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ROLE OF RENEWABLE ENERGY RESOURCES IN ENVIRONMENTAL QUALITY IN PAKISTAN

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Abstract

This study analyzes the role of renewable resources in influencing the environmental quality in Pakistan using time series data of Pakistan from 1990 to 2021. For estimation, Augmented-Dickey Fuller test, bound test and ARDL model is used. ARDL model is used when variables in a model are integrated at mixed order. Environmental quality is proxied by using CO_2 emissions and renewable energy sources are proxied by using renewable energy consumption and renewable electricity generation. The main outcomes suggest that the variables renewable energy consumption and renewable electricity output are significantly related to the environmental quality. The results also demonstrates that the variables industrialization, gross fixed capital formation, and fossil fuel energy consumption are positively related to CO_2 emissions while the variables human capital and final consumption expenditures are negatively related to the CO_2 emissions in Pakistan. Results imply that any policy intended to promote the use of renewable energy will benefit Pakistan's environmental quality.

Keywords: Renewable Energy resources; Energy Output; Environmental Quality; Sustainable development.
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1. Introduction

Environmental degradation is the most complex issue faced by all countries of the world. The main contributing factors to the problem are the industrial revolution, population growth, and an increase in the need for luxury products in daily life. Due to a lack of environmental education, awareness, understanding, and attitude among people, the condition of nature and its resources is currently worsening (Yadav et al., (2022). The Kyoto Protocol (1997) made a significant advancement by pledging industrialized economies to significantly cut their emissions of greenhouse gases (Lee & Chang, (2008). Since the world economy is becoming more and more dependent on carbon-intensive energy, lowering energy usage or experiencing a lack of energy has major financial ramifications. According to Wolde-Rufael & Menyah (2010), the excessive carbon dioxide emissions associated with nonrenewable energy use are the cause of environmental degradation. Utilizing renewable energy sources, such as solar, wind, and hydropower, can serve as a substitute for resolving these environmental problems. Utilizing renewable energy can meet energy production needs, improve environmental quality, and prevent pollution by displacing non-renewable technologies and non-degrading environmental standards (Akella et al., (2009). Expanding the use of renewable energy has several potential advantages, such as lowering emissions that contribute to global warming, diversifying energy sources, and reducing reliance on the fossil fuel energy market. Furthermore, the substitution of carbon-intensive energy sources is made possible by renewable energy initiatives. Because the renewable energy sector requires more labor,

expanding the supply of renewable energy could increase employment by generating positions in emerging "green" technology (Belad & Zrelli, (2019).

One of the developing countries located in South Asia is Pakistan. Its economy is growing swiftly, and it is expected that this pattern will probably hold over the coming years. The main industry in Pakistan and the foundation of its economy is agriculture. A byproduct of the expansion of the industrial sector, however, is the loss of agricultural land. The deforestation process is also accelerated by a fast-expanding population (Khan et al., (2020).

Pakistan's location on the elevated heating belt allows it to benefit economically from solar energy production. Since there are no costs associated with transportation or refinement, this power source is far more affordable than fossil fuels. That is the best alternative to fossil fuels because it doesn't pollute the environment. Pakistan is endowed with many energy resources that, if effectively utilized, can lessen its need on external assistance for oil imports. Such readily available undeveloped energy resources in Pakistan have the ability to both meet domestic energy needs and export energy to other countries. Pakistan has immense potential to use renewable energy. Security concerns and the nation's revolving debt are the key challenges that must be overcome to endorse renewable energy on-grid through the private sector (Mirza & Khalil, (2011). Keeping in view the above discussion, this study attempts to analyze the impact of renewable energy sources on environmental quality in Pakistan.

2. Literature Review

Different studies examined the impact of renewable energy sources on environmental quality, the literature review of some the studies is presented as follows: Dagar et al., (2022) evaluated the effects of financial development,

natural resource, industrial production, renewable energy consumption, and total reserve on environmental degradation in (38) OECD nations using panel data from 1995 to 2019. The GMM analyses findings revealed that in OECD nations, the use of natural resources and the consumption of renewable energy both work to slow down ED while FD, industrial production, and total reserve do the opposite. Kartal et al., (2022) analyzed the influence of energy use on environmental deterioration in USA using data from 1989 to 2021. The findings demonstrated that energy use has a significant short, and long-term impact on CO_2 emissions. Therefore, the empirical findings emphasized the significance of renewable energy in enhancing environmental quality by reducing CO_2 emissions at both aggregated and disaggregated levels. Khan et al., (2021) explored the impact of renewable energy, trade openness, FDI, and tourism on global developed and developing countries carbon emissions from 1985 to 2018. Findings showed that using more renewable energy adversely and significantly impacts carbon emissions in both developed and developing nations. FDI has a negative influence on carbon emissions in developing nations, but it has a positive and significant effect in developed countries. Andjarwati (2020) examined the factors of environmental degradation in Malaysia, using data from 1995 to 2017. The study concluded that energy consumption has both short and long-run effects on environmental degradation. Urbanization negatively impacts the environment, whereas population growth, industrialization, and poverty have positive impact. Khan et al., (2019) examined the effect of energy consumption and economic growth on environmental deterioration in Pakistan using data from 1965 to 2015. The dynamic ARDL results showed that economic growth, energy consumption had both short- and long-run positive impacts on environmental degradation

