

Measuring the Impact of Globalization on Environmental Degradation in Pakistan

Shagufta Ikram¹, Sher Ali², Amjad Amin³

¹Department of Economics, Islamia College Peshawar, Email: shaguftaikram30@gmail.com

²Department of Economics, Islamia College Peshawar, Email: drali@icp.edu.pk

³Department of Economics, University of Peshawar, Email: amjadamin@uop.edu.pk

Abstract

The study was aimed to investigate the impact of globalization on environmental degradation in Pakistan for the period 1990-2024. Stationarity test Augmented Dickey-Fuller and Phillips-Perron are employed to the order of stationarity. For estimation of the parameters of the model Auto-Regressive Distributed Lags approach is employed. Bound Test reported that there is long run relationship between the variables of the model. Long run results showed that globalization affect negatively and significantly environmental degradation, which means that globalization improves environmental quality through technological diffusion and the adoption of cleaner production practices. In contrast, population density has a positive and significant impact on environmental degradation, implying that higher population concentration increases carbon dioxide emissions and worsens environmental quality. Similarly, economic growth is found to have a positive and statistically significant long-run effect on environmental degradation, indicating that the process of economic expansion in Pakistan has been accompanied by increased energy consumption, industrial activities, and carbon emissions, thereby exerting pressure on environmental quality. Furthermore, poverty exhibits a positive and significant impact on environmental degradation, suggesting that higher poverty levels encourage the unsustainable exploitation of natural resources, reliance on environmentally harmful practices, and limited adoption of cleaner technologies. Based on these outcomes of the study, it is suggested that globalization, population dynamics, economic growth, and poverty should be paid special attentions regarding environmental policy formulation to provide clean and quality environment to the residents of the nation. It can be possible by Promoting environmentally sustainable technologies through globalization, implementing effective population dynamics, encouraging green economic growth, and reducing poverty through inclusive development are essential for achieving long-term environmental sustainability in Pakistan.

Keywords: Globalization, Population Density, Economic Growth, Poverty and Environmental Degradation.

Introduction

Globalization has emerged as one of the most important forces in the reshaping the economic, social, political, and environmental nature in the 21st century. It refers to the increasing interdependence and integration of the economies through the transfer of products, resources and technology across national borders. This emergence has been mainly determined by rapid develop-

Received 29 May 2026; Revised 26 June 2026; Accepted 08 July 2026; Published (online) 15 July 2026



Attribution 4.0 International ([CC BY 4.0](https://creativecommons.org/licenses/by/4.0/))

Corresponding Email: shaguftaikram30@gmail.com

DOI: <https://doi.org/10.69671/socialprism.3.5.2026.71>

ment and advancement in technologies and communication and transportation means. Moreover, trade liberalization policies, financial integration, and international investment flows are also the main sources of globalization (Ali et al., 2013; IMF, 2023; World Bank, 2021). It has been observed that the process has facilitated greater access to international markets, faster technological innovation, enhanced productivity, and promoted economic growth by allowing countries to specialize according to their strength areas. Resultantly, it has considerable and vital role in development of economies and standard of lives of world's inhabitants (Mishkin, 2009; Peterson Institute for International Economics, 2023).

It has several dimensions, like economic, social, political, and geographical dimensions. Economic globalization is reflected in the expansion of international trade, foreign direct investment (FDI), financial integration, and global production networks, all of which have become increasingly prominent since the latter half of the twentieth century. Social globalization has enhanced cultural exchange, communication, and the dissemination of knowledge through advances in information and communication technologies, while political globalization has strengthened international cooperation through multilateral institutions and global governance frameworks. Similarly, geographical integration, supported by modern transportation and digital technologies, has substantially reduced geographical barriers and enabled the rapid movement of people, goods, services, and information across borders (Ali et al., 2013; Ali et al., 2019).

Although globalization has generated substantial economic benefits, its environmental consequences remain highly debated. On one hand, globalization promotes the diffusion of advanced technologies, cleaner production processes, renewable energy technologies, and environmentally friendly innovations that improve resource efficiency and reduce greenhouse gas emissions. International cooperation and technology transfer enable developing countries to adopt sustainable production methods and strengthen environmental management systems, thereby contributing to improvements in environmental quality (Zafar et al., 2019). Increased international environmental awareness and stricter environmental standards have also encouraged firms to adopt cleaner technologies and more sustainable production practices.

On the other hand, globalization has accelerated industrialization, urbanization, international transportation, and large-scale production, leading to increased energy consumption and greater pressure on natural resources. The expansion of global markets has stimulated higher levels of production and consumption, often resulting in excessive exploitation of forests, minerals, water resources, and fossil fuels. In many developing countries, weak environmental regulations have encouraged pollution-intensive industries to relocate from developed economies, a phenomenon commonly referred to as the Pollution Haven Hypothesis. Consequently, globalization has been associated with rising carbon dioxide (CO₂) emissions, deforestation, biodiversity loss, land degradation, and environmental pollution (Shahbaz et al., 2020). These environmental challenges pose serious threats to ecosystem sustainability, public health, and long-term economic development.

