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The Impact of Globalization, Energy Use, and Trade on Ecological Footprint in Pakistan: Does Environmental Sustainability Exist?

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Abstract: Globalization has contributed to several advances in technology including linking people around the globe and driving us to modern economies. With fast economic growth and industrialization progress, the negative impact of globalization on biodiversity can be easily ignored. Globalization is an undeniable factor in our planetary devastation from pollution to global warming and climate change. The major intention of our recent analysis was to examine the globalization, energy consumption, trade, economic growth, and fuel importation to determine the ecological footprint in Pakistan by taking the annual data variables from 1974–2017. A linear ARDL (autoregressive distributed lag) technique with limited information maximum likelihood and linear Gaussian model estimation were utilized to check the variables association. Outcomes show that in the long run, globalization, energy usage, trade, and GDP growth have consistently productive interactions with the ecological footprint, while an examination of fuel importation uncovers an adversative linkage to impacts on the ecological footprint in Pakistan. Similarly, the findings of short-run interactions also reveal that globalization, energy usage, trade, and GDP growth have constructive linkages; however, an examination of fuel importation also uncovers an adversative linkage to impacts on the ecological footprint. The outcomes of limited information maximum likelihood also expose that the variables of globalization, energy usage, trade, and fuel importation have productive linkages, while an examination the GDP growth uncovers an adversative linkage to the ecological footprint. Furthermore, the outcomes of the linear Gaussian model estimation also uncover that globalization and energy usage demonstrate a constructive linkage, while other variables reveal an adverse linkage to the ecological footprint. Environmental pollution is now an emerging issue which causes the climatic variations associated with greenhouse gases emissions. The Pakistani government must adopt new strategies to ensure that CO_2 emissions are reduced in order to stimulate economic growth.

Keywords: globalization; ecological footprint; environmental pollution; trade; energy usage; linear ARDL

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1. Introduction

Globalization has propelled many countries to economic progress, which has had a significant impact on the socioeconomic, environmental, and political aspects of human existence. Globalization increases the interdependence of countries via the production and investment of goods and services, capital transfers, financial convergence, technological change, and knowledge sharing. Because of the extent of trade liberalization, financial development, technical advancement, and economic progress, there have been significant concerns about global environmental quality. Although each country aspires for strong GDP (Gross Domestic Product) development, trade, technology transfer, foreign investment, urbanisation, and industrialization all contribute to air, water, and land pollution. As a result of the increasing usage of traditional energy sources in key economic activities, the environmental situation has deteriorated [1–3]. The effects of global warming, soil depletion, desertification, and other ecological and human environmental distortions have been persistently addressed in many countries. Special policies are being developed to monitor CO_2 emissions and other greenhouse gases in order to raise awareness about the harmful effects of burning fossil fuels on humans and wildlife, as well as the implementation of a carbon tax, inventions, energy conservation, and high-efficiency technology [4–6].

Although the world takes risks in terms of global advancement, it works hard to preserve the environment. Many studies discovered that countries needed to develop specific strategies to minimize these degradations in order to improve environmental sustainability due to the continuous decline in environmental quality. Human demands are limitless, but natural resources are limited, and economic well-being and growth phases are prominent in economic studies; in this scenario, energy consumption is to blame for waste and environmental deterioration [7–9]. Economic globalization may have a favourable or detrimental impact on emission levels in the environmental debate. On the one side, more trade and globalization will result in lower import tariffs and increased economic investment. Economic growth and development levels will both increase. Then, since fuel is utilized as an input in the manufacturing process, the emissions would rise. The immediate effect is the result of this globalization of trade. More free trade, on the other hand, helps to enhance the structure. From an energy-dependent pre-industrial environment and established economy, the economy may transition to a green industry and service economy. Emission levels will be reduced due to changes in the economic structure as a result of trade globalisation [10–12].

