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Institutional Quality and Environmental Degradation Nexus: Asymmetric Analysis for Pakistan

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ABSTRACT

Purpose: This study explores the dynamics of the environmental degradation in the context of Pakistan. The primary objective is to empirically investigate the asymmetric nexus of institutional quality, financial development and carbon emissions in the short and long-run for Pakistan's economy.

Research Gap: The exploration of an asymmetric analysis regarding the nexus among the institutional quality, financial development and environment in Pakistan remains a significant gap in the existing literature. The available literature ignores the potential asymmetry in the relationship between these variables, the present study fills this gap by analyzing the asymmetrical relationship among the institutional quality, financial development and carbon emissions along with other macroeconomic variables. i

Design/Methodology/Approach: To estimate the model, non-linear ARDL estimation technique is employed using the data from 1984 to 2020 which allows for the exploration of nonlinearity in these relationships, offering a more accurate representation of the dynamic nature of the environmental degradation process.

The Main Findings: The findings of the study support the existence of the asymmetrical relation between institutional quality, financial development and environmental degradation in case of Pakistan. Results reveal a negative relationship between forest area, financial development, and institutional quality; when these factors improve, CO2 emissions decrease, hence improving environmental quality. While, economic expansion, urbanization, energy use, has also a significant positive effect on the environment.

Theoretical/Practical Implications of the Findings: The findings suggest that better institutional framework along with ensuring better governance, law and order, and political stability also helps to combat corruption which hold potential to reduce carbon emissions. Additionally, policies should be made regarding regulations of financial developments and more loan facilities should be provided for projects that mainly focus on clean and carbon free projects.

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1. Introduction

Institutional quality play crucial role in promoting environmental quality and its sustainability as by the enforcement of environmental regulations, protection of property rights, ensuring transparency and accountability, strong institutions can help to prevent environmental degradation and promote a more sustainable future. Countries with strong institutions tend to have better environmental policies, more effective enforcement, and greater public participation in decision-making, which can all contribute to better environmental outcomes. On the other hand, weak institutions can lead to corruption, rent-seeking, and poor decision-making, which can have negative environmental impacts.

Institutions are likely to effect the environment in and economy either in a good or a bad manner depending upon the quality. Effective regulatory frameworks with sound procedural enforcement bring a positive change in environment through institutions. Such regulations include rules not only include decreasing the levels of emissions but also encourage sensitized consumption of available natural resources. Institutions by rule of law, may focus renewable energy use, afforestation, and pro-environment agricultural practices. Therefore, environmental accounting by empowered institutions is the only way to make a responsible and environmentally aware community. Contrary to this, weak institutions provide a room for corruption and violation of environment friendly protocols. In this way poor governance structure adds up to ecological risks of an economy.

Pakistan is one of the developing economies with high risk of environment and sustainability problems. Pro-environment initiatives, their implementation and citizens' participation are made obligatory at constitutional level as per Pakistan Environment Protection (PEP) act 1997. However, the weak institutional structure has always limited the potential of these regulations. Currently, government of Pakistan has vowed to transfer thirty percent of total energy consumption to renewable sources before 2030 (World Bank, 2020). To achieve this goal, authorities have made various changes at policy level. These include, tax breaks and financial support for projects of renewable energy. But institutional inefficiency, poor governance, political instability, and financial constraints are delaying effective implementation of revised policies.

Similar to other developing economies, institutional setup in Pakistan has variability in environmental effectiveness. The institutional quality and environment relation is quite complex and generally poorly understood in the case of Pakistan which poses substantial economic challenges. It is important to consider the role of institutional framework such as governance structure and policy effectiveness for the improvement of environmental outcomes. At the same time, it is equally important to conduct the asymmetric analysis to deeply understand the nature of the institutional quality, other macroeconomic variables and the environmental degradation in the case of Pakistan. Besides energy issues, air and water quality is rapidly declining due to inefficiencies of institutions. This necessitates Pakistan to develop an institutional structure that must strengthen its financial setup and resolve governance deficiencies. Considering the role of institutions and quality for environmental protection, this research evaluates the asymmetric relation of environment with institutional quality.

The objective of the study is to take into account the asymmetric nexus of institutional quality variable on the carbon emissions in the case of Pakistan. The significance of this objective lies in the fact that good governance, rule of law and political stability can play a crucial role by addressing environmental issues effectively. In case of developing countries like Pakistan where institutional framework is weak provides motivation to explore the institutional quality and environment nexus to foster the deep understanding on this critical issue which will lead to the actionable policy formulation.