in Pakistan. It was suggested that encouraging renewable energy sources could lessen environmental deterioration. Lorente et al., (2018) investigated the relationship between economic growth and CO_2 emissions in the EU countries from 1985 to 2016. The outcomes supported that economic growth and CO_2 emissions in the EU-5 countries have a U-shaped relationship. Trade openness and economic growth and REC have positive impacts on CO_2 emissions, REC, natural resources, and clean energy use increase environmental quality. Dogan et al., (2017) observed the long-term dynamic link between carbon dioxide emissions, GDP, energy consumption, trade, and tourism in OECD countries using panel data from 1995 to 2010. The DOLS estimation method showed that increased trade results in better environmental conditions, energy consumption and tourism were major contributors to CO_2 emissions. Jamel & Derbali (2016) explored how energy use and economic growth affected the environmental degradation in Asian countries using data from 1991 to 2013. The findings showed that energy use and economic growth positively and significantly impacted environmental degradation. Shafiei & Salim (2014) investigated the factors that affect CO_2 emissions using data for OECD countries from 1980 to 2011. The findings demonstrated that using renewable energy reduces CO_2 emissions, and using NREC enhances them. Additionally, the findings were consistent with an EKC between urbanization and CO_2 emissions, signifying that the environmental impact diminishes as urbanization increases. Arouri et al., (2012) explored the relationship between real GDP, energy consumption, and carbon dioxide emissions for 12 MENA countries between 1981 and 2005. The outcomes revealed that EC has a positive, significant long-term influence on CO_2 emissions.

3. Data and Methodology

To examine the role of renewable sources in environmental quality in Pakistan, an annual time series data from 1990 to 2020 is used. The main source of data collection was Handbook of Statistics, Economic Surveys of Pakistan, and World Development Indicators. The dependent variable used in this study is environmental quality as measured by CO_2 emissions, while independent variables are industrialization, renewable energy consumption, renewable electricity output, human capital, gross fixed capital formation, and fossil fuel energy consumption. In this study, renewable energy sources are measured by using variables like renewable energy consumption and renewable electricity generation. In the time series analysis data stationarity is important to observe. For this purpose, Augmented Dickey Fuller (ADF) test is used while ARDL bound test, ARDL short and long-run model and different diagnostic tests are applied for data estimation. To analyze the role of renewable sources in environmental quality, the following model is developed:

Functional form of model

$$EQ = f\left(IND, REC, REO, HC, FCE, GFCF, FFEC\right) \tag{1}$$

The above model is transformed into following mathematical equation.

$$EQ_i = \beta_o + \beta_1 IND_i + \beta_2 REC_i + \beta_3 REO_i + \beta_4 HC_i + \beta_5 FCE_i + \beta_6 GFCF_i + \beta_7 FFEC_i + u_i \tag{2}$$

Where;

EQ = Environmental Quality

IND = Industrialization

REC = Renewable Energy Consumption

REO = Renewable Electricity Output

HC = Human Capital

FCE = Final Consumption Expenditures

GFCF = Gross Fixed Capital Formation

FFEC = Fossil Fuel Energy Consumption

u_i = Error Term

4. Empirical results

This section presents the analysis of the role of renewable sources in influencing environmental quality in Pakistan. The variable environmental quality is measured by using CO_2 emissions while renewable sources are measured by renewable energy consumption and renewable electricity generation.

4.1 Descriptive Analysis

This section presents the descriptive statistics of variables. Table 1 exhibits the descriptive statistics of variables. The results point out that the mean value of environmental quality as measured by CO_2 emissions is 0.638, maximum value is 0.703, minimum value is 0.577, SD is 0.035, skewness value is -0.150 which exhibits the negatively skewed distribution, and kurtosis value is 1.885 which exhibits platykurtic distribution.