Global warming is now the most serious environmental problem confronting humanity. Without appropriate supervision, such a tendency would have disastrous consequences for the environment, the economy, and human life. Climate change has an impact on human behaviour and practises, with carbon dioxide combustion being a major contributor to global warming. Increasing worldwide awareness of environmental problems has aided inter-governmental initiatives such as the Kyoto Protocol and the Paris Agreement. The main aim is to decrease global pollution while also ensuring a balanced economic expansion [13,14]. The main intention of the current analysis was to determine the impacts of globalization, energy consumption, trade, economic growth, and fuel importation on the ecological footprint in Pakistan. As many previous studies examined those factors separately, we have investigated their impact together in order to highlight the most significant determinants of the ecological footprint in a developing country that faces great challenges in the environmental protection area. Moreover, many studies have highlighted the impact of these variables on CO_2 emissions, while we have investigated their impact on the ecological footprint, which is a broader concept. We have utilized the annual data variables from 1974–2017, and stationarity among variables was rectified by using the two-unit roots technique. Further, a linear ARDL technique with limited information maximum likelihood and linear Gaussian model estimation were employed to estimate the linkage among variables. The findings supported the policy recommendations which are provided in the final section of this paper.

2. Literature Review

The global social and economic situation has been negatively impacted by environmental problems such as desertification, erosion, global warming, and climate change. The changes in the equilibrium of habitats, air quality, and extreme climatic conditions will result from global warming. Different analyses of the underlying causes and impacts of global warming and climate change have completed observational research over the past three decades. According to works on energy economics, the two most significant factors influencing the climate are energy use and economic growth. High use of fossil fuels has led to a significant increase in environmental degradation throughout the course of industrialisation. The increase in CO_2 emissions is seen as the cost of utilizing fossil fuels and economic growth, and it is a critical problem for the global environmental discussion to solve [15–17]. Financial development, for example, increases consumer trust in purchasing houses, equipment, air conditioners, and cars, all of which increase energy consumption and, as a result, contribute to environmental problems. Similarly, financial expansion eliminates spending barriers for companies by providing financial resources. Investors will ultimately design and build new industries that use a lot of energy and emit a lot of trash and carbon dioxide into the environment [18–20].

Globalization is also changing many aspects of the planet today, including culture, travel, language, way of life, and foreign relations; however, trade and environmental policy guidelines have a major impact on the potential to affect environmental sustainability. Currently, the world is transitioning from a traditional economic and financial framework to a more linked, innovative, and competitive market. There is little dispute that globalization rewards those that change market patterns, create economies of scale, and improve their inventiveness. The global contemporary environment has resulted in many economic changes, increasing reliance on home wealth and resulting in growth. However, in the context of economic and financial globalization, the fast-moving trends of international corporate solidarity, cost minimization, and commercial independence have stimulated people's interest in learning about the environmental impacts [21–23]. Globalization is a multi-faceted process that is becoming more and more the guiding factor behind the dynamic world economies. Since the start of the 21st century, globalization, in different fields such as finance, politics, and culture, has produced a new millennium of transactions. Now the old concept that the globe is growing smaller applies not only to the simplicity of travel and connectivity, but also to the purchase and sale of products and services on international and foreign markets. The term "globalization" currently refers to the merger of many markets that leads to worldwide growth via investment, such as international exchange [24–26].

According to Shahbaz et al. [25,27], globalization is a significant driver of the total energy demand. Fossil fuel sources create usability problems for the next generation. Price instability in fossil fuels imports is a disadvantage of their use and leads to bad economic effects [28]. Several studies have examined the effects of trade on the environmental indicators such as CO_2 emissions. Many studies have been conducted to observe the effect of trade on various environmental variables such as CO_2 emissions and total energy consumption for developed and/or developing countries [29–34], with varied results. Some found a positive correlation between trade, energy consumption, and CO_2 emissions, while others discovered an inversed U-curve, as well as uni-directional or bi-directional causality between these indicators. With the development of renewable energy sources, studies started to focus on investigating the relationship between trade and renewable energy [35–37] and found a positive relationship between trade and renewable energy use in OECD countries, in Europe or in Asian countries, which improves environmental conditions. However, Uzar [38] found that trade does not impact renewable energy consumption.

