Consequence of FDI on CO$_2$ emissions in case of Pakistan

Nadia Bukhari,
Kanwal Shahzadi and M. Shakil Ahmad

COMSATS Institute of Information Technology,
Department of Management Sciences, 43600, Attock, Pakistan

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.
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 foreign 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\textsubscript{2}. Findings of Pao and Tsai [25] mentioned that the FDI increase the energy consumption and take part in worsening the environment. Damijan \textit{et al}. [12] documented that FDI and emissions have unidirectional causality. Cole \textit{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:

\[ c_t = \beta_0 + \delta \text{fdi} + \alpha_2 cf + \epsilon_t \]  

Seeing as \( c \) is CO\textsubscript{2} emission per capita, \( \text{fdi} \) is foreign direct investment, \( cf \) explains the gross capital formation and \( \epsilon_t \) 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\textsubscript{2} emissions. Sign of \( \delta \) may be positive, as low abatement cost and environmental restrictions encourage international capital to relocate. Negative relationship can be expected for \( \alpha_2 \), as Grossman and Krueger [2] 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\textsubscript{2}O), methane (CH\textsubscript{4}), ozone (O\textsubscript{3}) and carbon dioxide (CO\textsubscript{2}) and Sulfur dioxide (SO\textsubscript{2}) and Nitrogen oxide (NO\textsubscript{x}) that contribute to global warming, but the share of CO\textsubscript{2} is large enough and comparatively more hazardous than others. CO\textsubscript{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\textsubscript{2} as an indicator of environmental quality. Further literature of Soytas and Sari [26]; Halicioglu [27]; Apergis and Payne [5] also consider CO\textsubscript{2} to substantiate the significance of the studies. In the assessment of environmental quality following research (Galeotti \textit{et al}. [28]; Zhang and Cheng [29] take CO\textsubscript{2} that is more appropriate indicator to analyze the environment. So this present study also considers CO\textsubscript{2} emissions to check the environmental quality. As during utilization of solid, liquid, gas fuels and gas burning due to increase activity of economy fabricate CO\textsubscript{2} emissions. Econometric rationale takes the per capita CO\textsubscript{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\textsubscript{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 stationarity 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 Johansen and Juselius’s procedure [33]. Accordingly ARDL frame of Equation (1) is specified under:

\[
\Delta c_t = \beta_0 + \sum_{i=1}^{p} \delta_i \Delta fdi_{t-i} + \sum_{i=1}^{p} \sigma_i \Delta cf_{t-i} + \sum_{i=1}^{p} \theta_i \Delta z_{t-i} + \lambda_0 fdi_{t-1} + \lambda_2 cf_{t-1} + \lambda_3 z_{t-1} + U_t
\]  

(2)

So \( \beta_0 \) 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 \( \lambda \) specifies the long run association. Initial task in ARDL process is bound analysis. So initially in the ARDL bounds analysis moves 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 test is 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. 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 (\( p + 1 \))' 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 Schwartz-Bayesian criteria (SBC) standard. By the establishment of long time information the short time information carried out on later stages that will helpful to specify the future adjustment with short time information.

\[
\Delta c_t = \beta_0 + \sum_{i=1}^{p} \delta_i \Delta fdi_{t-i} + \sum_{i=1}^{p} \sigma_i \Delta cf_{t-i} + \alpha ECM_{t-1} + U_t
\]  

(3)

In order to verify the goodness fit of the statistical calculated model heteroscedasticity 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.
Table 1: Unit Root Tests through Augmented Dickey Fuller Test

<table>
<thead>
<tr>
<th>Series</th>
<th>ADF</th>
<th>K</th>
<th>ΔADF</th>
<th>k</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>1.2183</td>
<td>0</td>
<td>-3.8609</td>
<td>0</td>
</tr>
<tr>
<td>FDI</td>
<td>-2.5273</td>
<td>0/1</td>
<td>-7.7509</td>
<td>0</td>
</tr>
<tr>
<td>CF</td>
<td>-3.6636</td>
<td>0</td>
<td>Δ CF</td>
<td>NA</td>
</tr>
<tr>
<td>DCPS</td>
<td>-2.5610</td>
<td>0</td>
<td>Δ DCPS</td>
<td>-5.2089</td>
</tr>
<tr>
<td>BM</td>
<td>-3.9572</td>
<td>1</td>
<td>Δ BM</td>
<td>-5.0917</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>F-Statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDI does not Granger Cause CO2</td>
<td>3.22032</td>
<td>0.0241</td>
</tr>
<tr>
<td>CO2 does not Granger Cause LFDI</td>
<td>0.73117</td>
<td>0.6201</td>
</tr>
<tr>
<td>CF does not Granger Cause LCO</td>
<td>4.4443</td>
<td>0.0043</td>
</tr>
<tr>
<td>CO2 does not Granger Cause LCF</td>
<td>0.4772</td>
<td>0.6715</td>
</tr>
</tbody>
</table>

Table 3: Long Run Assessments:

Dependent variable is the per capita CO2

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-states</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>4.1527</td>
<td>0.4719</td>
</tr>
<tr>
<td>Foreign direct investment</td>
<td>-0.0284</td>
<td>1.1128</td>
</tr>
<tr>
<td>Gross Capital formation</td>
<td>-3.3810</td>
<td>1.8395</td>
</tr>
<tr>
<td>Domestic credit to private sector</td>
<td>-4.2854</td>
<td>1.5282</td>
</tr>
<tr>
<td>Broad Money</td>
<td>4.8714</td>
<td>1.8395</td>
</tr>
</tbody>
</table>

Diagnostic Test Statistics (p-values)

- x2(Serial Correlation): 0.0334
- x2(Functional Form): 5.8201
- x2(Normality): 0.7706
- x2(Heteroscedasticity): 0.5320

Source: The author’s calculations

Table 4: Short Run Assessments:

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-states</th>
</tr>
</thead>
<tbody>
<tr>
<td>contan</td>
<td>-0.6462</td>
<td>-0.4392</td>
</tr>
<tr>
<td>Δ Foreign direct investment</td>
<td>0.0443</td>
<td>-0.1621</td>
</tr>
<tr>
<td>Δ Gross Capital formation</td>
<td>-0.0815</td>
<td>-0.2252</td>
</tr>
<tr>
<td>Δ Domestic credit to private sector</td>
<td>-0.5214</td>
<td>-1.8773</td>
</tr>
<tr>
<td>Δ Broad Money</td>
<td>0.7580</td>
<td>2.0480</td>
</tr>
<tr>
<td>ecm(-1)</td>
<td>-0.1556</td>
<td>-2.0617</td>
</tr>
</tbody>
</table>

Diagnostic Test Statistics (p-values)

- R2: 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 CO2 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 CO2. That implies FDI deteriorate the environment as multinational companies move to the 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 CO2 emission. If change in domestic credit to private sector is one percent it will change CO2 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 CO2 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 R2 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 most important idea of the study is to evaluate the relationship among FDI, capital formation and CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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.

REFERENCES


