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The Influence of Economic Growth and Energy Consumption on Environmental Degradation in Pakistan

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ABSTRACT

Globalization has substantial influence on the environmental issues and consequently on the economic activities of a country. Environmental problems are more prominent in developing countries. With the growing development, the issue of environmental degradation is also enhanced. The non-renewable energy consumption is the main cause of environmental degradation and this problem can't be ignored. Therefore, the main objective of this research is to analyze the connection among energy consumption, growth of an economy, and emission of carbon dioxide gas in Pakistan. The data is collected from World development Indicators. Autoregressive Distributed-Lag Model (ARDL) is used for the analysis. The outcomes of ARDL technique stipulate that energy consumption and growth of an economy rise the emission of CO2 in Pakistan. On the basis of these results, it is suggested that policy makers in Pakistan must implement and encourage different sources of energy, which are renewable and will support to fulfill the huge demand of energy to boost the economy and to contribute in a sustainable environment of Pakistan.

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1. Introduction

Maintaining a sustainable environment and growth of an economy is the most demanding issue of every economy, particularly in the world's developing countries. Pakistan continuously struggled to get a better position around the world; this objective makes its economy one of the developing economies of Asia that is highly focused on its economic growth. The pillar behind Pakistan's economic growth is the agriculture sector. However, the scenario is slightly changed due to the high technology and industrial boom. Most of the agricultural land has covered by industrial infrastructure. Energy consumption is also enhanced, which impacts the environment. Moreover, the continuous increase in the population becomes the reason for deforestation, which further becomes a reason for environmental degradation in Pakistan.

Therefore, an association between economic growth, energy consumption, and environmental degradation is established. Hence, it is essential to understand the true link between economic growth and energy consumption for effective environmental and energy strategies. The study by Ahmed, Asghar, Malik, and Nawaz (2020) revealed that EC & EG are linked with each other. The demand for energy in Pakistan is continuously increasing, and traditional energy sources are utilized to fulfill the existing demand for energy in Pakistan. However, the study by AlKhars, Miah, Qudrat-Ullah, and Kayal (2020) mentioned that the degradation of ecology adversely influences the society's well-being and health of several individuals.

There is a need to analyze the link between economic growth, energy consumption, and environmental degradation. Pakistan lies in a developing economy and quickly moving toward industrialization. Therefore, Pakistan is suffering from high-energy issues because of the short form in the energy supply of gas and electricity and the high circular debt. Load shedding is common in Pakistan to keep the balance between the supply and demand of energy requirements (Sufyanullah, Ahmad, & Ali, 2022). This is why exploring the relationship between EG, EC, and EG is very significant for the consumers and all the stakeholders of Pakistan, particularly the policymakers of Pakistan.

Anwar and Elfaki (2021) described that the emission of several adverse gases causes the key issue of environmental degradation due to using different sources of energy consumption. These harmful gases released from energy consumption are methane, carbon dioxide, and nitrogen gases. These gases are harmful to human health (Wang, Zhang, & Wang, 2018). The most destructive gas is carbon dioxide, which adversely influences different sectors of Pakistan, such as forestry and agriculture, which are highly contributed in the economic growth of Pakistan. Based on the existing gap and the aim of the research forming are the key objectives of this research paper:

Assess the relationship between economic growth, energy consumption, and environmental degradation. Moreover, to Identify this relationship by implementing a newly developed economic technique, the Autoregressive Distributed-Lag Model (ARDL), to explore the relationship. Also, to provide evidence-based suggestions to the policymakers to raise the quality of Pakistan's environment and economic growth.

2. Literature Review

Existing literature linked to energy economics and environmental problems explores the interconnection between the relationship of the environment with economic development from the energy consumption perspective. Banday and Aneja (2018) revealed that a significant association existed between the EG of a country with its energy consumption issues. The other study by Brini (2021) mentioned that environmental degradation, energy consumption, and the economy's growth have a particular causal relationship. Wen et al. (2021) mentioned that for the development of an economy, it is essential to enhance energy consumption which becomes a resource for several developmental plans. It is also mentioned that agriculture is the most important sector in developing and developed countries. Still, it is disturbed due to the high technology advancement and trend of industrialization around the globe (Yemelyanov et al., 2019).

