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Determinants of Environmental Degradation in Economy of Pakistan: Empirical Evidence of Pakistan (1980-2020)

Dr. Safia Begum[a*], Fizza Noor[b], Dr. Nasiha Begum[c], Miss Aneela Rustam[d], Miss Sabeena Rustam[e]

[a]Associate Professor, Department of Economics, Government Girls Degree College Nowshera. [b]BS Economics Student GGDC Nowshera. [c]Principal, Working Folks Grammar School Ziarat ka ka Sahib, Nowshera. [d]Vice Principal, Working Folks Grammar School Ziarat ka ka Sahib Npwshera. [e]SET, Working Folks Grammar School and College, Amangarh Nowshera.

[*]**Email:** safiakakakhail@gmail.com

Abstract

The entire globe is now facing significant challenges as a result of environmental deterioration, especially developing nations most of all. All living things depend on their environment for their health and well-being. To ensure the prosperity of future generations, environmental protection is crucial. Also the environmental factors have a considerable impact on Pakistan's economic growth. Examining the causes of Pakistan's environmental degradation is the study's primary goal. This study employed carbon dioxide (CO2) emissions, one of the most common pollutants, as a dependent variable and trade openness, population growth, energy consumption, industrialization, and GDP as independent factors. Secondary data collected from WDI, Handbook of Statistics and different other sources were used. For the purpose of Time series analysis, Auto-regressive distributed lag (ARDL) model technique was used for the short and long run analysis for the period of 1980 to 2020. According to the results of the CUSUM and CUSUMSQ tests, every coefficient in the model showed stability. The study's findings suggested that GDP, population growth, industrialization, and energy consumption were positively contributed to environmental deterioration in Pakistan, however trade openness had a negative influence on environmental degradation. This study may help in the development of suitable environmental initiatives and policies.

Keywords: *Carbon dioxide(CO2) emissions, GDP, Industrialization, Energy consumption, Population growth, Trade openness, ARDL, Pakistan.*

1. Introduction

Greta Thunberg told the World Economic Forum audience, "Planting trees is good but not a solution to global warming." Her worries are really valid, as the environment is the most pressing issue on the world agenda

(Rehman, Zeb, 2020). With the occurrence of catastrophic weather events, global warming, and environmental deterioration, environmental sustainability has gained significant importance. The available resources to support the world's burgeoning population need to be adequately distributed. The expansion of industry corresponded with a rise in the demand for more resources to support the expanding population. The environment is negatively impacted by this. (Musibau, et.al, 2021). The atmosphere, land surface, mountains, forests, water, and other natural resources make upthe environment. The state of the environment is essential to all living things for their survival, especially that of humans. Life is harmed by a continuous deterioration in the environment. "The Global Risk Report 2020" raised alarms during the past five years on hazards associated to climate change due to a significantly warmer planet. The study also predicts a 30C increase in global temperature by the end of this century, posing a significant threat to life on Earth (Rehman, Zeb, 2020). Environmental deterioration is one pressing issue that impacts everyone on the planet and in its population.

The term "degradation" describes how the environment is getting worse due to factors including pollution, habitat destruction, depletion of natural resources, and climate change (World Health Organization, 2018). Environmental degradationis the deterioration of the natural environment caused by human actions such as pollution, deforestation, and overexploitation of resources. It has the potential to reduce biodiversity, cause soil erosion, pollute the air and water, and have an impact on the health and well-being of all living things. Degradation of the environment has been observed to have grown dramatically worldwide. According to the study, there has been an increase in environmental deterioration as a result of urbanization, industrialization, and deforestation (Xie, et.al, (2019). CO_2 emissions are asignificant contributor to environmental deterioration since they cause air pollution, climate change, and ocean acidification. This can have a negative impact on ecosystems, wildlife, and human health (Holtz, 2020). Since the early 20th century, economists, environmentalists, and policy makers have considered pollution to be an issue because of its detrimental effects. This concerns a variety of stakeholders, including the general public, scientists, economists, and leaders in politics and international organizations. When hazardous substances or pollutants are introduced into the ecosystem, it can cause the air, water, and soil to deteriorate, a phenomenon known as pollution (Hassan, et.al, 2017).

The International Energy Agency (IEA) states that rising energy use raises resource demands, which in turn causes environmental deterioration (IEA, 2021). This is due to the fact that the extraction, creation, and use of energy from fossil fuels and other resources causes deforestation, habitat damage, and pollution of the air and water. Industrialization is largely responsible for environmental degradation since it has resulted in increased pollution and resource depletion due to the quick expansion of manufacturing and production facilities (Singh, 2018). The fast expansion of industrial activity and the unrestrained exploitation of natural resources throughout the Industrial Revolution led to a worsening of environmental degradation (Smith, 2016). Countries tend to emit more carbon dioxide as they develop, which adds to the problem of global climate change (Barbier, 2000). Also, rapid economic development often leads to the depletion of natural resources, deforestation, and biodiversity loss (Panayotou, 2000). Moreover, environmental deterioration can have detrimental effects on the economy by lowering agricultural production, decreasing the availability of natural resources, and intensifying and reoccurring natural disasters (Stern, 2007). These consequences may impede economic development and progress, resulting in lower GDP and higher rates of poverty. However, increases in resource use, greenhouse gas emissions, and waste production can also worsen environmental deterioration as a result of economic expansion (IPCC, 2014). This results in a vicious cycle whereby environmental deterioration is a direct cause of economic growth, which is then adversely affected by it. Although more resources are used to fulfil the demands of the expanding population, population growth can also contribute to environmental damage.

There are many types of Environmental Degradation such as

- Deforestation
- Soil erosion
- Desertification

- Overfishing
- Air pollution
- Water pollution, and
- Climate change etc.

