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Impact of Trade Liberalization and Corruption on Environmental Degradation in Pakistan

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Abstract The present study revealed the impact of trade liberalization and corruption on environmental degradation. Yearly data were used from 1980 to 2011 for estimation. Air and water pollution were used as the environmental indicators. First model confirmed the evidence of the EKC. Trade liberalization and corruption index were used as the explanatory variables. Income per capita, square of income per capita, industrial value added, secondary school enrollment, law and order index and fertilizer use were used as control variables. Augmented Dickey Fuller (ADF) test was applied to check the stationarity level of each variable included in the model. Autoregressive Distributed Lag (ARDL) was applied to find empirical results. Some policies were suggested on the base of empirical findings.

Keywords: *Trade liberalization, Corruption, Environmental degradation*

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1. Introduction

Growth and development are the cherished goals of every government. Various policies are adopted leading to increase in production both in agricultural and industrial sectors, boost the trade, gains competitiveness and build related infrastructure. Growth and environmental degradation have become the most controversial issue now. The consequences of environmental degradation are non adoption of proper remedies. Either some penalty imposes to compensate the environment or to stop the production at some certain level but mostly developing nations remain unconscious about their environment they suffered more (Wilson *et al.*, 2002) [25]. Environment condition has become more flimsy in developing countries. Unconscious use of natural resources and non-sustainability of the environment has become a danger for economies.

The relationship between income and environment is explained by an inverted U shape Environmental Kuznets Curve (EKC). Kuznets (1955) has introduced this relation but after the study of Grossman and Kruger (1991) it is known as the EKC, at an earlier stage of development environment degrades but improves after a certain level (Yandle *et al.*, 2002) [26]. The environment and income had inverse relation; inverted U shape EKC (Cole 2004, Copeland 2005, Haisheng *et al.*, 2005, Jessie *et al.*, 2006, Dutt 2009 and Sanglimsuwan 2011) [6,7,9,15,16,22]. The environment and income relation is inconclusive (Stern, 2004) [24].

Trade liberalization is undesirable for each economy because it promotes economic growth with resource depletion and environmental degradation that is increasing environmental costs (Esty, 2001) [11]. Trade has positive and contravening impact; FEH and PHH respectively (Ederington *et al.*, 2004, Mukhopadhyay and Chakraborty 2005, Feridum 2006 and Mukhopadhyay 2006) [10,12,18,19]. Increases in industrial production boost the emission of noxious gases and environment quality decrease. Emission of SO_2, NO_2 and toxic chemicals also increased because of trade openness (Beghin et al., 1997) [4]. A country may involve in dirty technology in order to expand the economy (Antweiler *et al.*, 1994) [2]. Emission of toxic chemicals has become a negative externality and pigovian tax is levied on dirty industry to control this externality efficiently (Krutilla, 1991) [17]. Trade is beneficial for the environment because of free factor mobility, democracy and international standards of production must be followed by firms (Damania *et al.*, 2003, Frankel and Rose 2005, Azhar *et al.*, 2007 and Rehman *et al.*, 2007) [3,8,13,21].

Further, adequate governance is also a considerable component of environmental degradation and demolishing of natural resources. High degree of corruption relaxed the environmental policies; dirty industries enter to economies and make environment polluted (Fredriksson and Svensson 2003) [14]. Corrupt economies promote artificial monopolies and high tariff (Sarwar and Pervaiz, 2013) [23]. Positive correlation is found between interaction term (corruption*trade openness) and environmental degradation; close economies are more corrupt (Damania *et al.*, 2003 and Rehman *et al.*, 2007) [8,21].

Expansion of industrial and agriculture sector has become a major factor of environmental degradation. Pakistan is ranked at 120th and 80th nations in air and water pollution respectively. It gets 18.76 scores out 100 regarding environmental performance (Yale and Columbia University, 2012). Pakistan's share in world's CO_2 emission is 0.55% (CDIAC, 2008) [5]. The main objective of this study is to confirm the evidence of EKC in case of Pakistan and to overlook the impact of trade liberalization and corruption on environmental degradation. This paper is based on four sections. A brief introduction is provided in the first section. Methodology and empirical findings are given in section 2 and 3 respectively. Finally section 4 is consisted of conclusion.