The environmentally friendly footprint examines the impact of human activities on the environment. Human demand pressures on arable soil, pastures, wetlands, cumulative soil, carbon footprint, and the ocean are all monitored. Human demand has outstripped resource efficiency, and we are confronted with an enormous dilemma. Strengthening demand and supply would decrease the planet's generational potential, produce greenhouse gases and pollution, consume energy, and possibly destroy our ecosystems. Recent environmental studies are increasingly using ecological footprint to evaluate the influence of human demand owing to its wide characteristics and ability to absorb the indirect and direct effects of development and energy use [39–41]. The economic and social growth of a nation is a key measure of natural resource rental, but intensifying industrial development and urban development, depletion of natural resources, low exploitation and lack of technology can all decrease a country's natural resources, as does renting natural resources. Globalization increases the productivity of natural resource exploitation via creative technology [21]. Carbon dioxide emissions are seen as a measure of environmental pollution in most environmental assessments, but they represent just a limited proportion of environmental degradation. The ecological footprint is a globally comparable, comprehensive, and reliable assessment of environmental impacts. Human activity's impacts on land, air, and water in ecosystems have lately been shown to be more prevalent than carbon dioxide emissions [42–44].

Economic growth has contributed to a massive use of fossil fuel energy in the industrialization phase. Currently, the global economy is highly dependent on energy input in all facets of the economy. It poses energy protection and sustainability problems and produces high levels of greenhouse gas pollution at the same time [31]. Economic development is one factor influencing energy use and carbon emissions are the other. We must acknowledge economic growth in order to support environmental improvements while meeting rising energy demands. The use of green energy will compensate for the irregularity of the energy mix sector and help to protect the environment. When compared with other energies, renewable energy has a lower impact on the environment, making the transition to a low-carbon economy a critical component for renewable energy. Moreover, renewable resources and international tourism flows will have a beneficial impact on foreign investment, research and development expenditure, trade, employment, quality of life, and a country's growth and development [45–48].

The EKC has carried out investigations focused on various environmental metrics including emissions of carbon dioxide, carbon footprint, sulphur emissions and environmental footprint, such as different resource use, trade openness and information technology parameters. However, the details of the analysis remain unfinished. Secondly, the most used environmental proxy was still carbon dioxide pollution. There are, however, costs for taking the wrong approach in managing carbon dioxide emissions. For example, water transferred to solid waste causes emissions of carbon dioxide from nitrogen oxides and sulphur to increase later on. Similarly, concentrations of carbon dioxide are a detrimental measure of environmental damage, and the depletion of the atmosphere goes outside the limits of the carbon dioxide pollution. More inclusive measures of environmental deterioration should instead be used [49–51]. Economic activities and progress have increased throughout human history. With such advancements, human demand for natural resources such as food, resources, raw materials, and a safe environment has risen considerably. Human hunger for biodiversity has resulted in environmental stress due to the use and depletion of natural resources, the discharge of waste and pollutants, and the extinction of animals, thus altering the global ecosystem. Global warming does not just exacerbate the impacts of stress on the environment; it also leads to habitat degradation, increased waste, biodiversity loss, and increased susceptibility of developing economies to adverse impacts. People's environment has deteriorated, putting the futures of all living beings in danger. As a result, the global economy is looking for better ways to avoid social and environmental issues [52–54].

3. Methods and Data

3.1. Data Sources

This analysis utilized the annual data variables from 1974–2017, which was collected from the World Development Indicators (WDI) (https://data.worldbank.org/country/pakistan, accessed on 20 April 2021 and Global footprint network (https://data.footprintnetwork.org/#/countryTrends?cn=165&type=BCpc,EFCpc, accessed on 20 April 2021). The variables for the analysis are described as follows: ecological footprint, globalization, energy usage, trade, GDP growth, and fuel importation. The trends of the variables are described in the Figure 1.