1.1 Environmental Degradation in Pakistan

In Pakistan**,** environmental degradation is a serious problem because of a number of issues. Deforestation, the clearing of vast areas of forest for industrial, agricultural, and urban development needs is one of the main causes. The combustion of fossil fuels and emissions from industrial facilities have led to elevatedlevels of air pollution, which have resulted in respiratory ailments and ecological harm (Ali, et. al, 2015). Water sources have also been contaminated by the improper dumping of sewage and untreated industrial waste, which has resulted in a drop in water quality and the spread of waterborne illnesses (Naqvi et al., 2014). The largest contributor to greenhouse gas emissions in Pakistan is the energy sector (Ali, et.al, 2015). Energy consumption is a necessary component of economic development, and it always results in environmental damage (Chol, 2020).

Like many developing nations, Pakistan has seen an increase in population pressure and economic activity over the past three decades, which has led to an increase in overall energy consumption. Pakistan's energy consumption increased from 34 million tonnes of oil equivalent(MTOE) in 1992 to 98 MTOE in 2019, causing a rise in average temperature and carbon emissions. The largest increase was in electricity and heat production, from 20.2% in 1970 to 35% in 2010. This excessive reliance on oil is due to its high production costs, decreased globalmarket competitiveness, and contribution to atmospheric CO2 levels, contributing to climate change (Ditta, et.al, 2021).

One of the main causes of Pakistan's changing climate is rising temperatures. Since non- renewable energy is Pakistan's main energy source and emits CO2 at a rate of 6% annually (Iram and Fatima, 2008). According to the World Bank, Pakistan's CO2 emissions rate has fluctuated since 2010. In 2010, Pakistan's CO2 emissions rate was 8.18 metric tonnes per person. This rate rose to 8.54 metric tonnes per capita in 2015, before falling slightly to 8.45metric tonnes per capita by 2020. However, the CO2 emissions rate is expected to rise to 8.60 metric tonnes per capita by 2023 (World Bank, 2021).Pakistan's CO2 emissions are predicted to exceed 400 million tonnes by 2030, which will result in an adverse environmental impact (Masood, Farooq, and Saeed, 2015).

1.2 Problem Statement

Environmental degradation is a serious problem in Pakistan, where a number of factors are causing the natural resources and ecosystems to deteriorate. This problem has become undesirable on account of human activities on the natural world whose end result is definitely the loss of species, clearing of forests, contamination of air and water and collapse of vital resources such as rich soil and pure water. On the other hand, there is less work done on this alarming issue in Pakistan.

1.3 Main Research Problem

The main research problem is to examine the "Determinants of environmental degradation in the economy of Pakistan."

1.4 Research Questions

1. What are the factors responsible for environmental degradation in the economy of Pakistan?

2. What is the impact of these determinants of environmental degradation on the economy ofPakistan?

1.5 Research Objectives

1. To determine the main determinants of environmental degradation in the economy of Pakistan in 1980-

2020.

2. To examine the impact of those factors on Pakistan's environment.

3. To provide policy recommendations for policy makers.

1.7 Research Hypotheses

The following null hypotheses have been established to achieve the mentioned objectives. H_o1 = CO_2 has negative impact on environmental degradation in Pakistan.
H_o2= Energy consumption has negative impact on environmental degradation in Pakistan.

H_o3= GDP has negative impact on environmental degradation in Pakistan.

H_o4= Population growth has negative impact on environmental degradation in Pakistan.H_o5= Industrialization has negative impact on environmental degradation in Pakistan.
H_o6 =Trade openness has positive impact on environmental degradation in Pakistan.

1.6 Significance of the Study

This study focuses on identifying the main determinants of environmental degradation in Pakistan's economy. It aims to provide practical solutions for policymakers and environmental organizations to address the problem. The research also emphasizes the economic implications of environmental deterioration, guiding actions and policy changes to support sustainable development and protect the environment for future generations.

2. Literature Review

2.1 Conceptual Framework

2.1.1 Carbon Dioxide (CO_2)

Carbon dioxide, a colourless, odourless gas, is produced naturally by human activities like burning fossil fuels and deforestation, as well as artificially through respiration and volcanic activity. It is the main indicator of pollution levels and is used to evaluate environmental quality.Carbon dioxide, also known as a greenhouse gas, is released during fossil fuel production, combustion, wildfires, and natural processes like volcanic eruptions.

2.1.2 Energy Consumption

Energy consumption refers to the consumption of energy by individuals, groups, or nations for various purposes, including industrial processes, transportation, heating, and cooling, and is a crucial indicator of human activity's impact on the environment and climate change (Reddy, Balachandra, 2006). The consumption of energy, particularly fossil fuels, contributes to environmental deterioration by releasing greenhouse gases like carbon dioxide, causing global warming and causing issues like rising sea levels, more frequent natural disasters, and habitat destruction for many species.

2.1.3 Gross Domestic Product (GDP)

The entire worth of all commodities and services produced within a nation during a given time period, generally a year, is measured by the gross domestic product, or GDP. It is frequently used as an indicator of the economic and living standards of a nation.Exploitation of natural resources is a common prerequisite to economic progress and can result in environmental deterioration. Deforestation and industrial operations can lead to habitat damage and a decline in biodiversity. Environmental Degradation can also have a detrimental effect on economic growth by raising business inspection costs and decreasing agricultural productivity.

2.1.4 Industrialization

The process through which an economy shifts from being based mainly on agriculture to manufacturing and other industrial activity is known as industrialization. Usually, this includes the development of urban areas, the establishment of factories, and technological advances.