This increasing trend becomes a cause of high energy consumption, which positively impacts economic growth while negatively impacting the environment. Both national and international warming is enhanced because of the different sources of energy consumption that participate in the economic growth of a country, like transportation, tourism, and trade (Rahman & Velayutham, 2020). Furthermore, some other studies considered that the relationship between energy consumption and economic growth leads to several environmental issues such as water pollution, land pollution, and a whole environmental degradation (Destek & Sinha, 2020; Jafri et al., 2021; Jian, Fan, He, Xiong, & Shen, 2019).

According to Economic theory, the EG and environmental degradation is closely embedded with energy consumption trends. Khan, Khan, and Rehan (2020) also revealed that the increase in a person's per capita income would enhance environmental degradation up to a particular threshold. Moreover, the study by Lai, Lu, and Liu (2019) mentioned that according to the scale effects, the environmental quality of a country and its economic development are the two conflicting objectives. However, this composition influences the structural changes in an economy that divert the system from a high-polluting industry to less polluting technology (Mahmood et al., 2019).

Referring to the study by Mohsin, Abbas, Zhang, Ikram, and Iqbal (2019), it is clear that economies that are going to develop their systems and focus on human development have enhanced their demand for using fossil fuels and other energy resources. In this way on one side, they help to grow an economy. On the other side, it releases several harmful gases like carbon dioxide and nitrogen gases to the environment, which are harmful to the environment (Muhammad, 2019).

According to the results by Ozcan and Ozturk (2019), it is indicated that when energy consumption is in hand, it adversely impacts the environment's well-being. Similarly, another study reported that labor per-capita income and energy consumption significantly influence carbon dioxide gas emissions (Ozcan, Tzeremes, & Tzeremes, 2020). Furthermore, in contrast to the above results, a study conducted in Malaysia revealed that no significant relationship existed between the growth of an economy and energy consumption (Rasoulinezhad & Saboori, 2018). Similar to these results, it is also mentioned that no long-term association existed between these two variables (Rahman, 2020). Therefore, in the light of present literature and to further generalize the results, this study develops its study framework to investigate the link between environmental degradation, EG, and EC in Pakistan.

3. Data and Methodology

The present research study examines the effects of energy consumption and EG on environmental degradation in the scenario of Pakistan. All variables' data has been collected from the (WDI) World Development Indicators over the period 1985-2020. The present study considers emissions of carbon dioxide as a dependent variable, energy consumption, and growth of the economy as independent variables, while the other variables are control variables that are linked with environmental degradation. The measurement of different variables is mentioned in Table. The given model of the research helps to assess the link among EC, EG, and CO2 emissions.

$$CO2 = f(ENG, GDP, FD, GFCF, URB) \quad (1)$$

Equation one in econometric form is written as:

$$CO2 = \beta_0 + \beta_1 ENG_t + \beta_2 GDP_t + \beta_3 FD_t + \beta_4 GFCF_t + \beta_5 URB_t + \varepsilon_t \quad (2)$$

Table 1
Description of the Variables

Abbreviation	Variable Name	Measurement
CO2	CO2 emissions	Metric tons per capita
ENG	Energy consumption	Energy Use (kg of oil equivalent per capita)
GDP	Economic growth	GDP growth (annual %)
FD	Financial development	Domestic credit to private sector (% of GDP)
GFCF	Gross fixed capital formation	% of GDP
URB	Urbanization	Urban population (% of total population)

The present research applied the Autoregressive Distributed-Lag Model (ARDL) for the analysis; this technique was introduced by Pesaran and Shin (1995). To apply ARDL, the variables must have mixed order of integration. If the variables are stationary at level, the

order of integration is I(0). If the variables are stationary at the first difference, the order of integration is I(1), as in our study.

4. Empirical Analysis and Results

This part provides information about descriptive analysis and bound test for the purpose of exploring the long-term link between dependent and independent variables of the research. The outcomes from these exercises explained co-integration exists among the variables like CO2 emission, EC, EG, and other explanatory variables.

4.1 Descriptive Statistics

Descriptive statistics delivers complete information about data. The given information in table 2 shows the values of descriptive statistics in form of mean, standard deviation, minimum and maximum values as well as skewness and kurtoses to find the normality and consistency existed among data.