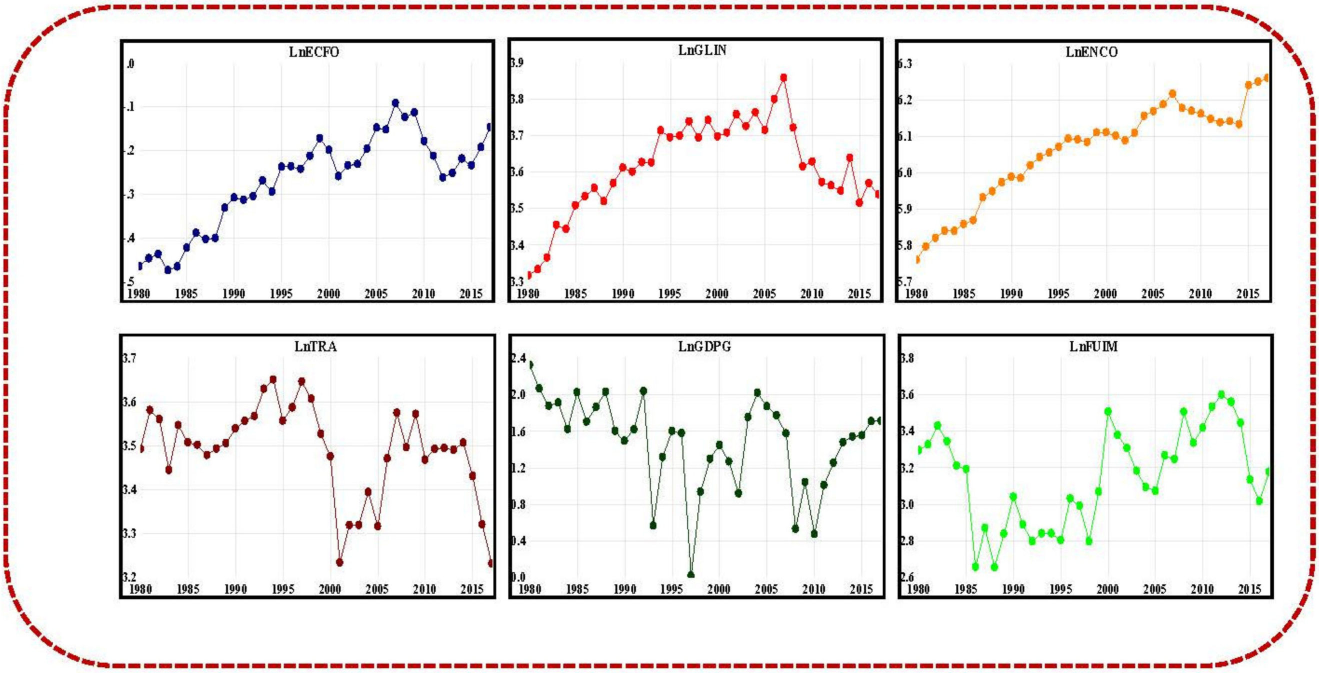

Figure 1. Trends of the study variables.

3.2. Model Specification

To demonstrate the association among the study variables including ecological footprint, globalization, energy usage, trade, economic growth, and fuel importation, we have produced the following model which can be stated as:

$$ECFO_t = f(GLIN_t,\ ENCO_t,\ TRA_t,\ GDPG_t,\ FUIM_t) \tag{1}$$

We can further expand the Equation (1) as:

$$ECFO_t = \omega_0 + \omega_1 GLIN_t + \omega_2 ENCO_t + \omega_3 TRA_t + \omega_4 GDPG_t + \omega_5 FUIM_t + \varepsilon_t \tag{2}$$