Industrialization leads to environmental and human health issues due to pollution in air, water, and soil, primarily from pollutants like carbon dioxide, sulphur dioxide, and nitrogen oxides. This expansion also causes deforestation, habitat devastation, and biodiversity loss, further affecting the environment. (Goudie, A. 2018).

2.1.5 Population Growth

The term "population growth" describes the rise in the total number of people residing in agiven area or region over a given time frame. Usually, it is expressed as a percentage or rate of change in the population's total size. Population growth can result in increased resource consumption, pollution, habitat destruction, and biodiversity loss, all of which can have a negative influence on the environment. Natural resources like land, water, and energy are under pressure from an increasing human population, which causes their depletion and degradation (Crist, M.C, et.al, 2017).

2.1.6 Trade Openness

The extent to which a nation imports and exports products and services in the global economyis referred to as trade openness. It is commonly expressed as the GDP to total trade (exports plus imports) ratio for a nation. The impact of trade liberalization on environmental deterioration can vary based on the particular conditions and regulations that are in place. Higher levels of production and consumption have been linked in some studies to increased trade openness and environmental degradation; however, other studies suggest that trade openness can encourage the adoption of cleaner technologies and practices, which can help to mitigate environmental degradation in the long run (Copeland, Taylor, 2003).

These study variables are incorporated into the model based on the conceptual framework shown in Fig. 1.

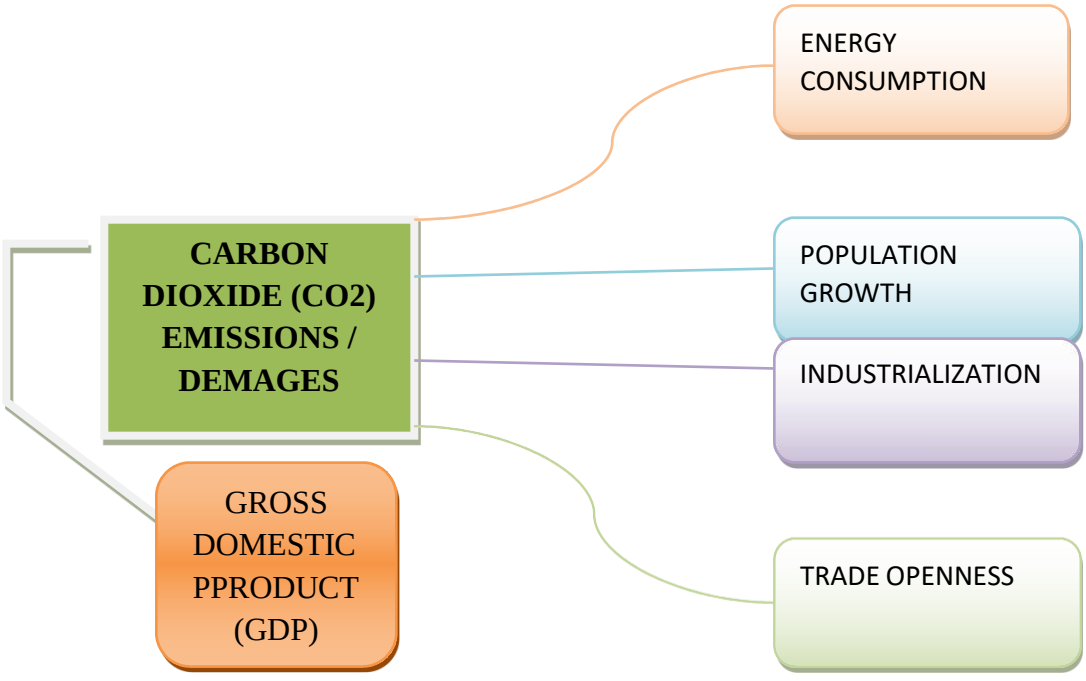

Figure 2.1: shows the determinants of environmental degradation in economy of Pakistan

2.2 Theoretical Framework

2.2.1 Environmental Kuznets's Curve

Simon Kuznets first put forth the environmental Kuznets hypothesis in the 1950s.

According to the Environmental Kuznets Curve (EKC), there is an inverse U-shaped link between environmental degradation and economic progress. This theory states that when a nation's economy grows and its income levels improve, environmental degradation will initially get worse before gradually getting better once a specific degree of economic growth is attained.

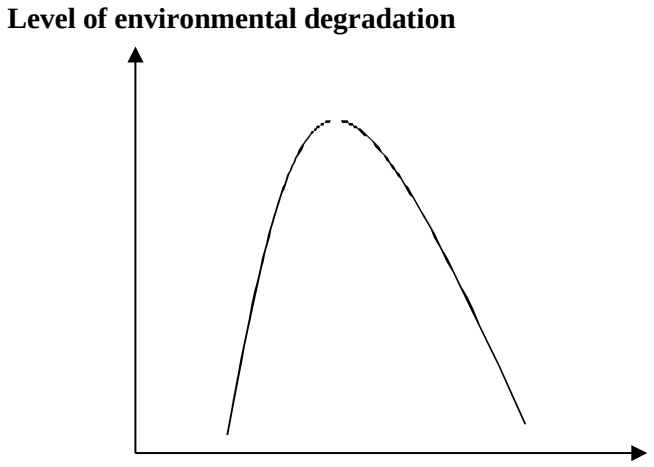

Figure 2.2: Demonstrates Environmental Kuznets curve

Criticism of EKC

Critics argue that there is no assurance that economic expansion would result in a better environment in fact, the opposite is sometimes true. The long-term decline in environmental degradation levels is not assured.

