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Determinants of Environmental Degradation in Economy of Pakistan

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Abstract

The study attempts to examine various factors responsible for environmental degradation in Pakistan. Contributing towards economic growth, these factors added pollutants as a byproduct to the environment. Carbon dioxide (CO_2) emission rate is one of such pollutants and has been used as a dependent variable in the study. Numerous factors are responsible for environmental damage, but the study includes the major ones. These determinants are economic growth, population, energy consumption and industrialization, and time-series data of these variables from 1972 to 2018 are utilized for empirical analysis in the study. Long run relationship is computed using Auto Regressive Distributed Lag (ARDL). Findings of the study revealed that three factors; population, energy consumption and industrialization are positively and significantly contributed to environmental degradation in Pakistan. While, economic growth is negatively contributing towards environmental degradation. The paper concluded with a finding that population growth needs to be controlled. Besides this, clean and green energy should be promoted. Lastly, EPAs must be strengthened for their effective role.

Keywords: carbon dioxide emission, energy consumption, industrialization, population growth
***JEL Classification*:** C32, Q43, Q56

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Disclaimer: Views expressed in the paper is of authors own point of view and does not reflect their organization stance on the issue

1. Introduction

"Planting trees is good but not a solution to global warming", told by Greta Thunberg to the audience on the World Economic Forum. Her concerns are quite relevant as the environment is the most burning issue on the global agenda. "The Global Risk Report 2020" alarmed about climate related risks during the last five years with a much warmer world. The report also forecasts 3^0C increase in world temperature by the end of this century, which is a huge threat to life on earth. The report emphasized on concerted efforts of all stakeholders for the protection of the environment.

The environment consists of atmosphere, land surface, mountain, forests, water and other natural resources. All living organisms depend on the quality of the environment for their survival, particularly human beings. A persistent decline in the quality of the environment is harmful to life. Therefore it is a matter of serious thinking and debate all over the world. Adverse impacts of such debacle are in the form of global warming, higher concentrations of toxic gases in the atmosphere, over exploitation of natural resources and extinction of various flora and fauna species.

Pollution is equivalently used to highlight the degradation of different components of the environment, which includes air, water and soil. Some of these degradations cause long lasting effects while others are short termed. Due to its negative role, pollution becomes a problem for the economists, environmentalists and policy makers from the beginning of the 20^{th} century. Different stakeholders like scientists, economists, political leaders, international organizations and general public are worried about this.

The problem became severe in the industrial revolution. The industrial revolution had sown the seeds of industry and transport development. Development in these sectors increased the emission manifolds due to usage of fossil fuel and deforestation at a higher pace. Higher concentration of carbon monoxide and dioxide gases raised the temperature, melted glaciers at higher speed and emerged the situation of water shortage.

Besides the declining air quality, industrialization has also led to water pollution. Industrial wastes are drained into fresh water

that caused water pollution. Water pollution caused severe problems in aquatic life. According to the World Economic Forum estimates, plastic will exceed the number of fish in 2050 if this pace of mixing industrial and human wastes in our rivers continues.

The development of industry provides a strong basis for economic growth. Such growth divides the world in poor, developing and developed countries. However, the environment is common among them. In pursuit of economic growth, man forgets the environment and continues to achieve higher GDP growth. Higher economic growth ensures social and human development but on the cost of environmental degradation.

Environmental degradation and economic growth are interlinked with each other. Ample studies investigated their relationships. Environmental Kuznets Curve (EKC) concept emerges during these endeavors. Researchers tried to validate this concept for one country or group of countries. In the same manner, many of them have discussed demographic factors in relation to the environment. Some focused on economic growth, pace of industrialization and public health awareness, etc. Hardly any researcher has combined all these factors.

This paper makes an effort to examine the impact of major factors responsible for the deteriorating environment. There is no doubt that various studies have been carried out for the purpose. This one combined important variables in a single model in order to see its impact individually as well as collectively. The study also adopted the latest technique for cointegration. Further, special consideration has been taken for the collection of data which in most cases, the researchers ignore. Hence, it is hoped that the study will help the readers and policy makers to think about the environment in true spirit while pursuing growth.

1.1. Objective of the Study

Main objective of this study is to identify main determinants of environmental degradation in the economy of Pakistan in long run. The secondary objective is to put forward some policy suggestions to handle the issue.