The relationship between globalization and environmental quality has therefore attracted considerable attention in the empirical literature. However, previous studies have produced mixed and inconclusive findings. Several researchers argue that globalization contributes to environmental degradation by increasing industrial production, energy consumption, and carbon emissions (Akadiri et al., 2019; Le & Ozturk, 2020). Conversely, other studies suggest that globalization

enhances environmental quality through technological innovation, improved energy efficiency, and the adoption of environmentally sustainable production techniques. Shahbaz et al. (2019), for example, found evidence supporting the Environmental Kuznets Curve (EKC) hypothesis for several developed and developing countries, indicating that globalization may improve environmental quality after economies reach certain income levels. These contrasting findings imply that the environmental effects of globalization depend on country-specific economic structures, institutional quality, technological advancement, and environmental policies.

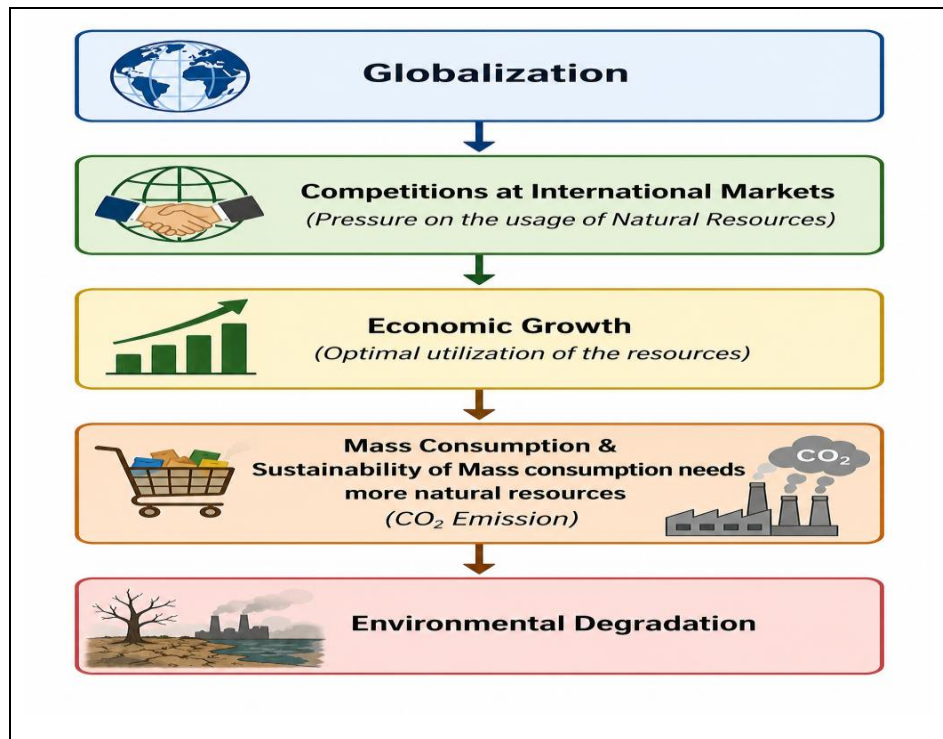
Globally, environmental degradation has intensified over the past four decades alongside rapid economic expansion and globalization. Since the 1980s, increasing industrial activities, fossil fuel consumption, and urbanization have substantially raised greenhouse gas emissions, contributing to global warming and climate change. Global CO₂ emissions have increased from approximately 20 billion metric tons in 1980 to more than 36 billion metric tons in recent years, accompanied by significant losses in forest cover, biodiversity, and ecosystem services. Air pollution has become one of the leading environmental risks worldwide, causing millions of premature deaths annually, while climate-related disasters have increased in both frequency and intensity. These environmental challenges have elevated sustainable development to a central objective of national and international policy agendas.

Pakistan is among the developing countries that have experienced rapid globalization since the late 1980s through trade liberalization, financial reforms, and increased integration into the global economy. Although globalization has contributed to economic development by expanding trade and investment opportunities, it has also intensified environmental challenges. Rapid population growth, urbanization, industrialization, increasing energy demand, weak environmental governance, and unsustainable exploitation of natural resources have significantly deteriorated environmental quality in the country. Pakistan is consistently ranked among the world's most environmentally vulnerable countries, facing severe air pollution, deforestation, biodiversity loss, water scarcity, and increasing greenhouse gas emissions. Urban centers such as Lahore, Karachi, and Peshawar regularly experience hazardous air quality levels, while continuous depletion of forest resources has increased the country's vulnerability to floods, landslides, and climate-related disasters. The country's CO₂ emissions have risen substantially over the past four decades, reflecting the environmental costs associated with economic growth and expanding industrial activities. Despite the growing body of literature on globalization and environmental quality, empirical evidence for Pakistan remains limited and inconclusive. Existing studies have primarily focused on individual aspects such as trade openness, energy consumption, or carbon emissions, while relatively few have comprehensively examined the overall impact of globalization on environmental quality using recent data and updated econometric techniques. Furthermore, the evolving nature of globalization, technological advancement, and environmental policies necessitates continuous re-evaluation of this relationship, particularly for developing economies where sustainable development remains a major policy challenge. Against this background, the present study investigates the impact of globalization on environmental quality in Pakistan over the period 1990–2024. The study seeks to determine whether globalization has contributed to environmental degradation through increased production, energy consumption, and resource exploitation or whether it has improved environmental quality through technological progress and the diffusion of cleaner production methods. The findings are expected to provide valuable insights for policymakers in designing strategies that simultaneously promote economic integration, sustainable development, and environmental protection.