2.2.2 Theory of Population growth

English economist and demographer Thomas Malthus put forward the population theory in his 1798 work "An Essay on the Principle of Population." Malthus postulates that population increase tends to outpace resource availability, which degrades the environment and eventually puts a pressure on society. According to the definition of the Malthusian hypothesis, population growth follows a geometric progression with values of 1, 2, 3, 4, and so on. On the other hand, the amount offood grows in a sequence of arithmetic progressions such as 2, 4,6, 8, 10, and 12. As a result,the theory predicts that in a few decades, the population will have grown enormously while the food supply will not keep up with this rate of growth. As a result, there will be a scarcity offood in the future, resulting in starvation, famines, hunger, and food crises.

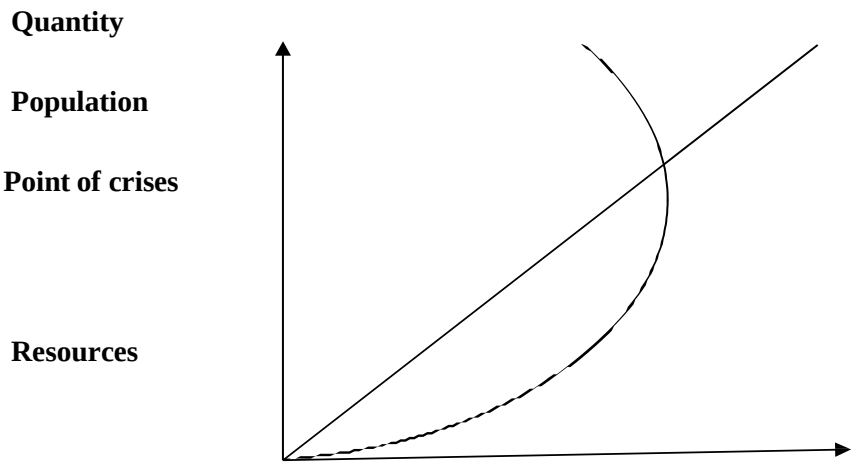

Figure 2.3: Malthus' basic theory

Malthus believed that in order to control population increase and stop environmental deterioration, moral constraint, preventative checks (like delaying marriage and abstinence),and positive checks (like sickness, war, and famine) were essential. This worsens human misery by increasing food shortages, conflicts, illnesses, and natural disasters that imprison people in their cities. He placed a strong emphasis on controlling population expansion and giving it thoughtful consideration.

2.3 International Studies

Researchers have been concerned about environmental degradation since the middle of the 20thcentury. The following paragraphs cover a few of the well-known studies. Ang. (2007) analyzed the dynamic causal links utilizing cointegration and vector error- correction modeling techniques between pollution emissions, energy consumption, and output for France. They argue that since there is a substantial correlation between these variables, an integrated framework needs to be used to study that link. For the years 1960–2000, the findings supported the existence of a reasonably strong long-run link between these factors. The findingsof the causality analysis provided support to the theory that, over time, rising economic expansion drives higher energy use and pollution. The findings also suggest a one-way causal relationship between short-term increases in output and energy use.Lakshmana, (2013) determined that the Asia-Pacific region has suffered significant environmental harm as a result of rapid population increase and ongoing economic development. Recent events, however, have demonstrated that developing nations are experiencing environmental degradation at a faster rate than industrialized nations. In order to achieve this, the study aims to evaluate the effects of population pressure on India's environment, paying special attention to the deterioration of natural resources such as water andland and the ensuing contamination of the environment in each of the country's six regions. There have been major environmental effects as a result of the recent decades' strong economic growth and expansion of infrastructural development, especially in the southern, northern, and western regions. However, rapid population increase has been the primary cause of environmental harm in the country's eastern, northeastern, and central areas.

Chen, Huang (2013) study examined the relationship between Next Eleven (N-11) economic growth and per capita carbon dioxide (CO2) emissions between 1981 and 2009. Panel unit roots,panel causality tests, and co-integration in heterogeneous panels served as the foundation for the empirical investigation. The study confirmed that there was a positive long-run link between CO2 emissions, electric power consumption, energy use, and GDP in order to assess the influence of CO2 emissions on relative variables. The bidirectional causal relationship between CO2 emissions and electric power usage was also demonstrated in this study. It is possible for policymakers to assess the external consequences of pursuing economic expansion in order to tackle global warming and create energy strategies.

Haq, Shafiq, (2016) observed the relationship between income, trade openness, carbon emissions, and energy consumption for Morocco between 1971 and 2011. The Johansen cointegration technique verified the long-

term relationship between the variables. Energy consumption was found to be true for both the short and long term, degrading the environment. Foreign trade is good for the environment because it has a negative impact on carbon emissions. The study did not support the long-term environmental Kuznets curve hypothesis. Additionally, there was a strong one-way causation from income to carbon emissions, meaning Morocco can improve environmental quality without slowing down the country's economic pace.

Ilham, (2018) examined how ASEAN's economic expansion continues to worsen the region's environmental quality, while the worst environmental conditions created a negative externality that decreased output across the board for the region's economic sectors. The objective of this article was to examine the interplay between environmental deterioration and economic development in ASEAN, as well as the variables that contributed to this interaction. Panel data from eight ASEAN nations covering the years 2004–2013 was used in this article. A simultaneous equation model was employed in the analysis process. The findings demonstrated an inverse association between ASEAN's environmental deterioration and economic progress. Moreover, energy consumption and GDP per capita had a positive impact on environmental degradation. On the other hand, trade openness and per capita carbon dioxide emissions contributed to economic progress. Consequently, raising GDP per capita and lowering energy consumption should be the main goals for ASEAN countries' economic growth strategies.

