Consequence of FDI on CO_2 emissions in case of Pakistan

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Abstract: The study is an effort to explore the long-run consequences of foreign direct investment and capital formation on the environment. The study used the time series data of 1974–2010 in the case of Pakistan. For the analysis of environmental quality CO_2 is used as an indicator. To analyze the long run relationship among CO_2 emissions, overseas direct investment and capital formation along with other control variables, Autoregressive Distributed Lag model (ARDL) technique is applied. Results of the study authenticate that foreign direct investment damage the environmental quality. At the same time capital formation can bring back environmental quality by introducing environment friendly techniques of production. Short term dynamics of model suggest that the signs of the coefficients are same with the long run coefficients. Subsequent to the observed effects it is suggested that Pakistan must plan policies for the betterment of environment by encouraging capital formation and less pollutant foreign production techniques.

Key words: CO_2 (ARDL) technique · Environmental quality · Techniques of production

INTRODUCTION

Foreign direct investment has meaningful importance in economic literature. Classical economic theory believes that foreign direct investment (FDI) is a potential source of gains for the countries. As theory of comparative advantaged, relative factor endowment theory and theory of absolute advantages promote the concept of FDI. Moreover neoclassical literature considers it as a engine of economic growth. In economic perspective achievement of economic growth is most important concern and FDI has a key role to gain economic growth Thomas [1].

Pakistan creates a center of attention of foreign investors because of its productive market and geographical location. Environmental degradation is one of the biggest costs of immense production by FDI. Use of oil, coal and other energy source in production and transportation system degrade environment by emitting Carbon dioxide (CO_2) emissions Grossman and Krueger [2] and Antweiler et al. [3] documented that foreign capital movement increase CO_2 emissions.

Empirical findings of Liang [4] explained that the energy consumption and trade increase CO_2 emissions. At the same time as research procedures and considerate with modern, foreign and less pollutant methods helped them in reducing CO_2 emissions in case of china.

Apergis and Payne [5] mentioned that foreign investments provide the great foundation to relocate new techniques for production. Cuadros et al. [6] Presents the role of technological advancement in the improvement of the environmental quality. Cuadros et al. [6] to reduce pollution, county can get advantages of new production techniques and expands benefits from FDI. With improved economic system and foreign investments countries can protect their environment by impressive environmental laws [8].

Moreover development and improved form of machinery and techniques of production can play an important role in environmental quality. Capital formation facilities the economy to get the advantages of modern and less pollutant techniques. So study takes the Capital Formation (CF) as an indicator of improved form of production methods.

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So this research work tries to find out the relationship among CO_2, FDI and CF in Pakistan for the time period of 1974-2010. The document is planned as follows: segment 2 provides reviews of the literature; segment 3 presents the econometric specifications; segment 4 gives details of variables construction; segment 5 makes available the estimation strategy; segment 6 demonstrates the empirical results; and segment 7 summarizes the conclusions of the study.

Literature Review: Past stream of research indicates the globalization is escorted by economic growth. Economic integration facilitates technological change, investment and capital flow. The integrations have the feature of economic, social and political as well as cultural implementations. [7-9] describe globalization promote immense productivity and also a prominent factor to reduce the poverty. Low tariff rates and soft conditions for trade pull the foreign direct investment (FDI). Believers of globalization take it blessing for the poor people on the other hand disbelievers discuss its negative side effects for the poor.

Economic literature of [9, 10] and Cuadros *et al*. [6] explained that FDI has constructive achievements for economic growth. So nations can improve production with the help of FDI at the same time this condition will help out countries to get better technology for the production and improve production by availing positive effects of integration [11-16]. Study of De Mello [17] mentioned the benefits of FDI that it enhances the vision of the country for adopting recent technologies for production functions. Moreover FDI is motivation to get awareness about ideas of training, skills and a better organizational environment of the country.

Raspiller and Riedinger [18] documented that countries having low environmental regulations are major exporters for the most of pollution intensive goods. So the countries with low environmental law have to face the pollution intensity of this type of production. Foreign investors normally escorted by capital intensive production techniques which have high cost in the host developing countries. Intensive capital use in production creates environmental pollution but these foreigner inverters get advantages of the low abatement cost from the host country [3, 8].

