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Impact of Industrial Production and FDI on CO2 Emissions in Pakistan

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Abstract

The impact of industrial growth and Foreign Direct Investment (FDI) on Carbon Dioxide (CO2) emission is not an ignorable issue. The environmental issues have always affected the developing countries. In this study, an effort is made to identify the impact of industrial growth and FDI on CO2 emission in Pakistan covering the time period 1980 to 2020. To do the analyses, econometric technique of Autoregressive Distributed Lag (ARDL) is used. Results show that the energy depletion, industrial value added, and FDI have negative impact on CO2 emission. Therefore, the suggestion is to frame worry less policy in entertaining these sources of economic growth since are altogether efficient in having no traces of negative effects on environment.

Key Words: FDI, Industrial Production, Emissions, Environment
JEL Codes: F21, L11, Q53, F64

1 Introduction

FDI is a platform that facilitates the business setup across the national frontier of the parent country. FDI comes into being when an entrepreneur sets up business activities abroad or gets involved in foreign business that is away from the headquarter. FDI is assumed to perform enormous function for the improvement of macroeconomic status of host country (Mehmood & Faridi, 2013; Mehmood & Hassan, 2015). FDI is multifaceted as it brings innovation, and healthier climate for recipient nations. Particularly, in Pakistan where there's scarcity of skillful human and cash related capital, FDI is always looked forwarded as a hope

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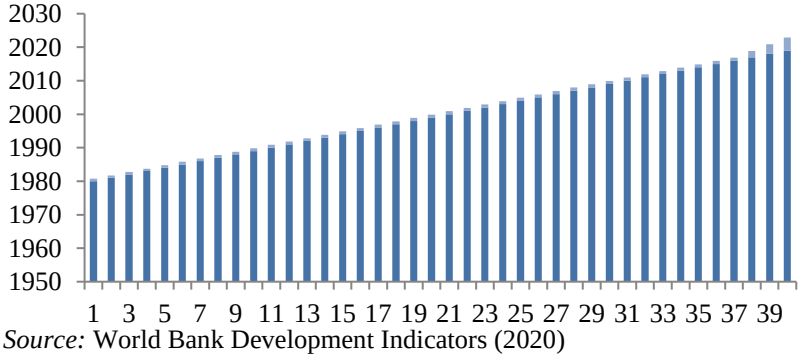
to resolve this shortfall through capital and expertise that FDI brings. Pakistan falls short of the intensive mechanical set up being an agrarian economy. Today, Pakistan is obtrusive in its strategy to create an opportunistic set up in the hosting of FDI and more of the industry value addition in order to be in line with the world developing economies by the mean of investment and industrialization. Because of the emphasis of investment on industrialization, farming persevered. Pakistan believes in disbanding the controls of imports and aims to gain progression in exports therefore, struggles to expand the interest of private sector.

However, more of economic activities are somehow related to the environmental issues. In this regard, CO2 emission is fatal substance that harms the ozone backed at human sporting activities. Essentially, the transmission of CO2 is initialed through the consumption of petroleum product such as flammable gasoline, oil, and coal for the production of electricity and transportation that are related with industrial units operating within the region. Rich nations still compensate with environmental damage by investing on the upgradation and removal of CO2 emission at large. However, poor nations end up at drastic negative spillovers on the general public's way of life due to running industrial units for their economic growth at the cost of nation's quality of life.

The Figure 1 displays state of CO2 emission with a consistent rise in the trend. This trend confirms of the damage to the quality of life of the Pakistani citizens.

Figure: 1

CO2 Emission (kg per 2010 Us$ of GDP) in Pakistan



Source: World Bank Development Indicators (2020)

Assembling location within the developing world, economy of Pakistan relies upon intense small and medium scale industries, particularly the textile. Pakistan approaches policies to draw the attentions of foreign investor(s) for heavy FDI inflows as well as local industry value added with a little thought of CO2 emission since the primary aim is to enable economic growth to be nurtured so that macroeconomic issues like of poverty and employment be addressed in favor of the nation specific.