Misibau, et.al, (2021) investigation of the connection between energy consumption, economic growth, and environmental deterioration gave rise to a debate about the applicability or not of the environmental Kuznets curve (EKC) theory in Nigeria. The secondary data used by the authors was sourced from the World Bank's World Development Indicators for Nigeria from 1981 to 2014. After assessing the unit root properties using the augmented Dickey–Fuller and Phillips–Perron methods and the long-run relationship using the ARDL bounds approach, the non-linear autoregressive distributed lag (ARDL) technique was employed to estimate the asymmetries in the effects of economic growth on the environment. Their study's conclusions supported the applicability of the EKC hypothesis in Nigeria, where GDP development firstly lowers environmental quality before eventually raisingit. Moreover, it was discovered that energy use worsens environmental quality because each increase in energy use in Nigeria causes a 0.002% increase in CO2.

Sikder, et.al, (2022) employed the heterogeneous causality test and the Panel Autoregressive Distributed Lag (ARDL) method. This study examined how 23 developing countries' CO2 emissions were affected by energy consumption, industrialization, GDP growth, and urbanization between 1995 and 2018. According to their analysis, the long-term results showed that CO2 emissions rise by 0.23%, 0.17%, 0.54%, and 2.32%, respectively, for every 1% increase in energy usage, economic growth, industrialization, and urbanization. Additionally, the short- to long-term equilibriums of their model are modified annually at a rate of 0.19%. Robustness tests were conducted using the Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) techniques in order to verify the panel ARDL long-run results. Their findings verified that GDP growth, energy consumption, industrialization, and urbanization are the main factors influencing CO2 emissions in developing countries. Moreover, a bidirectional causative association between energy consumption, GDP growth, urbanization, industrialization, and CO2 emissions was found bythe panel causality study. Karedla, et.al, (2021) used annual time series data from World Development Indicators from 1971 to 2016 to analyze the link between CO2 emissions, trade, manufacturing, and GDP per capita using an autoregressive distributive lag (ARDL) bounds test approach. The findings suggested that CO2 emissions and other variables have a long-term link. In contrast, industrialization and GDP have a long-term, significant, positive impact on CO2, while trade openness substantially reduces CO2 emissions. The study's conclusions added to the body of knowledge by presenting fresh data on the connection between environmental factors and developmental measures. Policymakers and regulatory agencies must take these findings into consideration in order to prioritize economic development over environmental deterioration.

2.4 National Studies

Khwaja, Khan, (2005) evaluated the factors contributing to Pakistan's rapidly increasing air pollution and identified several important problems. They claim that the main causes of the decline in air quality are excessive energy consumption, an increase in the number of cars and kilometers driven, an increase in industrial activity without appropriate air emission control, theburning of solid waste, including plastic, in the open air, and the use of ozone-depleting substances (ODSs). Muhammad, et.al, (2011) looked into the

connections between Pakistan's trade openness, energy use, economic growth, and CO2 emissions between 1971 and 2009. For the empirical study, the Granger causality test and the limits test for cointegration are used. The outcome supports the Environmental Kuznets Curve (EKC) theory and indicates that there may be a long-term relationship between the variables. The significant creation of EKC demonstrated the nation's efforts to reduce CO2 emissions and suggests that Pakistan has made progress in controlling environmental deterioration. Also, they discover a one-way causal relationship between CO2 emissions and income. In the short and long terms, energy use raises CO2 emissions. Long-term trade openness lowers CO2 emissions, while short-term effects are insignificant.

Nasir, Rehman, (2011)) looked into the connections between Pakistan's 1972–2008 foreign trade, revenue, energy use, and carbon emissions. The study confirms the presence of Pakistan'sEnvironmental Kuznets Curve by utilizing the Johansen method of cointegration to determine that there is a quadratic long-run relationship between carbon emissions and income. Furthermore, it is discovered that energy use and international trade both reduce emissions. However, the short-term outcomes refuted the existence of the Environmental Kuznets Curve. The absence of significance for any long-term factors of emissions in the short-run results set them apart from previous research. Policymakers had the chance to create distinct growth plans for the two terms, taking environmental concerns into account, as a result of the opposing outcomes of the short- and long-run. Furthermore, the one-way causal relationship between growth and energy consumption indicated that policymakers have to concentrate not only on estimating future energy demand under various development scenarios, but also on achieving the lowest possible energy cost. Moreover, the lack of a link between emissions and growth suggests that Pakistan reduced its carbon emissions without affecting economic expansion.

Shahbaz, et,al. (2012) evaluated an attempt to close the gap in the literature on energy by doing a thorough national analysis of Pakistan. They looked into the connections between Pakistan's trade openness, energy use, economic growth, and CO2 emissions between 1971 and 2009. For the empirical analysis, the Granger causality technique and the limits test for cointegration are used. The findings supported the Environmental Kuznets Curve (EKC) theory and indicatedthat there may be a long-term relationship between the factors. The notable establishment of EKC demonstrated Pakistan's efforts to reduce CO2 emissions and points to some successes in halting environmental deterioration in the nation. Moreover, they discover a one-way causal relationship between CO2 emissions and economic development. In the short and long terms, energy use raises CO2 emissions. Long-term trade openness lowers CO2 emissions, while short-term effects are insignificant.

Ahmad, Long, (2013) examined a carbon dioxide emissions experiment conducted in Pakistan and verified the environmental Kuznets curve (EKC) theory. CO2 emissions were considered the dependent variable, and they used GDP per capita, GDP per capita square, trade openness ratio, and population increase as independent variables. Time series data from 1971 to 2008 were used. Using co-integration analysis and an ARDL-bound testing technique, they discovered that while Pakistan showed evidence of the long-run Environmental Kuznets curve, the short-run EKC was not supported. Additionally, they discovered a strong, positive correlation between energy use and environmental deterioration. Although it is one-way, population expansion does have a significant impact on CO2 emissions. The only significant correlation found in the short term was between energy consumption and trade openness, which showed a short-term but not a long-term negative association with environmental deterioration.