In the context FDI- environment debate explanations of Deng and Song [19] presented first that conventional trade perception regarding comparative advantages, so that countries with strict environmental rules bear relatively high production cost and due to comparative advantages, are not accomplished by production of pollution intensive goods. Whereas countries with low level of environmental laws have low production cost and because of comparative advantages produces pollution intensive goods. Secondly technology improvements facilitate the countries to get less pollutant techniques of production. This perspective of cointegration shows the positive impact of FDI on environment.

In many cases countries can improve ecological conditions by getting less pollutant way of production the literature of [2, 20, 21] found that FDI has positive effects on environment. Cole & Elliott [8]; Liang [4]; Cole *et al*.[22]; Deng and Song [19] explore the relationship of FDI and environment, conclude that efficient production plants make possible for the nation to improve ecological system with the help of modern and less pollutant way of production. Whereas reduced energy intensity of plants which facilitate the country to get better environment.

Impact of foreign investment on carbon dioxide emissions is examined by Peter and Jeffrey [23] for a cross-national panel. Research mentioned that during the time of 1980 and 1996 FDI augmented CO_2 emissions growth, whilst internal level of investment has no effects on CO_2. Research justifies their findings on the basis of the following grounds. Initially it is discussed that foreign investment is highly interested for those firms that necessitate more energy. Secondly international production functions normally try to find the places or countries with low environmental regulations. Thirdly from the last three decade it is observed that countries with feeble infrastructure became energy expensive for the reason of extensive production in globalization. In last it is concluded that foreign investment receiving countries have low level of power creation as compare to countries of core.

Cole *et al*. [22] found that the inverse connection between FDI and environmental laws. This research mentions impact of FDI on environmental policy as strict environmental policy can be implemented if the level of corruption is low and vice versa. When the abatement cost increased this will move the manufacturing of pollution intense commodities to somewhere else [24].

Eskeland and Harrison [21] basically defy the pollution haven hypothesis because their research argues that foreign investments have the cleaner and updated energy plants of production that not only smooth the progress of economic growth of the host country but at the same time help them out from the ecological backwardness. Present research tries to analyze the effects of FDI on CO_2 emission as Pakistan is

comparatively attractive for foreigner investors. But this study also includes the role of capital formation and credit to private sector that can overcome the side effects mentioned relationship.

Econometric Specification: The most important intention of the article is to mark out the influence of FDI on CO_2. Findings of Pao and Tsai [25] mentioned that the FDI increase the energy consumption and take part in worsening the environment. Damijan *et al*. [12] documented that FDI and emissions have unidirectional causality. Cole *et al*. [22] measured FDI is as a good source for the environment of the host country. As production plants of international capital utilize the modern and efficient methods of production that are fewer toxins for environment. Consequently this draft tries to find the empirical association along with the variables. So, a specified econometric model in log linear is given:

$$c_t = \beta_0 + \delta\, fdi_t + \varpi2 cf_t + \varepsilon_t \qquad (1)$$

Seeing as ct is CO_2 emission per capita, fdi_t is foreign direct investment, cf explains the gross capital formation and ε_t is error term. To get rid of any econometric complexities all variables in the regression will be taken in logarithmic form at initial stages. Therefore, each data series is in their logarithmic class.

Foreign direct investment stimulate the economic growth and hence energy production but at the same time use of less pollutant plants of production help out the host country to reduce CO_2 emissions. Sign of δ may be positive, as low abatement cost and environmental restrictions encourage international capital to relocate. Negative relationship can be expected for ϖ, as Grossman and Krueger [20] found in their studies that recent technologies of production make possible for the host county to improve the environment. Underdeveloped countries can reduce environmental degradation by the using modern techniques of production from the developed countries.

Construction on of Variables: The core idea of this research work is to explore the performance of FDI for environment. There are a lot of green house gases responsible for the ecological condition. The gases consist of water vapor with three atoms (H_2O), methane (CH_4), ozone (O_3) and carbon dioxide (CO_2) and Sulfur dioxide (SO_2) and Nitrogen oxide (NOx) that contribute to global warming, but the share of CO_2 is large enough and

comparatively more hazardous than others. CO_2 created by the burning of fossil fuels that are used in the economic activities like production of electricity, transportation and industrial growth.