2. Empirical Literature on Institutional Quality and Emissions

The institutional quality and the environment nexus have received significant attention in the literature in recent years. Institutional quality refers to the effectiveness of institutions in ensuring stable governance, rule of law, and the safeguarding property rights. The environment encompasses all natural resources, including air, water, land, and ecosystems.

Many scholars argue that there is a strong link between institutional quality and the state of the environment. For example, Xaisongkham & Liu (2022) examine the relationship between institutional quality, sector wise employment trends and environmental quality for developing countries. The authors used a balanced panel for the period 2002 to 2016 and applied two-step system GMM estimators to estimate the impact of macroeconomics variables on CO2 emissions. The findings indicate that the environmental quality significantly improves in the developing countries with better institutional setups. Especially, the rule of law and the government effectiveness play a significant role in reduction of carbon emissions which improves the environment condition in these countries. Moreover, the re-testing of the Kuznets hypothesis confirm the validity of this hypothesis for developing countries which implies that environment quality deteriorated at initial level of growth but it starts improving after a threshold level of growth. Overall, this study provides an important insight to understand the impact of sectoral employment and institutional quality in determining the environment quality of the developing countries.

Similarly, Li et al., (2022) explain the institutional quality, FDI, growth, trade openness and the environment sustainability nexus by using the non-linear approach for G7 countries. The results of the study refer that these variables affect the environment sustainability differently across G7 countries during 1986 to 2022. Results show that the positive change in the institutional quality variable significantly reduces CO2 emissions in UK, the USA, Germany, France, Italy and Japan. However, the negative in the same variable has insignificant effect on the environment in context of France. The study suggests that the environment sustainability in the G7 countries can be achieved by adopting consistent and distinct policies for the region.

Recently, Jahanger et al. (2022) investigated the nexus between autocracy, democracy and globalization for 69 developing economies. The results indicate a positive and significant relation between autocracy and carbon emissions, while democracy reduces carbon emissions. According to the study one possible reason could be that democratic governments are more concern about public opinion and therefore, more concern about the implantation of environment policies. Whereas, in autocratic, governments prefer growth over the environmental protection. Moreover, the globalization and environment relationship implies that due to production and transportation activities, globalization increases carbon emissions which lead to environmental degradation. Overall, this study supports the findings of the existing literature on the environment by focusing on the institutional setup of an economy.

Makhdum et al. (2022) examined the quality of institutional structure, natural resources, renewable use, financial development, and ecological footprint and economic growth nexus in China from 1996 to 2022 using panel data analysis. The authors find that institutional quality has a significant effect on both ecological sustainability and growth. The natural resources variable is also positively affecting the ecological sustainability but do not significant impact on economic growth. Moreover, renewable energy consumption also is positively impacting both ecological sustainability and economic growth. The ecological sustainability is negatively affected by the financial development and positively affected by the growth. The validity of these results is also confirmed by the application of robustness test using various model specifications and estimation techniques. Overall, good governance and better functioning of institutions lead to the improvement in the environment quality. However, the role of natural resource availability and climate change cannot be ignored in determining the ecological sustainability. Moreover, Ozturk & Acaravci (2010), Farhani, et al. (2014), Omri et al. (2015), Zhu, et al. (2016), Mehmood & Kanwal (2017), Shahbaz et al. (2017), Siddique (2017), Jamel & Maktouf (2017), Shahzad et al., (2017), Ertugrul et al., (2019), Mahmood (2020), Khan et al., (2021), Ahmad et al. (2022), Amin et al. (2022) and Khan & Naqvi (2022) explored the relationship among different macroeconomic variables like energy use, openness, financial development, growth, FDI, urbanization, human capital and carbon emissions.

Adebayo et al. (2021) investigated the role of financial development, urbanization, energy use, growth on the carbon emissions in Latin American nations. The analysis employs a data from 1980 to 2017. Results reveal that energy consumption, urbanization and economic expansion have positive influence on the emissions. Furthermore, Ahmed et al. (2020) used data from 1996 to 2018 to examine the relationship between financial development, institutional quality, and environmental sustainability in the case of Pakistan. They contributed to the existing literature on the trade-environment nexus by looking at the empirical relationship between trade openness and environmental sustainability in the presence of institutional quality and financial development. On limitation of this study is they considered only trade openness with FD and IQ as explanatory variables. However it is well known in the literature that omitting the relevant variables can lead to spurious regression.

Overall, the review offers a thorough and comprehensive insight into the existing understanding of the link of institutional quality with the environmental quality, and its implications for policy and practice. However, to the best of our knowledge there are limited studies that explore the asymmetric relation of institutional quality and financial development by considering other important macroeconomic variables (such as GDP, energy consumption, urbanization and forest area) with the environmental degradation in case of Pakistan. This study supports to fill this gap.