Table 1: Descriptive Statistics

Variables	Mean	Max	Min	S.D.	Skew	Kurt	J-B.	Prob.
EQ	0.638	0.703	0.577	0.035	-0.150	1.885	1.723	0.423
IND	20.227	22.931	17.548	1.695	0.025	1.694	2.206	0.332
REC	49.063	58.091	42.035	4.349	0.293	2.341	1.003	0.606
REO	33.139	44.926	25.242	5.204	1.048	3.143	5.704	0.058
HC	76.216	95.484	58.629	11.332	0.064	1.810	1.851	0.396

FCE	87.727	94.624	82.601	3.954	0.168	1.540	2.900	0.235
GFCF	15.571	19.112	12.521	1.790	0.173	1.937	1.614	0.446
FFEC	58.505	62.476	52.305	2.650	-0.876	2.924	3.971	0.137

Source: Author's Calculations

4.2 Correlation Analysis

To analyze the degree of association between two variables correlation coefficient is used. Table 2 displays the correlation matrix. It is found that environmental quality as measured by CO_2 emissions is positively associated with industrialization (-0.086), gross fixed capital formation (0.233), and fossil fuel energy consumption (0.241) while negatively correlated to renewable energy consumption (-0.020), renewable energy output (-0.313), human capital (-0.190) and final consumption expenditures (-0.373).

Table 2: Correlation Matrix

Correlation	EQ	IND	REC	REO	HC	FCE	GFCF	FFEC
EQ	1.000							
IND	-0.086	1.000						
REC	-0.020	0.627	1.000					
REO	-0.313	0.736	0.736	1.000				
HC	-0.190	-0.636	-0.963	-0.663	1.000			
FCE	-0.373	-0.268	-0.788	-0.418	0.830	1.000		
GFCF	0.233	0.486	0.596	0.600	-0.605	-0.544	1.000	
FFEC	0.241	-0.594	-0.899	-0.828	0.840	0.634	-0.524	1.000

Source: Author's Calculations

4.3 ADF Test

Unit root test is crucial to analyze the stationarity level of variables in a model. Table 3 exhibits the unit root analysis. Augmented Dickey Fuller (ADF) test is applied to check the stationarity of variables. The outcomes point out that the variable renewable energy consumption is stationarity at level

while the variables environmental quality, industrialization, human capital, renewable energy output, final consumption expenditures, and fossil fuel energy consumption are stationarity at 1st difference so the mixed order of integration suggests that ARDL model is suitable to estimate the long-run parameters of the model.

Table 3: Results of ADF Test

Variables	Level		1st Difference		Outcomes
	Test	P-Value	Test	P-Value	
EQ	--	--	-6.176	0.000	I (1)
IND	--	--	-6.197	0.000	I (1)
HC	--	--	-6.641	0.000	I (1)
REC	-2.642	0.010	--	--	I (0)
REO	--	--	-6.038	0.000	I (1)
FCE	--	--	-7.846	0.000	I (1)
GFCF	--	--	-4.678	0.001	I (1)
FFEC	--	--	-5.388	0.000	I (1)

Source: Author's Calculations

4.4 ARDL Bound Test

Bound test is used to observe the long-run cointegration between variables in the model. Table 4 shows the ARDL bound test estimates. The outcomes demonstrate that the value of F-statistic (4.8997) is greater than the lower and upper bound values at 1 percent level of significance so it is concluded that there is an existence of long-run cointegration among variables in the model.

Table 4: ARDL Bound Test

Null Hypothesis: No long-run relationships exist		
Test Statistic	**Value**	**k**
F	4.8997	7
Critical Value Bounds		
P-Value	**I0 Bound**	**I1 Bound**
10%	2.03	3.13
5%	2.32	3.5
2.5%	2.60	3.84
1%	2.96	4.26

Source: Author's Calculations

4.5 Analysis of ARDL Long-Run Model

This section presents the ARDL long-run estimates of role of renewable energy sources in environmental quality in Pakistan. Table 5 shows the ARDL long-run results. Observing the relationship between renewable energy consumption and environmental quality, it is found that renewable energy consumption is negatively and significantly (*t-statistic* = -4.7794; *Prob.* = 0.0020) associated to with CO_2 emissions and positively influence the environmental quality. The coefficient of REC clarifies that as REC increases by one unit the environmental quality will likely to be improved by 0.0184%. These findings are in line with findings of Sharif et al. (2020), who found that CO_2 emissions decrease as the use of renewable energy is increased power in industry and households. So, using renewable energy aids in the fight against environmental degradation. These findings are also found by Duong & Ngo (2022); Magazzino et al., (2022); Adebayo & Kirikkaleli (2021) who noted that renewable electricity output is negatively and significantly (*t-statistic* = -