Moreover, the structure of Equation (2) in the logarithmic form can be as follows:

$$LnECFO_t = \omega_0 + \omega_1 LnGLIN_t + \omega_2 LnENCO_t + \omega_3 LnTRA_t + \omega_4 LnGDPG_t + \omega_5 LnFUIM_t + \varepsilon_t \tag{3}$$

We might explain the variables in Equation (3) by stating that $ECFO_t$ shows the ecological footprint, $GLIN_t$ presents the globalization index, $ENCO_t$ shows the energy usage, TRA_t presents the trade, $GDPG_t$ uncovers the gross domestic product growth, and $FUIM_t$ indicates the fuel imports in Pakistan. Furthermore, t measures the time trend, ε_t labels the error term, and ω_1 to ω_5 reveals the model's exponent for the long term.

3.3. Linear ARDL (Autoregressive Distributed Lag) Approach

We have applied the ARDL (autoregressive distributed lag) approach by the author Pesaran et al. [55], as well as Pesaran and Shin [56], to correct the relation between variables via long- and short-run estimations. The ARDL technique has many benefits compared with other one-time integer approaches. This method has many implications when compared with the methodologies of other studies, and all variables in the research must be included in the same series. In other words, the ARDL method is used in accordance with basic return order of integration I(2) irrespective of the distinction and the cointegration sequence being I(0) or I(1). The linear ARDL methodology is appropriate, although data collection is less adequate. The sample size of the model can be adjusted. The model is demonstrated by the UECM model for short and long-term use. In the long- and short-run phases, this pattern is described separately. As follows, the general classification of the model among variables is as follows:

$$\begin{aligned}\Delta \mathrm{LnECFO_t} = \xi_0 \quad &+ \sum_{s=1}^{s} \xi_{1s}\Delta \mathrm{LnECFO}_{t-i} + \sum_{s=1}^{s} \xi_{2s}\Delta \mathrm{LnGLIN}_{t-i} + \sum_{s=1}^{s} \xi_{3s}\Delta \mathrm{LnENCO}_{t-i} + \sum_{s=1}^{s} \xi_{4s}\Delta \mathrm{LnTRA}_{t-i} \\ &+ \sum_{s=1}^{s} \xi_{5s}\Delta \mathrm{LnGDPG}_{t-i} + \sum_{s=1}^{s} \xi_{6s}\Delta \mathrm{LnFUIM}_{t-i} + \eta_1 \mathrm{LnECFO}_{t-1} + \eta_2 \mathrm{LnGLIN}_{t-1} \\ &+\eta_3 \mathrm{LnENCO}_{t-1} + \eta_4 \mathrm{LnTRA}_{t-1} + \eta_5 \mathrm{LnGDPG}_{t-1} + \eta_6 \mathrm{LnFUIM}_{t-1} + \varepsilon_t\end{aligned} \tag{4}$$

The variables long-run estimation can be seen as:

$$\begin{aligned}\Delta \mathrm{LnECFO_t} = \theta_0 \quad &+ \sum_{v=1}^{v} \theta_{1v}\Delta \mathrm{LnECFO}_{t-i} + \sum_{v=1}^{v} \theta_{2v}\Delta \mathrm{LnGLIN}_{t-i} + \sum_{v=1}^{v} \theta_{3v}\Delta \mathrm{LnENCO}_{t-i} + \sum_{v=1}^{v} \theta_{4v}\Delta \mathrm{LnTRA}_{t-i} \\ &+ \sum_{v=1}^{v} \theta_{5v}\Delta \mathrm{LnGDPG}_{t-i} + \sum_{v=1}^{v} \theta_{6v}\Delta \mathrm{LnFUIM}_{t-i} + \varepsilon_t\end{aligned} \tag{5}$$