3. Analytical Framework

3.1 Theoretical Background

The Environmental Kuznets Curve (EKC, henceforth) conceptualizes a specified pattern in the relationship of environmental degradation with growth. The theory is named after economist Simon Kuznets, who originally proposed a similar curve for income inequality. The core idea of the EKC is that when the income of a country increases following growth, the environmental degradation initially worsen but after approaching to a certain level of economic growth the environmental quality starts improving which implies an inverted U-shaped relationship of growth and environmental degradation.

One possible reason of environmental degradation at early phases of growth could be the lack of environmental laws and regulations, use of obsolete technologies along with the extensive use of natural resources. However, after reaching a certain income level, it starts adopting cleaner technologies, investment in pollution control projects, and implements stringent environmental laws for environmental protection. Overall, it implies that the EKC starts declining when the country enters in the phase where economic growth improves the environmental quality. However, critics of this approach argue that the EKC is not valid universally for all countries as the shape and turning points of the EKC differs across the countries and regions as the institutional setup, environmental laws and regulations, technological advancements, and cultural attitudes towards the environment are not same around the world.

3.2 The Pollution Haven Hypothesis

According to the Pollution Haven Hypothesis (PHH, henceforth), pollution and environmental degradation shifts from the industrialized (developed) countries to less industrialized (less developed) countries with countries industrialization and development. The PHH implies that companies and industries prefer to relocate their production activities to countries with weak environmental laws and regulation which reduces their compliance costs and maximizes profitability. Moreover, countries at early stages of economic growth and development prefer growth over the environmental concern; therefore it offers an opportunity to industrialized countries to relocate their businesses to the countries having less stringent environmental laws and becomes pollution haven. This reallocation leads to the shifting of pollution from more developed and regulated countries to the developing countries with weak environmental laws and regulations.

3.3 The Theory of Environmental Governance

Environmental Governance Theory (EGT) explores numerous policy mechanisms such as laws and regulations, economic incentives, carbon trading and voluntary initiatives to attain the environmental goals. It measures the use and effectiveness of these policies in promoting sustainability. The EGT approach is based on principles reducing the environmental issues by focusing on the efficient utilization of resources. This theory suggests that the collaboration among the stakeholders including government, NGOs, communities, academic institutions and business) leads to environmental sustainability. Moreover, the inclusion of these groups in the environmental protection decision making processes ensures sustainable outcomes. Thus, EGT is a collective approach which enables the formulation of comprehensive environment oriented strategies to tackle environmental issues while considering the economic implications and foster the sustainable growth.

3.4 Econometric Model
The present study has adapted Makhdum et. al. (2022) as a reference study to develop the econometric model of analyzing the link of CO2 emissions and macroeconomic explanatory variables. The Non-linear Autoregressive Distributed Lag (NARDL, henceforth) approach is used to estimate the asymmetric relation among the variables of the study.

The non-linear model of the study is given as follow

$$CO_t = \alpha_1 + \alpha_2 INQ_t + \alpha_3 FD_t + \alpha_4 GDPPC_t + \alpha_5 GDPPC_t^2 + \alpha_6 FA_t + \alpha_7 UR + \alpha_8 EC_t + \varepsilon_t \quad (1)$$

where CO_2 represents the level of carbon emissions, $LNGDPPC$ is GDP in per capita form, $LNGDPPC^2$ is the squared GDP per capita, $LNEC$ is energy consumption , $LNFD$ is Financial development, $LNUR$ is Urban population , $LNFA$ is Forest area.

GDP per Capita: An important measure, GDP per capita is taken as constant 2015 US dollars, is derived by dividing the GDP by the total population. The data of the GDP per capita is taken from the World Development Indicators (WDI).

GDP per capita Square: It is estimated by taking the squared GDP per capita. "Data of per capita GDP has been sourced from World Development Indicators (WDI).

Financial Development: The credit to private sector is measured in percent form of country's GDP and it measure financial development. It signifies the extent of financial resources provided by various institutions (like banks, insurance companies, pension funds, etc.) to the investors in the form of borrowings, securities, and trade credits. This variable serves as an indicator of a nation's financial health and the level of support available for private businesses and individuals within the economy. In both positive and negative ways, Financial Development contributes to CO2 emissions. More energy is consumed as financial development increases the pace of investment, resulting in larger output sizes. As a result, CO2 emissions rise, having a detrimental impact. While a country's financial standing improves, it also reduces CO2 emissions by investing in technology that produces fewer emissions. World Development Indicators provided data on domestic lending to the private sector (WDI).

Energy Consumption: The energy consumption before it is converted to another purpose is referred to as energy use. It is calculated by deducting exports and fuels provided to ships and aero planes from starting production, which includes imports and stock changes. Energy consumption is proxied by the variable energy use in kg of per capita oil equivalent. The data on energy use is obtained from the WDI.

