Evaluating the Role of Sustainable Economic Growth on Environmental Sustainability: Fresh insights from ARDL Approach

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Abstract

Globalization has facilitated the development of contemporary economies and connected individuals worldwide, among other technological advancements and resource development. It is simple to overlook how rapidly industrialization and economic growth have affected biodiversity due to globalization. Unquestionably, globalization has contributed to the destruction of our world, from pollution to climate change and global warming. To verify the associations between the variables, a linear ARDL (autoregressive distributed lag) technique was applied. Results indicate that GDP and CO2 emission are related to each other in the long run, whereas the confirmation of EKC is also strongly confirmed with the sign of GDP2. Energy use and urban population are positively significant at a 1% confidence level. This means energy use deleteriously affects environmental sustainability or positively contributes to CO2 emissions in Pakistan. Comparably, the results of short-run interactions likewise show positive relationships between energy consumption and CO2 emission; nonetheless, a closer look at natural resources also reveals a negative insignificant relationship with ecological footprint effects. The growing problem of environmental pollution leads to the fluctuations in climate that are linked to emissions of greenhouse gases. To promote economic progress, the Pakistani government has to implement fresh measures to guarantee decreased CO2 emissions.

Keywords: Pakistan; Environmental Sustainability; Autoregressive Distributed Lag; Economic Growth; Energy Use; Natural Resources; Population

Introduction

Numerous nations have experienced economic growth as a result of globalization, which has had a profound effect on the political, social, and environmental facets of human existence. The quality of environment is becoming a long term source of worry globally. The negligence toward environment was occur when people more focused about production, investment, financial convergence and individual

nation strength. It could be reduced by interdependence of nation, exchange of knowledge, globalization, technical advancement in sense of environmental sustainability, financial development and economic prosperity. Even though every nation strives for a high GDP (Gross Domestic Product), industrialization, trade, urbanization, foreign investment, and technology transfer are all factors in the pollution of the air, water, and land. The environmental state has been worse as a result of major economic operations using more traditional energy sources. Many countries of the glob are fighting with the issue of soil erosion and desertification.Global warming hits the land utilization with carrying other ecological and human-caused environmental distortions. The awareness level can be increased among the population of the world (developed & developing) by explaining the facts of burning fossil fuels on people & wildlife, the carbon tax implementation, conservation of energy resources, transformation of technology from polluting advancement to green technology and a complete policies roadmap should be designed to monitor the CO2 emission and other greenhouse gases.

The world makes great efforts to protect the environment despite taking risks with global advancement. Numerous studies found that because environmental quality was continuously declining, countries needed to devise specific plans to reduce these degradations and increase environmental sustainability. The infinity of human demands and wishes enhance the energy consumption which brings the environmental deterioration. In the scenario of infinite demands, the resources are limited and gap among these two terminologies brutally hits the economic well-being and economic growth phases (Anatasia, 2015; Doytch & Uctum, 2016; Naseem et al., 2019). This debate concluded that the economic globalization definitely put a positive or negative impact on toxic emissions. Reduced import duties and higher economic investment are two benefits of increased trade and globalization. Both the rate of economic growth and development will rise (Godil et al., 2020). The fuel is used as an input in manufacturing process with emission carbon monoxide and this old fangled source of energy enhance the emissions and burden of environment. The immediate consequence of this trade globalization is this.

Conversely, increased trade liberalization contributes to strengthening the system. The transition of economy from established pre-industrial and energy dependent environment to green industrial development and services economy increase the level of environmental deterioration (Ahmad et al., 2016). This economic set-up leads toward trade globalization and positive change in economic structure for lowering the GHG emissions level (Le et al., 2016; Szigeti et al., 2017). The catastrophic effects of this global warming tendency on environment and ecosystem of earth species is just because of unappropriated and improper supervision of human life. Human behavior and practices are impacted by climate change, as the burning of carbon dioxide contributes significantly to global warming (Kirikkaleli et al., 2021) Global environmental consciousness has supported intergovernmental initiatives like the Paris Agreement and the Kyoto Protocol. The primary goals are to ensure balanced economic growth and reduce global pollution (Kassouri & Altıntaş, 2020). This research is focused to determine the effects of economic growth, energy use, urban population and natural resources on Pakistan' environmental condition. The current analytical goals were designed to fill the gap of previous research work where the combined effects are checking and negate their individuality. Furthermore, the CO2 emission is considered as environmental representation because of maximum contribution of it in GHG gases emissions. Variables are covering a yearly data approach from 1990 to 2017 and stationarity check is done by employing two unit-root approaches. Furthermore, the connection among variables was estimated using a linear ARDL approach with Schwarz Bayesian Criterion (SBC).