Baig, Baig, (2014) used the ARDL econometric technique based on time series data covering a 41-year period from 1970 to 2010 to explore the relationship between the four economic parameters, namely CO2 per capita, GDP per capita, energy consumption, and population growth in Pakistan. The ADF test first finds that, at a 1% level of significance, each variable had a unit root. According to the Auto-Regressive Distributed Lag (ARDL) test of co- integration, the econometric results showed a long-run link between GDP per capita, populationincrease, and energy consumption. According to research, there will be increases in CO2 emissions per person of 0.46%, 9.70%, and 0.005% for every 1% growth in GDP per capita, population, and energy consumption, respectively. The study also found that there was unidirectional causality between the variables of energy consumption, population growth, GDP per capita, and CO2 per capita in Pakistan, although the parameters remain stable, meaning all fall below the critical bound at the 5% significant level.

Haseeb, Azam, (2015) conducted an empirical investigation on Pakistan's energy consumption, economic

growth, and carbon dioxide (CO2) emissions. Annual time series data covering the years 1975–2013 were used in the study. In order to verify stationarity, the Augmented Dickey Fuller (ADF) unit root test was used. The results showed that the data are non-stationary atlevel and become stationary at first difference. Methods for empirical inquiry have included the use of vector error correction models and Johansen cointegration. The long-term correlation between energy consumption, economic growth, and CO2 emissions were confirmed by the vector error correction model's results. The study's conclusions indicate that while higher energy consumption contributes to economic expansion, it also raises CO2 emissions, which worsen Pakistan's environmental conditions. Increasing the usage of green and renewableenergy is a smart way to lessen CO2's negative environmental effects and support Pakistan's sustainable development.

Rasool, et.al, (2019) investigated the effects of population density, economic growth, oil prices, and the energy intensity of road transportation on the carbon dioxide (CO2) emissions of Pakistan's transportation sector from 1971 to 2014 using an autoregressive distributive lag model (ARDL). The Granger causality vector error correction model (VECM) is used todetermine the directions of causal links. The ARDL bounds test looked at cointegration and long-run interactions among the variables. The long-term findings showed that while increased energy intensity, population density, and road infrastructure raise CO2 emissions in the transportation sector, with population expansion having a major role they are also reduced by rising oil costs and economic growth.

Abbas, et,al. (2020) looked into how socioeconomic factors affected Pakistan's environmental degradation's characteristics between 1984 and 2017. Two tests are used to examine the effectof socioeconomic factors on environmental degradation dimensions: the autoregressive distributed lag limits test and the augmented Dickey-Fuller unit root test. The stability of the socioeconomic parameters on environmental degradation aspects in the three models under investigation was assessed using the cumulative sum of recursive residuals and the cumulative square sum of recursive residuals. In all three models, the study found a significant and adverse effect on environmental deterioration. According to the analysis, industrialization, FDI, per capita GDP, and the overall population all have a long-term, positive, and considerable impact on environmental degradation; as these factors rise, so will environmental deterioration. The relationship between agricultural land and the rural population and environmental degradation is negligible. The study also showed that Pakistan's government has a major impact on certain aspects of environmental degradation.

Rehman, Zeb, (2020) investigated efforts to look at several elements that contribute to Pakistan's environmental deterioration. These causes increased the amount of contaminants in the environment as byproducts of economic growth. Among these contaminants is the rate of carbon dioxide (CO2) emissions, which has been the study's dependent variable. Although there are many elements that contribute to environmental harm, the study focuses on the mostimportant ones. These factors include population increase, industrialization, energy consumption, and economic growth. Time-series data on these variables from 1972 to 2018 are used in the study's empirical analysis. The auto-regressive distributed lag (ARDL) method was used to calculate the long-term association. The study's conclusions showed that three factors; industrialization, population growth, and energy use, all positively and significantly contribute to Pakistan's environmental degradation. While environmental degradation is a direct result of economic expansion.

Chishti, et.al, (2022) explored the relationship between energy use, economic expansion, and carbon dioxide emissions in Pakistan. The World Development Indicators provided the data. For the analysis, the Distributed-Lag Model (ARDL) was employed. According to the results ofthe ARDL approach, Pakistan's CO2 emissions are increased by energy consumption and economic growth. Based on these findings, it was recommended that Pakistani officials adopt and support various renewable energy sources in order to meet the country's enormous energy needs, which will also help Pakistan maintain a sustainable environment and grow its economy.

The summary discusses the literature on environmental degradation in Pakistan's economy, revealing inconsistent findings from both domestic and foreign researchers. Some studies show a negative correlation between economic growth and environmental degradation, while others find the opposite. Trade openness can have mixed effects on environmental deterioration, with some nations seeing positive contributions and others seeing negative ones. The studies also highlights the inverse relationship between population and environment, indicating that an increase in population can worsen environmental degradation. Industrialization and energy

consumption are also contributing to environmental degradation.

3. Research Methodology

3.1 Data Type

For this study, annual time series data are used.

3.2 Sources of Data Collection

Secondary data for the specified variables is obtained from the database to provide more trustworthy results.

