omri*et al.* (2014),Ali *et al.* (2015). Few studies have just found unidirectional causality running from FDI to CO_2 emissions, Acharyya, J (2009), Blanco(2012), Shahbaz *et al.* (2011), Mahmood and Chaudhary (2012), and Blanco *et al.* (2013), and Bukhari *et al.* (2014). Few studies have found no relationship between FDI and CO_2 emissions, Shaari *et al.* (2014), and Linh and Lin (2014).

Data and Methodology

Time series data for the period of 1971-2014 will be used for the analysis. The analysis will be based on 44 years. Data is taken from the World Bank Data base, WDI 2015.

Model Specification

Environmental degradation is a major problem with the increase in the foreign direct investment in developing countries. Foreign direct investment, GDP per capita, Inflation, and Energy consumption are used in this paper as independent variables and CO_2 emissions as dependent variable.

$$CO_{2_t} = \delta_0 + \delta_1 FDI_t + \delta_2 GDP_t + \delta_3 INF_t + \delta_4 ENERGY_t + \mu_t \qquad [1]$$

CO_2 = Carbon Dioxide Emissions (metric tons)

FDI = FDI (net inflows)

GDP = Gross Domestic Product per-capita (% of GDP)

Inf = Inflation (CPI)

Energy = Energy Consumption (kt)

Where δ_0 is the intercept and δ_{1-4} are the coefficients of foreign direct investment, GDP per capita, inflation, and energy consumption respectively and $\mu_t$is error term of the model (see equation 1).

Stationary Test

The major problem with the time series data is its non-Stationarity characteristic. Thus, stationary tests are compulsory to check the stationarity level of the data. Augmented Dickey Fuller (ADF) was developed in 1982 by Dickey and Fuller (1979, 1981). ADF test is used to find the unit root problem in the series. $H_0 = 0$ is series has unit root problem. Stationary data means that series has zero means and constant variance over time.

The Autoregressive Distributed Lag (ARDL) Bounds Test

After determining the level of integration of the variables, next step is to examine the cointegration among the variables by using ARDL bounds test. Autoregressive Distributed Lag model is used when there is mix cointegrated levels in the series. In this paper,CO_2, FDI, GDP, and INF are stationary at level *I(0)*and energy consumption is stationary at 1st difference *I(1)*. One main advantage of ARDL model is that, it estimates both short and long-run parameters at once (see equation 2).

$$\Delta CO_2 = \delta_0 + \sum_{m=1}^{I} \xi \Delta CO_{2_{t-j}} + \sum_{m=0}^{I} \vartheta \Delta FDI_{t-j} + \sum_{m=0}^{I} \Omega \Delta GDP_{t-j} + \sum_{m=0}^{I} \nu \Delta INF_{t-i} + \sum_{m=0}^{I} \rho \Delta ENERGY_{t-j} + \psi_1 CO_{2_{t-j}} + \psi_2 FDI_{t-j} + \psi_3 GDP_{t-j} + \psi_4 INF_{t-j} + \psi_5 ENERGY_{t-j} + \eta_t \quad [2]$$

Where Δ is difference, $\xi, \vartheta, \Omega, \upsilon, and \rho$ are the short run parameters of CO_2emissions, Foreign direct investment, GDP per-capita, Inflation, and energy consumption respectively. $\psi_{1-5}$are the long-run parameters. $H_0 = \psi_1 + \psi_1 + \psi_1 + \psi_1 + \psi_1 = 0$

After restricting the variables, we compare the value of F-statistics with the table value provided by the Pesaran *et al.* (2001). Critical values tables have two bounds, Upper

bound and lower bound. If value of F-statistics is less than lower bound then test is no cointegration, if value is greater than upper bound then there is cointegration but if value lies between the upper and lower bound then the results are inconclusive (Narayan, 2005).

The Long Run Relationships

ARDL model has both long and short-run model. The following model is showing the impact of independent variables on the dependent variable in long run (see equation 3).

$$CO_2 = \alpha_1 + \sum_{j=1}^{k} \phi_{1i} CO_{2_{t-j}} + \sum_{j=0}^{k} \psi_{1i} FDI_{t-j} + \sum_{j=0}^{k} \Gamma_{1i} GDP_{t-j} + \sum_{j=0}^{k} \chi_{1i} INF_{t-j} + \sum_{j=0}^{k} \beta_{1i} ENERGY_{t-j} + \varepsilon_{1t} \quad [3]$$

The Short Run Relationships

Following model is short run model with additional error correction term (ECT). ECT shows adjustment speed towards equilibrium (see equation 4).

$$\Delta CO_2 = \alpha_2 + \sum_{m=1}^{k} \phi_{2i} \Delta CO_{2_{t-m}} + \sum_{m=0}^{k} \psi_{2i} \Delta FDI_{t-m} + \sum_{m=0}^{k} \Gamma_{2i} \Delta GDP_{t-m} + \sum_{m=0}^{k} \chi_{2i} \Delta INF_{t-m} + \sum_{m=0}^{k} \beta_{2i} \Delta ENERGY_{t-m} + \lambda ect_{t-i} + \varepsilon_{2t} \quad [4]$$