Similarly, the depiction of short-run linkage for the study variables may follow as:

$$\begin{aligned}\Delta \mathrm{LnECFO_t} = \vartheta_0 \quad &+ \sum_{w=1}^{w} \vartheta_{1w}\Delta \mathrm{LnECFO}_{t-i} + \sum_{w=1}^{w} \vartheta_{2w}\Delta \mathrm{LnGLIN}_{t-i} + \sum_{w=1}^{w} \vartheta_{3w}\Delta \mathrm{LnENCO}_{t-i} \\ &+ \sum_{w=1}^{w} \vartheta_{4w}\Delta \mathrm{LnTRA}_{t-i} + \sum_{w=1}^{w} \vartheta_{5w}\Delta \mathrm{LnGDPG}_{t-i} + \sum_{w=1}^{w} \vartheta_{6w}\Delta \mathrm{LnFUIM}_{t-i} + \tau \mathrm{ECM}_{t-1} + \varepsilon_t\end{aligned} \tag{6}$$

The Equation (6) expresses the short-term linkage among the variables with error correction representation.

4. Results and Discussion

4.1. Summary Analysis and Correlation

The study utilized the summary analysis and correlation among variables and outcomes are presented in Table 1. The correlation analysis among variables demonstrates that all variables including ecological footprint, globalization, energy usage, trade, GDP growth, and fuel importation are correlated with one another.

Table 1. Summary analysis and correlation analysis outcomes.

	LnECFO	LnGLIN	LnENCO	LnTRA	LnGDPG	LnFUIM
Mean	−0.295	3.569	6.009	3.474	1.490	3.105
Median	−0.261	3.586	6.076	3.493	1.577	3.083
Maximum	−0.092	3.857	6.259	3.651	2.324	3.599
Minimum	−0.493	3.266	5.701	3.231	0.014	2.625
Std. Dev.	0.120	0.162	0.172	0.107	0.480	0.275
Kewness	−0.236	−0.475	−0.504	−0.566	−0.984	0.068
Kurtosis	1.767	2.216	1.936	2.587	3.995	1.871
Jarque-Bera	3.196	2.779	3.935	2.660	8.919	2.372
Probability	0.202	0.249	0.140	0.264	0.012	0.306
LnECFO	1.000					
LnGLIN	0.536	1.000				
LnENCO	0.642	0.231	1.000			
LnTRA	0.014	0.189	0.015	1.000		
LnGDPG	−0.411	−0.318	−0.316	−0.217	1.000	
LnFUIM	0.358	0.215	0.408	−0.053	−0.116	1.000

4.2. Stationarity Validation among Variables

This study describes the relation between ecological footprints, globalization, energy usage, trade, GDP growth, and fuel importation in Pakistan. The study used two unit-root approaches, among them ADF [57] and P-P [58] testing, to demonstrate immobility in variables; however, the best procedure for the usage of unit roots for sequences is better tests and strong forecasting characteristics. The unit root test results were used in order to define the affiliation of parameter stimuli at I[0] (stationary at level) or I[1] (stationary at first difference), but not in I[2]. The drawback of the asymmetric process is that the outcome is null and void. Table 2 provides the findings of the unit root tests.

Table 2. Unit root tests.

UNIT ROOT TEST TABLE (P-P)							
At Level							
		LnECFO	**LnENCO**	**LnFUIM**	**LnGDPG**	**LnGLIN**	**LnTRA**
With Constant	*t*-Statistic	−1.1872	−1.0627	−2.8011	−4.3817	−1.6350	−2.4257
	Prob.	0.6715	0.7218	0.0665	0.0011	0.4564	0.1409
		n0	n0	*	***	n0	n0
At First Difference							
		d(ECFO)	**d(ENCO)**	**d(FUIM)**	**d(GDPG)**	**d(GLIN)**	**d(TRA)**
With Constant	*t*-Statistic	−8.1498	−6.1206	−7.5136	−16.6717	−8.0208	−6.4676
	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		***	***	***	***	***	***
UNIT ROOT TEST TABLE (ADF)							
At Level							
		LnECFO	**LnENCO**	**LnFUIM**	**LnGDPG**	**LnGLIN**	**LnTRA**
With Constant	*t*-Statistic	−1.1872	−1.0649	−2.8011	−4.3686	−1.6350	−2.2305
	Prob.	0.6715	0.7210	0.0665	0.0012	0.4564	0.1989
		n0	n0	*	***	n0	n0
At First Difference							
		d(ECFO)	**d(ENCO)**	**d(FUIM)**	**d(GDPG)**	**d(GLIN)**	**d(TRA)**
With Constant	*t*-Statistic	−8.1563	−6.1206	−7.3842	−9.9533	−8.0457	−6.4429
	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		***	***	***	***	***	***