Data will be acquired from the following sources:

- World Bank reports
- State Bank of Pakistan
- Handbook of statistics
- Economic Survey of Pakistan
- World Development Indicators (WDI)

3.3 Operational Model

The relationship between poverty and environmental degradation in Pakistan is examined in this study. An overview of variables is provided below:

$CO2 = \beta0 + \beta1ENG + \beta2GDP + \beta3IND + \beta4POP + \beta5TRADE + \mu o$

Where

$\beta0$=Intercept

Dependent variable

CO2= carbon dioxide

Independent variables

ENG=Energy consumption GDP=Gross domestic product IND= Industrialization POP=Population growth TRADE = Trade openness

μo=Error term

Table 1: Description of the study variables

Variables	Symbols	Explanation of the variables	Measuring units
Carbon dioxide	CO_2	Carbon dioxide damage (% of GNI)	% of GNI
Energy consumption	ENG	Energy consumption (oil/petroleum(tons))	Tons

Gross domestic product	GDP	GDP growth (annual %)	Annual growth (%)
Industrialization	IND	(IND) growth rate of output in large scale manufacturing (LSM).	Quantum index of manufacturing (QIM)
Population growth	POP	Pop growth (annual %)	Annual growth (%)
Trade openness	Trade	Trade (% of GDP)	% of GDP

3.4 Data Analysis Method

First, an augmented dickey fuller (ADF) test was employed to determine whether the variables were stationary. Based on these results of the analysis, the best model to use for empirical analysis was determined. If all the variables show stationarity at a level, the ordinary least square (OLS) method will be applied. If all the variables show stationarity at first difference, the Johanson co-integration test will be employed to identify whether cointegration exists. If co-integration exists, simple OLS will be applied. If mixed stationarity is observed, the autoregressive distributed lag (ARDL) model will be chosen for the empirical analysis.

4. Results and Discussion

4.1 Descriptive statistics

Before moving on, Table 1 provides some descriptive data.

Table 2: Descriptive statistics of the variables

Variables	*Mean*	*Medium*	*Maximum*	*Minimum*	*Std. dev*	*Skewness*	*Kurtosis*	*Jerque-bera*	*Prob.*
CO2	0.706486	0.797179	*1.240842*	*-0.119854*	*0.316972*	*-1.160282*	*3.934554*	*10.69144*	*0.004769*
Energy consumption	16.41544	16.56316	17.05662	15.27433	0.459117	-0.923753	2.904481	5.846600	0.053756
Gross domestic	4.726856	4.458587	10.21570	-1.2740	2.259517	-0.0973	3.184521	0.122958	0.940373

product (GDP)				87		74			
Industrialization	5.008168	4.938423	5.601750	4.605170	0.297092	0.602642	2.084667	3.913011	0.141352
Population growth	0.911501	0.965419	1.486846	0.185696	0.342716	-0.458267	2.286724	2.304197	0.315973
Trade Openness	3.439162	3.478366	3.650640	3.066189	0.150016	-0.799376	2.688677	4.532090	0.103722

4.2 Unit Root Test

The Unit Root test analysis looks at the observations to see if the data is stationary or not. The Augmented Dickey-Fuller (ADF) Test has been widely utilized to address this issue.

Table 3: ADF Test

Variables	***Result with constant at level***		***Result with constant at 1st difference***		
	ADF(t)	Prob.	ADF(t)	Prob.	Conclusions
Carbon Dioxide (CO2)			0.0000	I (1)	At 1st Difference
Population Growth (POP)	0.0095	1(0)			At Level
Gross Domestic Product (GDP)	0.0163	1(0)			At Level
Industrialization (IND)			0.0000	1(1)	At 1st difference
Energy Consumption (ENG)	0.0580	1(0)			At Level
Trade Openness (TRADE)			0.0000	1(1)	At 1st difference

Many variables demonstrate stationary behaviour at both the first difference and the level. This study used the ARDL model to look at both the short- and long-term relationships between the variables.

4.3 Result of Auto Regressive Distributed Lag (ARDL) Model

The Auto Regressive Distributed Lag (ARDL) Model is an OLS-based model that may be applied to both non-stationary and mixed order integration of time series. Pesaran& Shin (1999) established the limits test approach, and it was later created in 2001 by Pesaran, Shin, and Smith.
The Critical value at I(0) 2.39 and at I(1) 3.38 is less than the value of F-statistics (4.822475)which mean Co-integration exists and there is long term relationship between the variables. After determining the long-run connection, we may calculate the long-run estimate. E-views 12 is utilized for the purpose. The short-term and long-term relationship's outcome is displayed in the table below.

Table 4: ARDL Short Run Analysis

Variables	Coefficients	Std. Error	t- Statistics	Probability
Energy consumption (ENG)	0.399734	0.182906	2.185459	0.0451
Gross domestic product (GDP)	0.001113	0.008368	0.133011	0.8960
Industrialization (IND)	0.403970	0.127270	3.174105	0.0063
Population growth (POP)	0.721207	0.272473	2.646890	0.0183
Trade Openness	-0.945005	0.380785	-2.481731	0.0254

(Source: Author's calculation from Eviews 12)

The short-run results of the ARDL estimation of the chosen variables are displayed in Table 4.In the short run, energy consumption, industrialization, and population expansion have a significant and positive influence on CO2 (environment degradation) however, GDP has a negligible and positive influence on CO2, but trade has a significant and negative impact on the environment.

Table 5: ARDL Long Run Results Analysis

Variables	Coefficients	Std. Error	t- Statistics	Probability
Energy consumption	0.716662	0.070686	10.13867	0.0000
Gross domestic product (GDP)	0.070888	0.010441	6.789201	0.0000

Industrialization	0.177809	0.045646	3.895361	0.0014
Population growth	0.291142	0.087377	3.332043	0.0045
Trade Openness	-0.020691	0.115316	-0.179431	0.8600

(Source: Author's calculation from Eviews 12)