Research Methodology

This section is about the methods and material which is used in this study. In the start of this section it is necessary to explain how the impact from globalization is transmitted to environment this notion is defined with the help theoretical and conceptual framework and is convert to a model as under:

Globalization & Environmental



The transmission mechanism describes the sequence of interactions and feedback loops through which globalization leads to environmental degradation. Here's a detailed step-by-step explanation of the process: the increase in trade, international investments, labour movement and integration of economies is the outmost motive of the globalization. The country Pakistan like other developing countries has the desire to engage in intensive natural resource extraction to meet global demand and to keep its own integrity in competitive environment at international markets. To do so it leads to higher exploitation natural resources like forests, minerals, water, and fossil fuels consumptions. The growing demand for expansion in industrialization cause intensification in agriculture sector land use leads to deforestation and put pressure on minerals. Moreover, an increase in population size and expansion in industrial sector demand for labour and capital. This increase is one of the major causes of urban expansion.

Globalization & Environmental

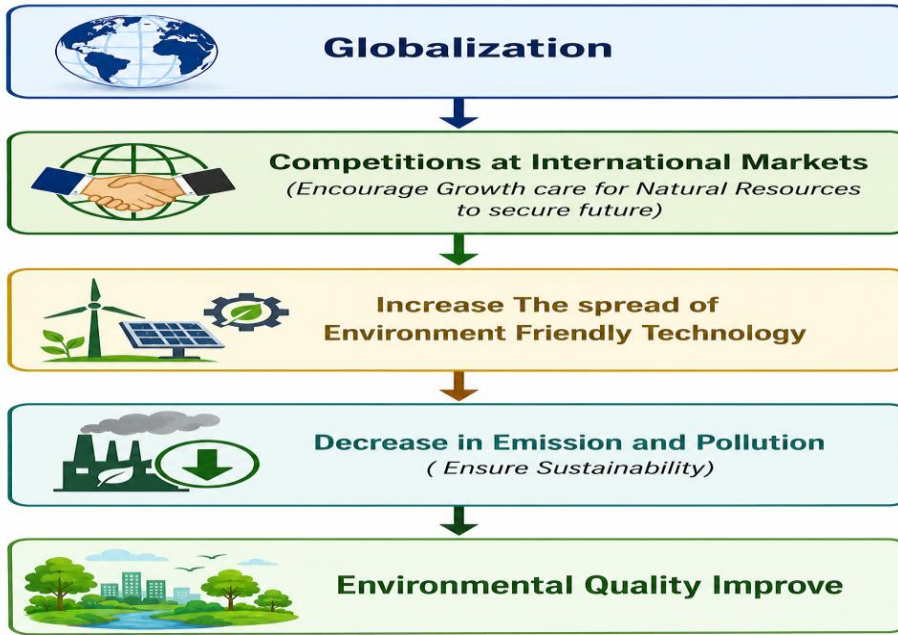


Figure-2: Globalization and Environment

This study uses the following model based on the studies conducted by Ali et al., (2013); Huang, Y., et al., (2022). Huang, Y., et al., (2022), Ali et al., (2019); Ullah et al., (2019); Ali, S., et al., (2013), Parveen, S., et al., (2021), Ali, S. et al., (2020); Luan et al., (2022); Liao et al., (2023), Khan, Z., et al., (2025).

$$ED = f(GB, Y, DI, Pov) \quad (1)$$

Where,

ED is environmental degradation proxy by CO₂ emission (CO₂ is the carbon dioxide emissions metric tons per capita). The other variables i.e. GB is globalization index (KOF globalization Index), Y is output of the economies (output/income is Per Capita income), DI is Domestic investment (investment made on gross fixed capital formation as % of GDP) and Pov is total final energy consumption per capita.

$$ED_t = \beta_0 + \beta_1 GB_t + \beta_2 DI_t + \beta_3 Y_t + \beta_4 Pov_t + \mu_t \quad (2)$$

Where ED is environmental degradation proxy by CO₂ emission, GD stands for Globalization, DI is Domestic investment, Y is national production, and EC is energy consumption. β 's indicated the estimated coefficients for short & long run effect of Globalization, DI, Y and Pov on Environmental degradation. The data of the presented study will be taken from World Development Indicators World Bank Website over the period of 1990 to 2025. The outcomes of the unit root tests are of mixed order which is given in next chapter therefore ARDL is suitable techniques for the purpose of estimation.