1.9673; *Prob.* = 0.0898) associated with CO_2 emissions and positively influence the environmental quality (at 10 percent level). The coefficient of renewable electricity output clarifies that as REO increases by one unit the environmental quality is improved by 3.1%. Use of renewable electricity can reduce the environmental degradation and improve the environmental quality in Pakistan. These findings are consistent with Luni & Majeed (2020), who disclosed that human capital is negatively and significantly (*t-statistic* = -5.7633; *Prob.* = 0.0007) associated with CO_2 emissions and positively influence the environmental quality. The coefficient of human capital clarifies that as HC increases by one unit the environmental quality will likely to be improved by 8.9%. By encouraging the use of recycling and renewable energy sources, human capital can aid economies in the conservation of energy, natural resources, and waste in landfills. Moreover, it motivates adherence to environmental laws and guidelines, which enhances environmental quality as stated by Majeed & Mazhar, (2020) who also found that gross fixed capital formation (GFCF) is positively and significantly (*t-statistic* = 4.1670; *Prob.* = 0.0042) associated with CO_2 emissions and negatively influence the environmental quality. The coefficient of gross fixed capital formation indicates that as GFCF increases by one unit the environmental quality will likely to be improved by 11.10%. Increase in GFCF increases employment and income level of the people which increases economic activities that lead to increase in environmental degradation. On the contrary, to increase in fixed assets of a country, machinery and energy is used which lead to increase in environmental degradation. These findings are also supported by Mitić et al., (2020); Rahman & Ahmad (2019) who found that fossil fuel energy consumption is positively and significantly (*t-statistic* = 3.4776; *Prob.* =

0.0103) associated with CO_2 emissions and negatively influence the environmental quality. The coefficient of fossil fuel energy consumption reveals that as FFEC increases by one unit the environmental quality will likely to be improved by 9.2%. These findings are in line with those of Asongu et al. (2020), who found that high levels of CO_2 emissions and unfavorable changes in the environment occur in the countries where commercial units heavily rely on fossil fuels to power large machines or plants in order to advance and achieve competitive goals. These outcomes are in line with findings of Gokmenoglu & Sadeghieh (2019); Dagar et al., (2022).

Table 5: Results of ARDL long-run Model

Dependent Variable: Environmental Quality (CO_2 Emissions)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
IND	0.0006	0.0033	0.1797	0.8624
REC	-0.0184	0.0038	-4.7794	0.0020
REO	-0.0031	0.0015	-1.9673	0.0898
HC	-0.0089	0.0015	-5.7633	0.0007
FCE	-0.0010	0.0022	-0.4553	0.6626
GFCF	0.0111	0.0026	4.1670	0.0042
FFEC	0.0092	0.0026	3.4776	0.0103
C	1.6772	0.4007	4.1857	0.0041

Source: Author's Calculations

4.6. Error Correcting Model

Table 6 displays the ARDL short-run Error Correction model. In short-run ECM model, the error correction term is vital to observe. It should be negative and also statistically significant. It is found that the ECM term is negative and also statistically significant. This suggests the disturbances are

corrected at the rate of 80.28 percent when moving from short-run to the long-run equilibrium.

Table 6: Results of Error Correction Model

Dependent Variable: Environmental Quality (CO_2 Emissions)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(EQ1(-1))	-0.2792	0.1649	-1.6926	0.1343
D(IND)	-0.0062	0.0022	-2.8350	0.0252
D(REC)	-0.0182	0.0028	-6.3774	0.0004
D (REC (-1))	-0.0119	0.0045	-2.6540	0.0328
D(REO)	-0.0004	0.0008	-0.5092	0.6262
D(HC)	-0.0053	0.0011	-4.8267	0.0019
D (HC (-1))	0.0018	0.0010	1.7135	0.1303
D(FCE)	-0.0001	0.0016	-0.0962	0.9261
D (FCE (1))	-0.0019	0.0013	-1.4726	0.1843
D (GFCF)	-0.0024	0.0022	-1.0638	0.3227
D (GFCF(-1))	-0.0023	0.0025	-0.8916	0.4022
D(FFEC)	0.0060	0.0030	1.9838	0.0877
D (FFEC (-1))	-0.0061	0.0030	-1.9741	0.0889
ECM (-1)	-0.8028	0.2558	-3.1376	0.0164

Source: Author's Calculations

4.7 Diagnostic Tests

Different diagnostic tests are applied to check the heteroskedasticity, autocorrelation, residuals normality and model stability. Table 7 illustrates the heteroskedasticity test using "Breusch-Pagan-Godfrey". The outcomes reveal that the value of F-statistic (2.2285) is turn out to be statistically insignificant so it is concluded that there is no issue of heteroskedasticity in the model.

Table 7: Heteroskedasticity Test

Breusch-Pagan-Godfrey			
F-statistic	2.2285	**Prob. F (21,7)**	0.1401
Obs*R-squared	25.2267	**Prob. Chi-Square (21)**	0.2375

Source: Author's Calculations

Table 8 illustrates the autocorrelation test using "Breusch-Godfrey Serial Correlation LM Test". The outcomes point out that the value of F-statistic (5.1215) is turn out to be statistically insignificant so it is concluded that there is no issue of autocorrelation in the model.

