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The Nexus of Foreign Direct Investment, Economic Growth and Environment in Pakistan

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This paper estimate the impact of sectoral FDI on economic growth and carbon dioxide emissions in Pakistan. To this end, it uses time series secondary data from 1972 to 2011 and applies Auto Regressive Distributed Lag (ARDL) models. The results showed that FDI inflows in manufacturing, transport, storage and communication sectors and energy consumption have positive effect on the GDP growth of Pakistan. Besides, FDI inflow in manufacturing, transport, storage and communication sector and population density are responsible for the CO_2 emissions in Pakistan. The results also validate Environmental Kuznet Curves in both long and short run.

JEL Classification: E2, O4, Q5
Keywords: Sectoral FDI, CO_2 emissions, Environmental Kuznet Curves, Gross Domestic Product Growth

1. INTRODUCTION

The growing concern for sustainable development diverted the world concentration from conventional growth to environmentally affable growth [Nasir and Rehman (2011)]. Environmental degradation has affected the economic activities in serious manner. This increase in environmental degradation is fueled by multi factors including the increasing trend of foreign direct investment [Mabey and McNally (1999)].

Foreign firms target developing countries that have low environmental standards, which attract investment in polluting sectors leading to "pollution heaven hypothesis"[1] [Chakraborty and Mukerjee (2010)]. Foreign firms choose to operate in developing countries in order to gain benefit from low cost of production which in turn effect environment negatively leading to "industrial flight hypothesis."[2] But not all the FDI inflow is bad for environment in developing world sometime it can be beneficial in form of "pollution holes hypothesis."[3] This means that even if we refuse these hypotheses

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[1]Companies move their official operations to less developed economies to take benefit of weak environmental laws or developing countries may put a low price on their environment to make new foreign investment much attractive, which leads to over use of natural resources and environmental degradation [Mabey and McNally (1999)].

[2]Companies move their operations to developing economies to take advantage of lower cost of production [Shahbaz, *et al.* (2011)].

[3]The foreign firms may use better management and advance technology that can result in clean environment in host country [Shahbaz, *et al.* (2011)].

there is considerable amount of environmental damage associated with FDI [Shahbaz, *et al.* (2011)].

When foreign investment and trade amplify, it leads to extend the net of economic activities. The increased level of economic activities result in environmental degradation, which leads to scale effect.[4] The emissions of CO_2 can be decreased by the use of environmental friendly technology imported by foreign investors, so the international investment and trade can lead to the environment friendly production, as the competition increase the domestic producer also try to focus on production and decrease per unit cost. This leads to technique effect.[5] The FDI can also alter the industrial configuration of the economy leading to composition effect[6] [Grossman and Krueger (1991)].

The FDI stimulates the domestic investment, human capital formation, facilitate the technology transfer. Hence, the foreign direct investment is considered as growth enhancing factor in developing countries [Acharyya (2009); Falki (2009) and Asghar, *et al.* (2011)]. FDI inflows have helped in boosting the economic growth through structural makeover of the economy of Pakistan. It also helped in initiating the industrial sector as well as lying foundations for agricultural sector, supplied modern technology and technical support [Din (2007)].

There is inverted "U" shape relationship between environmental degradation and economic growth, when economic growth increases, income also increases which affect the environment negatively. As a result of increased growth, the economy expands and income rises. At high level of income people are more conscious about environment so they demand to maintain clean environment. This relationship is called as "Environmental Kuznets Curves" (EKC) [Grossman and Krueger (1991)]. The same idea is also supported by Seldon and Song (1994).

Different sectors have different effects on the economic growth [Alfaro (2003)]. The type of FDI and sector in which it is going is very important from both environmental degradation and economic growth point of view. In this paper Carbon dioxide emissions are used as variable representing environmental degradation and GDP to represent economic growth. The FDI affect both environment and the economic growth. To test the Environmental Kuznets Curve (EKC), many researchers have used Carbon dioxide emissions as indicator for environmental quality.

There is very little work done on the sector specific FDI, economic growth and environmental degradation. Therefore, this paper contributes to empirically check the effect of sector specific FDI on economic growth and environment followed by checking the existence of EKC in Pakistan. For the analysis three sectors have been selected namely, manufacturing sector, mining and quarrying sector and transport, storage and communication sectors. Only those sectors are selected that have high actual emissions (emission per unit of output).

In the past researchers tried to relate FDI with other economic variables. Besides, they highlighted various influencing factors of economic growth. Falki (2009) examines

[4]When trade cause the expansion of economic activity thus trend to increase pollution [Dietzenbacher and Mukhopadhyay (2007)].

[5]Trade can induce technological spillovers that can lead to the adoption of ''cleaner'' production techniques by host countries [Dietzenbacher and Mukhopadhyay (2007)].