Grossman and Krueger [2] took the CO_2 as an indicator of environmental quality. Further literature of Soytas and Sari [26]; Halicioglu [27]; Apergis and Payne [5] also consider CO_2 to substantiate the significance of the studies. In the assessment of environmental quality following research (Galeotti *et al*. [28]; Zhang and Cheng [29] take CO_2 that is more appropriate indicator to analyze the environment. So this present study also considers CO_2 emissions to check the environmental quality. As during utilization of solid, liquid, gas fuels and gas burring due to increase activity of economy fabricate CO_2 emissions. Econometric rationale takes the per capita CO_2 emissions for further proceedings.

This study has FDI as an independent variable that determines the level of environmental quality of the country. Economic literature believes some of the gains and losses related with environmental effects of FDI. Theory of comparative advantages argues that the approach of FDI determines gain or losses. International inflow of capital makes possible for the backward economies to enhance production capacity by availing scale effect of the FDI. Technique effects of FDI assist the country's enterprise to use cleaner techniques of production. Structure effects transform industrial structure and will be helpful in reducing environmental degradation.

Environmental effects of FDI were analyzed by the following stream of research, for example Eskeland and Harrison [30]. Deng and Song [19] found that the outcome features of FDI are encouraging in nature for the host countries. In the same stroke Eskeland and Harrison [21]; Deng and Song [19] established that for the reduction in environmental deterioration FDI has a constructive function. Although the massive production level and low environmental regulations also boost the CO_2 emissions in host countries. Following literature found FDI as a factor responsible for deterioration of ecological system [8, 22, 31, 32]. In addition, Grossman [2] and Mani and Wheeler [20] documented low environmental cost in less developing countries. Moreover set of controlled variables as gross capital formation percentage of GDP, Domestic credit to private sector percentage of GDP and broad money percentage of GDP are also considered to examine the validity of results.

Estimation Strategy: The problem of sationarity can be tackled by Augmented Dickey-Fuller (ADF) check. So to avoid this problem past literature and this study apply conventional Augmented Dickey-Fuller (ADF) analysis to confirm the stationarity properties of the statistics generating process of the under consideration variables. This study applies Autoregressive Distributed Lag model (ARDL) technique to establish the connection among the selected indicators. Pesaran and Pesaran [33] employed this method and later on Pesaran and Smith [34] used it. Mentioned technique of estimation has various plus points as compared to available evaluating strategies. At first data series is stationary at I(0), I(1) or fractionally, no matters, this procedure can be useful [33]. Secondly, in the scheme of general to specific it obtains a considerable lag orders. Third, on the way to acquire the information regarding error correction model (ECM) availed by the process. ECM put together modification of short run and also considering long run report. In addition, given procedure is fine for small sample relatively to the Johensen and Juselius's procedure [33]. Accordingly ARDL frame of Equation (1) is specified under:

$$\Delta c_i = \beta_0 + \sum_{i=1}^{p} \delta_i \Delta fdi_{t-i} + \sum_{i=1}^{p} \varpi_i \Delta cf_{t-i} + + \sum_{i=1}^{p} \theta_i \Delta z_{t-i} + \lambda_1 fdi_{t-1} + \lambda_2 cf_{t-1} + \lambda_3 z_{t-1} + U_t \tag{2}$$

So β_0 is constant element and U error expression. Moreover to illustrate error correction vibrant symbol of summation is considered. Whereas next part of the equation having assign of λ_t specifies the long run association. Initial task in ARDL process is bound analysis. So initially in the ARDL bounds analysis moves toward the estimation of equation (2) by ordinary least square (OLS) process. Study applies the F- statistics to explore the long run bonding amongst the variables.

In longer time span variables are not correlated. The null hypothesis in the equation is H_0: $\lambda_1 = \lambda_2 = 0$. Where the alternative is H_0: $\lambda_1 \neq 0$, $\lambda_2 \neq 0$.