2. Materials and Methods

Time series data from 1980-2011 is used for this study. Air pollution is measured by gas emissions of CO_2, SO_2, NO_x and data is obtained from Regional Emission Inventory in Asia (REAS). Water pollution is measured in terms of biological oxygen demand (BOD) and data is obtained by Word Development Indicator (WDI) respectively while corruption and law and order index is taken from the International Country Risk Guide (ICRG). The model can be written as

Environmental Kuznets Curve (EKC) is written as

$$API_t = \delta_0 + \delta_1 YPC_t + \delta_2 YPC_t^2 + z\vartheta_t + \varepsilon_t \quad (1)$$

Trade liberalization effect on air pollution

$$API_t = \gamma_0 + \gamma_1 YPC_t + \gamma_2 YPC_t^2 + \gamma_3 X_{1t} + z\vartheta_t + \mu_t \quad (2)$$

The environment situation in the presence of trade liberalization and corruption is written below

$$API_t = \gamma_0 + \gamma_1 YPC_t + \gamma_2 YPC_t^2 + \gamma_3 X_{1t} + \gamma_4 X_{1t} * \gamma_3 X_{2t} + z\vartheta_t + \mu_t \quad (3)$$

Water pollution with trade liberalization and corruption

$$WP_t = \alpha_0 + \alpha_1 X_{1t} + \alpha_2 X_{1t} * X_{2t} + z\vartheta_t + \mu_t \quad (4)$$

Equation 1 is used to find the evidence of the Environmental Kuznet Curve in case of Pakistan. The second equation is used to describe the trade liberalization impact on air pollution and third equation is written with the corruption effect. Equation 4 described the water pollution with trade and corruption effect. YPC and YPC^2 are income per capita and square of income per capita respectively. X_1 and X_2 represented the trade liberalization and corruption respectively. $X_1 * X_2$ is used to define the combine effect of trade liberalization and corruption; interaction term. The control variables are mentioned by ϑ and Z is the coefficients of control variables. The control variables are industrial value added, secondary school education, law and order index and fertilizer use.

2.1. Model Specification

2.1.1. Autoregressive Distributed Lag Model (ARDL)

Autoregressive distributed lag model (ARDL) is used to measure the long run and short run dynamics. The ARDL bound test is based on joint F-statistic; first developed by Pesaran *et al.*, in 2001 [20]. This approach provides better results when integration order is different and sample size is small.

$$\Delta API_t = \gamma_o + \sum_{t-i}^{p} \gamma_1 \Delta API_{t-i} + \sum_{t-i}^{p} \gamma_2 \Delta YPC_{t-i} + \sum_{t-i}^{p} \gamma_3 \Delta YPC^2_{t-i} + \sum_{t-i}^{p} \gamma_4 \vartheta_{t-i} + \alpha_1 API_{t-i} + \alpha_2 YPC_{t-i} + \alpha_3 YPC^2_{t-i} + \alpha_4 \vartheta_{t-i} + \varepsilon_t \quad (4)$$

$$\Delta API_{t-i} = \gamma_o + \sum_{t-i}^{p} \gamma_1 \Delta API_{t-i} + \sum_{t-i}^{p} \gamma_2 \Delta YPC_{t-i} + \sum_{t-i}^{p} \gamma_3 \Delta YPC^2_{t-i} + \sum_{t-i}^{p} \gamma_4 TO_{t-i} + \sum_{t-i}^{p} \gamma_5 \Delta \vartheta_{t-i} + \alpha_1 API_{t-i} + \alpha_2 YPC_{t-i} + \alpha_3 YPC^2_{t-i} + \alpha_4 TO_{t-i} + \alpha_5 \vartheta_{t-i} + \varepsilon_t \quad (5)$$

$$\Delta API_{t-i} = \gamma_o + \sum_{t-i}^{p} \gamma_1 \Delta API_{t-i} + \sum_{t-i}^{p} \gamma_2 \Delta YPC_{t-i} + \sum_{t-i}^{p} \gamma_3 \Delta YPC^2_{t-i} + \sum_{t-i}^{p} \gamma_4 TO_{t-i} + \sum_{t-i}^{p} \gamma_5 TO * C_{t-i} + \sum_{t-i}^{p} \gamma_6 \Delta \vartheta_{t-i} + \alpha_1 API_{t-i} + \alpha_2 YPC_{t-i} + \alpha_3 YPC^2_{t-i} + \alpha_4 TO_{t-i} + \alpha_5 TO * C_{t-i} + \alpha_6 \vartheta_{t-i} + \varepsilon_t \quad (6)$$

