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Investigating the Linkages: Energy Consumption, Institutional Quality, and Environmental Quality in Pakistan

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***Abstract*:** Environment-related issues are always caused by using several kinds of energy resources that are used for production processes and economic growth and development. This study focused on examining the role of institutional quality and energy consumption on environmental quality in Pakistan by using data ranging from 1998 to 2022. In this study, we have used the ARDL method to analyze the relationship between independent and dependent variables. The results demonstrate the positive relationship between energy consumption and environmental quality, suggesting that efforts to boost energy efficiency and switch to cleaner energy sources might enhance environmental sustainability. Furthermore, there is a positive correlation between environmental indicators like CO2 levels and institutional quality, as determined by metrics like political stability, government efficiency, and the absence of violence or terrorism. This implies that improving governance procedures and institutional frameworks may contribute to better environmental outcomes. Furthermore, as efficient governance positively affects energy consumption, particularly oil and fossil fuel resources, it is essential for energy management. To address environmental problems and promote sustainable development in Pakistan, a multifaceted approach is needed. First and foremost, reforms must be implemented to enhance political stability and the efficiency of the administration. This necessitates improving governance structures, streamlining regulatory processes, and promoting transparency and accountability in decision-making. It is best to implement policies that promote the use of renewable energy sources and boost energy efficiency at the same time. This can include offering tax incentives or subsidies for renewable energy projects in addition to mandating the use of energy-efficient equipment in homes and businesses. In addition, it is imperative to uphold environmental sustainability and encourage business transparency.

Keywords: Energy Consumption, Institutional Quality, Environmental Quality, Pakistan.

1. Introduction

If environmental-related issues are concerned, CO2 is the most important indicator because it contributes up to 58% of the total greenhouse emissions around the Globe. In whole the world, CO2 emissions are increasing at an increasing rate, if we analyze the data, since the beginning of 1970, Pakistan has from one of the most affected countries (Global Carbon Project, World Metrological Organization, World Resource Institute, IEA (2021). Climate change has become one of the core points of discussion during the last few decades as the emission of CO2

is increasing at an increasing rate and causing global warming and environmental intensity. In response to the said discussion, globally, efforts are being made to cope with change in the environment and its impact on the globe using research while using different kinds of disciplines, resulting in enhancing more attention as well as new evidence to create consciousness and deliver a piece of information for countrywide policies and strategic planning to control global warming. This study provided new proofs from Pakistan by analyzing the emission of CO2, use of energy, and GDP using the ARDL method of applied econometrics methodologies. (Hamilton and Turton 2002; Hussain 2011; Sarkodie and Strezove 2018; Soytas et al., 2007) explored that gas, oil, and coal are the major sources of emission of CO2 that harm environmental quality.

Pakistan has an agriculture-based economy and is slowly shifting from an agriculture-based economy to an industry-led economy. As the economy has shifted from agriculture-based to industry-based, ultimately demand for energy has increased which resulted in increased pollution due to the very high rate of emission of carbon dioxide as Pakistan is using old technologies for energy production. There is also a lack of implementation of rules and policies in Pakistan. In conjunction with this, CO2 emission is increasing, and consequently, the country is facing the hostile effects of environmental change. In this study Carbon emission has been taken as the dependent variable and Energy consumption, Institutional quality, Natural resources, and GDP have been taken as independent variables (Bhatti et al., 2020). As we look at the relationship between different economic indicators that affect global warming, we come to know that CO2 is amongst those variables that apprehensions the climatic conditions in the economy globally. It is obvious that industries, also, are playing a critical role in the economic growth and expansion of every country in the whole of the world. However, industries cannot be operated without the use of energy and the emission of carbon dioxide, it is perceived that this is the major cause of ecological contamination as well as negatively impacting the quality of the environment. If anyone from the country wants to achieve higher economic growth, he will have to fall along the lines of environmental quality reduction (Sharma 2011). Emission of CO2 is damaging the ozone layer which is causing global warming and affecting the health of the public as well. We have focused on Pakistan as it is a developing country and it is assumed that energy consumption and carbon emission may be 127% higher in emerging countries than the technologically advanced countries, by 2040. (U.S. Energy Information Administration. 2016). Pakistan has recently shifted from agriculture to an industrial economy and is in the 5^{th} position of vulnerability regarding the change in environmental quality (Ahmad et al. 2015). Pakistan's economy is agriculture-based, and almost 25 million people are involved in agriculture-based labor. Increasing population growth is also one of the major issues in Pakistan and Pakistan is in the 6th position which has high population density and has approximately 2 % annual population increase. This population moves from rural areas to urban areas to search for a formal job in industries, resultantly industry grows, and new plants are installed, and these new plants require energy which causes the increase in CO2 (Awan & Yaseen, 2017). Paris Agreement was signed in November 2016, in this agreement most of the CO2-omitting countries agreed to eliminate the dangerous effects of increasing the rate of emission of carbon. In this agreement, all the countries agreed to make all kinds of possible attempts to resolve the issues of global warming by use of new and advanced technologies. Hence global warming has gained full attention as most of the countries have noticed the impacts of global warming. The use of new technologies, and new production techniques, are need of the hour to mitigate CO2 emissions (Haszeldine et al., 2018). Institutional quality, corruption, quality of bureaucracy, and rule of law, have less impact in terms of the causes of environmental degradation (Ibrahim et al., 2021).