The table 5 shows the result of ARDL estimation of selected variables in the long- run. In the long run, energy consumption, industrialization, GDP and population growth have a significant and positive influence on CO2 (environmental degradation), whereas Trade has an insignificant and negative impact on CO2 (environmental degradation). Results above indicated that one percent increase energy consumption resulted in a 0.71 percent increase in carbon emissions. Because increased energy use drives the demand for fossil fuels. As such, rising energy use is directly correlated with rising CO2 emissions. GDP is also contributed towards carbon dioxide (CO2) emissions. Economic expansion is frequently associated with higher levels of energy and industrial output as well as increased levels of transportation and building activity, all of which raise CO2 emissions. Growing economies tend to require more fossil fuels and other resources that release greenhouse gases into the atmosphere, which increases corporate expansion and consumer demand and ultimatelyraises CO2 emissions.
Further, one percent increase in trade openness may decrease by 0.020 decreases in carbon emissions (CO2). Because greater openness to trade makes it possible for nations to adopt greener practices and technology, which lowers the carbon footprint of manufacturing processes.Furthermore, trade agreements and partnerships promote the sharing of renewable and sustainable resources, reducing the need for fossil fuels in the production of energy. Also results shows that one percent increase in population growth resulted in a 0.29 percent increase in CO2 emissions. This fits with the Malthus population theory, which warned of the dangers associated with an increasing population. According to the hypothesis, resource depletion occurs at a faster pace due to population increase that is exponential in nature. Degradation of the environment results from this depletion.
Industrial emissions are the final significant cause of environmental deterioration. The study's findings indicate that a 1% rise in industrial production led to a 0.177 percent rise in emissions of carbon dioxide (CO2). Large volumes of carbon dioxide are released into the atmosphere during industrial operations including manufacturing and energy generation. Moreover one of the main causes of CO2 emissions is the combustion of fossil fuels, which iswidely used in industrial processes.

4.4 Residuals Tests

The Ramsey RESET test and potential Heteroskedasticity are examined in the model. The following table presents the findings of the numerous tests that are being conducted for thisaim.

Table 6: Results of Ramsey Reset Test

T- Statistics	***Probability***	***F- Statistics***	***Probability***
0.290061	0.7760	0.084136	0.7760

(Source: Author's calculation from Eviews 12)

Table 7: Result of Heteroscadasticity Test

Heteroscedasticity test: Breusch pagan Godfrey	
F- statistics	**Probability**
0.169082	0.9999

(Source: Author's calculation from Eviews 12)

The results revealed that the model is free from both issues.

Model stability has been proven by both CUSUM and CUSUM square at 5% significance.

5. Conclusions and Policy Recommendations

The data analysis clearly demonstrates that these factors are related to one another. It is claimedthat the factors that increase carbon dioxide emissions are energy consumption, GDP growth, population expansion, and industrialization. It reveals that a country's CO2 emissions will rise proportionately due to increases in GDP, population growth, energy consumption, and industrialization. On the contrary, it has been shown that there is a negative correlation betweentrade openness and carbon dioxide (CO_2). Based on these findings, a number of policy recommendations are made to reduce the nation's carbon dioxide emissions in relation to trade openness. Since trade openness and carbon dioxide emissions are negatively correlated, it is essential that the nation reduce its carbon emissions forthe sake of its citizen's well-being. Therefore, the government should develop environmentally friendly methods for reducing carbon emissions. Environmental protection is a long-term process that calls for ongoing planning, regulations, and involvement from the public and industry.

On the basis of above results, the following policies are recommended which is:

1) The government can offer tax incentives or subsidies to individuals and businesses thatinvest in clean and green energy sources such as solar panels or wind turbines. Establish a phase-out plan for the use of fossil fuels in the power sector, beginning with theprohibition of furnace oil use.

2) Population increase should be controlled to avoid negative consequences for the environment,resources, and individuals' quality of life. Enable people to make knowledgeable decisions about having children by implementing family planning programs that are both comprehensive and easily accessible. Women can also be empowered to make decisions about the number of their families and the health of their reproductive systems by investing in their education, healthcare, and employment prospects. Women who have education and job prospects are more inclined to put off having children and have smaller families.

3) Put into practice green growth techniques that minimize the negative environmental effectsof economic expansion and give priority to sustainable development. This can involve making investments in energy-efficient projects, encouraging the use of renewable energy sources, and supporting with environmentally friendly farming techniques. Establish a cap-and-trade orcarbon tax system to encourage businesses to invest in cleaner technology and cut back on their greenhouse gas emissions.

4) Promote the creation and application of clean technologies and substitute procedures that reduce the amount of persistent organic pollutants (POPs), produced during the manufacture and application of chemicals, insecticides, and other products. Federal and provincial Environmental Protection Agencies (EPAs) play a vital part in overseeing these industries in order to reduce their negative environmental consequences through the use of green technology,and they must be encouraged. Also to track and ensure that environmental regulations are being followed, establish a system for monitoring and evaluating the

environmental impact of industrial activities.

5) Even though trade openness and CO2 (environmental degradation)have a negative association, the government should only enter trade agreements with nations that compensate for environmental rehabilitation. Reducing manufacturing that uses polluting substitutes from overseas could lead to less pollution in Pakistan.

5.1 Limitations

The research has the following limitations

The study solely considers carbon dioxide (CO_2) emissions as the primary greenhouse gas; while there are other greenhouse gases, such as Methane, Sulphur Dioxide and Nitrogen Dioxide, etc are not in the study. The study examined five elements that lead to Pakistan's environmental deterioration. Since these variables' data were secondary in nature, difficult to collect or gather them. Gathering CO2 data is a difficult operation; it is done by visiting the website of the European Union. The quality of the data may be problematic. Similar to this Quantum Index of Measuring (QIM) is used as a substitute for industrial emissions data because it is not readily available. There are some issues with QIM.

5.2 Recommendations for Future Research

Future study topics that may be investigated by researchers for their work include the examination of these variables which are foreign direct investment (FDI), deforestation, technology, urbanization, air pollution, electricity production from coal, fertilizer use, and natural resources depletion are a few of the numerous other possible issues facing the environment.

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