Urbanization: Urbanization measured in percentage of total population indicates the proportion of people living in cities, representing the level of urban development and movement from rural to urban regions in per capita oil equivalent is employed. It has a pivotal effect on carbon emissions. The data on Urbanization is also retrieved from the WDI.

Forest Area: Forest Area (sq.km) refers to the extent of land covered by forests, including both naturally grown and planted trees with a minimum height of 5 meters. The data is also obtained from the WDI.

3.5 Estimation Technique
Researchers studying the role of macroeconomic variables for carbon emissions have employed diverse econometric methodologies. Numerous studies such as Mirza & Kanwal (2017), Farhani et al., (2014), Shahzad et al., (2017), and Ozturk and Acaravci (2013) employed the Autoregressive Distributed Lag

(ARDL) estimation technique. Shahbaz et al. (2017) applied panel cointegration techniques, while Abbasi and Riaz (2016) employed an augmented Vector Autoregression (VAR) strategy. Whereas, Amulali and Sab (2012) used the Engle and Granger cointegration technique. Amulali and Sab (2012) and Farhani & Solarin (2017), Fotros and Maaboudi (2010) and Ertugrul et al. (2015) have applied the Granger, Bayer Hanck Cointegration technique, GMM and the VECM Granger causality techniques respectively. The main purpose behind using different estimation is to verify the role different methods in determining the effect of macroeconomic variables on emissions. Most importantly, Shahbaz et al. (2017) use non-linear ARDL to estimate the impact of different economic variables on the emissions. However, the findings of these studies are sensitive to the estimation techniques and the nature of the data. In this study, we start by testing the stationary of all the time series of the study.

3.6 The Non-Linear Autoregressive Distributive Lag Testing Approach

Shin et al. (2014) presented the non-linear ARDL estimation technique that is employed to measure the asymmetric impact of economic variables on the carbon emissions which also captures effects of explanatory variables on the response variable for the short and long run. The asymmetric technique is better than other techniques such as VECM and ARDL due to the fact that it captures the effect of both the negative and positive changes in the exogenous variables on the response variables along with addressing the multi-collinearity issue (Shin et al., 2014).

The NARDL framework for the model of the study is as follow

$$\Delta CO2t = \alpha0 + \beta\ CO2\ t\text{-}1 + \theta1 + INQ{+}\ t\text{-}1 + \theta2\text{-}\ INQ\text{-}t\text{-}1 + \theta3 + FD{+}\ t\text{-}1 + \theta4\text{-}\ FD\text{-}t\text{-}1 + \theta5 + LNGDPPC + t\text{-}1 + \theta6 - LNGDPPC\ \text{-}\ t\text{-}1 + \theta7 + LNGDPPC22 + t\text{-}1 + \theta8 - LNGDPPC2\text{-}t\text{-}1 + \theta9 + LNFA{+}t\text{-}1 + \theta10\text{-}\ LNFA\text{-}\ t\text{-}1 + \theta11 + LNUR{+}\ t\text{-}1 + \theta12 - LNUR\ \text{-}\ t\text{-}1 + \theta13 + LNEC + t\text{-}1 + \theta14 - LNEC\ \text{-} + \sum_{i=1}^{\rho} \alpha1\Delta CO2\ t\text{-}1 + \sum_{i=0}^{q} \alpha2\Delta INQ + t\text{-}1 + \sum_{i=0}^{q} \alpha3\Delta INQ\ \text{-}\ t\text{-}1 + \sum_{i=0}^{q} \alpha4\Delta FD + t\text{-}1 + \sum_{i=0}^{q} \alpha5\Delta FD\ \text{-}\ t\text{-}1 + \sum_{i=0}^{q} \alpha6\Delta LNGDP{+}\ t\text{-}1 + \sum_{i=0}^{q} \alpha7\Delta LNGDPPC\text{-}\ t\text{-}1 + \sum_{i=0}^{q} \alpha8\Delta LNGDPPC2{+}\ t\text{-}1 + \sum_{i=0}^{q} \alpha9\Delta LNGDPPC2\text{-}\ t\text{-}1 + \sum_{i=0}^{q} \alpha10\ \Delta LNFA{+}\ t\text{-}1 + \sum_{i=0}^{q} \alpha11\Delta LNFA\text{-}\ t\text{-}1 + \sum_{i=0}^{q} \alpha12\Delta UR + t\text{-}1 + \sum_{i=0}^{q} \alpha13\Delta UR\text{-}\ t\text{-}1 + \sum_{i=0}^{q} \alpha14\Delta LNEC + t\text{-}1 + \sum_{i=0}^{q} \alpha15\Delta LNEC\text{-}\ t\text{-}1 + \mu\ t \qquad (2)$$

The NARDL method captures both the short and long-run relation among variables. The short term relationship is captured using αt, which represents the immediate influence of an explanatory variable on explained variable, while the long-run relationship is captured using θt. θt also captures the adjustment speed and time duration in which the independent variable affects the dependent variable and reaches the equilibrium point. To check the asymmetry of the variable we have applied the Wald test. Long period asymmetric association means ($\theta = \theta - = \theta +$) and short period asymmetric association means ($\alpha = \alpha - = \alpha +$).