World Bank Report has revealed that among the other indicators that are causing the increased pollution resulting in climate change & global warming, CO2 emission is the main indicator which is responsible for 58.8% of emission of CO2 (Mohiuddin et al., 2016). Institutional quality has also gained the attention of scientists, policymakers, and the Government. Policies that are made to control the spread of pollution, if implemented in true spirit, can play a vital role in mitigating environmental quality.

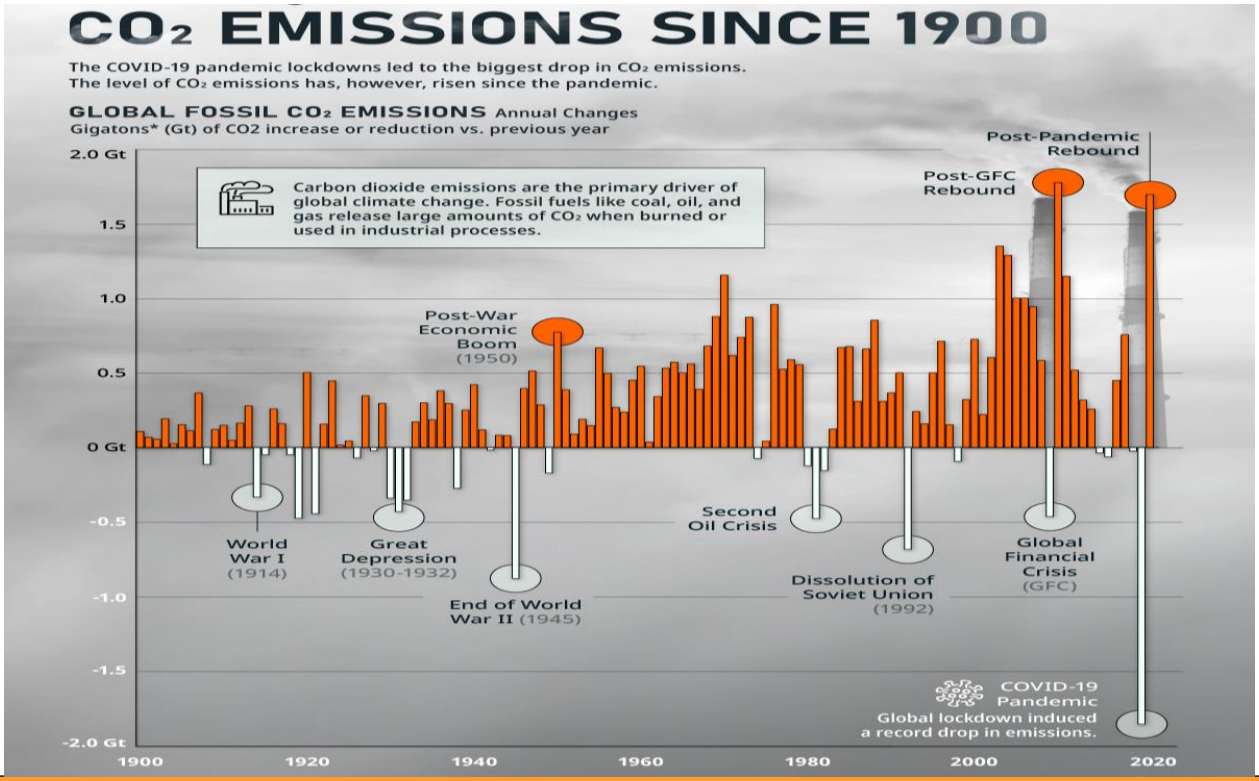


Figure 1: Source, Global Carbon project, World Metrological organization, World Resource Institute, IEA

The above diagram also shows that Carbon emissions fell during 1914(World War 1) and during the great depression 1930-1932. After the end of the 2nd world War in the 1950s Carbon emissions increased, during the oil crises in the 1970s Carbon emissions decreased. In 1992 during the dissolution of the Soviet Union Carbon emissions decreased, during global financial crises Carbon emission has decreased and later sudden increase in Carbon emissions showing that the institutions are working in a good and managed way, there will be a rule of law, carbon emission will be minimum. Lau et al. (2014) studied the impact of the quality of institutions and the emission of carbon dioxide and found that good quality of institutions is helpful in reduction of the carbon dioxide which results in a good quality environment.