Literature Review

The risks associated with climate change and global warming are growing and becoming more evident until they have major negative effects. According to Rahman et al. (2016), energy consumption is frequently cited as the main source of carbon dioxide emissions. Nevertheless, decision-makers and advocates learned that energy primarily contributes to atmospheric carbon dioxide

emissions, leading to global warming. As a result, an energy conversion plan has been implemented to reduce atmospheric carbon dioxide emissions; nevertheless, this type of energy conservation slows economic growth (Rehman et al., 2021). The globe's energy needs are growing throughout time, and this is what is causing the environment's carbon dioxide emissions. Coal plants and industrialization are two factors that contribute to carbon dioxide emissions (Ziabakhsh-Ganji & Kooi, 2014; Zafeiriou & Azam (2017). The primary cause of global warming is greenhouse gas emissions, which contribute significantly to global carbon dioxide emissions. This has an impact on human activity and sustainable development. According to Li et al. (2019), modernization is a broad term for the progression of human civilization that encompasses various processes such as technological advancements, industrial improvements, and adjustments to living and environmental standards (Martinho, 2016; Lotfalipour et al., 2010).

The carbon dioxide and other greenhouse gas emissions have contributed to climate change, a major concern associated with global warming. The main goal of the current study is to disentangle the impact of carbon dioxide emissions on Pakistan's rainfall, temperature, population growth, energy consumption, and forestry, agriculture, and livestock output. By using a time series data approach from 1970 to 2017, the stationarity and dynamic interaction among variables has been checked. The analytical method was vector autoregressive model. The Granger causality test contributes to determine the casual relationship and the long-term relationship dynamically extracted by using vector autoregressive model. A long term negative relationship has observed among crops & livestock production, energy consumption, and population growth. A positive and pleasant effect on CO2 comes from forestry production, rainfalls and temperature. The negative relationship of energy consumption and CO2 emission is confirmed for short-run while the forestry, livestock & agricultural productions, population rainfall and temperature behave positively for short-run. Similar findings are observed by applying Granger causality test and all variables interlinked with each other unidirectional.

Mohsin et al., (2021) & Naseem et al., (2021)has explored that the agricultural output increase in Pakistan is influenced the environmental quality and government of Pakistan should take steps to maintain the agricultural growth and environmental quality both. Being a developing country, there are other issues like as jobs, lower income, hunger and economic instability which are more depressing and seek the attention than environmental quality. The industrialization-based economies have led to the creation of new negative externalities to increase their per capita income like as soil erosion, natural resources depletion and obviously global warming. A strong correlation between CO2 emission and renewable energy resources can effectively address the issue of industrial-based economies. The claim of sustainability to save the resources without declining throughout the time of intergenerational well-being is required and its comes to happen through regular maintenance of sustainable ecosystem (Arrow et al. 2012; West et al. 2013; Mohsin et al., 2022). The environmental deterioration and global warming is a global issue so the decisions about the reduction of CO2 emission and GHG emissions controlling should be taken together without any kind of controversy and follow the designed policies strictly. Undoubtedly the Environmental Kuznets Curve theory and CO2 emission has comprehensively grasped of declining the graph of toxic emissions (Sugiawan & Managi, 2016) but the scientific study still dealing with troublesome issues for innovating an accurate scale of measurement and designing the policies after getting the exact facts and figures. Amadi et al., (2016) has declared that there is no other option yet to follow the model periodically evaluation and improve the new model generation for compensate the previous negligence's toward environmental management practices. A rising boos-up has seen in energy consumption and greenhouse gases emission globally. The transition of energy resources from fossil fuels to renewable energy consumption can help to reduce the global unacceptable temperature and depletion of fossil fuel energy resources (Kapica et al., 2015). The giant issue of 21st century is reducing the toxic emissions when the vast natural and artificial greenhouse gases are emitted in every single minute. The carbon dioxide emission reduction can be achieved by large energy