Summation sign represented the short run dynamics (error correction) and α's represented the long run dynamics. The hypothesis of cointegration is

$H_0 : \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = \gamma_6 = 0$

Null hypothesis revealed no cointegration; the nonexistence of log run relation while the alternative hypothesis showed the existence of a long run relation.

$$\Delta WP_{t-i} = \beta_o + \sum_{t-i}^{p} \beta_1 \Delta WP_{t-i} + \sum_{t-i}^{p} \beta_2 \Delta TO_{t-i} + \sum_{t-i}^{p} \beta_3 \Delta TO * C_{t-i} + \sum_{t-i}^{p} \beta_4 \vartheta_{t-i} + \delta_1 WP_{t-i} + \delta_2 TO_{t-i} + \delta_3 TO * C_{t-i} + \delta_4 \vartheta_{t-i} + \varepsilon_t \quad (7)$$

H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$

Two critical bounds value; upper bound and lower bound provided in the table by Pesaran *et al.*, (1999) [20]. If calculated F-value is greater than the upper critical value then the null hypothesis of no cointegration can't be accepted but if the calculated value is below than the lower critical value; the alternative hypothesis of cointegration existence can be rejected. If value is between the two bounds decision would be inconclusive. After the long run relation, error correction model (ECM) has used to find the short run relation.

2.1.2. Error Correction Model (ECM)

$$\Delta API_{t-i} = \gamma_o + \sum_{t-i}^{p} \gamma_1 \Delta API_{t-i} + \sum_{t-i}^{p} \gamma_2 \Delta YPC_{t-i} + \sum_{t-i}^{p} \gamma_3 \Delta YPC^2_{t-i} + \sum_{t-i}^{p} \gamma_4 \Delta \vartheta_{t-i} + \lambda ECM_{t-i} + \varepsilon_t \quad (8)$$

$$\Delta API_{t-i} = \gamma_o + \sum_{t-i}^{p} \gamma_1 \Delta API_{t-i} + \sum_{t-i}^{p} \gamma_2 \Delta YPC_{t-i} + \sum_{t-i}^{p} \gamma_3 \Delta YPC^2_{t-i} + \sum_{t-i}^{p} \gamma_4 TO_{t-i} + \sum_{t-i}^{p} \gamma_5 \Delta \vartheta_{t-i} + \lambda ECM_{t-i} + \varepsilon_t \quad (9)$$

$$\Delta API_{t-i} = \gamma_o + \sum_{t-i}^{p} \gamma_1 \Delta API_{t-i} + \sum_{t-i}^{p} \gamma_2 \Delta YPC_{t-i} + \sum_{t-i}^{p} \gamma_3 \Delta YPC^2_{t-i} + \sum_{t-i}^{p} \gamma_4 TO_{t-i} + \sum_{t-i}^{p} \gamma_5 TO * C_{t-i} + \sum_{t-i}^{p} \gamma_6 \Delta \vartheta_{t-i} + \lambda ECM_{t-i} + \varepsilon_t \quad (10)$$

λ is used as the coefficient of the error correction term and it is expected with negative value. To check the stability of estimated model CUSUM and CUSUMSQ model is applied.

3. Empirical Findings

Empirical results found by using the ARDL technique. Mostly time series data were non stationary that provides spurious results. Such type of results was not supported by economic theory. It was necessary to make data stationary to find better and meaningful results.

Table 3.1. Stationary Test of Variables using Augmented Dickey Fuller Test

Variables	At level		At first difference	
	Test Stat	Prob	Test Stat	Prob
API_t	-1.180	0.897	-9.215*	0.000
BOD_t	-5.575*	0.000	-9.577*	0.000
YPC_t	-1.865	0.647	-3.481***	0.059
YPC^2_t	-4.737*	0.004	-3.330***	0.080
TOt	-3.831**	0.028	-5.943*	0.000
$TO*C_t$	-2.929	0.167	-4.846**	0.002
$L\&O_t$	-2.776	0.216	-4.016**	0.019
IND_t	-3.075	0.133	-3.774**	0.036
EDU_t	-3.416***	0.067	-6.531*	0.000
FER_t	-7.677*	0.000	-18.23*	0.000

Note: *, **, *** shows the significance level at 1%, 5% and 10% respectively.