2. Literature Review

The use of fossil fuels is contributing to environmental problems such as global warming and air pollution, which cause health problems and affect the quality of life of the public. Li et al. (2020) determined Government of the China has made many structural reforms in industries, they have controlled and regularized the number of vehicles on the roads through developed policies, they have controlled their population growth rate, and they have mainly focused on the Beijing economic structure. He further concluded that policies made and implemented in China are the major driving force in controlling air pollution. Zhang et al. (2015) scrutinized the impact of trade openness and trade-related activities. He concluded that openness creates pollution. He focused on three areas of China and revealed the results that domestic trade also has a strong and positive impact on regional air quality. He concluded that if China wanted to have economic growth without polluting the environment, then it should have strong institutions in place that could implement the policies which are developed by the Government to control pollution. As far as our knowledge is concerned, an improvement in institutional quality (IQ) can result in a reduction in the emission of Carbon Dioxide. Bhattarai and Hamming (2004), in their study, proved the negative association between Institutional quality and the quality of the environment given institutional aspects for example bureaucracy

and corruption.

Similarly, Deacon (1999) concluded that countries in which people don't raise their voices and have no democratic rights tend to have higher levels of carbon emission. Likewise, Eriksson and Persson (2003) proposed that a more equitable distribution of income in democratic societies results in a low level of air pollution. In addition, Carlsson and Lundstrom (2003) suggested that the countries in which people are free to loud their voices for their rights would have better environmental quality due to low emissions of CO2. Ahmad et al. (2021) studied the association between institutional quality, economic complexity, overall use of energy, economic evolution, and development of emergent countries by using the data from 1984 to 2017. In this research they examined that imports and exports have positive impacts on environmental quality by enhancing ecological footprints, they also analyzed that the more the value of imports and exports higher the level of ecological footprints. Their study also revealed that institutional quality is helpful in the sustainability of the environment as it reduces the level of ecological footprints. The study also showed that renewable energy reduces the level of ecological footprints while energy that is not renewable worsens the ecological footprints.

Hunjra et al. (2020) examined the effect of institutional quality on financial development as well as environmental quality in connection with South Asia. By using panel data, they analyzed 35 years starting from 1984 till 2018. They found that financial development is only being used for the formation of capital, it is not benefiting the use of even clean energy, and it is causing a bad impact on the environment. So, it is obvious that financial development always worsens the environmental condition of Asian countries, especially South Asian countries., FDI is usually considered as a source of financial openness and is beneficial in the reduction of CO2. FDI is useful in the advancement of technologies as foreign investors bring new technologies with them, and it is helpful in the reduction of CO2 emissions. They came to know that the quality of the institution plays a moderating role in the growth of the economy, use of energy, and financial development. They also found that in the countries where the institutions were strong, there was less emission of CO2, and countries with weak institutions, where there was no rule of law were emitting a higher degree of CO2, as the policies made by the environmental protection department, were not being implemented in its true spirit. If South Asian countries were concerned. In terms of policy implications, they were of the view that environmental quality can be improved only if and only if the institutional quality is improved in South Asia. They suggested that the Government should launch public awareness campaigns about how to improve environmental quality, and laws should not only be made but also be implemented in true spirit.

Ali et al. (2019) examined the effect of institutional quality on the discharge of CO2. They used the data of 47 emerging countries and used a (GMM estimation) dynamic panel. They came to know that institutional quality reduces the emission of CO2. Furthermore, they concluded that the quality of institutions was improving the environmental quality. Their study also revealed that other controlled variables like economic performance, urbanization, trade openness, and use of energy also have positive effects on the emission of CO2. Jianguo et. al (2022) examined and found that the quality of institutions and high-tech revolution reduce CO2 emissions. If we see, on the other hand, this study shows that the quality of institutions and innovation in technology hurts the emission of carbon dioxide. Finally, this study shows that there is a negative role of IQ, innovation of technologies along financial development as far as carbon emission is concerned. Salman et al. (2019) examined the value of the emission of CO2 and the GDP growth rate, the study showed that South Korea has the highest mean of GDP which was followed by Thailand as well as Indonesia. They concluded that South Korea has the highest value of emission of carbon dioxide and Thailand is one of the lowest emitters of CO2. Furthermore, we see that South Korea was using the highest rate of energy consumption Indonesia was at second while Thailand was at third position. We came to know from this study that, as far as institutional quality is concerned, South Korea has very good institutional quality, while Thailand was in second position.