[6]It is the change in the share of dirty goods in GDP, because of a price change favouring their production [Acharrya (2009)].

the effect of total FDI on economic growth of Pakistan. The sector of economy in which FDI is coming is very important with relationship to economic growth. The outcomes in terms of economic growth can vary from sector to sector and can be misleading if total FDI is used [Wang (2009)]. Studies by Alfaro (2003); Ganges, *et al.* (2006); Chakraborty and Nunnenekamp (2007) and Wang (2009)] found out that manufacturing sector contribute positively towards economic growth, whereas there are insignificant contribution of primary sector and ambiguous contribution of services sector towards economic growth. Labour force and FDI have an important interaction and labour force play an important role in the absorption of FDI [Borenztein, *et al.* (1998)]. Energy consumption is a vital determinant of economic growth as it is considered as an engine of economic progress [Lee and Chang (2008)]. Economic growth and environmental degradation is the area of concern from early1990s, FDI tends to increase the level of economic activity which a leads to environmental degradation [Pao and Tsai (2010); Zhang, *et al.* (2011); Merican, *et al.* (2007) and Mulali (2012)]. Environmental degradation is also related to population density and the increase in population density trends to increase environmental degradation [Shi (2003)].

For understanding the costs and benefits of FDI in terms of economic growth and environmental degradation, it is critical to study their nexus. The studies of Baek and Kon (2008); Acharyya (2009) and Honglei, *et al.* (2011) are worth mentioning who explored the presence of "Pollution Heaven Hypothesis" and EKC's. The relationship between the economic growth and environmental degradation was first floated by Grossman and Krueger (1991) followed by Selden and Song (1994). Different studies on EKC's have been included in this regard are Lindmark (2002); Fodhaa and Zaghdoud (2011); Nasir and Rehman (2011); Shahbaz, *et al.* (2011) and Hitam and Borhan (2012). The studies regarding EKC's use different indicators for environmental degradation like CO_2 and SO_2. Nasir and Rehman (2011) and Shahbaz, *et al.* (2011), explored the validity of EKC for Pakistan but with the nexus of energy consumption, economic growth and total FDI.

2. THEORETICAL BACKGROUND

2.1. FDI Inflow and Carbon Dioxide Emissions Model

According to Dasgupta, *et al.* (2002) "The environmental Kuznets curve posits an inverted-U relationship between environmental degradation and economic development. Kuznets' name was apparently attached to the curve by Grossman and Krueger (1991), who noted its resemblance to Kuznets's inverted-U relationship between income inequality and development." The relationship between environmental degradation and economic growth can be expressed as:

$$Z_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 Y_t^2 + e_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Where Z_t can be any variable which represent environmental degradation and Y_t can be any variable which represent economic growth. The linear and nonlinear terms of economic growth are added in order to check the validity of EKC. Theoretically if the coefficients of Y are positive and that of Y^2 is negative; it validates the existence of the EKC hypothesis [Shahbaz, *et al.* (2011)].

To check the impact of sectoral FDI on Carbon dioxide emission, the additional variables namely FDI in manufacturing, FDI in mining and quarrying, FDI in transport, storage and communication sector are added to the model. The population density is added to the existing model because population density is related to Carbon dioxide emissions [Shi (2003)]. The final model is as follows:

$$mt_t = f\ (g_t, g_t^2, man_t, mn_t, tr_t, pd_t, D, e_t) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Where

mt_t is Carbon dioxide emissions in year t measured in metric ton per capita.
g_t is Real GDP per capita in year t and measured in million rupees.
g_t^2 is square term of real GDP per capita in year t and measured in million rupees.
man_t is FDI inflow in manufacturing sector in year t measured in million rupees.
mn_t is FDI inflow in mining and quarrying sector in year t measured in million rupees.
tr_t is FDI inflow in transport, storage and communication sector in year t measured in million rupees.
pd_t is population density in year t measured in per square km of land area.

Whereas D is dummy variable which represent structural breaks namely in year (1994, 2000, 2005, 2007, 2008, and 2009) in sectoral FDI data. e_t is error term.

2.2. FDI Inflow and GDP Growth Model

The neoclassical economist gave the theory of output (production) function as follows;

$$Y = Af(K, L) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Equation 3 represents Cobb Douglas production function where K represents capital and L represents Labour. Energy variable was first added to the economic theory by Roegen (1975). Then Kraft and Kraft (1978) was first to use energy consumption variables in production function. Further FDI is used in sectoral form in this study because different sectors have different effects on economic growth. Borensztein, *et al.* (1998) stressed on the importance of human capital because it plays very important role in the absorption of foreign direct investment, this is the reason for the inclusion of labour force in the model.