The general form of the ARDL (p,q1,q2,...,qkp,) model is:

$$A_t = \alpha + \sum_{i=1}^p \phi_i A_{t-i} + \sum_{j=1}^k \sum_{m=0}^k \beta_{j,m} B_{j,t-m} + \varepsilon_t$$

Where,

A = the dependent variable,

A_{t-1} = is the lagged value of the dependent variable

α = Constant term

B = the explanatory variable

ϕ_i = Coefficient of the lagged dependent variable

β = is the coefficient of the m^{th} lagged regressors

ϵ = Error term.

Results and Discussions

Descriptive Statistics

In the first step the descriptive analysis is done and the results of the descriptive statistics are presented on the following table-4.1.

Table-1: Descriptive Statistics

	CO ₂	GLB	POPD	EG	POV
Mean	0.388	35.909	219.929	4.152	44.90
Median	0.420	35.000	226.198	4.060	48.00
Maximum	0.690	44.000	300.179	7.700	66.50
Minimum	0.150	32.000	0.000	0.010	21.50
Std. Dev.	0.155	02.940	60.312	1.873	13.77
Skewness	0.074	01.213	-1.383	-0.100	-0.311
Kurtosis	1.961	03.865	6.309	2.855	1.92
Jarque-Bera	1.513	9.129	25.589	0.084	2.12
Probability	0.469	0.010	0.000	0.958	0.35
Observations	33	33	33	33	33

Table-1 presents the descriptive statistics of the variables used in the study. These statistics provide information about the average values, variation, and distribution of the data. The mean value of CO₂ emissions is 0.3875, while the mean values of globalization, population, energy consumption, and poverty are 35.9, 219.9, 4.1, and 44.9, respectively. The median values are 0.42, 35.9, 226.1, 4.06, and 48.0, respectively. The close values of the mean and median indicate that the data are reasonably balanced. The minimum and maximum values show the range of each variable. For example, CO₂ emissions range from 0.15 to 0.69, indicating the lowest and highest observed values during the study period. Similar interpretations apply to the remaining variables. The standard deviation measures the variation of data around the mean. A higher standard deviation indicates greater variability. Population has the highest standard deviation (60.312), showing considerable variation, while CO₂ emissions have a relatively low standard deviation (0.1551), indicating more stable values. Skewness describes the symmetry of the data distribution. A posi-

tive value indicates a right-skewed distribution, whereas a negative value indicates a left-skewed distribution. Globalization is positively skewed (1.213), while population is negatively skewed (−1.383). Kurtosis measures the peakedness of the distribution. Poverty has a kurtosis value of 1.927, indicating a relatively flat distribution, whereas population has a kurtosis value of 6.309, suggesting a more peaked distribution with relatively more extreme values. The Jarque–Bera (JB) test is used to examine the normality of the data. A p-value less than 0.05 indicates that the data are not normally distributed. The globalization variable (JB = 9.129, $p = 0.01$) and population (JB = 25.589, $p = 0.000$) are not normally distributed. However, CO₂ emissions have a p-value of 0.469, which is greater than 0.05, indicating that the data are approximately normally distributed.

Table -2: Correlation’s Coefficients

Variables	CO ₂	GLB	POP	EG	POV
CO ₂	1.000				
GLB	0.114	1.000			
POP	0.472	0.248	1.000		
EG	-0.265	0.273	-0.156	1.000	
POV	-0.733	0.025	-0.529	0.177	1.000

Table-2 presents the correlation coefficients for various variables, including CO₂, GLB, POP, EG, and POV. These values represent the pairwise linear correlation between the variables. The correlation coefficient ranges from -1 to 1. A value of 1 indicates a perfect positive correlation, meaning the variables move in the same direction. A coefficient of -1 signifies a perfect negative correlation, where the variables move in opposite directions. Meanwhile, a correlation coefficient of 0 suggests no relationship between the variables.

Correlation coefficient between the variables i.e. CO₂ and GLB is 0.114 which show that there is a weak positive correlation. The correlation between the variable CO₂ and POP is 0.472 which show that moderate positive correlation is existed between the variables of the study. Population seems to influence CO₂ levels. CO₂ and EG is −0.265, which means that there is a weak negative correlation between economic growth and emission. Economic growth has a slightly negative relationship with CO₂ emission. CO₂ and POV is −0.733 which means strong negative correlation. Higher poverty rates are strongly associated with lower CO₂ emissions.

GLB and POP are correlated with a correlation coefficient value of 0.248 which showed some weak positive correlations between the variables of interest, which shows that there is a slight alignment with population. GLB and EG is 0.273 which shows that Weak positive correlation between GLB aligns slightly with economic growth. The value of the correlation coefficient between GLB and POV is 0.025, which shows that near zero correlation between GLB is not meaningfully related to poverty.