Notes: (*) significant at the 10%; (***) significant at the 1%, and (no) not significant; * MacKinnon (1996) one-sided *p*-values.

4.3. Bounds Testing for the Validation of Cointegration

The linear bound testing is used to validate the cointegration and can be found in Table 3. The F-test value is (4.735148) meaning that the normal significance is at 1%, 2.5%, 5%, and 10% with I(0) statistics (2.26), (2.62), (2.96), and (2.41), and at I(1) shows (3.35), (3.79), (4.18), and (4.68) individually, and the cumulative assumption of the high parameter and the lower boundary is obtained. In bounds testing, the linear technique is used to validate communion and long-term associations of modules and balance measures are assumed.

Table 3. Bounds testing for the validation of cointegration.

Test Statistic	**Value**	**k**
F-statistic	4.735148	5
Critical Value Bounds		
Significance	**I0 Bound**	**I1 Bound**
10%	2.26	3.35
5%	2.62	3.79
2.5%	2.96	4.18
1%	3.41	4.68

4.4. Cointegration Techniques

This analysis also utilized the cointegration technique of Johansen and results are displayed in Table 4. The connection between the variables in this study is defined as vital after checking the effective solutions within the test parameters. The main persistence of this study is the implementation of introductive real-time methods to verify the connection between the correlation analyses. In this way, test scenario parameters may be offered that estimate whether the statistical importance is higher than the values up and down. The consistency of this portion can be determined by intervention in the cointegration procedure of Johansen [59].

Table 4. Outcomes of Johansen cointegration technique.

		Trace Statistics Test Values		
H-No. of CE(s)	**E-Value**	**T-S**	**At (0.05) C-Value**	**Prob. ****
None	0.588	90.317	95.754	0.112
At most 1	0.438	53.029	69.819	0.504
At most 2	0.309	28.856	47.856	0.775
At most 3	0.175	13.351	29.797	0.875
At most 4	0.117	5.281	15.495	0.778
At most 5	0.002	0.076	3.841	0.783
		M-Eigenvalue Statistics		
H-No. of CE(s)	**E-Value**	**Max-Eigen Statistic**	**At (0.05) C-Value**	**Prob. ****
None	0.588	37.289	40.078	0.100
At most 1	0.438	24.173	33.877	0.443
At most 2	0.309	15.504	27.584	0.707
At most 3	0.175	8.070	21.132	0.899
At most 4	0.117	5.205	14.265	0.716
At most 5	0.002	0.076	3.841	0.783

* signifies at 0.05 level hypothesis rejection; ** shows the probability values of MacKinnon–Haug–Michelis (1999).

4.5. Evidence from Short- and Long-Run Estimations

The linear ARDL (autoregressive distributed lag) assessments via long- and short-run estimations are expressed in Table 5. The short-run estimation reveals that the variables energy usage, GDP growth globalization, and trade have productive linkages with ecological footprint with coefficients (0.653), (0.274), (0.336), and (0.139) having probability values (0.087), (0.000), (0.000), and (0.012), while the variables fuel importation exposed an adversative linkage to ecological footprint with coefficients (-0.063) and p-value (0.018), consistently.