1.2. Environmental Issue in Pakistan

Pakistan is bestowed with immense natural resources. The northern parts of the country are covered by purple headed Himalayan Mountains that give this piece of land a magnificent beauty and grandeur. These mountainous series are occupied by eternal glaciers that provide a permanent source of water for rivers. However, due to climate change and global warming in recent days, these glaciers are melting at a higher pace than natural. According to the Economic Survey of Pakistan (2018-19), this global warming has increased the country's average temperature by 0.6^0 C in the last century. The winter has become warmer than ever. On the other hand, average precipitation in air is also higher, resulting in cloud outburst.

This situation disappointed the Prime Minister of Pakistan, and he explicitly and categorically showed his concerns on the matter while writing an article to New York Times on 25th August 2019. Besides this, the Prime Minister also launched "Green and Clean Pakistan" project in September 2018. The purpose of the project is to clean the environment which suffers from different human activities. The project will aim to plant ten billion trees throughout the country. This major step is taken for an increase in forest cover and according to the Economic Survey (2018-19) estimates; 139.515 million trees were planted in 2018 with a survival rate of 76%. This shows that the government is committed to achieving the global target (6%) of forest cover.

In another move for the conservation of energy and environment, the minister for science and technology inaugurated electric motorbike and rickshaw. These two types of vehicles are used by middle income group of the country and made a considerable portion in country's transport sector. Currently, bikes are run by hydrocarbons (Petrol/Gasoline). However, with the introduction of electric technology, it is estimated that demand for petroleum products will be decreased considerably. The minister emphasized on conversing energy and using green energy. According to him, the development of green energy is the goal and priority based agenda of the government.

In similar developments, the Pak Environmental Protection Agency (EPA) imposed a ban on the use of plastic in the country

capital. According to the agency, plastic remains for a long time in the environment resulting in air and water pollution. This paper agrees with the stance of the agency as a quantity of plastic accumulates in the environment because after using, people throw this non-degradable plastic in an open environment. Due to no management, these plastic wastes drain to rivers, ponds and lakes etc. Besides causing obstacles in the flow of water, plastic also affects the aquatic biosphere.

From above, it is clear that the environment is an important issue which may threaten the life of people in Pakistan. Now, the problem is on the priority list of the government and is being discussed openly in the echelons of power. In this regard, our paper appreciates the work done by the Ministry of Climate Change. The ministry is effectively working on different projects for the protection of the environment which can be seen in the Economic Survey of Pakistan (2018-19). So, it is hoped that the government's attention, along with its positive steps taken towards the conservation of the environment, will mitigate the adversities of the problem. These steps guaranteed sustainable environment friendly economic growth.

2. Literature Review

Environmental degradation remains a burning issue among the researchers since the mid of 20th century. Some of the prominent studies are reviewed in subsequent paragraphs.

2.1. Economic Growth and Environmental Degradation

Studies by Grossman and Krueger (1991, 1995) and the World Development Report (1992) on environment usher a new era of discussion on the subject. According to these studies, high growth in GDP resulted in massive pollutants leading to environmental degradation. On the other hand, rising per capita income cautions people about health and better life which emerges thinking for a secure environment and thus guaranteed for environmental guidelines. These guidelines introduce environment friendly techniques for output and production process. Such relationship followed an inverted U shape and is known as Environmental Kuznets Curve (EKC). Studies like Apergis and Payne (2009), Lean

and Smyth (2010), Saboori, Sulaiman, and Mohd (2012), Ahmed and Long (2013) and Bölük and Mert (2015) also confirmed inverted U relationship between these two variables.

In contrast to the above U shape relationship, Panayotou (2016) sees an increase in income because of the degradation for the environment due to exploitation of natural resources, waste accumulation, and higher amount of pollutants. These factors naturally reduce biosphere absorption capacity and resulted in a reduction of human welfare. Nwagbara, Abia, Uyang and Ejeje (2012) associated the issue of environment with the alleviation of poverty and suggested that sustainable utilization of resources can tackle the problem of poverty. The society cannot control environmental degradation without taking serious actions for the alleviation of poverty.