Stationarity results of ADF revealed the unit root problem and different stationary level for all the variables. Augmented Dickey Fuller results showed ARDL technique was suitable to find the empirical results because ARDL provide better results when order of integration was different.

Table 3.2. Bound Test Results

F-value	*Lag order*	*Critical value (1%)*		*Critical value (5%)*		*Critical value (10%)*	
		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
6.12*	1	**4.40**	**5.72**	3.47	4.57	3.03	4.06
6.22*	1	**3.93**	**5.23**	3.12	4.25	2.75	3.79
5.59*	1	**3.19**	**4.90**	2.87	4.00	2.53	3.59
6.11*	1	**4.40**	**5.72**	3.47	4.57	3.03	4.06

Note: 1% significance level indicated by *.

After applying the ADF test, the long run relation is estimated by using bound test. F-value of bound test is greater than the upper critical bound value in all four models which showed rejection of the null hypothesis of no cointegration. F-value of all models is greater than the upper bound critical value of 1%.

Table 3.3. Long run and short run dynamics of Environmental Kuznets Curve

Variables	Long run dynamics		Variables	Short run dynamics	
	Coefficient	t-values		Coefficient	t-value
YPC_t	0.002*	7.93	ΔYPC_t	.0069*	6.736
YPC^2_t	-0.000000373*	-9.00	ΔYPC^2_t	-.000000157 *	-4.928
IND_t	0.0000575**	2.18	ΔIND_t	.0000207***	1.732
EDU_t	-0.048	-.823	ΔEDU_t	-.0173	-.856
Constant	-27.18*	-8.29	$\Delta Constant_t$	-9.824 *	-6.545
			ECM(-1)	-.361*	-4.792
			R^2	.68	
			$AdjR^2$	.60	
			F-statistics	10.58(.000)	

Note: *, ** and *** showed significance at 1, 5 and 10% level of significance

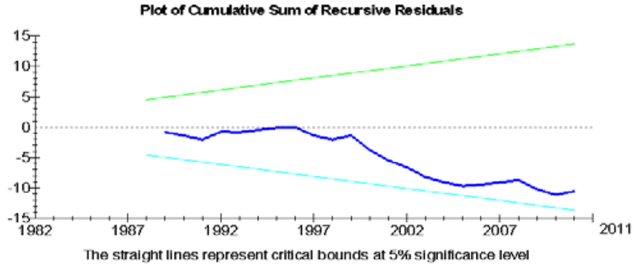

Figure 3.1. CUSUM Graph

ARDL results are represented in the Table 3.3. Empirical findings confirmed the evidence of EKC in case of Pakistan. Cole (2004), Jessie *et al.*, (2006) and Rehman *et al.*, (2007) [6,16,21] also confirmed this inverted U shape curve. Industrial value added also showed significant and positive sign and supported by Jessie *et al.*, (2006) [16]. Secondary school enrollment has insignificant impact on the environment. Short run dynamics also revealed the EKC evidence in short run and ECM coefficient with (-ve) sign showed the convergence towards equilibrium. The value of R^2 and adjusted R^2 indicated the variation of dependent variable caused by independent variable and F-statistics revealed the goodness of the model. Graph of stability test of CUSUM and SUSUMSQ lie between the critical 5% bounds which showed model is stable.

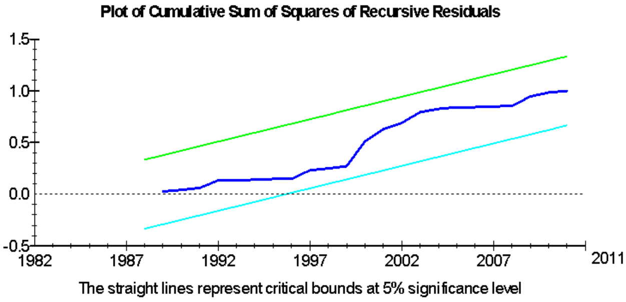

Figure 3.2. CUSUMSQ Graph

Table 3.4. Air pollution long run and short run dynamics with trade openness

Variables	Long run dynamics		Variables	Short run dynamics	
	Coefficient	t-values		Coefficient	t-value
YPC_t	0.002*	7.73	ΔYPC_t	.0058*	5.201
YPC^2_t	-.00000036*	-8.55	ΔYPC^2_t	-.00000013*	-4.774
TO_t	-2.73	-.869	ΔTO_t	-.993	-.878
IND_t	.0000512***	1.87	ΔIND_t	.000012	1.537
EDU_t	-.054	-.897	ΔEDU_t	-.021	-.938
Constant	-26.02*	-7.87	$\Delta Constant_t$	1.52	-6.210
			ECM(-1)	.075	-4.792
			R^2	.69	
			$AdjR^2$	.60	
			F-statistics	8.84(.000)	