Here, LNFD is financial development; INQ is the institutional quality index; LNEC is energy usage; LNFA is the forest area and LNUR is the urbanization in the above model. The selection of lags for both the variables being analyzed is determined using the Akaike information criteria, a statistical method aiding in the optimal lag selection. Furthermore, in economic terms, the explanatory variables are segmented in positive partial sums, highlighting increments or positive changes in the independent variable, and negative partial sums, representing reductions or negative changes in the independent variable. This division provides a detailed economic perspective, enabling the model to distinguish and assess the effects of both positive as well as negative variations in the variables under examination which is as fellowTop of Form:

$$Xt+ = \sum_{j=1}^{t} \Delta x\ j+ = \sum_{j=1}^{t} \max(\Delta x_j, 0) \text{ and} \qquad (3)$$

$$Xt- = \sum_{j=1}^{t} \Delta x\ j- = \sum_{j=1}^{t} \min(\Delta x_j, 0) \qquad (4)$$

Here, the Xt represents independent variables such as GDPPC, $GDPPC^2$, FD, FA, UR, INQ and EC. Shin et al. (2014) introduce a boundaries test that examines asymmetric long-run cointegration. This test also serves as a combined evaluation for the lagged of all the regressors at level. The boundaries test is based on the t-statistics and F-statistics. In case of rejection of the null hypothesis it is implied that the variables have long run association. The long-period coefficients check the association among explained and explanatory variables concerning positive or negative changes of explanatory variables. While the long-term coefficients which are non-linear are analyzed on the basis of LGi+ = θ + / ρ and LGi- = θ - / ρ. The following equation is used to test the multiplier effects:

$$Gh+ = \sum_{j=0}^{h} \frac{\partial CO2\ t+j}{\partial LNYt+},\ Gh- = \sum_{j=0}^{h} \frac{\partial CO2\ t+j}{\partial LNYt-},\ Gh+ = \sum_{j=0}^{h} \frac{\partial CO2\ t+j}{\partial LNYsqt+},\ Gh- = \sum_{j=0}^{h} \frac{\partial CO2\ t+j}{\partial LNYsqt-},$$

$$Gh+ = \sum_{j=0}^{h} \frac{\partial CO2\ t+j}{\partial FDt+},\ Gh- = \sum_{j=0}^{h} \frac{\partial CO2\ t+j}{\partial FDt-},\ Gh+ = \sum_{j=0}^{h} \frac{\partial CO2\ t+j}{\partial FAt+},\ Gh- = \sum_{j=0}^{h} \frac{\partial CO2\ t+j}{\partial FAt-},$$

$$Gh+ = \sum_{j=0}^{h} \frac{\partial CO2\ t+j}{\partial LECt+},\ Gh- = \sum_{j=0}^{h} \frac{\partial CO2\ t+j}{\partial LECt-},\ Gh+ = \sum_{j=0}^{h} \frac{\partial CO2\ t+j}{\partial URt+},\ Gh- = \sum_{j=0}^{h} \frac{\partial CO2\ t+j}{\partial LURt-},$$

$$Gh+ = \sum_{j=0}^{h} \frac{\partial CO2\ t+j}{\partial INQt+},\ Gh- = \sum_{j=0}^{h} \frac{\partial CO2\ t+j}{\partial INQt-}$$

For h = 0, 1, 2, 3----.

Where, when h→∞ then Gh+→LGi+ and Gh-→LGi-.

These multipliers represent the asymmetry effect of the explained variable in response to some shock in the explanatory variable in negative or positive direction. This equation observes the dynamic modifications that occur inside the system as it moves from primary equilibrium to a different equilibrium when the independent variable varies.

3.7 Data Sources

The required data of the study from 1984 to 2020 is sourced from the WDI, focusing on CO2 emissions, GDP per capita, urban population, Forest area, energy consumption and financial development.