Table 2
Descriptive Statistics

	CO2	ENG	GDP	FD	GFCF	URB
Mean	0.718754	441.3927	4.340565	22.22071	15.76265	33.37567
Minimum	0.544419	349.9989	-1.329520	14.68225	12.52063	29.34400
Maximum	0.956345	500.4320	7.705898	29.78608	19.11229	37.16500
Std. Dev.	0.119766	36.94608	2.042531	4.585936	0.733417	2.303016
Skewness	0.011660	-0.936075	-0.423654	-0.309350	-0.083370	-0.107206
Kurtosis	1.964484	3.128139	3.175611	1.801328	1.930713	1.868317
Observations	36	36	36	36	36	36

4.2 Unit Root Test

The most suitable software for this analysis is E-views software, by using this software the Augmented Dickey-Fuller (ADF) test is applied in order to explore that whether variables are stationary or not. Some of the variables like CO2 emissions and economic growth are stationary at a level while the other variables are stationary at first difference.

Table 3
Augmented Dickey-Fuller (ADF) Unit Root Test

Variable	At Level	At 1st Difference	Result
CO2	-4.147336*	-3.814937*	I(0)
ENG	-1.534420	-5.468182*	I(1)
GDP	-3.134671*	-5.034423*	I(0)
FD	-2.667505	-4.862813*	I(1)
GFCF	-3.111844	-5.215574*	I(1)
URB	-2.334195	-5.450931*	I(1)

Note: * indicates 5% level of significance

4.3 Bound Test

This test explains how the different explanatory variables and the DV's are linked with each other in long-run. The value of F-statistic shows there is a long-run relationship exists between the variables.

Table 4
Bound Test for Long-run Relationship

Test statistic	Value	Level of Significance	Lower Bound	Upper Bound
F-statistic	5.583578	10%	2.26	3.35
K	5	5%	2.62	3.79
		2.5%	2.96	4.18
		1%	3.41	4.68

4.4 Optimal lag selection

For minimizing the residual correlation, the optimal lag selection criteria are utilized. These are the commonly used criteria's for lag selection. As the value of AIC shows, the optimal lags are two. Hence, we use two lags in the present study.

Table 5
Optimal lags selection

Lag	AIC	SC	HQ
0	19.95331	20.22266	20.04517
1	6.857917	8.743421*	7.500927
2	5.286464*	8.788115	6.480628*

4.5 Results of ARDL Model

This research applied ARDL model suggested by Pesaran, Shin, and Smith (2001) in order to assess the effect of energy consumption, economic growth, and other control variables on CO2 emissions in Pakistan. Table 6 provides the information about the outcomes in short-run in upper part, while in lower part it provides the results regarding long-run relationship of variables. In short run energy consumption has positive and significant impact on CO2 emissions. Urbanization has a negative and significant impact on CO2 in the short run. In contrast, the other variables are insignificant in the short run.

Table 6
Results of the ARDL

Short Run Results				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(ENG)	0.001970	0.000786	2.505827	0.0201
D(GDP)	0.000697	0.002895	0.240830	0.8119
D(FD)	-0.002203	0.002623	-0.839624	0.4102
D(GFCF)	0.004461	0.005598	0.796948	0.4340
D(URB)	-1.745440	0.580840	-3.005027	0.0065
D(URB(-1))	1.806795	0.592510	3.049391	0.0059
CointEq(-1)	-0.489258	0.159049	-3.076156	0.0055
Long Run Results				
ENG	0.012641	0.011017	2.629511	0.0157
GDP	0.013528	0.010238	2.321378	0.0327
FD	-0.004502	0.006316	-0.712803	0.4835
GFCF	0.030840	0.011623	2.653322	0.0145
URB	0.065365	0.016934	3.860046	0.0008
C	-2.179017	0.420508	-5.181873	0.0000

In the long run, energy consumption and economic growth both significantly and positively impact CO2 emissions (Anwar & Elfaki, 2021; Muhammad, 2019; Qi et al., 2022; Wen et al., 2021). If energy consumption is increased by one percent it will increase CO2 emission by 0.0126 percent. Similarly, if economic growth increased by one percent it increased the CO2 emissions by 0.0135 percent. Financial development has negative but insignificant impact on CO2 emission in case of Pakistan. Control variables like gross fixed capital formation and urbanization positively and significantly impact CO2 emission. It means if urbanization and gross fixed capital formation increase by one percent it will increase CO2 emissions by 0.030 and 0.065 percent, respectively.