Another opinion prevails on environment-growth nexus is that economic growth is achieved at some cost of environmental degradation. Accordingly, economic growth is not reflected truly until the degradation of the environment is not accounted for, and (EKC) is not endorsed by some researchers. For example, Stern, Common and Barbier (1996) who tried to identify some econometric problems related to the estimation of the EKC by reviewing various empirical studies. According to them, the basic concept of EKC is based on per capita income assumption, which is normally distributed in the world. However, in reality, the median income is far below from mean income, making the existence of EKC doubtful. Similarly, Rothman and De-Bruyn (1998) consider EKC as a temporary phenomenon because the effects of pollutants are global and hence difficult to control. Such universality of pollutants provides a strong basis of not observing inverted U-shaped EKC. Lee, Chung, and Koo (2005) considered EKC as Pollution Kuznets Curve and suggested that pollution measure can be improved with income and not all the environmental measures. While Ilham (2018) emphasized on transformation from fossil oil to renewable energy for ASEAN countries as energy and growth both are responsible for the degradation of the environment.

Bruyn (1997) claimed N-shaped long run relationship between income and environmental degradation rather than inverted U-shaped. N-shaped relationship shows that after crossing various levels of income, the relationship between two variables becomes positive. This argument is based on the plea that technological advancement gets exhausted on reaching a certain level. This N-Shaped relationship is further supported by the studies of Dijkgraaf and Vollebergh (2005), Akbostanci, TürütAşık, and Tunç (2009) and Yang, He, and Chen (2015).

The results of the above studies are mixed ones. In many cases, negative relationship is proved by the researchers between these two variables and in others vice versa.

2.2. Population and Environment

Population growth is a leading source of degradation of the environment. Malthus (1798) was the first one who highlighted the issue by writing a book "An Essay on the Principle of Population". Malthus described an interesting fact about the growth of population and food supply where the former is growing geometrically while the latter is available arithmetically. Such increases the human sufferings in the form of shortage in the food supply, war, diseases and catastrophes resulting in population trap. He emphasized on serious thinking over population growth and its control.

Ehrlich (1968), in his book "The Population Bomb" highlighted the brutality of human for fulfilling his need. Such brutalities converted the axe to a machine which deteriorates natural environment. The writer emphasized on maintaining an optimal size of population growth and will be a great threat to human life, if not maintained.

Ehrlich and Holdren (1971) adopted IPAT model that includes income and technology besides population growth and suggested that population control, technological advancement and equal opportunities are important factors for the environment.

Trainer (1990) supported the views of Malthus and elaborated that most underdeveloped countries are suffering from higher population growth. These countries are unable to grow more

food for the rising population, and such uncontrolled growth depletes their resources at a higher pace.

Study of Cropper and Griffiths (1994) showed that population growth puts pressure on agricultural land and causes the conversion of forest land for cultivation of crops. Such conversion also resulted in an extension of various species and posed a potential threat for flora and fauna of the area.

Clay and Reardon (1998) suggested that for tackling the issue of population and environment, right analytical tool and strategic approach are required for the government and public policy makers.

The study of Rosa and York (2002) while using STIRPAT model found that all types of environmental impacts are proportional to the size of population and concluded that population is a major driving force of environmental change.

Ahmed et al. (2005) suggested that population growth and its density increase CO2 emission and arable land in Pakistan. The study emphasized on appropriate policy implementation to overcome the issues related to the environment in Pakistan.

Study of Pimentel et al. (2007) suggested rising imbalance between rising human population, environmental degradation, and limited resources must be considered. The study concluded that comprehensive rational population control policy coupled with an effective environmental management program is essential.

Lakshmana (2013) pointed out that higher population growth with continuous economic development has caused some serious environmental issues in the Asia Pacific region. The study suggested that these countries should come with a complete roadmap for curbing the issue.

The studies discussed above clearly show that population and environment are inversely related to each other, and population growth will increase environmental degradation.

2.3. Energy consumption and Environment

Excessive use of energy due to industrial sector growth poses a great threat to environmental sustainability. Race of economic

development compels the nations to use energy which exponentially increased with the passage of time. Higher economic growth necessitates lead to high consumption of energy, which in turn increase carbon emission and cause environmental pollution.

Study of Ang (2007) confirms the existence of long run relation between energy consumption and environmental pollution in France. Similarly, empirical work of Chebbi and Boujelbene (2008), Soytas, Sari, Hammoudeh and Hacihasanoglu (2009) and Lotfalipour, Falahi, and Ashena (2010) also verified long run relation between energy consumption and CO_2 emissions in Tunisia, Turkey and Iran respectively.