Note: *, ** and *** showed significance at 1, 5 and 10% level of significance.

Table 3.5. Air pollution long run and short run dynamics with trade openness and corruption effect

Variables	Long run dynamics		Variables	Short run dynamics	
	Coefficient	t-values		Coefficient	t-value
YPC_t	0.002*	9.57	ΔYPC_t	.008*	7.127
YPC^2_t	-.00000038*	-11.38	ΔYPC^2_t	-.00000017*	-5.127
TO_t	-3.020	-1.20	ΔTO_t	-1.347	-1.234
$TO*C_t$	1.185***	1.97	$\Delta TO*C_t$	.528***	1.839
IND_t	.000084*	3.64	ΔIND_t	.0000208***	1.702
EDU_t	-.0475	-1.027	ΔEDU_t	-.0212	-1.080
Constant	-24.93*	-9.77	$\Delta Constant_t$	-11.12*	-6.542
			ECM(-1)	-.446*	-5.204
			R^2	.73	
			$AdjR^2$	.63	
			F-statistics	8.70(.000)	

Note: *, ** and *** showed significance at 1, 5 and 10% level of significance.

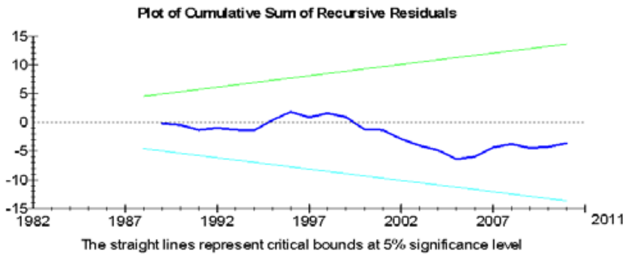

Figure 3.3. CUSUM Graph

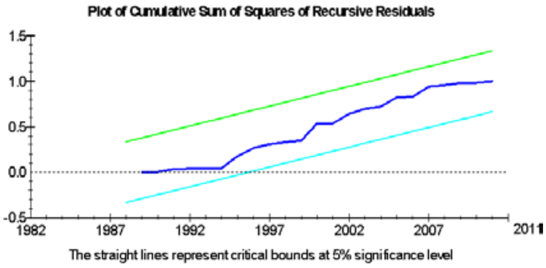

Figure 3.4. CUSUMSQ Graph

Table 3.4 showed the EKC evidence in the presence of trade liberalization. Trade openness inversely correlated with environmental degradation and this sign supported by the empirical findings of Frankel and Rose (2005) and Rehman *et al.*, (2007) [13,21]. As industrialization increased problem of environmental degradation also increased as a positive sign indicated. Secondary school enrollment insignificantly but inversely correlated with air pollution index. An error correction coefficient sign indicated the convergence towards equilibrium in within a specific time period. F-statistics revealed goodness fit of the model. Graph of CUSUM and CUSUMSQ revealed that estimated model is stable.

Table 3.5 explained the air pollution situation with trade and corruption effect. Interaction term has a positive and significant sign. Empirical findings of Dmania *et al.*, (2003) [8] and Rehman *et al.*, (2007) [21] also showed the interaction term of trade openness and corruption with a positive sign. Short run dynamics also revealed the negative and significant ECM coefficient. Stability test revealed that the model is stable.