FDI and industry value added are ultimate means needed for the nurture of macro economy. Similarly, the need is to locate any effects of FDI, and industry value added on CO2 emission. Therefore, with a purpose to observe these variables towards CO2 emission, the objectives of the study are follows.

i. To analyze the cointegration between the CO2 emission, FDI, and industry value added.
ii. To determine the impact of FDI on CO2 emissions.
iii. To discover whether effects of industrial value added are similar to that of FDI.

2 Literature Review

Organizations like Greenpeace, The World Wildlife Fund, Friends of the Earth, and Environmental Defense Fund do work for the safety of environment. The empirics such as Collins (1991), Suri and Chapman (1998), Grossman and Krueger (1994, 1995), Shafik and Bandyopadhyay (1992), and Faridi, et al., (2019) examined the impact of macroeconomic variables on CO2 emission.

Earlier, in the decade of 1980's; Hankinson and Rhys (1983), Boyd et al. (1988), Reitler et al. (1987) and Doblin (1988) explored low and high energy groups including industry, government, agriculture, commercial, and transport sector in affecting CO2 emission.

By 21 century, Rustad et al. (2000), Friedl and Getzner (2003), Alam et al. (2007), Martı´nez and Bengochea (2004), Liu (2005), Manage et al. (2009) following Copeland and Taylor (2005a,b) and Taylor (2005), Nasir and Rehman (2011), Stern and Common (2001), Coondoo and Dinda (2008), Shahbaz et al. (2012), Ozturk and Acaravci (2013), Zaman et al. (2013), Munir and Ameer (2019), and Faridi et al. (2019) examined the impact of varied range of macroeconomic components on CO2 emission.

At precise, Munir and Ameer (2019) explored nonlinear impact of foreign investment, industrialization, and monetary developments on CO2 emission in Pakistan. The findings were recorded for the duration between 1975 and 2016. The results signified the impacts of foreign investment and industrialization on CO2 emanation.

Earlier to that Aye and Edoja (2017) and Abdouli and Hammami (2017) studied CO2 effects against FDI, trade, electricity utilization, financial development on MENA nations and 31 non-business international locations, similar to Shari et al. (2014). Both researches went with GMM technique of regression estimates. The collective outcomes were found same and positive in case of FDI, industrialization, and CO2 emission.

In the bracket of same year, Kizilkaya (2017) and Kilicarslan and Dumrul (2017) analyzed FDI, financial development, and monetary improvement on CO2 emission in Turkey. Regression estimates that depended upon ARDL technique ascertained FDI, financial development, and monetary improvement altogether brought significant increasing effect on CO2 emission in Turkey.

2.1 Theoretical Framework.

The primary objective carried by this study is to analyze the effects of FDI and industry value addition on CO2 emission in Pakistan. In this content of study, it is observed that scope to discover FDI and industrialization is broad while it is to locate the trace out effects of the same on the environment conditions.

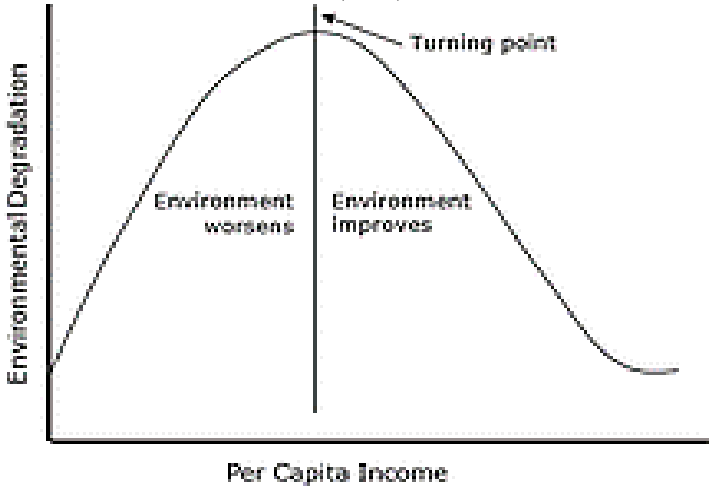
The environmental Kuznets Curve (EKC) portrays the hypothesized relationship among various indicators related to the environmental degradation along with that of income per capita. This growth in per capita can be traced back at FDI and industrial growth that is foresighted to cause environmental hazards and on the other hand enable economic growth and improvement in per capita income.