POP and EG is −0.156 which shows that there is a weak negative correlation between the variables. Population is inversely related to economic growth. POP and POV is −0.529 which shows that there is a moderate negative correlation. Higher population is associated with lower poverty

rates. *Economic Growth* and *Poverty* is 0.177 which shows that there is a weak positive correlation. Higher economic growth shows a slight association with higher poverty.

To sum-up the above discussion this study found that there are weak relationships between *POV* and *CO₂*, stand out as having a meaningful, strong negative correlation. Correlations do not imply causation. Further regression analysis or ARDL modeling can help identify causal effects and short/long-term dynamics.

Table-3: Stationarity Test Results (ADF)

	Augmented Dickey Fuller Test				
Variable	I(0)		I(1)		Decision
	T-test	Prob-statistic	T-Test	Prob-statistic	
CO ₂	-0.086	0.644	-2.011	0.044	I(1)
GLB	1.698	0.422	5.500	0.000	I(1)
DI	-1.75	(0.39)	-5.36	(0.001)	I(1)
POPD	2.320	(0.889)	-5.106	0.0002	I(1)
EG	-3.73	(0.0081)			I(0)
Pov	0.964	0.753	4.900	0.0022	I(1)

It is cleared from the table-4.3 that estimates regarding stationarity testing regarding ADF are presented. From the values of the T-values and P-values that all the variables are non-stationary at level except the variable economic growth.

Table-4: Stationarity Test Results (PP)

Variable	Phillips Peron				Decision
	I(0)		I(1)		
	T-Test	Prob	T-Test	Prob	
CO ₂	0.841	0.343	-5.335	0.000	I(1)
GLB	1.740	0.402	5.503	0.000	I(1)
DI	-1.750	(0.39)	-5.36	0.001	I(1)
POPD	2.320	(0.889)	-5.106	0.000	I(1)
EG	-3.730	(0.0081)			I(0)
Pov	0.964	0.753	4.900	0.0022	I(1)

The values described in the above table PP test's results. It is clear that all the variables are non-stationary at level except economic growth from test statistic and probability. The variables are found of order one I(1) except economic growth. The results of the ADF and PP are turned about the same.

After the confirmation that all the variables are not stationary at level and the study cannot have assessed through Ordinary Least Square (OLS) method of estimation. Therefore, it is suggested that co-integration technique can be better option for estimation of the parameter of the model; this study is intended to use ARDL cointegration technique for estimation of the parameters of the model. The 1st step in using ARDL technique is the testing of co-integrational relationship. In

Bound Test the confirmation of the long run is tested with the following hypothesis: The test statistic is turned as a significant with the value of the test statistic is 13.1829, which means that the test is significant and the study can have the power to reject the null hypothesis of no co-integrational association between the variable of the model. As the value of the Bound test statistic is 13.1829, which is greater than the upper bound critical value and this study in the position to reject the null hypothesis of no co-integrational relationship. Therefore, this study sum-up with that there is long-run equilibrium relationship among the variables of the model and the study should be continuing for the estimation of long run and short run parameters estimates.

Table-5: Best Results

F-Bounds Test	Null Hypothesis: No levels Relationship		
Test Statistic (F-statistic) Value=13.18297	Signif.	I(0)	I(1)
K= 4	5%	2.947	4.088
Sample Size = 31	1%	4.093	5.532

Long Run Estimates

The results of the long run parameters are estimated with the help of ARDL and presented in the following table:

Table-6: LONG RUN COEFFICIENTS (Dependent Variable CO₂ Emission)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GLB	-0.104	0.049	-2.1224	0.0465
POPD	0.045	0.015	3.00	0.0112
EG	0.142	0.067	2.119	0.0489
POV	0.27	0.10	2.700	0.0183
C	-0.3830	0.1116	-3.4323	0.0026

Table-6 presents the long-run estimation results of the study. The sign of each coefficient indicates whether the independent variable has a positive or negative effect on the dependent variable (CO₂ emissions), whereas the t-statistics and p-values determine the statistical significance of these effects. A variable is considered statistically significant if its p-value is less than 0.05. The results show that globalization has a negative and statistically significant effect on CO₂ emissions in the long run. The estimated coefficient is -0.104, implying that a one-unit increase in globalization reduces CO₂ emissions by 0.104 units. The t-statistic (-2.12) and p-value (0.0465) confirm significance at the 5% level. This finding suggests that greater globalization contributes to environmental improvement by promoting cleaner technologies, technological diffusion, and environmentally friendly production practices. These findings are consistent with Ozlem and Atis (2024), who also reported that globalization reduces environmental degradation in the long run through technological advancement and improved environmental policies. The coefficient of population density is 0.045, indicating that a one-unit increase in population density increases CO₂ emissions by 0.045 units. This positive relationship suggests that increasing population pressure raises energy demand and production activities, resulting in higher environmental degradation. This finding supports the environmental impact theory of Ehrlich and Commoner and is