The model is as follows

$$GDP_t = f\ (man_t, mn_t, tr_t, lab_t, ene_t, D, e_t) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

Where;

GDP_t is gross domestic product in year t measured in million rupees.
man_t is FDI inflow in manufacturing sector in year t and measured in million rupees.
mn_t is FDI inflow in mining and quarrying sector in year t measured in million rupees.
tr_t is FDI inflow in transport, storage and communication in year t measured in million rupees.

ene_t is energy consumption in year t measured in million metric tons of oil equivalent.

lab_t is labour force in year t measured in millions.

Whereas D is dummy variable which represent structural breaks namely in year (1994, 2000, 2005, 2007, 2008, and 2009) in sectoral FDI data. e_t is error term.

3. DATA AND METHODOLOGY

3.1. Data and Sources

The data used in this study is time series from1972 to 2011. Data on per capita CO_2 emissions, population density is obtained from World Development Indicators (WDI). The data for the energy consumption is taken from Statistical, Economic and Social Research and Training Centre for Islamic Countries (SESRIC). While the data for the labour force, real per capita GDP, real GDP and sectoral FDI is taken from State Bank of Pakistan (SBP).

3.2. Methodology

3.2.1. *Test of Stationarity*

Augmented Dickey Fuller (ADF) test is widely used to identify the order of integration I(d) of variables. The general form of Augmented Dickey Fuller test is

$$\Delta X_t = \alpha + \beta t + \varphi X_{t-1} + \theta_1 \Delta X_{t-1} + \theta_2 \Delta X_{t-2} \ldots\ldots\ldots \theta_p \Delta X_{t-p} + \varepsilon_t \quad \ldots \quad \ldots \quad (5)$$

Where, X_t denotes the time series variable to be tested, used in model. t is time period, Δ is first difference and φ is root of equation. βt is deterministic time trend of the series and α denotes intercept. The numbers of augmented lags (p) determined by the dropping the last lag until we get significant lag. The Augmented Dickey Fuller unit root concept is illustrated through equation $\Delta X_t = (\rho - 1) X_{t-1} + \varepsilon_t$, Where, $(\rho - 1)$ can be equal to φ, if $\rho = 1$ so series has the unit root, so root of equation is $\varphi = 0$.

3.2.2. *Test of Cointegration*

For finding the cointegration among the variables, Pesaran, *et al.* (2001) has proposed bound test through ARDL approach to test the co-integration. Through ARDL bound testing approach, the long run and short run dynamic association between the variables can be estimated at a same time by estimating the unrestricted error correction model (UECM).

Following is the general form of ADRL model of co-integration or UECM;

$$\Delta Y = c + \beta t + \lambda_y Y_{t-1} + \varphi_x X_{t-1} + \sum_{i=1}^{n} \gamma \Delta Y_{t-i} + \sum_{i=0}^{n} \delta \Delta x_{t-i} + u_t \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

Where; Y is dependent variable and X is vector of independent variables, Pesaran, *et al.* (2001). Following two hypotheses will be tested to check the co-integration between variables. u_t is normally distributed with zero mean and constant variance $(0, \sigma^2)$. We have applied the restrictions on Equation 6 to check the following hypotheses.

$H_0^1 : \varphi_x X_{t-1} = 0$ ($\varphi_x X_{t-1}$ is of lag of independent variables equal to zero)

H_0^2: $\lambda_y Y_{t-1}=0$ ($\lambda_y Y_{t-1}$ dependent variable lag equals to zero)
H_0: $H_0^1 \cap H_0^2$
H_a: $H_0^1 \cup H_0^2$

We check H_0^1 and H_0^2 jointly. First to check the co-integration joint hypothesis; H_0 is tested through F-statistics, by comparing with critical values of F for bound test [Pesaran, *et al.* (2001)]. There are two bound for each level of significance, I (1) upper bound and I (0) lower bound. If F-statistics lies outside the upper bound I (1), the null of hypotheses is rejected. If it lies below the lower bound I (0), the null hypothesis cannot be rejected and if it lies between the two bound then results are inconclusive.