networking but it will reduce the energy efficiency. The relationship of renewable energy and non-renewable energy with CO2 emission can be elaborated that clean energy with minimum CO2 emission and energy with free exchange of CO2 emissions (Hashimoto et al., 2016). The effect of energy consumption on economic growth cannot denied because energy is the main force behind a stable economy but the consumption of it brings significant rise in carbon dioxide emissions (Antonakakis et al., 2017; Ivascu et al., 2021). The clear instructions and restrictions on per capita energy use can seriously affect the economic growth if it would become the reason of downfall in CO2 emission. The economic growth and industrial growth are compulsory to stabilize the economy and per capita income of a country while these both ingredients are seriously hurts the environmental quality.

Ulucak et al., (2020) observed that in industrialized nations, the agriculture industry plays a major role and still plays a big role in various activities, including raising livestock, fishing, and forestry. Ecological sustainability is significantly impacted by the cycle of economic advancement. Initiatives in the agricultural sector are required to meet the increased demand for food and fiber worldwide due to population growth. Strengthening the current input and output system has been the driving force behind increased environmental concerns. Crop transformation, energy processing, and the use of livestock manure instead of artificial fertilizers are some of the ways that agriculture helps mitigate climate change. Renewable energy can be applied in agricultural growth and the applying sources of renewable energy are hydropower, solar & wind and biomass which are renewable energy resources and environmental friendly too.

Data Description

Empirical Data

The time series data, which comes from the World Development Indicators, spans the years 1970 to 2017. The following variables were employed in this study: GDP (independent variable), CO2 emission (dependent variable), energy use, urban population growth, and natural resources (Control variables). The methodology employed in this study to describe the relationship between factors is outlined in Fig-1.

Methodology

Unit Root Test

Stationarity of data series is checked by utilizing the unit-root test because non-stationary data can be misled the results of this research. Two methods are utilized in this research with constant and trend analysis i.e. Augmented Dickey-Fuller (ADF) & Phillip Perron (PP) tests. The fundamental equation of unit-root test is presented below:

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-1} + \varepsilon_t \qquad Equation - 1$$

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_{2t} \sum_{i=1}^{p} \beta_j \Delta y_{t-1} + \varepsilon_t$$

ARDL Model

After checking the stationarity of time series, the analytical process moves toward the determining the long and short-run relationship among variables. The Environmental Kuznets Curve (EKC) primarily focused while calculating the relationship of variables by employing ARDL method(Sarfraz et al., 2023; Naseem et al., 2023a). Firstly, the EKC is addressed because it's a little bit tricky-based analytical approach as the real GDP per capita is proxy of economic growth. The assumption of EKC required the GDP coefficient with positive sign and the square of GDP with negative sign to confirm the existence of it (Naseem et al., 2023b). The first equation of above argument and empirical model construction is given below:

$$\boldsymbol{E = f(GDP, GDP^2, CV)} \qquad \boldsymbol{(1)}$$

$$E = Environmental\ sustainability$$

$$GDP = Economic\ Growth;$$

$$GDP^2 = Square\ of\ Economic\ Growth$$

$$CV = Control\ Variables\ i.e.\ Energy\ use\ (EU),$$

$$Urbanization\ (URB), and\ Natural\ Resources\ (NR)$$

The equation-1 can be detailed as:

$$\boldsymbol{E = f(GDP, GDP^2, EU, URB, NR)} \qquad \boldsymbol{(2)}$$

$$\boldsymbol{CO_2 = f(GDP, GDP^2, EU, URB, NR)} \qquad \boldsymbol{(3)}$$

In equation-2, E is denoting as representative of Environment which replaced with CO_2 in equation-3 due to used proxy (Aboagye, 2017).