4. Results & Discussion

4.1 Descriptive Statistics

We used descriptive statistics to analyze the characteristics of data series. Results in Table 5.1 report the mean of CO2 (0.69), LNINQ (3.51), LNFD (3.03), LNGDPPC (6.57), LNGDPPC2 (43.44), LNFA (10.55), LNUR (3.52) and LNEC (3.89). Besides, LNGDPPC2 and LNFA have the highest maximum values of (54.62) and 10.80) respectively. All of the variables are positively skewed except LNFD, LNFA, and LNUR. LNGDPPC2 has the highest value of standard deviation which shows the normal values of LNGDPPC2 far from its mean.

Table 1: Descriptive Statistics

Variables	Mean	Min	Max	Std. Dev.	Skewness	Kurtosis
Co2	0.6969	0.5059	0.9189	0.1059	0.1980	2.3419
LNINQ	3.5184	2.2383	4.9725	0.5997	0.282913	3.208311
LNFD	3.0395	2.6796	3.3534	0.2157	-0.383510	1.684519
LNGDPPC	6.5732	5.8484	7.3906	0.5006	0.182972	1.557211
$LNGDPPC^2$	43.4492	34.2034	54.6216	6.6282	0.241696	1.593711
LNFA	10.5568	7.2775	10.8076	0.6143	-5.139399	27.98097
LNUR	3.5232	3.4202	3.6153	0.0572	-0.144074	1.908908
LNEC	3.8913	3.7398	4.0620	0.0852	0.2223	2.2529

Source: Authors' Estimations

4.2 Unit Root Test

In time series modelling unit root testing is the pre-requisite. Hence, the Augmented Dickey-Fuller (ADF) test was used to avoid problem of spurious regression. The unit root test is reported in the Table 5.2 shows that LNFA and LNUR are level stationary and the remaining variables are integrated of first order. Since none of the variable is stationary at second difference, so we continue to estimate the bounds test cointegartion.

Table 2: Augmented Dickey-Fuller (GLS) Unit Root Test

Variable	Mackinnon Critical Values to Reject Unit Root			
	Level	First Difference	5% level of Significance	Order of Integration
Co2	-0.294140	-4.867993	-1.952910	I(1)
LNINQ	-1.489075	-3.949236	-1.952910	I(1)
LNFD	-0.567700	-4.045107	-1.952910	I(1)
LNGDPPC	0.174573	-4.455165	-1.952910	I(1)
$LNGDPPC^2$	-4.890326		-1.955681	I(0)
LNFA	2.911643		-1.952910	I(0)
LNUR	-0.576573	-4.309421	-1.952910	I(1)

Source: Authors' estimations by EVIEWS 12

4.3 F- Bounds Test

The F-Bound test is applied to test the null hypothesis of no cointegration among the variables of the study. The hypothesis is tested on the basis of value of F-statistic.

If the F statistic exceeds the upper bound threshold, it indicates the existence of a long-run relationship among all the series of the study. Conversely, if the F-statistics value lies below the lower critical bound, it suggests the absence of long-run cointegration among the variables under examination. The table 5.3 shows the results of the F Bound test.

Table 3: Results of Bound Test

Significance Level (%)	Critical Values		
	Lower Bound	Upper Bound	F-Statistics
0.10	2.2	3.09	16.727
0.05	2.56	3.49	
0.0225	2.88	3.87	
0.01	3.29	4.37	

Source: Authors' estimations by EVIEWS 12

The obtained F-statistic value of 16.727, significant at the 1% significance level, rejects the null hypothesis. This outcome suggests that the variables exhibit a long-run relationship. The statistical significance of the F-statistic indicates a strong association among the variables over the long time.

4.4 Long-run and Short-run Estimates of NARDL

After validating that the series are cointegrated in the long run, the results of the long run and short run asymmetric relationship are given in Table 5.4(a) and Table 5.4(b) respectively. The asymmetric link of carbon emissions, financial development, and institutional quality is examined for short and long run in the current study. The results show statistical significance of all the explanatory variables except $LNFD^-$ in the long-run while, D($LNFD^-$) and D($LNFD^-$(-1)) in the short-run.

The results in Table 5.4(a) and Table 5.4(b) verify that the association of environmental degradation with institutional quality is asymmetric both in the long and short run. The results also confirm a negative relationship between positive shock of institutional quality and carbon emissions in the long-run, while a direct relationship in the short-run. It show that for every one percent increase in institutional quality ($LNINQ^+$), CO2 emissions are, reduced by 0.007 in the long-run and increase by 0.166 units in the short-run. Conversely, for every percent decrease in institutional quality ($LNINQ^-$), CO2 emissions are, increased by 0.005 units in the long run, and decline in short run by 0.034 units. Furthermore, we find that compared to negative changes in institutional quality ($LNINQ^-$), positive changes in institutional quality ($LNINQ^+$) have a larger effect on emissions in the long run and the short run. The outcomes are consistent with research by Mehmood et al. (2021), Ahmed et al. (2020), Ibrahim and Law (2016) and Bernauer and Koubi (2009) that declares a negative effect of institutional quality on CO2 emissions, which in turn enhances environmental sustainability. Every study that has been cited above has argued for the significance of institutional quality to enhance sustainability.