3. Data

In this study, we focused our attention on examining the role of institutional quality on environmental quality and energy consumption in Pakistan by using data ranging from 1998 to 2022. Time-series data have been used in this study. Environmental quality has been taken as the dependent variable and Energy consumption, Institutional quality, Natural resources, trade openness, and GDP have been taken as independent variables. Different indicators

that cause the environment to be affected are discussed in this study like CO2 emissions as a proxy for the environment, fossil fuel consumption as a proxy for energy consumption, GDP constant 2017 UD Dollar is taken, Institutional quality (IQ) index is taken form international court of risk guide (ICRG), and trade openness is measured by sum of Imports and exports and then divided it by GDP deflator. All the variables are taken from World Development Indicators (WDI) expect Institutional quality (IQ).

3.1 Economic Model

CO_2=f (EC, GDP, IQ, TO, TNR)………………………………………………………………… (1)

The economic model shows that Carbon emission is the dependent variable and Energy consumption, Gross domestic product, Institutional quality, Trade openness, and Total Natural Resources are the independent variables.

$$C_{O2\ t} = \beta_1 + \beta_2 EC_t + \beta_3 GDP_t + \beta_3 IQ_t + \beta_3 TO_t + \beta_3 TNR_t + \mu_t \quad \text{(2)}$$

3.2 Methodology

3.2.1 ARDL

A bound test was used to examine the long-run connection between the variables in our model. Based on our theory, we used the ARDL bound test form to estimate the long-run connection between the research variables.

$$\Delta \mathrm{C02PCt} = \varphi + \varphi_1 \mathrm{EC}_{t-1} + \varphi_2 \mathrm{GDP}_{t-1} + \varphi_3 \mathrm{OIQ}_{t-1} + \varphi_4 \mathrm{TO}_{t-1} + \varphi_5 TNR_{t-1} + \sum_{i=1}^{q} \beta_1 \Delta EC_{t-i} + \sum_{i=1}^{q} \beta_2 \Delta GDP_{t-i} + \sum_{i=1}^{q} \beta_3 \Delta IQ_{t-i} + \sum_{i=1}^{q} \beta_4 \Delta TO_{t-i} + \sum_{i=1}^{q} \beta_5 \Delta TNR_{t-1} + \varepsilon t \quad \text{(3)}$$

In the given equation, Δ represents the initial difference. EC is energy consumption, GDP is gross domestic product, IQ is institutional quality, and t-1 is the appropriate lag selection using the Akaike information criteria. The variables Φ and β will be approximated to determine the long-term relationship between the variables under discussion. The model demonstrates the relationship between variables; hence we will estimate the short-run and long-run ARDL models.

3.2.2 For Short Run Relationship

$$\Delta \mathrm{C02PGt} = a + \sum_{i=1}^{q} \lambda_1 \Delta \mathrm{EC}_{t-1} + \sum_{i=1}^{q} \lambda_2 \Delta \mathrm{GDP}_{t-1} + \sum_{i=1}^{q} \lambda_3 \Delta \mathrm{OIQ}_{t-1} + \sum_{i=1}^{q} \lambda_{4\Delta} \mathrm{TO}_{t-1} + \sum_{i=1}^{q} \lambda_5 \Delta TNR_{t-1} + \omega\, ECM_{t-1} \quad \text{(4)}$$

The parameters in the above-mentioned short-run equation with the sign of summation represent the short-run parameters, whereas the coefficient of ECM (ω) in the three equations above represents the time it takes to adjust to long-run equilibrium. For union to achieve long-run equilibrium, this ECM coefficient should be negative and significant. With an F-statistic of 8.4196, we may reject the null hypothesis that there is no long-term relationship between the variables since it falls beyond the crucial value ranges at the 1% significance level.