$$CO_{2t} = \beta_0 + \beta_{1GDp} GDP_t + \beta_{2GDP^2} GDP_t^2 + \beta_{3EU} EU_t + \beta_{4URB} URB_t + \beta_{5NR} NR_t + \mu_t \quad (4)$$

$$\Delta lnCO_{2t} = \beta_0 + \sum_{j=1}^{m} \varphi_i \Delta lnCO_{2t-j} + \sum_{j=0}^{m} \alpha_i \Delta lnGDP_{t-j} + \sum_{j=0}^{m} \delta_i \Delta lnGDP_{t-j}^2 + \sum_{j=0}^{m} \gamma_i \Delta lnEU_{t-j} + \sum_{j=0}^{m} \vartheta_i \Delta lnURB_{t-j} + \sum_{j=0}^{m} \pi_i \Delta lnNR_{t-j} + \theta_1 lnCO_{2t-1} + \theta_2 lnGDP_{t-1} + \theta_3 lnGDP_{t-1}^2 + \theta_4 lnEU_{t-1} + \theta_5 lnURB_{t-1} + \theta_6 lnNR_{t-1} + \mu_t \quad (5)$$

Equation-5 is a re-written form of equation-4 with addition ***In*** sign to show the conversion of a linear model into double log specification as STRIPTA identity stated and conditional error correction model formulation. There are four different conclusion or hypothetical approaches while applying the cointegration test are presented below:

No Cointegration: $H_0 = \theta_1 = \theta_2 = \theta_3 = \theta_4 = \theta_5 = \theta_6 = 0$

$\mathrm{F-statistic} < Lower\ bound\ value = no\ cointegration$

Cointegration: $H_1 = \theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq \theta_5 \neq \theta_6 \neq 0$

$\mathrm{F-statistic} > upper\ bound\ value = cointegration\ exists$

Inconclusive Cointegration: lower bound value $< F - statistic < upper\ bound\ value$

The eligibility and accuracy of ARDL for long and short-run can be specified after confirmation of cointegration (Naseem et al., 2023) among variables by equation 6 & 7:

$$lnCO_{2t} = \beta_0 + \sum_{j=1}^{m} \varphi_{1i} \Delta lnCO_{2t-j} + \sum_{j=0}^{m} \alpha_{1i} \Delta lnGDP_{t-j} + \sum_{j=0}^{m} \delta_{1i} \Delta lnGDP_{t-j}^2 + \sum_{j=0}^{m} \gamma_{1i} \Delta lnEU_{t-j} + \sum_{j=0}^{m} \vartheta_{1i} \Delta lnURB_{t-j} + \sum_{j=0}^{m} \pi_{1i} \Delta lnNR_{t-j} + \mu_{1t} \quad (6)$$

$$lnCO_{2t} = \beta_0 + \sum_{j=1}^{m} \varphi_{2i} \Delta lnCO_{2t-j} + \sum_{j=0}^{m} \alpha_{2i} \Delta lnGDP_{t-j} + \sum_{j=0}^{m} \delta_{2i} \Delta lnGDP_{t-j}^2 + \sum_{j=0}^{m} \gamma_{2i} \Delta lnEU_{t-j} + \sum_{j=0}^{m} \vartheta_{2i} \Delta lnURB_{t-j} + \sum_{j=0}^{m} \pi_{2i} \Delta lnNR_{t-j} + \tau ECT_{t-1} + \mu_{2t} \quad (7)$$

The term ***t***in equation-7 has represented Error Correction Term (ECT). The EC calculated the speed of adjustment of variables from short-run period to long-run period by carrying equilibrium status. The post test of results and analysis accuracy i.e. Serial correlation, heteroscedasticity cumulative sum of recursive residuals (CUSUM), and cumulative sum of squares of recursive residuals (CUSUMSQ) are implemented.

Empirical findings

Table-1 Descriptive Summary of Pakistan

	$lnCO_2$	lnEU	lnGDP	$lnGDP^2$	lnURB	lnNR
Mean	-0.493	4.013	6.132	38.029	7.326	1.246
Median	-0.382	4.067	6.086	37.039	7.328	1.281
Maximum	-0.041	4.274	7.289	53.138	7.857	1.505
Minimum	-1.176	3.637	4.607	21.229	6.662	0.974
Std. Dev.	0.361	0.189	0.662	8.114	0.288	0.178
Skewness	-0.522	-0.411	-0.063	0.169	-0.294	-0.228
Kurtosis	1.899	1.742	2.494	2.359	2.946	1.571
Jarque-Bera	4.502	4.424	0.532	1.028	0.681	4.403
Probability	0.105	0.109	0.766	0.598	0.711	0.111
Observations	47	47	47	47	47	47