Similarly, Boutabba (2014), Shahbaz (2013) and Islam et al. (2013) confirmed that energy consumption and carbon are positively correlated in long run in India, Indonesia and Malaysia, respectively.

Omay (2013) stated that CO_2 emission is a byproduct of economic activities and enhancing these economic activities caused its higher emission. He concluded that best available technologies might control CO_2 to a great extent.

International Energy Agency (IEA) Report (2013) declared the impact of socioeconomic and technological characteristics on emissions. Report elaborates trends in CO_2 emissions from fuel combustion which required focus of all countries to plan a more sustainable energy policy for the future.

Khan et al. (2019) hold energy consumption responsible for environmental deterioration. The study emphasized on the adaptation of energy protection policies and curbing of using furnace oil. The study also confirms an inverted U shape relationship.

2.4. Studies on Pakistan

Some empirical work on environment-growth nexus carried out by different researchers in the economy of Pakistan are also reviewed and presented in the subsequent paragraphs.

Khwaja and Khan (2005) explored the causes of rapidly growing air pollution in Pakistan and pointed out some key issues in this regard. According to them, high inefficiency in the usage of

energy, rising growth in the number vehicles and kilometers traveled, rising industrial activity without proper air emission control, burning of solid waste in the open atmosphere, including plastic, and the use of ozone depleting substances (ODSs) are the major contributors of deterioration in the quality of air.

Findings of Mallick and Masood (2011) suggested some simple actions such as reducing the consumption of fuel and electricity, engaging in volunteer activities to clean up waste products in urban centers and ecologically sensitive zones such as beach fronts and forest lands and demanding more environmentally friendly practices of the state and corporations can go a long way towards curbing emissions and protecting the environment.

Malik et al. (2012) discussed the main factors in causing the global climate change, which included emissions from excessive combustion of fossil fuels and deforestation. Pakistan is a minor contributor to the overall Greenhouse Gas (GHG) emissions, however; the negative impacts of climate change are the harshest in the country. It is estimated that in Pakistan the carbon emissions have raised from 76 million tons in 1990 to 200 million tons in the year of 2006 and CO_2 emissions by an average increase of 6.5% annually and would grow to 482 million tons by 2020.

Khan and Jamil (2015) tried to decompose the changes in overall CO_2 emissions in Pakistan for the period of 1990 to 2012 by using Log Mean Divisia Index (LMDI). On the basis of findings, the researchers suggest that policy makers should try to encourage the conversion of the output level towards more energy efficient sectors in Pakistan.

The studies discussed above show that energy consumption and expansion of industry is degrading the quality of the environment at global as well as Pakistan level.

3. Model and Variables

In this study, we focus only on air quality. The total emission of carbon dioxide in the atmosphere is considered by most of the studies as the prime indicator for measuring pollution. Well-renowned reports classified world countries and cities according to CO_2 emission. This is the only indicator which is largely considered

for environmental quality, and hence this study also utilized the same for the environment. The model may be specified as under:

$$\mathbf{CO_2} = \mathbf{f}(\mathbf{GDP}, \mathbf{POP}, \mathbf{ENG}, \mathbf{IND}) \quad \textbf{(1)}$$

Where CO_2 is total carbon dioxide emissions to air and measured in kilotons (kt). GDP is used as a proxy for economic growth and measured in a million rupees. Similarly, POP stand for the population which is measured in a million and ENG represent total energy consumption which is measured in millions of tons of oil equivalent (TOE) while IND denotes industrialization and measures as the growth rate of output in large scale manufacturing (LSM). Quantum of Index of Manufacturing (QIM) which is used for large scale manufacturing industries growth rate is utilized for industrial emissions. The above function may be re-written in a linear format as under:

$$\mathbf{CO_{2t}} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1 GDP_t} + \boldsymbol{\beta_2 POP_t} + \boldsymbol{\beta_3 ENG_t} + \boldsymbol{\beta_4 IND_t} + \boldsymbol{u_t} \quad \textbf{(2)}$$

Where β's are the coefficients for the impacts of explanatory variables and 'u' is the error term with usual properties and t representing time period. In order to resolve the problem of linearity, the above model is transformed into log linear form and re-written as:

$$\boldsymbol{lnCO2} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1 lnGDP_t} + \boldsymbol{\beta_2 lnPOP_t} + \boldsymbol{\beta_3 lnENG_t} + \boldsymbol{\beta_4 lnIND_t} + \boldsymbol{\varepsilon_t} \quad (\mathbf{3})$$

3.1. Data Sources

Secondary data for the above stated variables have been collected from the Pakistan Bureau of Statistics, World Bank, Crippa et al. (2020) and State Bank of Pakistan from 1972 to 2018.