In next step log run estimates can be calculated from UECM by normalising the variables.

$$Y_t = c+\beta t+ \varphi_x X_{t-1}+ \mu_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

Where; c is constant and βt is trend. $\varphi_x X_{t-1}$ is vector of independent variables. Finally, short run dynamics are estimated from the UECM as follows;

$$\Delta Y = c + \beta t+\sum_{i=1}^{n} \gamma \Delta Y_{t-1} +\sum_{i=0}^{n} \delta \Delta x_{t-1}+ECT_{t-1} + u_t \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

So finally UECM for FDI inflows and CO_2 can be estimated as follows:

$$\begin{aligned}\Delta mt_t = {} & a_0 + \beta t+a_1 mt_{t-1}+ a_2 g_{t-1} + a_3 g^2_{t-1} + a_4 man_{t-1} + a_5 mn_{t-1} + a_6 tr_{t-1} + a_7 pd_{t-1} + \\ & \sum_{i=1}^{n} \delta_1 \Delta mt_{t-i}+\sum_{i=0}^{n} \delta_2 \Delta g_{t-i}+\sum_{i=0}^{n} \delta_3 \Delta g^2_{t-i}+\sum_{i=0}^{n} \delta_4 \Delta man_{t-i}+\sum_{i=0}^{n} \delta_5 \Delta mn_{t-i} \\ & +\sum_{i=0}^{n} \delta_6 \Delta tr_{t-i} +\sum_{i=0}^{n} \delta_7 \Delta pd_{t-i} + \sum_{i=1}^{n} \omega D_i + \mu_t \quad \ldots \quad \ldots \quad \ldots \quad (9)\end{aligned}$$

a_0 and β are the intercept and trend respectively. Whereas a_1 to a_7 are the long run coefficients and δ_1 to δ_7 are short run coefficients. ω is the coefficient of dummy variable and μ_t error term.

UECM for FDI inflows and GDP growth can be estimated as follows:

$$\begin{aligned}\Delta GDP_t = {} & a_0 + \beta t+a_1 GDP_{t-1}+ a_2 man_{t-1} + a_3 mn_{t-1} + a_4 tr_{t-1} + a_5 lab_{t-1} + a_6 ene_{t-1} + \\ & \sum_{i=1}^{n} \delta_1 \Delta GDP_{t-i}+\sum_{i=0}^{n} \delta_2 \Delta man_{t-i}+\sum_{i=0}^{n} \delta_3 \Delta mn_{t-i}+\sum_{i=0}^{n} \delta_4 \Delta tr_{t-i}+ \\ & \sum_{i=0}^{n} \delta_5 \Delta lab_{t-i}+ \sum_{i=0}^{n} \delta_6 \Delta ene_{t-i}+\sum_{i=1}^{n} \omega D_i + \mu_t \quad \ldots \quad \ldots \quad (10)\end{aligned}$$

a_0 and β are the intercept and trend respectively. Whereas a_1 to a_6 are the long run coefficients and δ_1 to δ_7 are short run coefficient. ω Coefficient of dummy variable and μ_t error term.

3.3. Bound Test Procedure

The first step in the ARDL bounds testing approach is to estimate Equation (9 and 10) by ordinary least squares (OLS) in order to test for the existence of a long-run relationship among the variables by conducting an F-test for the joint significance of the coefficients of the lagged levels of the variables, i.e., H_0: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$ against the alternative H_1 : $\delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq 0$. We denote the test which normalise on *mt* by F_{mt} (*mt/c,t, g, g*^{2}*, man, mn, tr, pd*) and normalised on GDP by F_{GDP} (*GDP/c, t, man, mn, lab, ene*) for second model. A symptotic critical values bounds provide a test for co-integration when the independent variables are I(d) (where $0 \leq d \leq 1$): a lower value assuming the regressors are I(0) and an upper value assuming purely I(1) regressors. If the F-statistic

is above the upper critical value, the null hypothesis of no long-run relationship is rejected. Conversely, if the test statistic falls below the lower critical value, the null hypothesis cannot be rejected. Finally, if the statistic falls between the lower and upper critical values, the result *b* inconclusive.

In the second step, once co-integration is established the conditional *ARDL* (p_1, q_1, q_2, q_3, q_4) long model for the dependent variable is estimated. The long run model of FDI inflow and CO_2 emission is as follows:

$$\Delta mt_t = a_0 + \beta_t + a_1 mt_{t-1} + a_2 g_{t-1} + a_3 g^2_{t-1} + a_4 man_{t-1} + a_5 mn_{t-1} + a_6 tr_{t-1} + a_7 pd_{t-1} + \omega D_t + \mu_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (11)$$

Long run model of FDI inflow and GDP growth is as follows:

$$\Delta GDP_t = a_0 + \beta t + a_1\, GDP_{t-1} + a_2\, man_{t-1} + a_3 mn_{t-1} + a_4 tr_{t-1} + a_5 lab_{t-1} + a_6 ene_{t-1} + \omega D_t + \mu_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (12)$$

Short run dynamics of FDI inflows and Carbon dioxide emissions is as follows:

$$\Delta mt = \sum_{i=0}^{n} \delta_2 \Delta g_{t-i} + \sum_{i=0}^{n} \delta_3 \Delta g^2_{t-i} + \sum_{i=0}^{n} \delta_4 \Delta man_{t-i} + \sum_{i=0}^{n} \delta_5 \Delta mn_{t-i} + \sum_{i=0}^{n} \delta_6 \Delta tr_{t-i} + \sum_{i=0}^{n} \delta_7 \Delta pd_{t-i} + ECT_{t-1} + \sum_{i=1}^{n} \omega D_i + \mu_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (13)$$