Table 1

Review of Existing Literature (2009-15)

Author	Study	Time Frame	Variables	***Findings***
Acharyya, J (2009)	FDI, growth and the environment: evidence from India on CO_2 emission during the last two decades	1980 – 2003	LFDI, LGDP, and LCO_2	$Long-run$ $FDI \rightarrow GDP$ $FDI \rightarrow CO2$
Blanco *et al.* (2011)	The Impact of FDI on CO2 Emissions in Latin American	1980 – 2007 18 Latin Countries	FDI, GDP per capita, and CO_2	$Causality$ $FDI \rightarrow CO2$
Shahbaz *et al.* (2011)	Environmental consequences of economic growth and foreign direct investment: evidence from panel data analysis	1985 – 2006 110 developing countries	CO_2 emissions, GDP, and GDP^2	$EKC\ exists,$ $FDI \rightarrow CO2$ $FDI \uparrow Environment \downarrow$
Mahmood and Chaudhary (2012)	FDI, Population Density and Carbon Dioxide Emissions: A Case Study of Pakistan	1972 – 2005	CO_2, FDI, PD, and MVAG	$No\ short\ run, only\ long-run\ relationship\ exists,$ $FDI, Pop \rightarrow CO2$
Blanco *et al.* (2013)	The Impact of FDI on CO2 Emissions in Latin America	1980 – 2007 Latin American Countries	Sector specific FDI and CO_2emissions	$Causality\ FDI \rightarrow CO2$ $Only\ in\ industries$
Shahbaz, M. (2013)	Does financial instability increase environmental degradation? Fresh evidence from Pakistan	1971 – 2009 Pakistan	FNS, Y, EC, and TR	
Gu*et al.* (2013)	An Empirical Research on Trade Liberalization and CO_2 emissions in China	1981 – 2010 China	FTD, FDI, and CO_2 emissions	$FDT \rightarrow CO2$ $FDI \rightleftarrows CO2$

Shaari *et al.* (2014)	Relationship among Foreign Direct Investment, Economic Growth and CO2 Emission: A Panel Data Analysis	1992 to 2012 Panel of 15 developing countries	FDI, CO_2, and GDP	$FDI \nrightarrow CO2$ $GDP \rightarrow CO2$
Omri*et al.* (2014)	Causal interactions between CO emissions, FDI, and economic growth: Evidence from dynamic simultaneous-equation models	1990 – 2011 54 Panel countries	FDI and CO_2 emissions	$FDI \rightleftarrows CO2$ $FDI \rightleftharpoons GDP$
Shahbaz *et al.* (2014)	Environmental Consequences of Economic Growth and Foreign Direct Investment: Evidence from Panel Data Analysis	1985 – 2006 110 Developed and Developing countries	CO_2, Y, Y^2, and F	$FDI \rightleftarrows CO2$
Ali *et al.* (2015)	The Effect of International Trade on Carbon Emissions: Evidence from Pakistan	1980 – 2010 Pakistan	FDI and CO_2 emissions	$Bidirectional\ causality$ $FDI \rightleftharpoons CO2$
Linh and Lin (2014)	Dynamic Causal Relationships among CO2 Emissions, Energy Consumption, Economic Growth and FDI in the most Populous Asian Countries	1980 – 2010 12 most populous countries of Asia	FDI, EC, and CO_2	$FDI \nrightarrow CO2$ $No\ EKC\ exists$

Source: Literature Review

Empirical Results and Discussions

All estimations are presented here in standard form. Table 2 is showing descriptive statistics and correlation matrix (CM). Correlation shows the interdependence among the variables. All variables have negative association with CO_2 emissions except FDI

Table 2

Descriptive Statistics and Correlation Matrix

	CO2	***FDI***	***GDP***	***INF***	***ENERGY***
Avg.	0.6477	0.7690	1.9865	9.3660	74.109
JB	1.3921	2.0149	24.200	3.2297	2.6311
Prob.	0.4985	0.3651	0.0060	0.1989	0.2683
			Correlation		
CO2	1.0000				
FDI	0.6914	1.0000			
GDP	-0.0573	0.0411	1.0000		
INF	-0.1115	0.0737	-0.0472	1.0000	
ENERGY	-0.8933	-0.5012	-0.0941	0.1603	1.0000

Source: Author's calculations

Augmented Dickey-Fuller unit root test is widely used test to investigate the stationary level of series. Table 3 is showing the stationary levels of the variables with both level and 1st difference values. All variables are stationary at level but only energy consumption is stationary at 1st difference. In this paper, variables are mix cointegrated so ARDL cointegration approach is the best estimation to investigate the cointegration.