3.2. Methodology

As per the objectives of paper, model is chalked out for its achievement. Accordingly, it will check long run relationship among the variables. As study utilized time series data, there is a fair chance of possible trend in data. In the presence of a trend, OLS generate biased and inefficient estimators. Thus estimators computed through OLS in the presence of Serial Correlation is misleading.

In order to check the possible trend, Augmented Dickey Fuller (ADF) test has been carried out. The test estimated unit root using the following equation.

$$\Delta Z_t = \mu + \beta Z_{t-1} + \sum_{k=1}^{r} \alpha_k \Delta Z_{t-r} + \mathfrak{f}_t \quad (4)$$

Where μ is intercept and f is white noise term.

The second step is the estimation of long term relationship. Co-integration method was introduced by Granger (1981) and Engle and Granger (1987) for measuring long run relationship. For long run relationship, the following Auto Regressive Distributed Lag (ARDL) Bound test is carried out.

$$\Delta \ln CO_2 = c + \beta_1 \ln CO_{2t-1} + \beta_2 \ln GDP_{t-1} + \beta_3 \ln POP_{t-1} + \beta_4 \ln ENG_{t-1} + \beta_5 \ln IND_{t-1} + \sum_{i=1}^{p} \alpha_{1i} \Delta \ln CO_{2t-1} + \sum_{i=1}^{p} \alpha_{2i} \Delta LnGDP_{t-1} + \sum_{i=1}^{p} \alpha_{3i} \Delta \ln POP_{t-1} + \sum_{i=1}^{p} \alpha_{4i} \Delta \ln ENG_{t-1} + \sum_{i=1}^{p} \alpha_{5i} \Delta \ln IND_{t-I} + \varepsilon_t \quad (5)$$

Where t-1 is lag value of every variable.

4. Results and Discussion

Before proceeding further, some descriptive statistics are given in Table 1

Table 1: Descriptive Statistics

Name of Statistic	CO_2	GDP	Population	Industry	Energy
Mean	92.84	5312576	126.40	59.60	2.4171
Median	88.87	4655375	124.54	47.13	2.1143
Mode	22*	131252*	61*	12*	6.9701
Std. Deviation	52.521	3199305.815	43.836	41.843	1.3698
Variance	758.496	1.024E13	1921.584	1750.862	1.8761
Skewness	0.294	0.579	0.207	0.647	0.931
Std. Error of Skewness	0.347	0.347	0.347	0.347	0.347
Kurtosis	-1.228	-0.812	-1.094	-0.983	0.490
Std. Error of Kurtosis	0.681	0.681	0.681	0.681	0.681
Range	174	1103094	151	136	5.7752

*= Multiple modes exist. The smallest value is shown

Apart from this, the normality test is also carried out, and the result is given in the following table. The result shows that distribution is normal.

Table 2: Tests of Normality

Variable	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
CO_2	0.124	47	0.068	0 .928	47	0.006
GDP	0.106	47	0.200*	0.923	47	0.004
Population	0.081	47	0.200*	0.954	47	0.065
Industry	0.179	47	0.001	0.882	47	0.000
Energy Consumption	0.125	47	0.065	0.916	47	0.002

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

4.1. Unit Root Test

Unit Root tests are carried out for checking the stationarity in data. Most of the economic variables are non-stationary when their time-series data is checked. In order to check the possible stationarity in the variables, Augmented Dickey Fullers (ADF) is carried out. Result of ADF test is given in Table 3

Table 3: Results of ADF

	At level		1st difference		
Name of Variables	ADF values	P-Value	ADF values	P-Value	Result
ln CO_2	0.114	0.996	-4.725*	0.002	I(1)
LnGDP	-1.176	0.903	-4.948*	0.001	I(1)
lnPOP	-0.713	0.966	-12.708*	0.000	I(1)
lnENG	0.223	0.745	-3.928*	0.000	I(1)
lnIND	-2.639	0.266	-2.414*	0.017	I(1)

*= Significant at 5% level

The above table shows all variables are stationary at first difference. Hence, any other estimators except simple OLS may be used. The long run estimates are given in the next section.