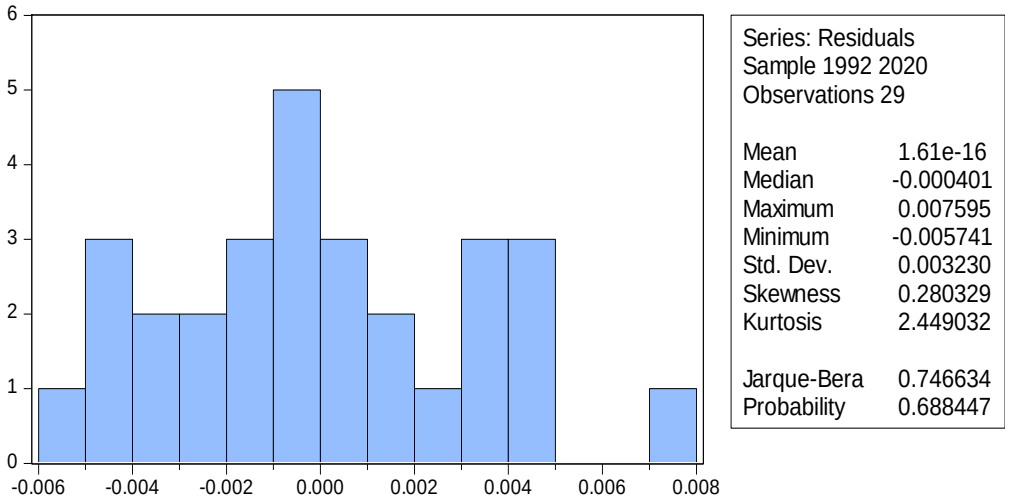
Table 8: Autocorrelation Test

Breusch-Godfrey Serial Correlation LM Test			
F-statistic	5.1215	**Prob. F(2,5)**	0.0616
Obs*R-squared	19.4874	**Prob. Chi-Square (2)**	0.0001

Source: Author's Calculations

To observe the residuals normality in a model, Jarque-Bera test of residuals normality is applied. Figure 1 shows the residuals normality analysis. The outcomes found that the value of Jarque-Bera test (0.746634) is turn out to be statistically insignificant so it is concluded that the residuals of the model are normally distributed.

Fig 1: Residuals Normality Analysis



Source: Author's Calculations

To check the model stability, a recursive model of CUSUM and CUSUM of squares is used. Figure 2 displays the model stability analysis. It can be observed from the Figure 2 that the fitted lines are ranged between critical lines at 5 percent level of significance so it is concluded that the model is dynamically stable during study period.

Figure 2: CUSUM Test

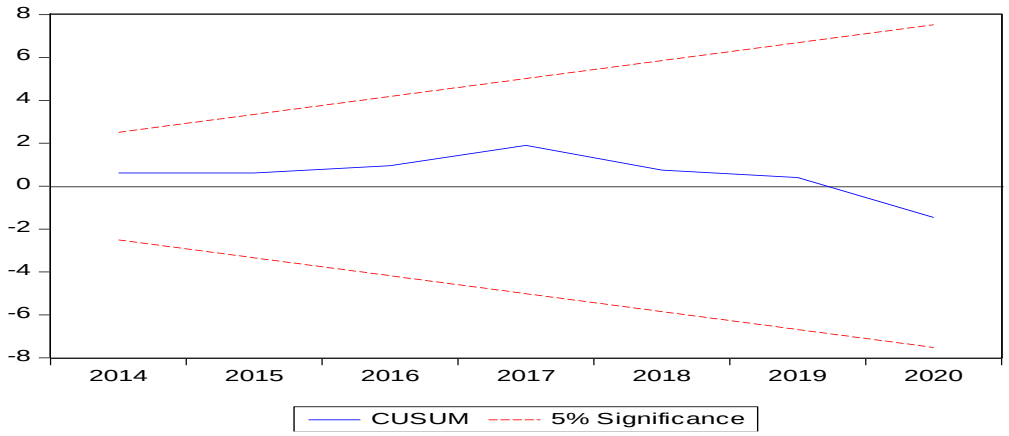
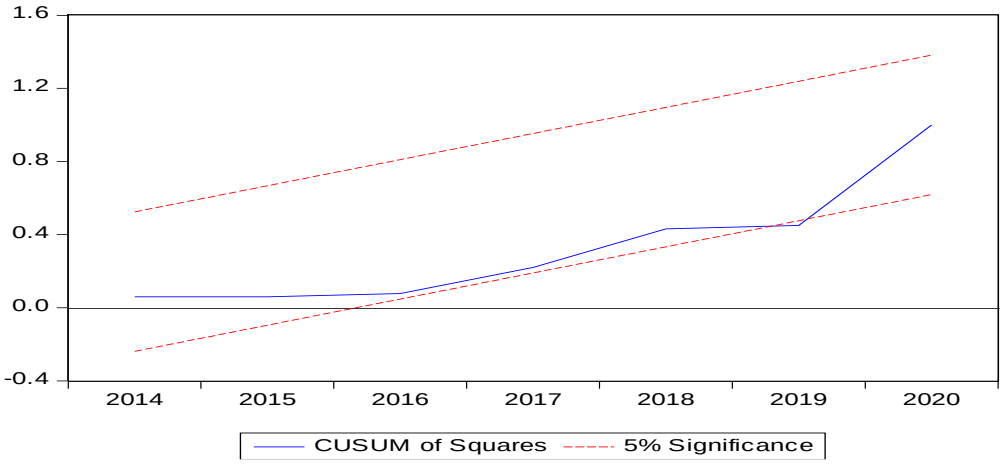