The EKC is associated with Kuznets (1955) who hypothesized that any upgrading in economic development is led by income inequality at the stage of prelim and later falls in line with proceeds of economic development. The EKC framework got emerged by Grossman and Krueger (1991) in the study of the impacts of NAFTA and popularization through 1992 World Bank Development Report (IBRD, 1992). In this regard, Meadows et al.

(1972) rather called EKC as an opportunity that facilitates economic development rather than considering a thread to the environment.

Figure: 2

Environmental Kuznets Curve (EKC)



The Figure 2 illustrates ecological state of conditions traced back by CO2 discharge. The consistent per capital income growth is referred to varied posture of environmental degradation which gets abrupt in the beginning but later improves with a unswerving growth of per capital income.

3 Methodology and Data Source

The principal aim of this study is to look into the prevalence of FDI and industry value addition on CO2 emission in case of Pakistan. For the purpose of analyses, time series data is used to explore the trends and relationship of FDI, industry value addition and CO2 emission. The data of the range from 1980 to 2020 is obtained from The World Bank Development Indicators.

3.1 Model Specification

Keeping in view the objectives of the study, following model is prescribed to locate the effects of FDI and industry value added on CO2 emission in Pakistan. The variables are incorporated in log form.

$$CO2 = (FDI, GDP, IND, END, TRN, EXP) \quad (1)$$

The succinct summary of variables is briefed in Table 1.

Table 1
Summary of the variables

Variables	Abbreviation	Formula of Variables
Gross Per Capita	GDP	Gross domestic product in $ million
Foreign Direct Investment	FDI	FDI in current US$
Industry Value Added	IND	Industry value added, annual percentage growth
Energy Depletion	END	ratio of the value of the stock of energy resources to the remaining reserve lifetime (capped at 25 years)
Transportation	TRN	Domestic transport consumption expenditure
Exports	EXP	Total exports within a year in US $
Carbon Dioxide Emission	CO2	Carbon dioxide emission

Source: Author's Description

3.2 Unit Root Test

For the regression analyses, the Augmented Dickey Fuller (1979, 1981) test is used to locate the status of unit root on each variable. ADF is given as follows.

$$\Delta R_t = c + \Gamma v_{t-1} + \sum_{j=1}^{k-1} \rho R_{t-j} + \beta T + \varepsilon_t \quad (2)$$

Where, explanatory variables are referred by R. and time period and stochastic term are shown by t and ϵ, respectively. $p = 0$ is the H0 that refers to non-stationarity against $p \neq 0$ of stationary series.

If the variables are integrated at I(0), simple Ordinary Least Square Technique is incorporated for the computation of results. However, if the variables are got to be integrated of mixed order of integration i.e. I(0) and I(1), the ARDL approach of modeling is to be employed to obtain the information about the long run and short run coefficient estimates.

3.3 ARDL Approach of Cointegration Analyses

ARDL approach estimates the long run and short run results simultaneously. To Narayan (2004), ARDL is useful in case when data sample is smaller in length and is unbiased and efficient (Odhiambo, 2008). Importantly, there are two stages involved in this technique. First is the exploration of cointegration. It is done by the mean of testing the computed F-

Statistic. The Second stage is to measure the long run and short run coefficients.

3.4 Procedure of Bound Testing

Bound test is based on certain assumption. First is to use the ARDL model of analyses after identification of the orders of integrations of the series (Pesaran, et al., 2001). Second, the series may not be integrated of the same order. They may be integrated of I(0) or I(1) or a blend of both. Third; the ARDL technique is efficient even if the data size is small in length (Pesaran, et al., 2001).