Short run dynamics of FDI inflow and economic growth is as follows:

$$\Delta GDP = \sum_{i=0}^{n} \delta_2 \Delta man_{t-i} + \sum_{i=0}^{n} \delta_3 \Delta mn_{t-i} + \sum_{i=0}^{n} \delta_4 \Delta tr_{t-i} + \sum_{i=0}^{n} \delta_5 \Delta lab_{t-i} + \sum_{i=0}^{n} \delta_6 \Delta ene_{t-i} + ECT_{t-1} \sum_{i=1}^{n} \omega D_i + \mu_t. \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (14)$$

4. RESULTS AND DISCUSSION

It can be seen from Table 1 that FDI in manufacturing sector (man), FDI in mining and quarrying sector (mn) and population density (pd) are stationary at level whereas Carbon dioxide emissions (mt), Gross Domestic Product (GDP), real GDP per capita (g), Square of GDP per capita(g^2), FDI in transport, storage and communication (tr), Energy consumption (ene) and labour force (lab) are stationary at first difference. The results explores that the order of differencing of these variables are not the same, so ARDL model is appropriate to use.

Table 1

Stationarity Results of the Study Variables

Variables	ADF Test Statistics		Order of Integration I(d)
	Level	First Difference	
Mt	–3.02	–7.94***	I(1)
GDP	–1.06	–3.93**	I(1)
G	–2.15	–4.27***	I(1)
g^2	–1.55	–3.90***	I(1)
Tr	2.80	–12.76***	I(1)
Man	–4.16***	–3.21	I(0)
Mn	–3.46**	–2.91	I(0)
Pd	–3.84***	–2.91	I(0)
Ene	–2.63	–5.16***	I(1)
Lab	0.02	–6.57***	I(1)

Note: *,**,*** 10 percent, 5 percent and 1 percent level of significance respectively. Both trend and intercept are included in checking stationarity except for "pd" where only intercept is taken.

4.1. ARDL Model for FDI Inflow and Carbon Dioxide

First the UECM is estimated that contains Carbon dioxide emissions per capita as dependent variable as shown in Table 2. The estimated UECM is given below which includes long run as well as short run coefficients. This is parsimonious form of equation, from which insignificant terms are deleted. The outcome of test depends on the lag selection that is p=1, selected on the basis of AIC (Akaike criterion). In the model dummy variables are also included to check the impact of structural breaks in data. The significant dummies were in year 2007 and 2008. The year 2007 dummy represent structural break in FDI inflow in transport, storage and communication sector. The year 2008 dummy show structural break in FDI inflow manufacturing sector. Both dummies are significant. As stated by the Board of Investment Pakistan, Foreign direct investment inflow in the country was at 485 million dollars during 2001-02, following which there was a rise in FDI inflow in the country for the subsequent six years. The FDI inflow spiked in the year 2007-08, attaining a massive level of 5409 million dollars. After that, there was a gradual fall till 2011-12 level. If the spike through 2007-08 is taken as a point of reference among 2001 and 2012, 10–15 percent increase was recorded till 2007-08, after that there was a decline of 89 percent till 2011-12. One of the reasons was the democratic government in Pakistan which gained foreign confidence and engrossed foreign direct investment in Pakistan. Secondly the democratic government failed to solve the problems of the energy sector. Energy crisis has increased in the past three years. Continuous power cut downs and riots took place in Pakistan, specifically at

Table 2

Results of UECM for the Impact of FDI Inflow on Carbon Dioxide Emissions

Dependent Variable = Δmt (Metric Ton Per Capita)			
	Coefficient	t-stat	P values
Constant	–1.05	–4.35	0.00
mt_{t-1}	–0.78	–6.89	0.00
g_{t-1}	–56.17	–5.83	0.00
g^2_{t-1}	268.9	2.54	0.01
mn_{t-1}	–0.000919	–1.53	0.13
man_{t-1}	–0.000785	–2.08	0.04
tr_{t-1}	–0.000866	–2.44	0.00
pd_{t-1}	–0.011	–4.00	0.00
Δmt_{t-1}	0.43	2.59	0.01
Δg	19.6	3.27	0.00
Δg^2_{t-1}	–461.04	–2.83	0.00
Δtr	0.00517	2.08	0.04
Δman_{t-1}	0.0078	3.75	0.00
Δpd	0.10	3.77	0.00
Δpd_{t-1}	0.0887	3.87	0.00
D_{2007}	0.150	2.01	0.05
D_{2008}	0.059	3.89	0.00
Breusch-Godfrey Serial Correlation LM Test, F-statistics		0.02 (0.86)	
R-square		0.70	