Moreover, we find insignificant relationship of environmental degradation with positive shocks to financial development ($LNFD^{+}$) in the long run and significant and inverse relationship in the short run. The negative shocks to financial development ($LNFD^{-}$), in Pakistan economy, are significantly increasing CO2 emissions in long-run while insignificant the short-run. Specifically, in the long-run 1 percent decrease in financial development ($LNFD^{-}$) will lead to increase 0.478 units in CO2 emissions, and in the short-run 1 percent increase in financial development $LNFD^{+}$ will lead to decrease 0.004 units in CO2 emissions. This result is consistent with Tao et al. (2023) and Ahmed et al. (2020) that found negative relationship of financial development with emissions.

Table 4(a): Asymmetric Long Run Effect of Macroeconomic Variables on Carbon Emissions

Optimal Lag: ARDL (2, 1, 1,2, 2, 1, 1,1,1)		
Response Variable: CO2 Emissions		
Explanatory Variables	**Coefficient**	**t-value**
$LNINQ^{+}$	-0.007**	-2.528
$LNINQ^{-}$	-0.005***	-4.593
$LNFD^{+}$	-0.006	-0.174
$LNFD^{-}$	-0.478**	-2.363
LNGDPPC	0.693***	3.691
$LNGDPPC^{2}$	0.090*	1.759
LNFA	-1.079***	-6.147
LNUR	0.754**	2.812
LNEC	1.283***	7.577

Note: ***, ** & * refer to significance at 1%, 5%, and 10% level, respectively.

The results suggest negative and adverse effect on environment by a nation's growth both in the long and short run. In long run a 1 percent increase in LNGDPPC and $LNGDPPC^{2}$ lead to increase 0.693 and 0.09 units in carbon emissions respectively, while 0.132 and 0.005 units increase in CO2 emissions, which ultimately cause the environmental degradation. Our findings align with those of previous research as well. Studies by Mirza and Kanwal (2017) and Farhani et al. (2014) demonstrate a bidirectional causation between economic growth and CO2. However, Khan et al. (2019) found that the relation of economic growth and carbon emissions exhibits the EKC curve.

Our findings also demonstrate that a 1 percent increase in forest area decreases carbon emissions by 1.079 and 0.992 units respectively. As more trees are planted, more carbon will be absorbed by them, which will reduce environmental degradation, hence this outcome is expected. This outcome is supported by findings of Li et al., (2021) and Waheed et al. (2018), they found that afforestation reduced carbon emissions in Pakistan China and neighboring countries.

Table 4(b): Asymmetric Short Run Effect of Macroeconomic Variables on CO2 Emissions

Optimal Lag: ARDL (2, 1, 1,2, 2, 1, 1,1,1)		
Dependent Variable: Carbon Emissions		
Variable	**Coefficient**	**t-value**
D(CO2(-1))	0.381^{***}	3.253
$D(LNINQ^{-})$	0.166^{**}	4.940
$D(LNIQN^{-})$	0.034^{*}	2.704
$D(LNINQ^{-}(-1)$	-0.234^{*}	0.070
$D(LNFD^{+})$	-0.004^{**}	-2.163
D(LNFD-)	0.0074	1.288

D(LNFD$^-$(-1))	0.2015	0.645
D(LNGDPPC)	0.132**	2.095
D(LNGDPPC2)	0.005***	3.221
D(LNFA)	-0.992***	-6.844
D(LNUR)	0.095***	4.1708
D(LNEC)	0.016***	2.959
ECT(-1)	**-0.365****	**-2.502**
C	7.830***	6.077

Note: ***, ** & * refer to significance at 1%, 5%, and 10% level, respectively.

According to our research, an increase of 1 percent in urbanization increases CO2 emissions by 0.754 and 0.095 units over the long and short terms, respectively. Our results are consistent with those of Pata (2018), Bekhet and Othman (2017), Poumanyvong and Kaneko (2010), Liddle (2014), and Alam et al. (2007). The results conflict with those of Sharma (2011) and Ali et al. (2017). Since the country's inception, Pakistan has experienced rapid urbanization, and in the last several decades, this trend has increased. Currently, almost 50% of Pakistan's population resides in cities. Because large industries are located close to cities, people travel to metropolitan regions in search of greater employment prospects. Furthermore, because of Pakistan's poor transport infrastructure, those who live in cities choose private transportation, which has resulted in massive emissions from vehicles that worsen the environment. As a result, urbanization eventually causes carbon emissions and worsens Pakistan's environmental conditions.