The above table-1 shows the results of descriptive statistics of India. The average value of carbon emission (CO2) is -0.493, energy consumption (EU) is 4.013, Gross domestic (GDP) product is 6.132, Gross domestic-square (GDP2) is 38.029, Urban population growth (URB) is 7.326 and Natural resources (NR) is 1.246. The median shows the middle most value of the arrange data. The median values of the all variables are lies between -0.382 and 37.039. The maximum values of CO2 are -0.041, EU is 4.274, GDP is 7.289, GDP2 is 53.138, URB is 7.857 and the NR is 1.505. The minimum of the data is between -1.176 and 21.229. The stander deviation evaluates the spread of data about the mean value. The value of standard deviation is between 0.177 and 8.114. The skewness shows that GDP2, URB and NR are positively skewed while the CO2, EU, and GDP are negatively skewed. The values of mean and median also support the signs of skewness. The mean value of CO2, EU, and GDP is less than median value which shows a right lean curve or negative skewness (Dean & Illowsky, 2018; Sarfarz et al., 2022).

The kurtosis value is less than 3 in all variables which mean that series of variables are platy-kurtic distributed and produce fewer and less intensive outliers than normal distribution (Kahane, 1960; Rudelson & Vershynin, 2013) The Jarque- Bera test confirms that all variables are not normally distributed because the P-value is more than 5% in all variables which mean reject the null hypothesis normal distribution. The value of Jarque-Bera far from zero and fulfill the assumption of non-negativity which strongly support data is not normally distributed (Jarque & Bera, 1980; Thadewald & Büning, 2007). The data covers total 47 number of observation for this descriptive summary. The LN means taking a natural log before calculation of statistics summary. Descriptive of all variables graphically represent in figure-2. Fluctuations of all variables and economy (GDP) can be clearly visualized by these graphs.

Table-2Empirical Results of Unit Root Tests

	Level				First Difference				
	ADF		PP		ADF		PP		
Variable	***Constant***	***Constant Trend***	***Constant***	***Constant Trend***	***Constant***	***Constant Trend***	***Constant***	***Constant Trend***	***Integration***
CO_2	-0.3021	-2.644	3.056	3.056	-5.998[a]	-7.719[a]	-5.64[a]	-7.583[a]	1(1)
GDP	-2.903[b]	-0.39	-1.579	-0.390	-4.785[a]	-6.267[a]	-5.29[a]	-6.264[a]	1(1)
GDP^2	-1.992	1.364	-1.921	0.9752	-5.225[a]	-7.115[a]	-5.20[a]	-7.115[a]	1(1)
Energy use	-1.663	-2.278	-0.843	-2.225	-5.167[a]	-9.340[a]	-8.83[a]	-9.138[a]	1(1)
urbanization	-0.54	-2.895	-3.51[a]	3.505[a]	-3.176[b]	-3.018[a]	-3.37[a]	-3.018[a]	1(0)
Natural resources	-2.499	-2.08	-1.843	-2.2	-7.253 [a]	-7.010[a]	-7.27[a]	-7.011[a]	1(1)
Note: [a,b,c] denotes 1%, 5% and 10% level of Significance									

The table-2 is contained the results of unit-root test from two renowned methods of unit-root i.e. ADF and PP. The alternative hypothesis is tested on different version of test i.e. stationary and trend stationary. Stationary or constant process of unit root test (ADF, PP). It is a stochastic process that unconditional joint probability remains unchanged when time shifting occurs. Mean and Variance also remained unchanged in constant. Trend stationary process is not strictly constant or stationary but it can easily be converted into stationary process. Basically stationary of data is being disturbed by outliers or shocks and trend stationary is mean reverting process (transitory, the time series will converge again towards the growing mean, which was not affected by the shock) (Meyer, 2006; Nielsen, 2005; Nelson & Plosser, 1982; Naseem et al., 2021).Only urbanization shows stationarity at level under the constant for ADF and PP while remaining all variables is significant at first difference with 1% level of significance for constant and constant trend. We can say

that result of unit root test is a mixture of level and first difference. As per the assumption of ARDL model, the integration of variables at level and first difference (mixed) is necessary and unit-root test create an ideal situation though (Hegwood & Papell, 2007).