4.2. Result of Auto Regressive Distributed Lag (ARDL)

Auto Regressive Distributed Lag (ARDL) is appropriate when all variables in the time series are stationary on first difference and hence applied. This test starts from the hypothesis that there is no cointegration among the variables and for that ARDL Bounds test is used. Result of Bounds is given in Table 4

Table 4: Result of ARDL Bounds Test

Test Statistic	Value	K
F Statistic	4.02	4
Critical Values		
Significance Level	**I(0)**	**I(1)**
0.1 or 10%	2.45	3.52
0.05 or 5%	2.86	4.01
0.025 or 2.5%	3.25	4.49
0.01 or 1%	3.74	5.06

From the above table, long run or co-integration exists as null hypothesis is rejected. The test also shows that there exists long run association among variables. After the existence of long run relationship, we further proceed to obtain long run estimate. For the purpose, Stata 13.0 and Eview 10 both are simultaneously used. Result of long run relation with lag 4 is given in the following table

Table 5: Long run coefficients

Variables	Coefficients	Standard error	t-statistic	Prob
lnGDP	-3.2200	1.6015	-2.0100	0.055
lnPOP	4.3412	1.9788	2.1988	0.037
lnENG	0.2934	0.0850	3.4513	0.0019
lnIND	1.2446	0.4875	2.7500	0.0169
C	5.9879	2.7103	2.2100	0.036
R^2	0.6621	**F-Statistics**	14.7018	

All the four variables that are income, population, energy consumption and industrial emission can significantly explain environmental degradation. The coefficients of population, energy consumption and industrial emission have positive signs, which show that the increase in these variables causes degradation of the environment. The results are consistent with the theory and explain in the subsequent paragraphs

Results above indicated that one per cent increase in population growth resulted in a 4.3 percent increase in CO_2 emission. This is consistent with Malthus theory of population which pointed about perils lurked due to population explosion. The theory explains the exponential growth in population, which is responsible for resource depletion at a higher rate. Such depletion causes environmental degradation. The large house scheme built on agriculture and forest land is a common phenomenon in Pakistan in the recent past which resulted in environmental degradation.

Further, one per cent growth in GDP may decrease by 3.22 percent in CO_2 emission. This result sheds lights on important aspects of the economy of Pakistan. Growth in the economy has mainly come from the service sector, which is pollutant free. This is the reason that growth in GDP decreases CO_2 emission.

Energy consumption also contributed towards an increase in CO_2 emission. The use and growth of fossil fuel adversely affect the environment. The coefficient of energy consumption is very least (0.29). The reason behind such low value is the share of environment harming fuels that are furnace oil and coal is minor in energy mix of the country.

The last important factor which is responsible for environmental degradation is industrial emission. According to the results of the study, one per cent growth in industrial production increased CO_2 emission of about 1.24 percent. The study used Industrial production index. The index also considered the production of environmentally friendly products like sugar and cotton. Inclusion of these products lessens the negative impact on the environment. This resulted in the moderate impact of industrial emission on the environment.

In addition to these, all coefficients of variables have a significant impact on the environment and thus have important policy implications which will be discussed later. The short run results are also given in the following table

Table 6: Short Run Coefficients

Variables	Coefficients	Standard Error	t-statistics	P Value
D(lnGDP)	-0.023	0.381	-0.06	0.952
D(lnGDP(-1))	0.695	0.259	2.70	0.012
D(lnPOP)	0.947	0.485	1.95	0.062
D(lnENG)	0.008	0.034	0.24	0.811
D(lnIND)	0.271	0.112	2.42	0.023
C	5.988	2.710	2.21	0.036
Cointeq(-1)	-0.217	0.045	-4.816	0.000

In the short run, GDP has a significant impact on CO_2 emission with a time lag of one. Similarly, population is significant at 10% and industrial emission also has short term impact on CO_2 emission. Further, a significant and negative value in the last column indicated the existing of long run relationship in the model. Further,

the value also shows the speed of adjustment in case of short term supply shock. From the above table, speed of adjustment may be seen as 21%, which is on a slower side. This result suggested that any shock in these variables will offset in five years. Generally, mitigation of damages to the environment will take longer time and result of the study is also showing the same phenomenon.