Pakistan, as an emerging economy, is currently experiencing rapid economic growth, resulting in a significant increase in energy demand for manufacturing, transportation, and industry. Moreover, Pakistan's lack of usage of environmentally friendly energy sources raises CO2 emissions. In case of our study, a 1 percent increase in consumption of energy leads to 1.283 and 0.016 units in carbon emissions both in the long and short run. Our results validate the claims made by Khan et al. (2019), Oh & Bhuyan (2018), Abbasi and Riaz (2016), Ertugrul et al. (2015), Al-mulali and Sab (2012) and others that there is a positive correlation between energy use and carbon emissions. Dogan and Seker (2016) claim that whereas using non-renewable energy has a favorable impact on carbon emissions, using renewable energy has an adverse effect on carbon emissions.

Additionally, Table 5.4(b) demonstrates a statistically significant speed of adjustment (ECT) and a negative coefficient. The long run co-integration among the variables is established by the ECT terms, or 0.365. This suggests that the explanatory factors account for 36% of the short-run shocks associated with environmental degradation.

4.5 Wald Test for Institutional Quality index

To check the existence of association between Institutional quality and environment variables in the long run Wald Test is applied and the result of which is given in Table 5.5.

Table 5: Wald Test Estimates

Test Statistics	Value	Df
Chi-Square	7.365 (0.000)*	1

Note: * shows the probability value of Chi-square

The result reveals a Chi-square value of 7.365 with a probability of 0.000, leading to the rejection of the null hypothesis that C(5) equals C(6). This null hypothesis posits that the "negative and positive components of institutional quality have similar impact on emissions." The rejection of this hypothesis proves the importance of the findings, indicating an uneven or asymmetrical relation of institutional quality with CO2 emissions in Pakistan over time. This outcome suggests that the positive and negative aspects of institutional quality exert differing influences on CO2 emissions, highlighting a non-linear relation of institutions' quality with environment in Pakistan.

4. 6 Wald Test for Financial Development

To check the existence of long run association of financial development with carbon emissions, Wald Test is applied. Table 5.6 gives the result of test."

Table 6: Result of Wald Test

Test Statistics	Value	Df
Chi-Square	13.542 (0.000)*	1

Note: * shows the probability value of Chi-square

The Chi-square estimate of 13.542, with a probability of 0.000, leads to the rejection of the null hypothesis i.e., C(3) = C(4). This hypothesis suggest that there is no difference in negative and positive shocks of financial development for environment. Since the hypothesis is not accepted, it implies that in Pakistan financial development has an asymmetric link with emissions over time.

5. Conclusion

Environmental protection and sustainability are among the major global concerns and have gained more attention in recent decades. Economies are struggling constantly to mitigate the effects of climate change by reducing polluting activities. This required including institutional efforts and effectiveness for switching towards renewable resource consumption. To meet this goal, instructional quality along with financial development is evaluated for their effect on environmental degradation in Pakistan. Time series data extending from 1984 to 2020 is used for NARDL bounds test to obtain the hypothesized relationship of the interested parameters. The results verify that, in the case of Pakistan, there is an asymmetrical relation between institutions' quality, financial development and environmental degradation. There is an inverse relationship among financial development, forest area, and institutional quality; when these factors improve, CO2 emissions decrease, hence improving environmental quality. While, economic expansion, urbanization, energy use, have also a significant effect on the environment.

6. Policy Implications and Limitations

The research findings have significant implications for policy. First, the findings suggest that better institutional framework along with ensuring better governance, law and order, and political stability also helps to combat corruption which hold potential to reduce carbon emissions. Second, financial sector development also increases CO2 emissions so policies should be made regarding regulations of financial institutions and more loan facilities should be provided for projects that mainly focus on clean and carbon free projects. Third, GDP per capita contributes significantly towards CO2 emissions, alternative resources should be utilized in increasing GDP per capita that are less dependent on energy uses detrimental for the environment.

This study has certain limitations in addition to the previously mentioned implications, which may guide future research. Firstly, the study's focus was limited to Pakistan's economy, which means its findings might not apply to other developing economies. Furthermore, Pakistan's economy is growing significantly faster than that of other developing nations, which may indicate a variety of environmental degradation features. In order to offer more information, future study should take into account comparative studies in both developed and developing nations. Second, due to data unavailability, this study only looks at IQ and FD's contribution to reducing carbon emissions. Last but not least, additional factors like green finance might produce intriguing additions to the body of current knowledge.

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