The results of ARDL bounds cointegration has shown the significance of F-statistic at 1% with value of 11.514. The F-statistic is greater than upper bound value which is 3.15 at level and 4.43 at first difference. The detailed results of bounds test are presented in table-3 and these results are acquired by utilizing Schwarz Bayesian criterion (SBC) due to its avariciousness (Farhani et al., 2013).

Table-3 Bounds test critical values

Unrestricted intercept & no trend			
F-statistic	**Level of significance**	**1(0)**	**1(1)**
11.514[a]	10%	2.12	3.23
	5%	2.45	3.61
	2.50%	2.75	3.99
	1%	3.15	4.43

Note: a,b,c denotes 1%, 5% and 10% level of Significance

The validity of the study's model confirmed by diagnostic tests because all the explanatory variables and CO2emission are cointegrated for longer periodic term or variables are moving simultaneously.

Table-4Long Run Coefficients EstimationBased on Schwarz Bayesian Criterion (SBC)

Dependent variable $lnCO_2$		
Regressor	**Coefficients**	**T-ratio**
GDP	0.000[a]	5.147
GDP^2	-0.007[a]	-4.002
Energy use	0.002[a]	13.858
Urbanization	0.012[a]	2.825
Natural resources	-0.038[a]	-3.303

Note: a,b,c denotes 1%, 5% and 10% level of Significance

Table-4 is displaying the outcome of ARDL coefficients for long-run and relationship compatibility of selected set of variables. In long-run the EKC is strongly confirmed due to positive signs of GDP and negative sign of GDP2coefficients which confirms long-run relationship with environmental quality indicator (CO2 emission) (Aboagye, 2017). The complete values of GDP coefficient were 0.000084 which approximately presented in table-3. The value of GDP coefficient has declared that 1% increase in GDP per capita of Pakistan contribute 0.0000884 in CO2 emission. The positive significance of urbanization and energy use at 1% confirms their positive contribution in CO2 emission and enhancing pollution in Pakistan (Naseem et al., 2023). The negative significance of natural resources has shown the friendly relationship between natural resources and environmental quality.

Table-5 The Short-Run Coefficients Estimation Based on Schwarz Bayesian Criterion (SBC)

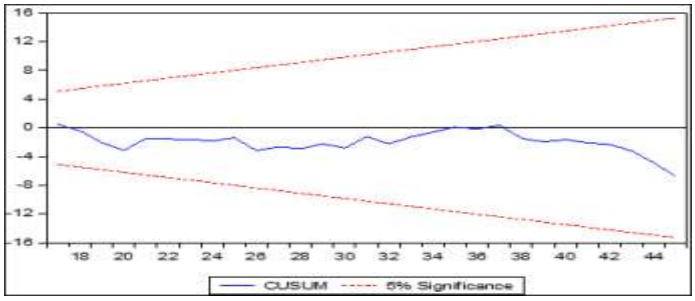
Dependent variable $lnCO_2$		
Regressor	***Coefficients***	***T-ratio***
GDP	0.000	1.552
GDP^2	-0.003	-1.618
Energy use	0.002[a]	6.824
Urbanization	0.002	4.325
Natural resources	-0.023	-1.268
ECM(-1)	-0.987[a]	-9.862
R^2: 0.890, DW-statistic: 2.584, Schwarz Bayesian Criterion (SBC): -4.088, F-stat.: 18.11[a] (0)		
Note: [a,b,c] denotes 1%, 5% and 10% level of Significance		

The results of short-run relationship among variables on the basis of Schwarz Bayesian Criterion (SBC) are presented in table-5. The EKC exist as per its assumption of positive GDP coefficient and negative GDP square coefficient. The error correction term is also satisfying the long-run relationship confirmations' requirement that the negative significance of ECM (-1). The ECM (-1) coefficients is -0.987which elucidated that speed of return toward equilibrium corrected about 98%. It's an indication approximately 1.1 period is required to return variables to long-run equilibrium. Energy use is positively significant which means the excessive use of energy resources are negatively influenced the environmental quality of Pakistan for short-run.