consistent with the results of Ahmad et al. (2019) for Pakistan. Economic growth also has a positive and significant long-run effect on CO₂ emissions. The estimated coefficient (0.142) indicates that a one-unit increase in economic growth raises CO₂ emissions by 0.142 units. The t-statistic (2.10) and p-value (0.0489) confirm significance at the 5% level. This result implies that economic expansion increases production and energy consumption, which in turn leads to higher carbon emissions. Similarly, poverty has a positive and statistically significant impact on CO₂ emissions. The estimated coefficient is 0.27, indicating that a one-unit increase in poverty increases CO₂ emissions by approximately 0.27 units. The t-statistic (2.57) and p-value (0.0183) confirm that the relationship is significant at the 5% level. This finding suggests that higher poverty encourages greater dependence on natural resources and the use of environmentally harmful production and consumption practices, thereby increasing environmental degradation. It also implies that environmental protection receives less attention in poorer economies, where meeting basic economic needs is often the primary concern.

Table-7: Short Run Estimates (Dependent Variable CO₂ Emission)

ECM Regression (Case 2) : Restricted Constant and No Trend				
Variable	Coeffic	Std. Error	t-Statistic	Prob.
D(CO ₂ (-1))	-0.2340	0.1131	-2.069	0.051
D(GLB)	-0.0059	0.0008	-0.071	0.943
D(GLB(-1))	0.0044	0.0008	5.078	0.000
D(POPD)	-0.0005	0.0002	-1.790	0.132
D(EG)	0.0022	0.0006	3.361	0.003
CointEq(-1)*	-0.2880	0.0289	-9.943	0.000
R ² = 0.7612			Adj- R ² = 0.7134	
Durbin-Watson stat = 2.3356				

The ECM regression results indicate a strong long-run relationship between CO₂ emissions and the explanatory variables, as evidenced by the highly significant error correction term (-0.2880, p = 0.000), suggesting that about 28.8% of disequilibrium is corrected each period. In the short run, past global variables (D(GLB(-1)), p=0.000) and economic growth (D(EG), p = 0.003) significantly impact CO₂ emissions, while current global variables, population density, and lagged CO₂ changes show weaker or insignificant effects. The model explains 76% of the variation in CO₂ emissions (R² = 0.7612), with no severe autocorrelation (Durbin-Watson = 2.3356), making it a well-fitted model for analyzing CO₂ dynamics.

The findings are supported by the Environmental Kuznets Curve (EKC) hypothesis, which suggests that as economies grow, pollution initially rises but eventually declines once a certain level of development is reached (Grossman & Krueger, 1995). The significant positive impact of economic growth (D(EG), p = 0.003) on CO₂ emissions in the short run aligns with the early stages of the EKC, where industrialization and energy consumption drive emissions upward. However, the presence of a strong error correction term (-0.2880, p = 0.000) suggests that over time, CO₂ levels adjust towards equilibrium, potentially reflecting long-run policies or technological advancements that help stabilize emissions.

The results also align with the STIRPAT model (Stochastic Impacts by Regression on Population, Affluence, and Technology), which suggests that economic growth and industrialization are key drivers of environmental degradation (York, Rosa, & Dietz, 2003). The insignificant impact of population density ($D(\text{POPD})$, $p = 0.132$) contrasts with some STIRPAT findings, but this could be due to differences in how population effects manifest in different regions, especially when accounting for urbanization and energy efficiency.

The strong and significant influence of past global factors ($D(\text{GLB}(-1))$, $p = 0.000$) on CO₂ emissions is consistent with studies highlighting the persistent nature of emissions and climate change feedback loops. For example, Stock & Watson (2007) found that past global economic and environmental changes have a delayed but lasting impact on current CO₂ levels due to the lagged effects of industrial production, energy use, and policy implementation. The marginal significance of lagged CO₂ changes ($D(\text{CO}_2(-1))$, $p = 0.051$) aligns with studies indicating path dependency in environmental systems (Stern, 2004). This means that past emission levels can influence future emissions, but their effect diminishes over time as policy interventions, energy transitions, and technological improvements take place. Additionally, the strong model fit ($R^2 = 0.7612$) and the absence of severe auto-correlation (Durbin-Watson = 2.3356) suggest that the model is robust, consistent with findings from Ang (2007), who used ECM approaches to study CO₂ emissions in developing economies and found that economic growth plays a significant role in shaping emission trends. From a policy perspective, these results suggest that economic growth remains a key driver of emissions, emphasizing the need for sustainable development policies, such as promoting renewable energy and energy efficiency to decouple growth from environmental degradation. The strong long-run adjustment mechanism (error correction term) implies that policy interventions can have lasting effects on stabilizing emissions, but short-run dynamics remain influenced by past global economic conditions. Overall, the findings align with key environmental economic theories like the EKC, as well as past empirical studies showing the persistent and lagged effects of economic growth on emissions. This supports the need for long-term sustainability strategies, as immediate policy actions may not always show instant effects but can contribute to significant environmental improvements.