Table 3

Augmented Dickey-Fuller Unit Root test

Var.	*Stat.*		*Stationary*
	Level	**1st Diff**	
CO2	-4.1747***	-8.0518***	*I(0)*
FDI	-4.8582***	-5.0246***	*I(0)*
GDP	-5.2839***	-10.3658***	*I(0)*
INF	-3.3813**	-6.2913***	*I(0)*
ENERGY	-1.3883	-8.4133***	*I(1)*
***** shows 1% ** shows 5% significant level**			

Source: Author's calculations

First step to find the cointegration is to investigate the optimal lag of the data. Lag length criteria is used to find the lag. It has 6 different criterions but we choose the decision of AIC test. Lag which has most "*" is the optimal lag of the data. Table 4 is showing lag length criterions.

Table 4

Lag length Criteria

Optimal Lag Order	AIC
2	8.116054

Source: Author's calculations

ARDL test is applied to check the cointegration after finding the optimal lag order. Calculated values are compared with the critical values. F-value value is 6.1030. When we compare this value with table,it is found that there exists a long run cointegration relationship because our F- value >upper bound *I(1)* value and relationship is significant at 1% level of confidence interval (see table 5). Table 5 also has diagnostic test results which depicts the normality and no-serial correlation in the model and specification of the model.

Table 5

ARDL bounds test results

***Dependent Variable*: CO_2**			
ARDL(2, 0, 2, 1, 2)			
H_0: There is no Long-run relationship			
Statistic		**Value**	
F-statistic		6.1030***	
Critical Value Bounds			
Significance	**Lower**	**Upper**	
10%	2.45	3.52	
5%	2.86	4.01	
1%	3.74	5.06	
***Significant at 1% level, Long run relationship exists			
Diagnostic Test Results			
χ^2_{serial}	χ^2_{ARCH}	χ^2_{RESET}	χ^2_{BPG}
0.893[2]	0.773 [1]	2.802 [1]	1.54

Source: Author's calculations

Table 6 is showing the long run coefficients which depict FDI and GDP has direct relationship with CO_2 emissions with significance level at 1% level. This means that when FDI increases it also increases the CO_2 emissions and hence environmental degradation in long-run. If FDI will increase by 1%, it will harm the environment by 5%. GDP per-capita also has positive relationship with CO_2 emissions in long run which means that when per-capita income increase, people now have better standard of living and thus have more businesses and use more vehicles. Inflation and Energy consumption do not have significant relationship with CO_2 emissions.

Table 6

Estimations of Long-Run Coefficients

Variable	Coefficient	t-Statistic	Prob.
FDI	0.0516	5.0534	0.0000***
GDP	0.0088	1.8303	0.0765*
INF	-0.0004	-0.3936	0.6965
$ENERGY$	-0.0011	0.6631	0.5120
C	0.3748	2.4727	0.0189*

*** shows 1% ** shows 5% * shows 10% significant level
Source: Author's calculations

Short run coefficients are given in following table VI. ECT $_{t-1}$ shows the adjustment speed of variables. ECT $_{t-1}$ has negative coefficient of -0.52 which depicts that the speed of adjustment is 52% at 1% level of significance. All short run variables are significant except inflation. FDI, GDP, and energy consumption has positive relationship with CO_2 emissions. These results show that FDI increases 2% CO_2 emissions in short run (see table 7).

Table 7

Estimation of Short run Coefficients

Variable	Coefficient	t-Statistic	Prob.
ΔFDI	0.0270	5.1028	0.0000***
ΔGDP	0.0046	2.6978	0.0110**
ΔINF	-0.0002	-0.4173	0.6792
$\Delta ENERGY$	0.0076	3.8798	0.0005***
$ECT\ (-1)$	-0.5223	-3.7564	0.0007***

*** ** * significant at 1%, 5%, and 10% respectively
Source: Author's calculations

ARDL cointegration approach does not show the direction of the variables. So, ARDL causality test has been applied to investigate the direction of causality (see table 8).

Table 8

ARDL Causality Test

ARDL Causality			
	F-Value	**Prob.**	**Result**
$FDI \nrightarrow CO_2$	3.29773	0.0320**	$FDI \rightleftharpoons CO_2$
$CO_2 \nrightarrow FDI$	2.53160	0.0734*	
$GDP \nrightarrow CO_2$	4.51163	0.0091***	$GDP \rightarrow CO_2$
$CO_2 \nrightarrow GDP$	1.12467	0.3528	
$INF \nrightarrow CO_2$	4.53903	0.0088***	$INF \rightarrow CO_2$
$CO_2 \nrightarrow INF$	1.65897	0.1942	
$INF \nrightarrow FDI$	2.95222	0.0464**	$INF \rightarrow FDI$
$FDI \nrightarrow INF$	0.94265	0.4308	

*** shows 1% ** shows 5% * shows 10% significant level
Source: Author's calculations

Conclusion

Foreign direct investment is rapidly increasing in Pakistan from last few years and environment is also getting polluted day by day. Therefore, this study has empirically tested the effect of FDI on environmental degradation. Results have suggested that FDI and environmental degradation have short-long run relationship and also have bi-directional causation between each other. It depicts that increasing FDI is degrading the environment rapidly. All GDP per-capita and energy have positive relationship with CO_2 emissions. Short

run coefficient is moderate which depicts that government should take care of this and start some clean environment programs.

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