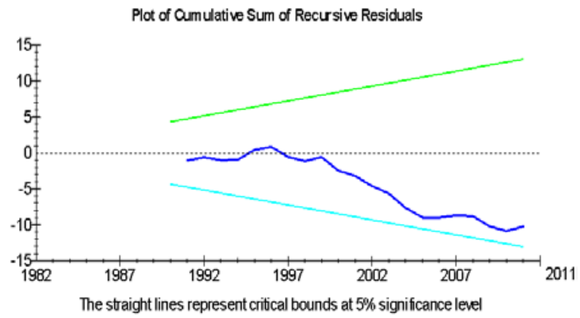

Figure 3.5. CUSUM Graph

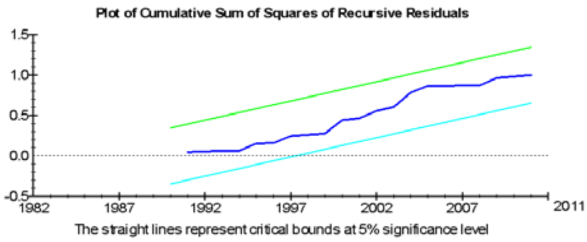

Figure 3.6. CUSUMSQ Graph

Table 3.6. Water pollution long run and short run dynamics with trade openness and corruption

Variables	Long run dynamics		Variables	Short run dynamics	
	Coefficient	t-values		Coefficient	t-value
TO_t	-16.47	-1.50	ΔTO_t	-54.2***	-1.66
$TO*C_t$	47.09***	1.68	$\Delta TO*C_t$	15.4**	2.27
LAW_t	-26.75	-1.60	ΔLAW_t	-6.3**	2.21
FER_t	7.41*	3.75	ΔFER_t	0.35**	2.20
Constant	-709.9	-3.67	ΔConstant	-233.5***	-2.86
			ECM(-1)	-0.32***	-2.86
			R^2	0.77	
			Adj R^2	0.62	
			F-stat	6.38(0.000)	

Note: *, ** and *** showed a significance level of 1, 5 and 10% level of significance.

Trade openness is also friendly related regarding water pollution as Alam *et al.*, (2010) [1] reported and interaction term positively related to BOD level. Law and order index is negatively correlated with water pollution while fertilizer use significantly and positively related with BOD level. Short run dynamics also supported by error correction model negative value. Negative and significant value revealed that short run relation also exists in water pollution. Significant F-statistics showed good fitness of the model. Stability graph showed the stability of the estimated model.

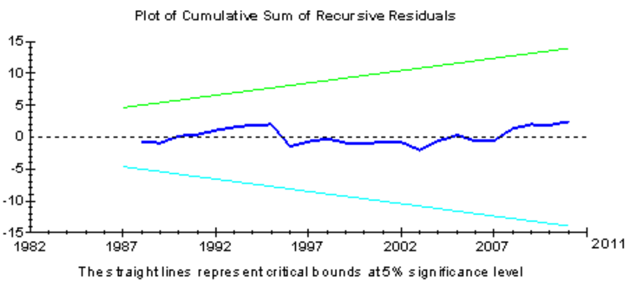

Figure 3.7. CUSUM Graph

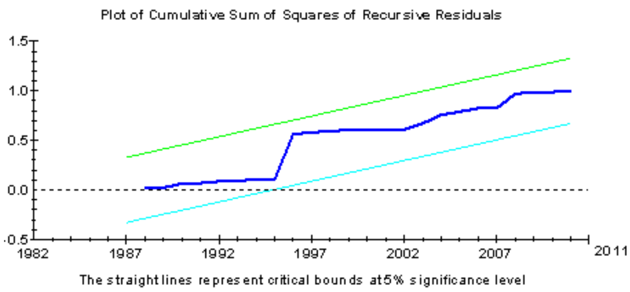

Figure 3.8. CUSUMSQ Graph

4. Conclusion

Effect of trade liberalization and corruption on environmental degradation in case of Pakistan has estimated in this study. Air and water pollution is used as the environmental indicators. Evidence of environmental Kuznets curve (EKC) is confirmed in case of Pakistan. Empirical findings revealed that trade liberalization behaved friendly to the environment. Corruption results supports that open economies are not more affected by corruption. It is seen that as economies involve in industrialization process environment is degrade. Education can play an important role to reduce the problem. Awareness can increase the demand of the clean environment. Law and order situation must be improved to reduce the problem of environmental degradation.

It is recommended to reduce the corruption and impose compensation remedy on the industrial sector. Pigovean tax should be imposed on such imports which is harmful for the environment. Higher education can also help in resolving the problem. The recommended dose of fertilizer should be used to avoid the pollution.

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