Results of F-statistics are considered beside by two sets of critical values offered by the Pesaran *et al*. [33]. In one set supposed that each variable are I (0) and other supposed they are I (1). When upper critical value is lesser than the computed F-statistics decision is followed by that no cointegration among variables. When F-statistics is less than the lower value indicates that null hypothesis of no cointegration cannot be discarded. If it goes down, within the critical value set, the

analysis is uncertain. In regression analysis $(p + 1)^k$ digit is used for lag length of all variables in the model. k denotes the total variables in model and p states the maximum number of lags. To choose minimum possible lag span, study at hand utilizes Schawrtz-Bayesian criteria (SBC) standard. By the establishment of long time information the shot time information carried out on later stages that will helpful to specify the future adjustment with short time information.

$$\Delta c_i = \beta_0 + \sum_{i=1}^{p} \delta_i \Delta fdi_{t-i} + \sum_{i=1}^{p} \varpi_i \Delta cf_{t-i} + \alpha ECM_{t-1} + U_t \tag{3}$$

In order to verify the goodness fit of the statistical calculated model heteroscidasticity test, normality test, serial correlation test and functional form test will be carried out. In order to make certain solidity of model in short run and long run Pesaran and Pesaran [33] propose the technique of cumulative sum recursive residuals (CUSUM) and cumulative sum of squares recursive residuals (CUSUMSQ) of the Brown *et al*. [28]. If the graphs of (CUSUM) and (CUSUMSQ) versus break points remain within critical bonds of a 5 %level of significance, designates the accurateness of every coefficients in the specified model. To test the relation between FDI and CO_2 time period under consideration is 1974-2010. World Development Indicators (WDI-CD-ROM, 2012) source is utilized for collection of yearly statistics on CO_2 emissions, FDI, CF, DCPS & BM.

Empirical Results: In this section empirical results are obtained. Unit root problem of data series is analyzed by ADF test. Outcomes of ADF analysis are presented in Table 1. As ARDL model accept the stationarity of time series data at I(0) or I(1) but not any of the data series is stationary beyond the first difference. Results of ADF give details of CO_2, FDI, DCPS, BM all are stationary at first difference and CF has no unit root problem at level so that no need to take its first difference.

To find out long run affiliation amongst the variables the F-test ting is carried out. Granger causality test is conducted to check which variable is causing the other variables. However the results in Table 2 present the robustness check to the above observations. Results are obvious that here exists only one sided causality that is from FDI and CF towards CO_2 emissions.

Table 1: Unit Root Tests through Augmented Dickey Fuller Test

	ADF	K		ADF	k
CO_2	1.2183	0	ΔCO_2	-3.8609	0
FDI	-2.5273	0/1	Δ FDI	-7.7509	0
CF	-3.6636	0	Δ CF	NA	-
DCPS	-2.5610	0	Δ DCPS	-5.2089	0
BM	-3.9572	1	Δ BM	-5.0917	0

Note : Mackinonn (1991) critical values are 3.1620 at 1 percent, 2.2294 at 5 percent and 2.9062 at 10 percent

Table 2: Pair wise Granger Causality Test

Null Hypothesis	F-Statistic	Probability
FDI does not Granger Cause LCO_2	3.22032	0.0241
CO_2 does not Granger Cause LFDI	0.73117	0.6201
CF does not Granger Cause LCO_2	4.4443	0.0043
CO_2 does not Granger Cause LCF	0.4772	0.6715

Table 3: Long Run Assessments:

Dependent variable is the per capita CO_2

Regressor	Coefficient	T-states
Constant	4.1527	0.4719
Foreign direct investment	-0.0284	1.1128
Gross Capital formation	-3.3810	-1.8395
Domestic credit to private sector	-4.2854	1.5282
Broad Money	4.8714	1.8395
Diagnostic Test Statistics (p-values)		
x^2*(Serial Correlation)*		0.0334
x^2*(Functional Form)*		5.8201
x^2*(Normality)*		0.7706
x^2*(Heteroscedasticity)*		0.5320

Source: The author's calculations

Table 4: Short Run Assessments:

Regressor	Coefficient	T-states
contant	-0.6462	-0.4392
Δ Foreign direct investment	0.0443	-0.1621
Δ Gross Capital formation	-0.0815	-0.2252
Δ Domestic credit to private sector	-0.5214	-1.8773
Δ Broad Money	0.7580	2.0480
ecm(-1)	-0.1556	-2.0617
Diagnostic Test Statistics (p-values)		
R^2		0.9112
DW		1.9384

Source: The author's calculations

Long Run Estimate of Auto Regressive Distributed lag Model: Table 3 presents the long run estimates and natural log form of all independent and dependent variables is obtained. Hence, the coefficient of the regressor states the long time span elasticities of CO_2 for the particular variable. The coefficient of foreign direct investment is 0.0284 that indicates a one percent change in the foreign direct investment will pass on to a 0.02 percent change in the CO_2. That implies FDI deteriorate the environment as multinational companies move to the