4.3. Residual Tests

The model is checked for possible heteroskedasticity, serial correlation and Ramsey RESET tests. For the purpose, various tests are being carried out, and results are given in following table

Table 7: Diagonostic Tests:

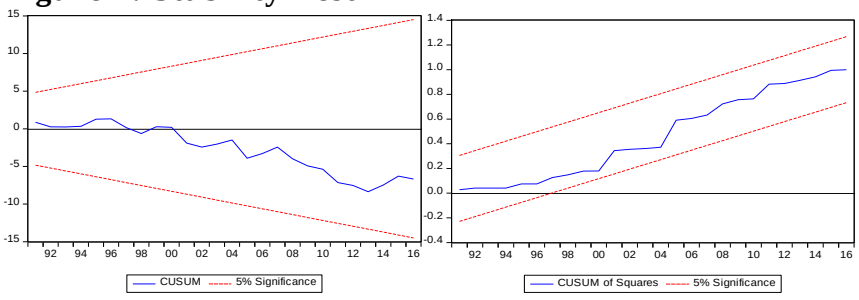
Name of Test	Value of Statistic	Prob.
Breusch-Pagan / Cook Weisberg test	2	0.1573
Durbin-Watson d-test	0.6349	----
Breusch-Godfrey LM	21.205	0.000
Ramsey RESET	20.91	0.000

The result showed that the model is homoskedastic with no serial correlation. Further, Ramsey Reset test also suggested that there is no need for square or higher value of variables. The model has no omitted variables which have higher explanatory power.

4.4. Stability Tests

Stability tests are also carried out and produce as follow

Figure 1: Stability Test



Both CUSUM and CUSUM square show that model is stable at 5% significance.

5. Conclusion and Policy Recommendations

The environment is a burning issue on global agenda. It gains significant importance after the earth's average temperature increased at a higher speed. The Global community meets every year in Davos for possible solutions of such warming and deteriorating environment condition throughout the globe. Pakistan is not a higher contributor to the world's CO_2 emission but on the top of the list of vulnerable of global warming and climate change. Due to such a critical position, environmental problems are a potential threat to the economy and lives of the people. This study considers four important determinants of environmental degradation. These are economic growth, population, energy consumption and industrial emission. All these variables have a significant impact on CO_2 emission, leading to environmental degradation. The study also confirms the Malthus population explosion phenomenon. The study does not support the negative role of economic growth in environmental degradation. However, on the other hand, energy consumption and industrial emission are found responsible for environmental damage. Industries like cement, chemicals, and steel are larger contributors to the CO_2 emission. Similarly, furnace oil used in the power sector is another potential threat to the environment.

On the basis of the above results, the following two policy recommendations are given:

i) Population growth should be controlled. Public awareness through various programs must be accelerated. Family Health Workers need to be trained, streamlined and empowered.
ii) Clean and green energy consumption should be encouraged, and imposition of ban on fossil fuel (Furnace Oil) in power sector should be initiated through medium to long term policies. Such policy should emphasize on increasing the share of renewable energy that is hydro, solar, wind and biogass in energy mix of the country.
iii) Emissions, particularly Persistent Organic Pollutants (POPs), from industries like cement, brick kiln, steel, chemical and sugar mills should be kept under control. Federal and provincial Environmental Protection Agencies (EPAs) play a vital role in

supervisions of these industries for mitigating its adverse impacts on environments through adaptations of green technology, and therefore they should be empowered.

6. Limitation and Future Research

The study takes four factors for environmental degradation in Pakistan. The data on these variables are secondary in nature which is sometimes difficult to collect. Data on CO_2 is a challenging task and is collected from the European Union website. The data may have some quality issue. Similarly, data on industrial emission is not available and QIM is used as a proxy for it. QIM has some shortcoming.

There are many other potential factors which also affect the environment like technology, household preference for green products, environment tax, trade openness and deforestation etc. Inclusions of these variables are future research areas and researchers may explore these areas for their research.

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