4.6 Diagnostic tests

In diagnostic test the table 7 provides the information about the whole research model to analyze the heterosedacity, normality, and serial correlation among data. The prob-value shows that diagnostic tests are fulfilled.

Table 7
Diagnostic Test

Test	Name	F-statistic	Probability
Normality	Jarque-Bera	0.966136	0.6168
Serial correlation	Breusch-Pagan-Godfrey LM test	0.031763	0.9688
Heteroskedasticity	Breusch-Pagan-Godfrey	0.811609	0.6759

4.7 Stability Tests

In order to stabilize the parameters in long run, this test explore the link through using the technique of CUSUM and CUSUMSQ. The cumulative residuals are shown in fig 1 and 2.

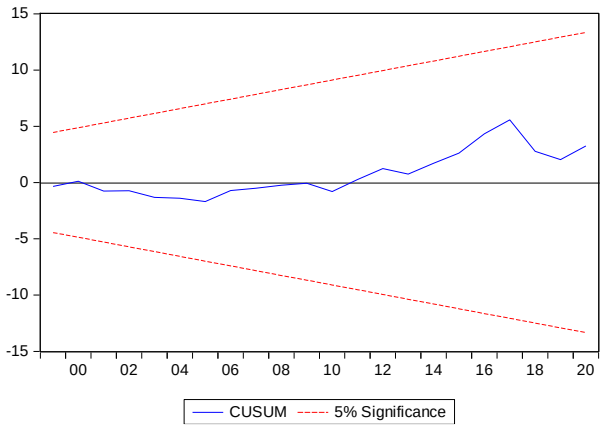

Figure 1: Cumulative sum of recursive residuals

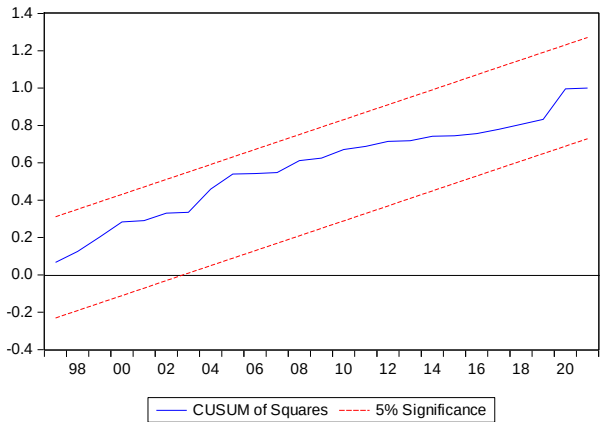

Figure 2: Cumulative sum of squares of recursive residuals

5. Conclusion and Recommendations

This paper is based on the concept to find out the key reason of environmental degradation in Pakistan. The literature shows that the problem of environmental degradation is very serious in developed and underdeveloped countries (Lai et al., 2019). So, the main aim of this research study is to analyze the connection between EC, EG, and CO2 emissions in Pakistan. The study used Augmented Dickey–Fuller approach to test the stationarity of the data. The outcomes of this test show that the data is reliable, and all the variables are stationary at level and first difference. After this test Autoregressive distributed lag model is also used for analysis. The results of ARDL revealed that EC has a particularly positive influence on the carbon dioxide emissions in Pakistan. On the other hand, the coefficient of EG specifies a positive influence on the emission of carbon dioxide in Pakistan.

In developing countries, industrialization and economic activities also become a reason for environmental degradation because these countries are boosting their industries and other developing projects by using non-renewable energy resources. However, this study is highly significant for the economic policymakers and environmental administrators to manage this problem effectively and efficiently. Secondly, this study is also academically beneficial as it supports the existing literature and explores one of the Asian countries to broaden the research scope. Future research must include different economic factors and take the different proxies of energy consumption in order to explore this problem in depth.

Authors Contribution
Seemab Zahra Chishti: conceived the presented of idea, literature searching, references
Muhammad Hasnain Ali: drafting, data analysis, study design, critical revisions
Madiha Khan: introduction and methodology guidance
Muhammad Sabihul Hassan: data collection, proof reading, editing

Conflict of Interests/Disclosures

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