For bound test, Ordinary Least Square method is used to find the F-statistic of joint significance of parameters. The H0 and H1 are given in Eq. (3) and Eq. (4).

$$H0 = \beta1 = \beta2 = \beta3 = \beta4 = \beta5 = \beta6 = 0 \quad (3)$$

$$H1 = \beta1 \neq \beta2 \neq \beta3 \neq \beta4 \neq \beta5 \neq \beta6 \neq 0 \quad (4)$$

The version of unrestricted vector error correction is written in Eq. 5

$$\Delta CO2 = \beta_0 + \sum_{i=1}^{\beta_0} \delta_1 \Delta CO2_{t-i} + \sum_{i=1}^{\beta_1} \delta_2 \Delta FDI_{t-i} + \sum_{i=1}^{\beta_2} \delta_3 \Delta GDP_{t-i} + \sum_{i=1}^{\beta_3} \delta_4 \Delta IND_{t-i} + \sum_{i=1}^{\beta_4} \delta_5 \Delta END_{t-i} + \sum_{i=1}^{\beta_5} \delta_6 \Delta TRN_{t-i} + \sum_{i=1}^{\beta_6} \delta_7 \Delta EXP_{t-i} + \varphi_1 CO2_{t-1} + \varphi_2 FDI_{t-1} + \varphi_3 GDP_{t-1} + \varphi_4 IND_{t-1} + \varphi_5 END_{t-1} + \varphi_6 TRN_{t-1} + \varphi_7 EXP_{t-1} + \varepsilon_t \quad (5)$$

Where β0 and βi (i=1,2,3,…..,6) are the long run and short run representations for the independent and dependent variables. The Δ is first difference and δi and φ_i are the short run and long run coefficients and ε is the error term.

3.5 Long run Coefficient Estimation

The long run coefficients are estimated through Eq. (6).

$$\Delta CO2 = \beta_0 + \sum_{i=1}^{\beta_0} \delta_1 \Delta CO2_{t-i} + \sum_{i=1}^{\beta_1} \delta_2 \Delta FDI_{t-i} + \sum_{i=1}^{\beta_2} \delta_3 \Delta GDP_{t-i} + \sum_{i=1}^{\beta_3} \delta_4 \Delta IND_{t-i} + \sum_{i=1}^{\beta_4} \delta_5 \Delta END_{t-i} + \sum_{i=1}^{\beta_5} \delta_6 \Delta TRN_{t-i} + \sum_{i=1}^{\beta_6} \delta_7 \Delta EXP_{t-i} + \varepsilon_t \quad (6)$$

3.6 Short Run Coefficient Estimation

The short run coefficients are estimated in forms of Eq. (7).

$$\Delta CO2 = \beta_0 + \sum_{i=1}^{\beta_0} \delta_1 \Delta CO2_{t-i} + \sum_{i=1}^{\beta_1} \delta_2 \Delta FDI_{t-i} + \sum_{i=1}^{\beta_2} \delta_3 \Delta GDP_{t-i} + \sum_{i=1}^{\beta_3} \delta_4 \Delta IND_{t-i} + \sum_{i=1}^{\beta_4} \delta_5 \Delta END_{t-i} + \sum_{i=1}^{\beta_5} \delta_6 \Delta TRN_{t-i} + \sum_{i=1}^{\beta_6} \delta_7 \Delta EXP_{t-i} + \gamma ECT_{t-1} + \varepsilon_t \quad (7)$$

The γECT_{t-1} is the error term representing the speed of adjustment of disequilibrium.

4 Results and Discussion

This section is to provide the discussion on results which are bifurcated into three segments which are Descriptive Statistics, Empirical Results, and Diagnostic Tests, respectively.

4.1 Descriptive Statistic Analysis

The summary of descriptive statistics is given in Table 2. Attributes such as mean, median, standard deviation as well as skewness and kurtosis and nonetheless the Jarque-Bera statistics are elaborated on each variable as are given in equation (1).

Table 2

Descriptive Statistic Analysis

Measure	CO2	FDI	IND	END	TRN	EXP	GDP
Mean	-0.06	20.16	23.55	20.25	19.65	23.12	4.98
Median	-0.11	20.24	23.36	20.15	19.29	23.07	4.80
Std. Dev.	0.33	1.35	0.78	1.34	0.60	0.76	1.92
Skewness	3.26	-0.27	0.17	-0.19	0.87	-0.23	-0.05
Kurtosis	13.05	2.23	1.68	1.87	2.33	1.80	2.81
Jarque-Bera	23.37	1.49	3.09	2.38	5.82	2.75	0.07
Prob.	0.00	0.48	0.21	0.30	0.05	0.25	0.96

Source: Author's Calculations

Descriptive Statistics on each variable clarify that all the variable show diversified range of variation from their respective mean value. Moreover, FDI, END, and EXP are negatively skewed. However, IND, END, and EXP are platykurtic. Whereas CO2 is found to be leptokurtic. Findings of Jarque-Bera probabilities represent that residuals of the variables except CO2 and TRN are normally distributed.