Punjab. This situation influenced all economic sectors from manufacturing sector to transport sector, where FDI inflow was concentrated. After estimating the UECM, long run relationship has been checked, through testing the hypothesis that $H0:\beta=a_2=a_3=a_4=a_5=a_6=a_7=a_8=0$ by applying the F-test on lagged variables and comparing its values with the critical bound values provided by Pesaran, *et al.* (2001). The F calculated F =12.8. As there are k = 6, the F_{III} (unrestricted intercept and no trend) has critical values of upper I (1) and lower bound I (0) that are (2.45 3.61), so calculated F is greater than the upper bound critical value.

4.1.1. *Normalisd Long Run Estimates*

In the next step, long run equation is estimated whose coefficients are estimated by normalising it on dependent variable (mt). The normalised long run estimates are given in Table 3 which shows that one million rupees rise in GDP per capita income will increase per capita Carbon dioxide emissions by 72.01 metric ton per capita. The coefficient is also significant at 1 percent level of significance. The long run results are also in line with the study conducted by Fodha and Zaghdoud (2011).

The results shows that one million rupees increase in FDI inflow in transport, storage and communication sector will increase Carbon dioxide emissions by 0.0011 metric ton per capita. The coefficient of transport, storage and communication (tr) is also significant at 1 percent level of significance and results are also in line with the study done Gallagher (2004). According to Gallagher (2006) "the increased emissions from transport sector mainly depended on the non-provision of clean technologies by the foreign firms" (pp. 28). Transport sector have high emissions rate amongst all sectors and accountable for quarter of CO_2 emissions in Pakistan. Emissions control in transport sector is decisive for management of Climate Change [Draft National Climate Change Policy (2011)].

Besides, one million rupees increase in mining and quarrying sector will increase emissions by 0.0013 metric ton per capita but coefficient of mining and quarrying sector (mn) is insignificant at 1 percent, 5 percent and 10 percent level of significance. Similarly if FDI inflow in manufacturing sector increases by one million rupees the Carbon dioxide emissions will increase by 0.0012 metric ton per capita. The coefficient of manufacturing sector (man) is also statistically significant at 1 percent level of significance. The results are also in line with the study done by Jorgenson (2007). In developing countries the foreign firms use more pollution technology both in manufacturing sector and in transport sector [Jorgenson (2007)]. The results may also get support from that only Carbon dioxide emissions from the manufacturing sector in Pakistan stands at 42.2 (million metric tons) in year 2011. Further it is also suggested that the industrial sector contribute positively towards Green House Gases (GHG) [Draft National Climate Change Policy (2011)].

The results show that if the population density is increased by one unit then the emissions will increase by 0.014 metric ton per capita. Similar results were also found by Shi (2003) who proposed that population density is positively related with the Carbon dioxide emissions in long run.

Pakistan is in the list of most vulnerable countries against climate change. The recent United Nations Framework Convention on Climate Change (UNFCCC) Paris

conference 2015 has agreed to set-up a special "Technology development and transfer mechanism" for the development and transfer of new technologies from developed to developing countries [Draft Paris outcome (2015)]. In case of Pakistan there is lack of policy regarding the clean technology transfer through FDI in manufacturing, mining and quarrying and transport, storage and communication sectors. There is lack of mechanisms which can keep a check and balance on the capital equipment coming in the form of FDI.

The aforementioned discussion confirms the effect of sectoral FDI on environmental degradation in terms of Carbon dioxide emissions. Furthermore, the results show that the sign of variable (g) is positive and sign of variable (g^2) is negative which validate the existence of Environmental Kuznets Curves. The results for the Environmental Kuznets Curves are in line with the study done by Nasir and Rehman (2011).

Table 3

Normalised Long Run Results for the Impact of FDI Inflows on Carbon Dioxide Emissions

Dependent Variable= Carbon Dioxide Emissions in Metric Tons Per Capita (mt)			
	Coefficient	t-stats	P values
Constant	1.35	4.35	0.00
g_t	72.01	5.83	0.00
g^2_t	–344.74	–2.54	0.01
Tr_t	0.0011	2.44	0.00
Mn_t	0.0013	1.53	0.13
Man_t	0.0012	2.08	0.04
Pd_t	0.014	4.00	0.00
D_{2007}	0.150	2.01	0.05
D_{2008}	0.059	3.89	0.00