4. Results and discussion

Table 1: Descriptive analysis

	CO2	TNR	LTO	LIQ	LGDP	LEC
Mean	0.6321	1.8617	21.0283	0.6735	26.197	6.0544
Median	0.6423	1.8560	21.0225	1.2461	26.272	6.0531
Maximum	0.7030	2.8911	21.7038	1.6964	26.653	6.1347
Minimum	0.5542	0.9653	20.5279	-4.0726	25.625	5.9996
Std. Dev.	0.0424	0.5843	0.40488	1.6831	0.2985	0.0324
Skewness	-0.3046	0.0323	0.16509	-2.1518	-0.0930	0.4417
Kurtosis	2.0081	1.7396	1.41892	6.1767	1.8698	2.8607
Jarque-Bera	1.4113	1.6767	2.72116	29.805	1.3666	0.8333
Probability	0.4937	0.4371	0.25618	0.0000	0.5049	0.6592
Sum	15.804	46.540	525.793	16.880	653.24	151.36
Sum Sq. Dev.	0.0433	8.1951	3.92277	67.9918	2.1385	0.0252
Observations	25	25	25	25	25	25

This study used the ARDL method to analyze the relationship between independent and dependent variables. Use the unit root test to determine the stationarity of each variable and the pattern of integrating the variables that matter. If any of the variables is nonstationary, it may produce incorrect regression results. We tested the stationarity of each variable using the level and first difference. We observed that our data is stationary as we have not applied the second difference and our data is showing that there is no unit root because it is significant either at level or at first difference. Only the variable that is stationed at I (0) or I(I) can be used to apply dynamic ARDL simulations. Table 5 shows that the probability value of each indicator at either level or first difference is significant which shows that our data is stationary and there is no existence of unit root in any indicator. We have used ADF and PP methods to identify unit root to diagnose whether our data is stationary or not, results of both tests show that data is stationary either at level or at first difference, indicating that data is stationary. Tabel No1 shows the probability of Jarque-Bera. If the probability is < 0.05 we reject Null shows the distribution is not normal and if the probability value is >0.05 then we accept Null which shows the distribution of the data is normal. The results of Jarque-Bera in the above table show that the probability value of all independent variables is > 0.05 which indicates that the distribution is normal, and the model is stable.

Table 2: Covariance Analysis

	CO2	TNR	LTO	LIQ	LGDP	LEC
CO2	1					
TNR	0.290	1				
LTO	0.7822	0.456	1			
LIQ	-0.328	-0.1438	-0.370	1		
LGDP	-0.792	-0.395	-0.882	0.539	1	
LEC	0.227	0.505	0.0816	0.341	0.139	1

Table No. 1shows that there is a very weak and positive correlation between C_{O2} and Energy consumption, is energy consumption is increased then there will be a very little increase in the amount of carbon Emission which is almost 0.227%. GDP and C_{O2} have strong negative correlation, as GDP increases, C_{O2} decreases and vice versa Above data is shows that if we increase one unit of carbon emission it will decrease GDP by .0792 %. Institutional quality and emissions CO2 emission have a weak and negative correlation, each of them affects each other negatively and have very little effect on each other. As institutional quality is increased, laws made to control pollution, are implemented in their spirit, then there will be less emission of CO2 emission will increase Trade

openness by 0.7822%.

Table 3: ARDL Bond Test

Value of F-Statistics	Lower Bond 1(0)	Upper Bond 1(1)
4.387	1.99	2.94
	2.27	3.28
	2.55	3.61
	2.88	3.99

The use of energy has different ways. First, the use of machinery and all kinds of equipment that are used in production functions uses energy, these are also important indicators that are used to produce energy. On the other hand, imports and exports of raw materials require energy. If we do not have enough energy resources, trade openness will be useless and will have a negative impact, so we can say that energy resources are an important indicator of trade openness and the value of imports and exports (Zeren & Akkus, 2020).

Table 4: Unit root test

	Augmented Ducky-fuller (ADF)		Phillips Perron (PP)	
Variable	Level	First Difference	Level	First Difference
CO2	0.6982	0.0001	0.7604	0.0001
EC	0.435	0.0320	0.3652	0.0120
GDP	0.8980	0.0264	0.8980	0.0313
IQ	0.0104	0.063	0.0943	0.0000
TNR	0.5938	0.004	0.5868	0.0051
TO	0.3263	0.004	0.335	0.004

Table 5: VIF

Indicator	VIF
CO2(-1)	3.051
TNR	2.246
LTO	5.604
LIQ	1.969
LGDP	7.368
LEC	2.172

Economic growth is largely affected by trade openness, the higher the value of imports and exports, the higher the value of pollution and it negatively affects the environmental quality in some countries. (Khan et al., 2021).

institutional quality has positive effects on energy consumption, focusing on the long-run period. We can also see that Carbo dioxide emission positively indicates the level of newborn energy consumption. However, the higher the economic growth, the lower the effect of renewable energy. This study shows institutional quality is an important indicator for solving issues related to the environment if the use of renewable energy is concerned (Uzar, 2020).