4.2 ADF Test of Stationarity

The test of ADF is applied to explore the state of stationarity on each of the variable. The findings are given in Table 3 which confirm varied integration orders i.e., of I(0) and I(1). Thus, for the regression analyses, ARDL approach is appropriate for the fulfillment of the objectives of the study.

Table 3
Results of ADF Test of Stationarity

Variable	At level		At 1st difference		Conclusion
	Intercept	Intercept & trend	Intercept	Intercept & trend	
CO_2	3.09	-3.17	-3.61	-3.62	I(0)
	-1.00	-0.03	1.00	0.03	
END	-1.01	-3.61	3.68	-5.44	I(0)
	-0.74	-0.03	-0.01	0.00	
EXP	-1.33	-3.61	-3.62	-6.10	I(0)
	-0.61	-0.01	0.00	0.00	
FDI	-1.44	-3.61	-3.17	-5.48	I(1)
	0.5513	-0.51	-0.01	0.00	
GDP	-3.01	-0.40	-3.16	-5.97	I(0)
	-0.01	-0.09	0.00	0.00	
IND	-2.65	-0.56	-2.49	-5.34	I(0)
	0.00	-0.88	0.00	0.00	
TRN	-4.66	1.17	-3.62	-6.79	I(0)
	-0.01	-1.00	0.00	0.00	

Source: Author's Calculations
Note: Rows show the computed ADF statistics followed by the respective prob.

4.3 Bound Test Results

In ARDL approach, the existence of long run relationship is examined by the mean of Bound Test. To do it purposefully, Walt Test (F-Statistics) is checked for the confirmation of cointegration among the dependent variables and the regressors prescribed in model. The results are given in Table 4.

Table 4
Bound Test Results

Model	*F*-Statistics	Upper Bound Critical Value	Conclusion
Model I *CO2 = f (FDI, GDP, IND, END, TRN, EXP)*	6.21	3.15	Co-integration exists

Source: Author's Calculations

The computed F-Statistic is 6.21. It is above the upper bound critical value of 3.15 at 1 percent rate of significant. Therefore, the H0 of no cointegration is rejected. In conclusion, the cointegration is found to exist among the regressors and the dependent variable i.e., CO2.

4.4 Estimated Long Run Coefficients

Later to the Bound Test, the coefficients are estimated for distinguishing the nature of impacts on dependent variables. In this respect, the summary of ARDL long run and short run coefficient estimates is given in Table 5. The dependent variable is CO2 and independent variables are FDI, GDP, IND, END, TRN, and EXP.

Table 5

Estimation of Long run Coefficients

Regression Results of Eq. (6)				
Variable	**Coefficient**	**Standard Error**	***t*- Ratio**	**Prob.**
FDI	-0.26	0.11	-2.25	0.07*
GDP	-3.47	0.81	-4.29	0.01**
IND	-2.18	1.11	-1.96	0.10*
END	-0.65	0.13	-5.15	0.00**
TRN	3.49	0.52	6.79	0.00**
EXP	4.12	0.93	4.41	0.01**
C	3.49	0.52	6.79	0.00**

Source: Author's Calculations

Note: * & ** show significant at 5 and 10 percent, respectively.

The long run impact of FDI inflows on CO2 emission are found negative. It is encouraging to note that FDI is significant in its effects on CO2 emission and nevertheless, rests upon such advanced mode of industrial infrastructure that is environment friendly. Therefore, the results confirm that any increase in such capital inflows depress the environmental hazards.

Moving on to GDP, findings are the same as found in case of FDI. The variable is significant and the direction of impact on CO2 emission is negative. It is therefore sufficient in an evident that economic growth of Pakistan is at least not attained at the cost of environmental degradation.