Diagnostic Tests

Table-8: Serial Correlation Test Results

BREUSCH-GODFREY SERIAL CORRELATION LM TEST			
F-statistic	2.6026	Prob. F(2,18)	0.1017
Obs*R-squared	6.9537	Prob. Chi-Square(2)	0.0309

The Breusch-Godfrey test checks for the presence of serial correlation (auto-correlation) in the residuals of a regression model. Serial correlation occurs when the error terms in a model are correlated across time, which can lead to biased standard errors and unreliable hypothesis tests. The F-statistic ($p = 0.1017$) suggests no significant serial correlation at the 5% level. The Obs*R-squared ($p = 0.0309$) indicates possible serial correlation at the 5% level. The conflicting results suggest marginal evidence of serial correlation, but it is not very strong.

Hetero-Scedasticity

F-statistic	0.541880	Prob. F(10,20)	0.8402
Obs*R-squared	6.608601	Prob. Chi-Square(10)	0.7618
Scaled explained SS	3.062466	Prob. Chi-Square(10)	0.9799

The results of the test statistic showed that there are no hetero-scedasticity in the model and confirm that the results of the ARDL are efficient.

The stability of the parameters is tested with the help of CUSUM and CUSUM-square tests. The outcome of the CUSUM and CUSUM Square tests are presented in Figure-4.1 & Figure-4.2. It is clear from both the figures that the estimated line shown in Blue line in the figure which within the defined limits (the red lines) and remain throughout the time period from 2000 to 2022. Which show the parameters of the model of the study are stable.

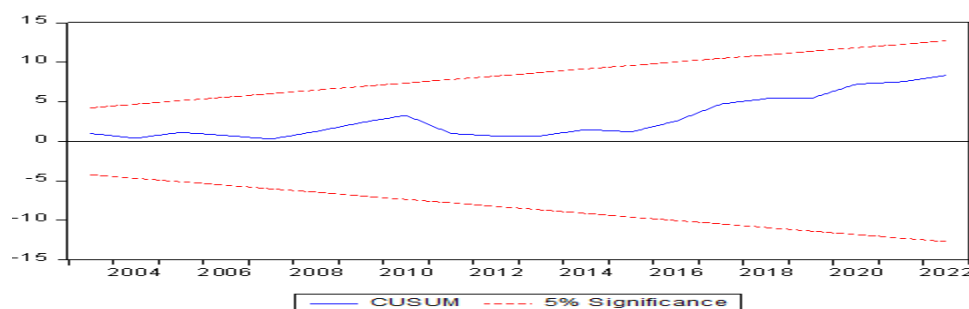


Figure-1 CUSUM Test

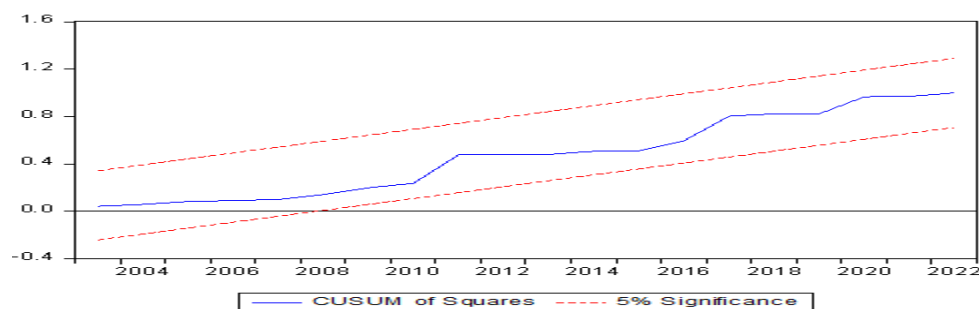


Figure-2 CUSUM Square Test

Conclusion

The present study is an attempt to examine the impact of globalization on environmental degradation in Pakistan. To test the existence of the impact this has used an annual time series data over the period of 1990 to 2025. The results of ADF and PP tests reported that variables are of mixed order of stationarity. The long-run results indicate that globalization has a negative and statistically significant effect on CO₂ emissions, suggesting that greater integration with the global economy helps improve environmental quality through technological diffusion, cleaner production methods, and stronger environmental policies. In contrast, population density, economic growth, and poverty all have positive and statistically significant effects on CO₂ emissions, implying that increases in these factors contribute to environmental degradation in Paki-

stan. Higher population density increases pressure on natural resources, economic growth raises emissions through increased production and energy consumption, and poverty encourages greater reliance on environmentally harmful practices. These findings are consistent with previous empirical studies and support the view that while globalization can promote environmental sustainability, population growth, economic expansion, and poverty remain major drivers of environmental degradation.