Table no 3 shows that the value of F-statistics, which is 4.387 is more than the value of the lower bond and upper bond which shows that there exists a long-run relationship between the indicators.

Table No 7: shows that the P- P-value of each of the tests applied above is insignificant showing that we are rejecting the Null hypothesis means there is no problem with heteroscedasticity, autocorrelation, and estimated

parameters are normally distributed.
Table No6 shows that the value of the VIF of all the indicators is less than 10 and even the VIF value of most of the indicators is <5 which shows that our model is a very good fit.
Table 7 shows the different tests applied to know heteroskedasticity, autocorrelation, and normality of the data, P-vale of all the tests applied, like the Bruesch-pagan-Godfrey, Harvey Test, Breusch-Godfrey Serial correlation LM test, is insignificant showing that there is no problem of heteroskedasticity, autocorrelation and any kind of abnormality is not found in the data.

Table 6: Dynamic ARDL Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.559467	0.076853	-7.279694	0.0003
CO2(-1)	0.983804	0.185748	5.296441	0.0018
LIQ	-0.001648	0.002262	-0.728497	0.4937
DLIQ	-0.014937	0.002980	-5.012858	0.0024
LEC	0.621532	0.210526	2.952284	0.0255
DLEC	-2.123887	0.354588	-5.989735	0.0010
LGDP	-0.362401	0.192464	-1.882948	0.1087
DLGDP	0.504898	0.207251	2.436165	0.0507
LTO	0.153387	0.046117	3.326039	0.0159
DLTO	0.187976	0.041288	4.552818	0.0039
TNR	0.016226	0.010625	1.527176	0.1776
CointEq (-1)*	-0.797	0.112366	-7.096074	0.000
R-squared	0.793839	Adjusted R-squared		0.747677
Adjusted R-squared	0.747677	F-statistical Probability		0.000694

The CointEq (-1)* value is -0.797 which is minus as well as less than 1 and the P-value is 0.000 which is significant. CointEq (-1)* value shows how many years our model or economy will be in equilibrium. The above value shows that after 1.25 years the economy will be in equilibrium. Table 4 shows that in the long run, a 1% increase in the betterment of the institutional quality will decrease carbon emissions by 0.001% and 0.014% in the short run. Bhattarai and Hamming (2004), in their study, proved the negative association between Institutional quality and the quality of the environment given institutional aspects for example bureaucracy and corruption. Similarly, Deacon (1999) concluded that countries in which people don't raise their voices and have no democratic rights tend to have higher levels of carbon emission. Likewise, Eriksson and Persson (2003) proposed that a more equitable distribution of income in democratic societies results in a low level of air pollution. In addition, Carlsson and Lundstrom (2003) suggested that the countries in which people are free to loud their voices for their rights would have better environmental quality due to low emissions of CO2. Similarly, a 1% increase in energy consumption will increase carbon emission by 0.621 %in the long run and 2.123% in the short run. Some previous studies have similar findings (Gardezi et al., 2023; Farooq et al., 2020; Aurangzaib et al., 2022). Salman et al. (2019) examined the value of the emission of CO2 concerning the quality of institutions, they concluded that the countries with good quality institutions have lower levels of emission of carbon dioxide, the reason is where the laws and policies made for the reduction of CO2 are implemented in true spirit, ultimately provide a positive result in contributing the reduction of CO2. Some previous researchers concluded the same findings (Gardezi et al., 2023; Zaib et al., 2023; Aurmaghan et al., 2022; Gardezi et al., 2020; Latif et al., 2023; Farooq et al., 2023; Gardezi et al., 2022). Trade openness also increases carbon emission by 0.153% and 0.1879 % respectively in the long run and short run. If we look at the total natural resources, the result shows that a 1% increase in TNR will increase carbon emissions by 0.0162. Zhang et al. (2015) scrutinized the impact of trade openness and trade-related activities. He concluded that openness creates pollution. He focused on three areas of China and revealed the results that domestic trade also has a strong and positive impact on regional air quality. He concluded that if China wanted to