4.1.2. *Short Run Estimates*

Short run estimates of ARDL are given in Table 4. The coefficient of Error Correction Term (ECT) is significant and negative. The estimated coefficient of ECT shows disequilibrium is corrected or adjusted with the speed of 78 percent in-between one year. The significance ECT also confirms the long run relationship of variables as estimated earlier. According to short run results, the Δg is positively associated with the Carbon dioxide emissions in Pakistan and these results are also in line with the study by Fodha and Zaghdoud (2011). The first lag of FDI inflow in manufacturing sector (Δman_{t-1}) affect the Carbon dioxide emissions in short run also. This means that previous year FDI in this sector will affect Carbon dioxide emissions in current year. This is valid because FDI from the previous year will also produce CO_2 emissions, therefore adding to current year amount of emissions produced, the coefficient of (Δman_{t-1}) is also statistically significant at 1 percent level of significance. Δtr is also positively related to CO_2 emissions in short run. While results also showed that difference and first lag of population density are also positively related to the Carbon dioxide emissions in short run both of the coefficients are statistically significant at 1 percent level of significance. The results for population density are also in line with the study done by Shi (2003). While interestingly the EKC exist in short run also.

Table 4

Short Run Results of Impact of FDI Inflows on Carbon Dioxide Emissions

Dependent Variable = Δmt			
	Coefficient	t stats	P values
Constant	–1.05	–4.35	0.00
Δg	19.6	3.27	0.00
Δg^2_{t-1}	–461.04	–2.83	0.00
Δtr	0.0052	2.08	0.04
Δman_{t-1}	0.0078	2.01	0.05
Δpd	0.10	3.75	0.00
Δpd_{t-1}	0.088	3.88	0.00
D_{2007}	0.150	2.01	0.05
D_{2008}	0.059	3.89	0.00
ECT	–0.78	–6.89	0.00

4.2. ARDL Results for the Impact of FDI Inflows on GDP Growth

First the UECM is estimated, that contains GDP as dependent variable. The estimated UECM is given in Table 5 which includes long run as well as short run coefficients. This is parsimonious form of equation, from which insignificant terms are deleted. The outcome of test depends on the lag selection that is p = 2, selected on the bases of Akaike Info Criteria (AIC). In the model dummy variables are also included to check the impact of structural breaks in data. Different dummies were added to capture the effect of structure break. The significant dummies were in year 2007 and 2008.

Table 5

Results of UECM for the Impact of FDI Inflow on GDP Growth

Dependent Variable = Δmt			
	Coefficient	t stats	P values
Constant	–92.25	–2.88	0.00
GDP_{t-1}	–0.22	–2.74	0.00
mn_{t-1}	–13.45	–1.55	0.14
man_{t-1}	–5.34	–2.40	0.02
tr_{t-1}	–42.6	–5.83	0.00
ene_{t-1}	–0.12	–2.56	0.01
lab_{t-1}	0.03	0.71	0.48
Δman	7.44	4.24	0.00
Δtr	3.23	1.95	0.06
Δlab_{t-2}	–0.28	–3.41	0.00
Δtr_{t-2}	51.26	5.32	0.00
Δene_{t-2}	0.38	6.78	0.00
D_{2007}	0.73	2.34	0.03
D_{2008}	0.50	4.41	0.00
Breusch-Godfrey Serial Correlation LM Test, F-statistics			0.07(0.72)
R-square			0.93

After estimating the UECM, long run relationship has been checked, through testing the hypothesis that $H0:\beta=a_2=a_3=a_4=a_5=a_6=a_7=a_8=0$ by applying the F-test on lagged variables and compared its values with the critical values bound provided by Pesaran, *et al.* (2001). As the value of F is 15.21, k is 5, the F_{III} (Unrestricted intercept and no trend) has critical values of upper I (1) and lower bound I (0) that are (2.96 4.81), so the null hypothesis H_0, that there is no co-integration is rejected at, 0.05 level of significance. This further concludes existence of co-integration.

4.2.1. *Long Run Estimate*

The results show that if FDI in manufacturing sector is increased by one million rupees, the GDP will increase by 24.27 million rupees. The coefficient of FDI inflow in manufacturing sector (man) is also statistically significant at 1 percent level of significance and it is positively related to GDP growth in long run (Table 6). The results are also in line with the study conducted by Chakraborty and Nunnekamp (2008).

The results further showed that one million increases in FDI inflow in mining and quarrying sector will increase GDP by 61.33 million rupees. The coefficient of FDI inflow in mining and quarrying sector (mn) is statistically insignificant at 1 percent, 5 percent and 10 percent level of significance. There is no significant relationship between the FDI inflow in mining and quarrying sector and economic growth, that is because of the fact that when foreign investment is involved in this sector foreign firms take lions share from the host countries that's the reason that FDI in this sector does not contribute towards economic growth. The results are also in line with the study by Chakraborty and Nunnekamp (2008).