The short-run estimates reveal that economic growth and the lagged effect of globalization significantly influence CO₂ emissions, whereas the current effect of globalization and population density is statistically insignificant in the short run. The error correction term is negative and highly significant, confirming the existence of a stable long-run relationship and indicating that any short-run disequilibrium gradually adjusts toward long-run equilibrium. The model explains a substantial proportion of the variation in CO₂ emissions and demonstrates good explanatory power. The results are broadly consistent with the Environmental Kuznets Curve (EKC) and STIRPAT frameworks, highlighting that economic growth initially increases environmental pressure, while globalization can contribute to environmental improvement over time through technological progress. Furthermore, the diagnostic tests confirm that the estimated model is reliable, with no evidence of heteroscedasticity, only weak evidence of serial correlation, and stable parameters, as verified by the CUSUM and CUSUMSQ tests. Overall, these findings suggest that long-term environmental sustainability in Pakistan requires policies that promote clean technology, renewable energy, poverty reduction, and sustainable economic growth.

References

1. Afzal, M. (2007). The impact of Globalization on economic growth of Pakistan. *The Pakistan Development Review*, 723-734.
2. Ali, S., Ali, A., & Khan, S. (2019). Impact of globalization on inflation in selected South Asian countries: Using panel data techniques. *Global Social Sciences Review*, 4(2), 245-53.
3. Ali, S., Ali, A. Amin, A. (2013). The impact of population growth on economic development in Pakistan. *Middle-East Journal of Scientific Research*, 18(4), 483-491.
4. Ali, S., Sadiqa, B. A., Ali, S., & Parveen, S. (2020). Impact of poverty and population increase on environmental degradation: A comparative study of Pakistan and India. *Review of Applied Management and Social Sciences*, 3(2), 169-176.
5. Ali, S., Saeed, S. Saeed, A. (2024). Macro-Economic Policy Coordination and Macro-Economic Instability in Pakistan. *Global Regional Review*, 9(3), 116-130.
6. Ali, S., Uz Zaman, K., & Shah, M. (2013). The impact of economic globalization on macroeconomic performance in Pakistan (1980–2010). *International Journals of Marketing and Technology*, 3(4), 25-37.
7. Ali, S., Zaman, K. U., & Shah, M. (2013). The Impact of Globalization on Unemployment (The case study of Pakistan 1980-2010). *International Journal of Physical and Social Sciences*, 3(4), 148.
8. Grossman, G. M., & Krueger, A. B. (1995). 2 Environmental Impacts of a North American Free Trade Agreement. *The Mexico-US Free Trade Agreement*, 11(2), 13.
9. Huang, Y., Ahmad, M., & Ali, S. (2022). The impact of trade, environmental degradation and governance on renewable energy consumption: Evidence from selected ASEAN countries. *Renewable energy*, 197, 1144-1150.

10. Huang, Y., Ahmad, M., Ali, S., & Kirikkaleli, D. (2022). Does eco-innovation promote cleaner energy? Analyzing the role of energy price and human capital. *Energy*, 239, 122268.
11. Ma, Q., Zhang, M., Ali, S., Kirikkaleli, D., & Khan, Z. (2021). Natural resources commodity prices volatility and economic performance: evidence from China pre and post COVID-19. *Resources Policy*, 74, 102338.
12. Le, H. P., & Ozturk, I. (2020). The impacts of globalization, financial development, government expenditures, and institutional quality on CO2 emissions in the presence of environmental Kuznets curve. *Environmental Science and Pollution Research*, 27(18), 22680-22697.
13. Mishkin, F. S. (2009). Globalization and financial development. *Journal of development Economics*, 89(2), 164-169.
14. Ni, X., Wang, Z., Akbar, A., & Ali, S. (2022). Measuring natural resources rents volatility: Evidence from EGARCH and TGARCH for global data. *Resources Policy*, 76102553.
15. Ni, X., Wang, Z., Akbar, A., & Ali, S. (2022). Natural resources volatility, renewable energy, R&D resources and environment: Evidence from selected developed countries. *Resources Policy*, 77, 102655.
16. Parveen, S., Sadiqa, B. A., Ali, S., & Yasmin, F. (2021). Impact of private investment, economic growth and financial development on environmental degradation: evidence from Pakistan. *Review of Economics and Development Studies*, 7(1), 13-24.
17. Peterson Institute for International Economics. (2023). *Globalization: Concept, Causes, and Consequences*. Retrieved from <https://www.piie.com>.
18. Shahbaz M, Shafiullah M, Khalid U, Song, M (2020) A nonparametric analysis of energy environmental Kuznets Curve in Chinese Provinces. *Energy Econ* 89:104814.
19. Shahbaz, M., Shahzad, S. J. H., Mahalik, M. K., & Hammoudeh, S. (2019). Does globalization worsen environmental quality in developed economies? *Environmental Modeling & Assessment*, 23, 141-156.
20. Ullah, I., Qian, X., Shah, M. H., Rehman, A., Ali, S., & Ahmed, Z. (2023). Forecasting wages inequality in response of trade openness in Pakistan: An artificial neural network approach. *The Singapore Economic Review*, 68(06), 1875-1890.
21. Zafar, M. W., Saud, S., & Hou, F. (2019). The impact of globalization and financial development on environmental quality: evidence from selected countries in the Organization for Economic Co-operation and Development (OECD). *Environmental science and pollution research*, 26, 13246-13262.