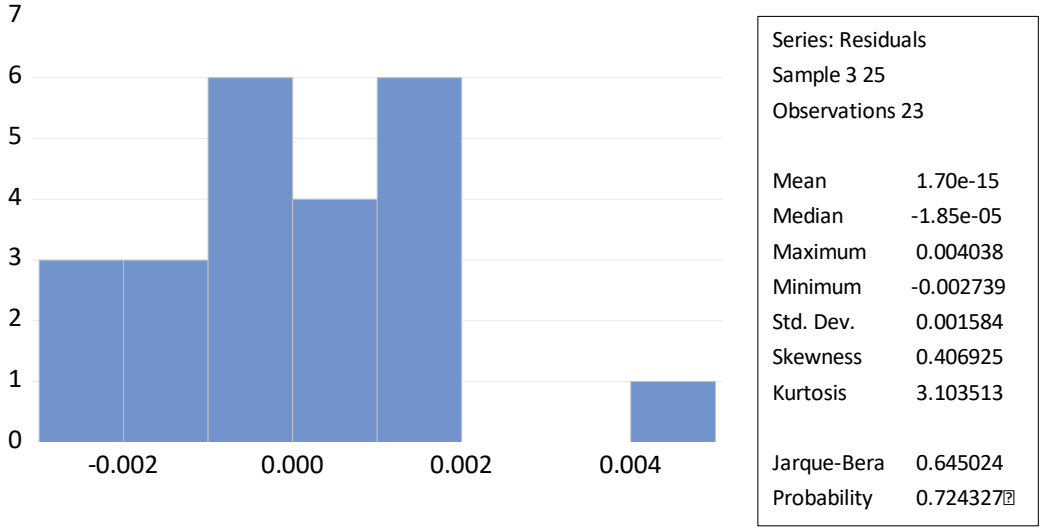
have economic growth without polluting the environment, then it should have strong institutions in place that could implement the policies which are developed by the Government to control pollution. As far as our knowledge is concerned, an improvement in institutional quality (IQ) can resulted decrease in the emission of Carbon Dioxide.

Table 07: Diagnostic tests

Diagnostic tests statistics	P-Value	Results
Heteroscedasticity	0.725 (Bruesch-pagan-Godfrey)	There is No problem of heteroscedasticity
Heteroscedasticity	0.768 (Harvey Test)	There is No problem of heteroscedasticity
Serial correlation/Autocorrelation	(0.987) Breusch-Godfrey Serial correlation LM test	There is No problem with serial correlation
Normality test	0.724	Distribution of the data is normal

Some previous studies are lined with this. Structural and operational changes have shifted high-CO2-emitting industries into low-carbon-emitting industries in advanced countries (Shahbaz et al., 2018). Furthermore, sustainable environment-related policies, technological advancements, and quality of institutions have improved environmental quality in industrialized economies (Danish et al., 2019). Furthermore, limited latest technologies have resulted in emerging countries evolving as docks of high CO2 releases with very poor condition environments (Sarkodie, 2018; Wang et al., 2018). If the growth level is increasing constantly, the countries under consideration are expected to adopt modern technologies with increased rule of law, thus leading to improved environmental practices (Hassan et al., 2019). In the intervening time, as GDP increased, the demand for fuel also increased. in this way, ecological pressure will be increased which will lead to damage environment badly (Dogan and Seker, 2016; Baloch et al., 2019; Akbar et al., 2023; Charfeddine and Kahia, 2019). Similarly, if we increase one unit of energy consumption it will increase emission emissions $\boldsymbol{C_{O2}}$ emission by 2.58 %, GDP is also showing a negative relationship as we increase one unit of GDP it will decrease C_{O2} emission by 0.125 %, trade openness has pa positive association with carbon emission, if we increase one unit of trade openness it will increase C_{O2}emission by 0.138 %, TNR also has negative impact on C_{O2} emission. If we increase total natural resources, it will decrease C_{O2}emission by 0.035 %. Zafar et al. (2019) also have revealed the same results that natural resources like the use of oil, gas, and minerals are increasing CO2 emissions all over the globe.

Figure 2: Normality test



The probability value of the normality test is 0.724 which is insignificant showing that the distribution of the data is

normal.