With no dissimilarity, the impact of industry value added, and energy depletion are also found negative in relation to CO2 emission. The results encourage to write that any furtherance in industrial growth is to make environment factor to get better off. On the contrary, the transport sector is found to lead the

environmental factor to get worse-off. One percent increase in transport factor increases CO2 emission by 3.49 percent.

Akin to transport factor, the exports are also found to be harsh in their effects on environment. The reason is the fact that export growth is reciprocal by the industry that facilitates it. Much of the exports are textile backed that are having huge number of textile units operating in Pakistan. The result of such growth is sequel by negative effects on environmental factor.

4.5 Estimated Short Run Coefficients

The short run coefficient estimates are published in Table 6. The findings are rarely significant. Moreover, the variables are found to have otherwise direction of impacts on dependent variable. The conclusion can be drawn here in a way that any of the environmental impacts are better traced in long run. However, the ECT is significant and within the range. It shows complete adjust of disequilibrium.

Table 6

Estimation of Short run Coefficients

Regression Results of Eq. (7)				
Variable	**Coefficient**	**Std. Error**	***t*- Ratio**	**Prob.**
D(FDI)	-0.09	0.09	-0.94	0.38
D(FDI(-1)	0.06	0.11	0.53	0.61
D(FDI(-2)	0.04	0.08	0.53	0.61
D(FDI(-3)	0.06	0.07	0.83	0.44
D(GDP)	-1.80	0.65	-2.75	0.04*
D(GDP(-1))	0.89	0.46	1.90	0.11
D(GDP(-2))	0.72	0.49	1.44	0.20
D(GDP(-3))	-1.05	0.64	-1.64	0.16
D(IND)	0.14	0.53	0.27	0.79
D(IND(-1))	-0.56	0.52	-1.07	0.33
D(IND(-2))	0.97	0.45	2.12	0.08**
D(IND(-3))	1.32	0.50	2.63	0.04*
D(END)	0.073	0.08	0.89	0.41
D(END(-1))	0.15	0.12	1.26	0.26
D(END(-2))	0.29	0.11	2.60	0.04*
D(TRN (-1))	-0.73	0.25	-2.96	0.03*
D(TRN(-2))	-1.13	0.26	-4.40	0.01*
D(TRN(-3))	-0.50	0.23	-2.23	0.08**
D(EXP)	1.53	0.51	2.99	0.03*
D(EXP(-1))	-1.18	0.46	-2.55	0.05*
D(EXP(-2))	-0.08	0.47	-0.17	0.87
D(EXP(-3))	-0.65	0.37	-1.77	0.14
ECT(-1)	-1.00	0.29	-3.44	0.02*

Source: Author's Calculations

Note: * & ** show significant at 5 and 10 percent, respectively.

4.6 Diagnostic Tests

Ramsey Reset Test

To investigate the authenticity of correctly specified ARDL model, Ramsey Reset Test is run. Computed F-Statistic is 0.45 that confirms that the model is correctly specified.

Breusch-Godfrey Serial Correlation LM Test

The computed p-value of Breusch-Godfrey test of serial correlation is found to be 0.92 therefore, the H0 of absence of serial correlation is not rejected.

5 Conclusion and Policy Implication

This study went to scrutinize the impact of FDI, END, and IND on carbon dioxide emissions. Further to the core variables, exports of goods and services, gross domestic product, and transportation expenditure were also incorporated to explore any impact on carbon dioxide emission in case of Pakistan. The yearly time series annual data was used for the range of 1980-2020. Bound Test revealed long run relationship between the variables of the selected model. Importantly, FDI, GDP, IND, and END are found to have negative and significant impact on CO2 emission in Pakistan.

On the bases of long run findings, following policy implications are suggested.

Government while taking care of the environmental issue should in-focus the fact that FDI, GDP, IND, and END are improving the ecological pleasance in Pakistan. Therefore, the need is to further struggle to be welcoming for the foreign investors. It is so to learn the means by which industry and business is run altogether with the way of saving the environment from the hazards like that of CO2 emission.

The concerned sectors who are related to the production of exportable in Pakistan must understand that increase of export should not be at the cost of environmental depletion. In this matter, without neglecting transport sector towards its contribution into environmental issues, the government is to look towards the cause(s) which are amicably replaceable for the control of environmental degradation.

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