Fig 3: CUSUM of Square Test



Source: Author's Calculations

5. Conclusions and policy Recommendations

This study attempts to analyze the role of renewable resources in influencing the environmental quality in Pakistan. For this purpose, annual time series data from 1990 to 2020 was used. This study measured renewable resources by using variables such as renewable energy consumption (REC) and renewable electricity output. For analysis, the ADF test was used to check the stationarity of data which suggests that the ARDL model is fit for long-run estimation of the parameters. The main outcomes suggest that the variables REC and renewable electricity output have positive relationship with environmental quality in Pakistan. The results imply that any policy intended to promote the use of renewable energy will benefit Pakistan's in terms of environmental quality. Using creative energy-saving solutions that might increase working intensity in the production process can result in more stable energy consumption. Using renewable energy sources, CO_2 emissions can be completely eliminated while using less oil and coal. Incentives for

modernizing the energy sector may also come from the rise of the nuclear and renewable energy sectors.

Based on the outcomes of the study, the following recommendations are suggested to improve environmental quality in Pakistan:

- The study indicates that promoting the use of renewable energy sources, such as solar, wind, and hydroelectric power, can significantly improve environmental quality. The government should implement policies and incentives to encourage the adoption of renewable energy technologies in both the residential and industrial sectors.
- Implementing energy-saving solutions and improving energy efficiency can contribute to a more sustainable energy consumption pattern. This could involve promoting energy-efficient appliances, building insulation, and adopting sustainable practices in industries. By reducing energy waste, the environmental impact can be minimized.
- Pakistan heavily relies on fossil fuels like oil and coal for energy generation. Reducing dependence on these non-renewable resources will not only improve environmental quality but also enhance energy security. Policies should focus on diversifying the energy mix and gradually phasing out fossil fuels in favor of renewable energy sources.
- The study highlights that renewable energy sources can help eliminate CO2 emissions. Pakistan should prioritize efforts to mitigate greenhouse gas emissions by promoting clean technologies and investing in carbon capture and storage (CCS) projects. Additionally, afforestation and reforestation initiatives can aid in carbon sequestration.
- The rise of the nuclear and renewable energy sectors presents an opportunity for Pakistan to modernize its energy infrastructure. The government should

provide incentives for the development and deployment of advanced and efficient energy technologies. This could involve supporting research and development, attracting investments, and fostering public-private partnerships.

- To ensure the long-term sustainability of environmental improvements, it is essential to strengthen environmental regulations and enforcement mechanisms. This includes setting emission standards, monitoring and reporting mechanisms, and penalties for non-compliance. Effective governance and coordination among relevant institutions are crucial in enforcing environmental policies.
- Increasing public awareness about the importance of environmental conservation and the benefits of renewable energy is vital. Educational campaigns, community engagement, and outreach programs can help in promoting sustainable practices and encouraging individual actions to protect the environment.

By implementing these recommendations, Pakistan can enhance its environmental quality, reduce its carbon footprint, and contribute to global efforts in mitigating climate change.

5.1 Contribution of this study

This study contributes to the understanding of the role of renewable resources in influencing environmental quality in Pakistan. By analyzing annual time series data from 1990 to 2020, the study provides empirical evidence of the relationship between renewable resources, such as REC and renewable electricity output, and environmental quality. The study's findings support the recommendations mentioned above, providing valuable insights for policymakers and stakeholders involved in environmental and energy-

related decision-making. The contributions of this study can be summarized as follows:

The study establishes a robust empirical link between renewable resources and environmental quality in Pakistan. It provides evidence that increasing the use of renewable energy sources, as measured by REC and renewable electricity output, can positively impact environmental quality by reducing CO2 emissions and dependence on fossil fuels. The study's outcomes offer policymakers tangible insights into the potential benefits of promoting renewable energy in Pakistan. It emphasizes the importance of formulating and implementing policies that encourage renewable energy adoption, improve energy efficiency, and reduce greenhouse gas emissions. Policymakers can use these findings to design effective and targeted strategies to address environmental challenges in the country. The study contributes to outlining a clear pathway for Pakistan's energy transition. By highlighting the advantages of renewable energy sources and the need to diversify the energy mix, it provides guidance on how to reduce reliance on fossil fuels and promote a sustainable energy sector. The recommendations emphasize the importance of investing in modern and clean energy technologies, such as nuclear and renewables, to achieve long-term environmental and energy goals. The study underscores the significance of strengthening environmental regulations and enforcement mechanisms. It highlights the need for setting emission standards, monitoring energy consumption, and implementing penalties for non-compliance. These insights can aid policymakers in designing effective governance frameworks and regulatory structures to ensure the sustainability of environmental improvements. Public Awareness and Participation: The study emphasizes the importance of raising public

awareness about renewable energy and environmental conservation. By engaging communities, promoting educational campaigns, and fostering a sense of responsibility, the study encourages individual actions to support sustainable practices. This can lead to a broader societal shift towards embracing renewable energy and actively contributing to environmental quality improvements.

Overall, this study's contributions provide a comprehensive understanding of the potential benefits of renewable resources in improving environmental quality in Pakistan. The recommendations derived from the study can serve as a roadmap for policymakers, guiding them in formulating effective policies, promoting renewable energy, and creating a sustainable and environmentally friendly future for the country.

Data Statement

The data that supports the findings of this study will be made available on strong request.

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References

Adebayo, T. S., & Kirikkaleli, D. (2021). Impact of renewable energy consumption, globalization, and technological innovation on environmental degradation in Japan: application of wavelet tools. *Environment, Development and Sustainability*, *23*(11), 16057-16082. (Google Scholar)

Akella, A. K., Saini, R. P., & Sharma, M. P. (2009). Social, economic and environmental impacts of renewable energy systems. *Renewable Energy*, *34*(2), 390-396. (Google Scholar)

Andjarwati, T. (2020). Impact of energy consumption, and economic dynamics on environmental degradation in ASEAN. *International Journal of Energy Economics and Policy*, 10(5), 672-678. (Google Scholar)

Arouri, M. E. H., Youssef, A. B., M'henni, H., & Rault, C. (2012). Energy consumption, economic growth and CO2 emissions in Middle East and North African countries. *Energy policy*, *45*, 342-349. (Google Scholar)

Asongu, S. A., Agboola, M. O., Alola, A. A., & Bekun, F. V. (2020). The criticality of growth, urbanization, electricity and fossil fuel consumption to environment sustainability in Africa. *Science of the Total Environment*, *712*, 136376. (Google Scholar)

Balsalobre-Lorente, D., Shahbaz, M., Roubaud, D., & Farhani, S. (2018). How economic growth, renewable electricity and natural resources contribute to CO_2 emissions. *Energy policy*, *113*, 356-367. (Google Scholar)

Awan, Abdul Ghafoor (2013). Relationship between Environment and Sustainable Economic Development: A Theoretical approach to Environmental Problems, *International Journal of Asian Social Sciences*, 3 (3):741-761. (Google Scholar)

Awan, Abdul Ghafoor; Yaseen, Ghulam (2017). Global Climate Change and its impact on Agriculture sector in Pakistan. *American Journal of Trade and Policy,* 4 (1): 41-48 (Google Scholar)

Awan, Abdul Ghafoor; Aslam, Atteqa (2015). Impact of Agriculture Productivity on Economic Growth-A case study of Pakistan. *Industrial Engineering Letters*, 5 (7): 27-33 (Google Scholar)

Awan, Abdul Ghafoor (2013). Environmental challenges to South Asian countries. *Asian Accounting and Auditing Advancement*, 3 (1):84-103. (Google Scholar)

Awan Abdul Ghafoor; Sammar, Wamiq (2016) Relationship between environmental awareness and green marketing. *Science International*, 28 (3): 2959-2963. (Google Scholar)

Belad, F., & Zrelli, M. H. (2019). Renewable and non-renewable electricity consumption, environmental degradation and economic development: evidence from Mediterranean countries. *Energy Policy*, *133*, 110929. (Google Scholar)

Dagar, V., Khan, M. K., Alvarado, R., Rehman, A., Irfan, M., Adekoya, O. B., & Fahad, S. (2022). Impact of renewable energy consumption, financial development and natural resources on environmental degradation in OECD countries with dynamic panel data. *Environmental Science and Pollution Research*, *29*(12), 18202-18212. (Google Scholar)