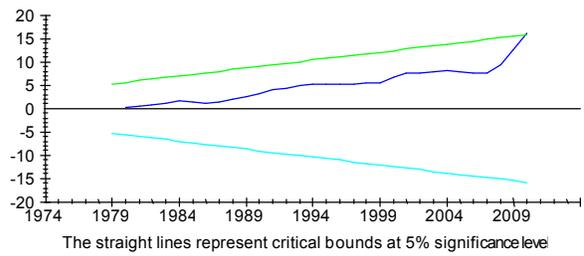The straight lines represent critical bounds at 5% significance level

Fig. 1: Plot of Cumulative Sum of Recursive Residuals

developing countries where they have to face low environmental restrictions. But the coefficient of capital formation is -3.3810. It reveals that 1 percent change in capital formation will improve environmental quality by 3.38 percent and negative sign of the coefficient implies that the higher capital formation will lead to lower CO_2 emission. If change in domestic credit to private sector is one percent it will change CO_2 by 4.28 percent and facilitate the producers to get the cleaner techniques of production that improves the environmental quality, sign of coefficient also statistically significant. As, the capital formation and domestic credit to private sector with help of FDI provides the environmental improvements, possibly in future, during escalating competition and the good organization of source can be supportive. These finding are in line with Jalil and Mehmud [35] in case of china and Cole [31]. Broad money has positive sign that indicates increased money supply refers large size of demand. Consequently to cope up this huge production, firms are eager to produce more and more without paying attention to the environment.

Short Run Dynamics: Table 4 gives the details of short period dynamics of the model. Results of the study are appealing as the signs of the coefficients are same in long period and short period. Yet, the magnitudes are much smaller in almost every case. That informs the bonding along with the variables is more strongly in long time period. Statistics sign of ECM(-1) term is considerable and correct. The value of terms is 0.1556 in the results that indicates 15 percent of disequilibria of CO_2 emission of the previous will be adjusted in this year and 6.8 years are requires to correct this problem in the long run. Moreover value of R^2 indicates good fit of the model.

To investigate the stability of the model CUSUM and CUSUMSQ test are formulated. Figure 1 and Figure 2 plots of CUSUM and CUSUMSQ statistics that stuck by the given level of 5% significance. That verifies the precision of parameters in both long and short time span in the model and designates the accurateness of every coefficient in the specified model.
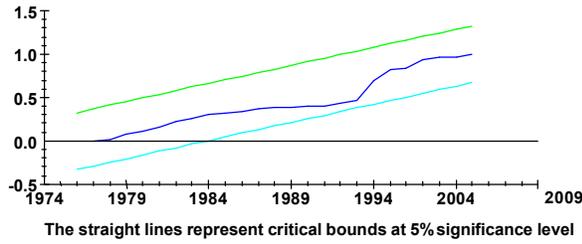
The straight lines represent critical bounds at 5% significance level

Fig. 2: Plot of Cumulative Sum of Squares of Recursive Residuals

CONCLUSIONS

The most important idea of the study is to evaluate the relationship among fdi, capital formation and CO_2 emissions along with some other controlled variables. Study used the ARDL model to investigate this relationship by taking data from 1974 to 2010 for Pakistan. Findings show that indicator of environmental quality CO_2 has a positive relationship with fdi in short duration and long duration. As developing economies have low environmental rules and regulations, firms from developed nation feel relax by facing low environmental restrictions. The results also have support of pollution heaven hypothesis.

However the coefficient and sign of capital formation shows that country can improve environmental condition by boosting the capital formation side. It will help the firms to get the less pollutant and environmental friendly technique, equipment and machinery as a result of capital formation. Broad money holds the positive sign for both short duration and long duration. For the betterment of environment quality, impact of domestic loans to private segment is algebraically suggestive in short period and long period with same sign and also indicates reduced CO_2 emissions.

Empirically findings facilitate the policy makers to take in account the impact of overseas direct evolvement in investment, assets formation and the set of controlled variables. As increasing rate of FDI deteriorate the environmental quality but at the same time capital formation can reduce CO_2 emissions. Although study has several limitations like FDI data was taken in aggregate form it's disaggregate form can provide more details. Moreover which type of capital formation is required for environmental improvements further research on these issues can provide more details to policy makers for best decisions.

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