Further results showed that one million rupees increase in FDI inflow in transport, storage and communication sector will increase GDP by 193.43 million rupees. The coefficient of FDI inflow in transport, storage and communication sector (tr) is also statistically significant at 1 percent level of significance. Similar result was also found by Gangnes, *et al.* (2006).

One million increases in labour force variable will decrease GDP by 0.13 million rupees. Labour can contribute negatively towards GDP growth, this happens when labour is not efficient. This idea was also supported by Khan and Qayyum (2007).

Table 6

Normalised Long Run Results for the Impact of FDI on GDP Growth

Dependent Variable= GDP (Million Rupees)			
	Coefficient	t stats	P values
Constant	419.3	2.88	0.00
Man_t	24.27	2.40	0.02
Mn_t	61.33	1.55	0.14
Tr_t	193.43	5.83	0.00
Ene_t	0.54	2.56	0.01
Lab_t	–0.13	–0.71	0.48
D_{2007}	0.73	2.34	0.03
D_{2008}	0.50	4.41	0.00

Results showed that increase of one million metric tons of oil equivalent in energy consumption will increase GDP by 0.54 million rupees. This shows a positive relationship among energy consumption variable and GDP growth variable, further the coefficient of energy consumption (ene) is statistically significant at 1 percent level of significance. The results are also in accordance with the results of Glasure (1998) and lee and Chang (2008).

4.2.2. *Short Run Estimates*

Short run estimates of ARDL are given below in Table 7. The ECT is significant and negative. The estimated coefficient of ECT shows disequilibrium is corrected or adjusted with the speed of 22 percent in-between one year. The significance ECT also confirms the long run relationship of variables as estimated earlier. The results showed that FDI inflow in manufacturing sector and transport, storage and communication sector contribute positively towards GDP in short run also. The difference and second lag of variable transport, storage and communication sector (tr) is statistically significant at 10 percent and 1 percent level of significance which shows that FDI inflow in this sector is positively related to GDP increase in short run. This argument is valid because services sector is the largest contributor towards Pakistan's GDP [Economic Survey of Pakistan (2011)]. When the investment in this sector take place the effect can be seen in GDP growth after one or two year that is the reason that second lags of variable (tr) is statistically significant. The investment made in this sector affect the GDP in coming years also.

Further the energy consumption is also positively associated with the increase in GDP in short run. The variable of energy consumption is also statistically significant at 1 percent level of significance. The short run results of energy consumption are also in line with the results of Lee and Chang (2008). Interestingly the second lag of labour force is negatively affecting the GDP; the coefficient of second lag of labour force is also statistically significant at 1 percent level of significance. This happen due to labour inefficiency in Pakistan. This demands human capital growth in the country.

Table 7

Short Run Results of Impact of FDI Inflows on GDP Growth

ΔGDP= Gross Domestic Product (Million Rupees)			
	Coefficient	t stats	P values
Constant	–92.25	–2.88	0.00
Δman	7.44	4.24	0.00
Δtr	3.23	1.95	0.06
Δlab_{t-2}	–0.28	–3.41	0.00
Δtr_{t-2}	51.26	5.32	0.00
Δene_{t-2}	0.38	6.78	0.00
D_{2007}	0.73	2.34	0.03
D_{2008}	0.50	4.41	0.00
ECT	–0.22	–2.74	0.00

5. CONCLUSION AND POLICY IMPLICATION

This study examined the effect of FDI inflow on Carbon dioxide emissions and GDP growth and checked the validity of EKC hypothesis in Pakistan for the time period of 1972–2011. Per capita Carbon dioxide emissions was used as indicator of environmental degradation and real GDP as economic growth. The ARDL model was employed for the estimation purposes. The findings revealed that FDI inflow in manufacturing sector, transport, storage and communication sector and population density have positive impact on the environmental degradation in the long run. The EKC hypothesis is also valid in the long-run for Pakistan. Further, population density, FDI inflow in transport, storage and communication sector and manufacturing sector variables add significantly to the deterioration of environment in the short-run also. The EKC hypothesis is valid in the short-run also. Furthermore, the coefficient of FDI inflow in manufacturing sector, transport, storage and communication sector and energy consumption are statistically significant and these are the major influencing factors of GDP growth.

To protect environment from increasing Carbon dioxide emissions, the government should consider sector specific FDI inflow in the economy in their policy. Special attention should be given to population control to lessen the pressure on the increasing Carbon dioxide emissions in the country. Furthermore, to stimulate economic growth in both short and long run, the FDI inflow in manufacturing and transport, storage and communication sector must be promoted. The government must also invest in human capital. This will not only increase the labour productivity but also the quality of the labour.

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