Table-6The ARDL Diagnostic Tests Estimation

Test statistics	F-version	Test statistics	Prob.
Serial correlation	F(2,27)	2.911	-0.233
Heteroscedasticity	F(1,40)	0.128	-0.721

Table-6 conclusively presented the reliability of model specification and its accuracy in term of numeric. The post-reliability checks test i.e. Serial correlation and Heteroscedasticity are strongly rejected the null hypothesis and confirm the reliability of models. The model is good-to-fit and free from heteroscedasticity and serial correlation. This reliability checksfurther comprehended by applying cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests (Pesaran & Pesaran, 2010). The graphic presentation of cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) can be visualized in figure-3.



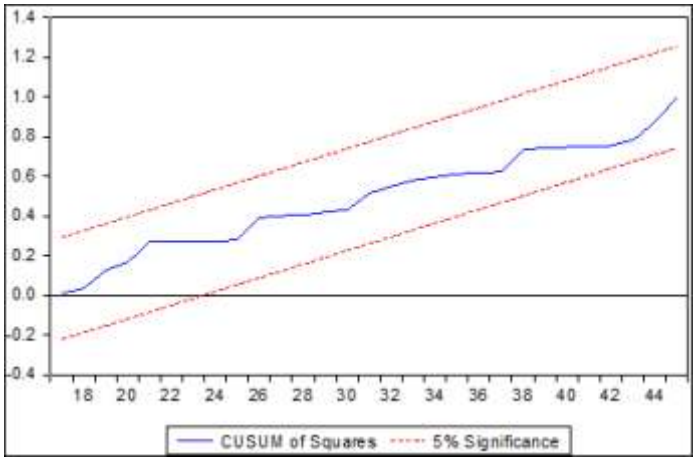


Figure-3 Graphical representation of CUSUM and CUSUM2

Conclusion

The primary goal of the current analysis was to increase the body of knowledge by combining and examining the effects of economic growth, energy consumption, urban population and natural resources on Pakistan's ecological footprint in a single model. Two-unit root tests were employed to correct for stationarity in the annual data utilized in the study, which covered the years 1990–2017. To examine the associations between the variables, a linear ARDL approach with limited information maximum likelihood was used. Results indicate that GDP and CO2 emission are related to each other in the long run, whereas the confirmation of EKC is also strongly confirmed with the sign of GDP2. Energy use and urban population are positively significant at a 1% confidence level. This means energy use deleteriously affects environmental sustainability or positively contributes to CO2 emissions in Pakistan. Comparably, the results of short-run interactions likewise show positive relationships between energy consumption and CO2 emission; nonetheless, a closer look at natural resources also reveals a negative insignificant relationship with ecological footprint effects. The urban population, economic growth and natural resources are positively insignificant in the short run. Additionally, the existence of the EKC was confirmed in the long and short-run with accurate signs of GDP and GDP2. The ECM (-1) coefficient is -0.987, fairly large, and this value elucidated the return to equilibrium speed of variables is corrected about 98% for Pakistan, which indicates that approximately 1.1 period is required to return variables to long-run equilibrium. There would need to be some profound changes made to economic institutions and society at large in order to completely and significantly reduce the demands and impacts of the environment. With time, everyone understood the necessity of adjusting to new climate change regulations and began to adopt ecologically beneficial practices. Research has demonstrated that investing in green projects, green innovation, and sustainability can lead to sustainable economic growth and prosperity. These strategies are also the most effective means of improving a nation. Because global warming has increasingly detrimental socioeconomic implications, several scholars have examined the relationship between pollution, globalization, and economic growth.

Policy Recommendations and Suggestions

It is suggested that policymakers and officials continue to improve their interventions targeted at supporting effective trade strategies, economic development, fuel use, and, in particular, lowering carbon emissions based on the analytical conclusions of this study. This would maximize economic production, preserve sustainable surroundings, and lessen the harm done to ecosystems. Globalization, politics, the environment, and laws have all had a negative impact on Pakistan. Pakistan, like many other industrialized nations, has experienced both positive and negative effects from globalization. Every municipality has its community and way of life. Pakistan retains old customs and has a rich and varied culture. As a result of economic globalization, developing nations can expand their export markets, attract foreign investment, and experience economic prosperity. Higher rivalry among businesses is one more benefit of globalization that benefits consumers by enabling them to purchase things at ever-lower prices. Free trade between developed and developing nations is preferable since it allows them to buy goods at cheaper prices and raise their living standards. Open trade should be viewed as one of several strategies for reducing poverty.

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