Figure 3: Stability Diagnostic COSUM Regressive Estimates

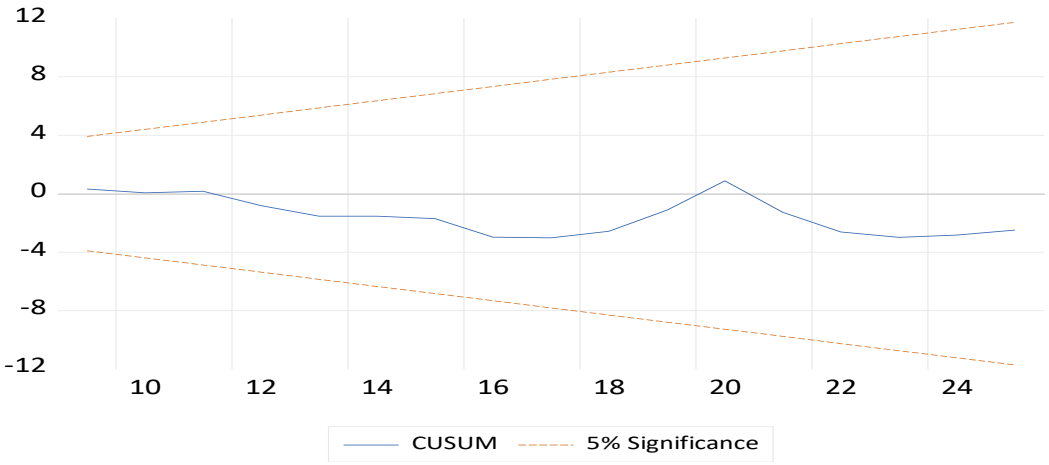
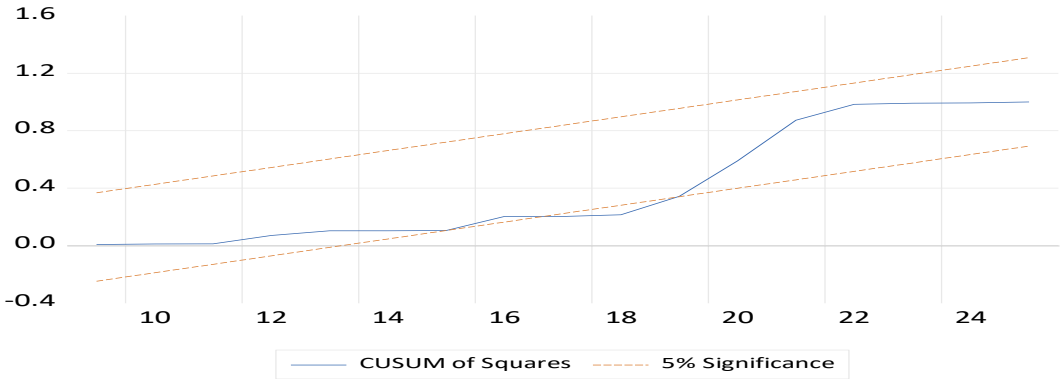


Figure 4: Stability Diagnostic COSUM of Squares Regressive Estimates



The CUSUM and CUSUM of square tests are shown in the graphs above. It is possible to assess whether the coefficients are stable using CUSUM and CUSUM of squares. The fact that the blue lines on both figures are below the crucial lines indicating coefficient stability suggests that the coefficients are stable at a 5% level of significance. The graphs mentioned above demonstrate how reliable the models are.

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5. Conclusion and Policy Recommendation

The study found that institutional quality has a considerable impact on environmental quality and energy consumption in Pakistan. Using data from 1998 to 2022, the study applies time-series analysis to investigate the link between several parameters. The findings show that energy consumption has a positive influence on environmental quality, implying that efforts to increase energy efficiency and shift to cleaner energy sources may improve environmental sustainability. Furthermore, institutional quality, as assessed by measures such as government efficiency, political stability, and the lack of violence/terrorism, has a positive relationship with environmental indicators such as CO2 levels. This suggests that enhancing institutional frameworks and governance processes might help to improve environmental results. Additionally, effective governance is crucial for energy management as it has a favorable impact on energy consumption, especially when it comes to oil and fossil fuel resources.

A diversified strategy is required to solve environmental issues and advance sustainable development in Pakistan. First and foremost, changes must be made to improve political stability and government effectiveness. This calls for enhancing regulatory procedures, simplifying governance frameworks, and encouraging accountability and openness in decision-making. Policies that increase energy efficiency and encourage the use of renewable energy sources should be put in place concurrently. This might entail requiring the use of energy-efficient technology in businesses and homes as well as providing tax breaks or subsidies for renewable energy projects. Furthermore, it is critical to promote commercial openness while maintaining environmental sustainability. Trade can make it easier to obtain resources and cleaner technology, but action must be taken to lessen its detrimental effects on the environment. This includes encouraging eco-friendly business practices and upholding environmental laws. By putting these all-encompassing policies into practice, Pakistan may strike a healthy balance between environmental preservation and economic growth, promoting long-term sustainability and improving the welfare of its people.

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