Dogan, E., Seker, F., & Bulbul, S. (2017). Investigating the impacts of energy consumption, real GDP, tourism and trade on CO2 emissions by accounting for cross-sectional dependence: a panel study of OECD countries. *Current Issues in Tourism*, *20*(16), 1701-1719. (Google Scholar)

Duong, K. D., & Ngo, T. Q. (2022). Impact of energy consumption and agriculture growth on the environmental degradation: evidence from ASEAN countries. *AgBioForum*, *24*(1),116-128. (Google Scholar)

Gokmenoglu, K. K., & Sadeghieh, M. (2019). Financial development, CO2 emissions, fossil fuel consumption and economic growth: the case of Turkey. *Strategic Planning for Energy and the Environment*, *38*(4), 7-28. (Google Scholar)

Jamel, L., & Derbali, A. (2016). Do energy consumption and economic growth lead to environmental degradation? Evidence from Asian economies. *Cogent Economics & Finance*, *4*(1), 1170653. (Google Scholar)

Kartal, M. T., Kılıç Depren, S., Ayhan, F., & Depren, Ö. (2022). Impact of renewable and fossil fuel energy consumption on environmental degradation: evidence from USA by nonlinear approaches. *International Journal of Sustainable Development & World Ecology*, *29*(8), 738-755. (Google Scholar)

Khan, H., Weili, L., Khan, I., & Khamphengxay, S. (2021). Renewable energy consumption, trade openness, and environmental degradation: a panel data analysis of developing and developed countries. *Mathematical Problems in Engineering*, *2021*. (Google Scholar)

Khan, M. K., Khan, M. I., & Rehan, M. (2020). The relationship between energy consumption, economic growth and carbon dioxide emissions in Pakistan. *Financial Innovation*, *6*(1), 1-13. (Google Scholar)

Khan, M. K., Teng, J. Z., & Khan, M. I. (2019). Effect of energy consumption and economic growth on carbon dioxide emissions in Pakistan with dynamic ARDL simulations approach. *Environmental Science and Pollution Research*, *26*(23), 23480-23490. Google Scholar

Lee, C. C., & Chang, C. P. (2008). Energy consumption and economic growth in Asian economies: a more comprehensive analysis using panel data. *Resource and energy Economics*, *30*(1), 50-65. (Google Scholar)

Luni, T., & Majeed, M. T. (2020). Improving environmental quality through renewable energy: evidence from South Asian economies. *International Journal of Energy and Water Resources*, *4*, 335-345. (Google Scholar)

Magazzino, C., Toma, P., Fusco, G., Valente, D., & Petrosillo, I. (2022). Renewable energy consumption, environmental degradation and economic growth: the greener the richer? *Ecological Indicators*, *139*, 108912. (Google Scholar)

Majeed, M. T., & Mazhar, M. (2020). Reexamination of environmental Kuznets curve for ecological footprint: the role of biocapacity, human capital, and trade. *Pakistan Journal of Commerce and Social Sciences*, 14(1), 202–254. (Google Scholar)

Mirza, I. A., & Khalil, M. S. (2011). Renewable energy in Pakistan: opportunities and challenges. *Science Vision*, *16*, 13-20 (Google Scholar)

Mitić, P., Kostić, A., Petrović, E., & Cvetanovic, S. (2020). The relationship between CO2 emissions, industry, services and gross fixed capital formation in the Balkan countries. *Engineering Economics*, *31*(4), 425-436. (Google Scholar)

Rahman, Z. U., & Ahmad, M. (2019). Modeling the relationship between gross capital formation and CO 2 (a) symmetrically in the case of Pakistan: an empirical analysis through NARDL approach. *Environmental Science and Pollution Research*, *26*, 8111-8124. (Google Scholar)

Shafiei, S., & Salim, R. A. (2014). Non-renewable and renewable energy consumption and CO2 emissions in OECD countries: a comparative analysis. *Energy policy*, *66*, 547-556. (Google Scholar)

Sharif, A., Mishra, S., Sinha, A., Jiao, Z., Shahbaz, M., & Afshan, S. (2020). The renewable energy consumption-environmental degradation nexus in Top-10 polluted countries: Fresh insights from quantile-on-quantile regression approach. *Renewable Energy*, *150*, 670-690. (Google Scholar)

Shengwen Wu, Zhixin Wu, Ziqing Gao, Abdul Ghafoor Awan, Bakhtawar Sumra (2023) Green Energy Resources, Products Recycling, and Clean Environment. *The Journal of Environment & Development* 10704965231217048 (Google Scholar)

Yadav, S. K., Banerjee, A., Jhariya, M. K., Meena, R. S., Raj, A., Khan, N.& Sheoran, S. (2022). Environmental education for sustainable development. In *Natural Resources Conservation and Advances for Sustainability* (pp. 415-431). (Google Scholar)