Moving toward the outcomes of the long-run which reveal that globalization, energy usage, trade, and GDP growth have constructive linkages to ecological footprint, having coefficients of (0.449), (0.577), (0.907), and (0.525), and having probability values of (0.001), (0.000), (0.000), and (0.034). Furthermore, the fuel importation variable demonstrates an adversative linkage to ecological footprint, having coefficients of (-0.180) and a p-value of (0.005). Energy is an irreplaceable aspect of manufacturing and plays a dynamic part in economic progress. The most widely consumed supply of power and a significant industrial force in manufacturing is traditional energy. Countries aim to foster economic prosperity and international trade activity in order to reap comparative benefits. The growth in industry, increasing resource use, and environmental destruction also increased economic development. Resource deployment and waste production are the key factors leading to global greenhouse gas, carbon, and ecological footprints in a region. Excessive use of fossil fuels and other human activities have led to global warming and environmental imbalances that threaten environmental sustainability. According to the concept of interpenetrative equity, environmental preservation is a legal and spiritual obligation to future generations. To begin, stringent sustainability measures must be implemented in order to fulfil the criteria, rather than just calculating carbon dioxide emissions, since overall deterioration is only a tiny part of total degradation [60–62]. Deterioration of the atmosphere as a result of greenhouse gases is the greatest problem impacting variations in global sustainability. In terms of greenhouse gas pollution, carbon dioxide emissions are also used as a descriptor for environmental risk analysis because they are the greatest proportion of greenhouse gases and statistics are readily accessible. However, carbon emissions are not necessarily an accurate indication of environmental deterioration. Carbon dioxide emissions may be a poor predictor in some circumstances, such as the storage of oil, land, mining, and forest resources. In order to address the erosion problem and promote long-term development, we also require a reliable indication. In this respect, the ecological footprint method is commonly used to quantify depletion of the ecosystem and constitutes environmental protection. The ecological footprint reflects environmental anthropogenic strain and contrasts the biosphere's potential for restoration and consumer use [63–65].

Table 5. Consequences of short- and long-run estimates.

Estimated Consequences of Short-Run Error Correction Regression				
Variables	**Coefficients**	**S-E**	**T-S**	***p*-Values**
D(ENCO)	0.653	0.373	1.750	0.057
D(ENCO(−1))	0.585	0.270	2.162	0.036
D(FUIM)	−0.063	0.026	−2.458	0.018
D(GDPG)	0.274	0.014	19.218	0.000
D(GLIN)	0.336	0.065	5.167	0.000
D(TRA)	0.139	0.053	2.621	0.012
CointEq(−1)	−0.434	0.146	−2.981	0.005
Long-Run Estimation				
Variables	**Coefficients**	**S-E**	**T-S**	***p*-Values**
LnGLIN	0.449	0.125	3.603	0.001
LnENCO	0.577	0.128	4.525	0.000
LnTRA	0.907	0.107	8.505	0.000
LnGDPG	0.525	0.240	2.184	0.034
LnFUIM	−0.180	0.061	−2.974	0.005
C	−3.687	0.630	−5.856	0.000
R-squared	0.935	Mean dependent var		−0.29154
Adjusted R-squared	0.924	S.D. dependent var		0.11852
S.E. of regression	0.033	Akaike info criterion		−3.85885
Sum squared resid	0.038	Schwarz criterion		−3.57214
Log likelihood	89.965	Hannan–Quinn criter.		−3.75312
F-statistic	86.313	Durbin–Watson stat		2.263147
Prob(F-statistic)	0.000			

The ecological footprint is a special environmental sustainability indicator that is responsible for other natural areas essential for promoting economic development. These natural environments provide water reservoirs, woodland reserves, arable land, and the ecologically friendly air that can be achieved. Their abundance and sustainability could rely on the eutrophication capacity, acidification of the earth, as well as ecotoxicity of the atmosphere and ecosystems [66–68]. In recent decades, depletion of the atmosphere has become a significant concern for academics and decision makers worldwide. This increasing challenge involves an unprecedented rate of greenhouse gas emissions, which have a strong effect on the environment, climate change, ecology, air quality, and environmental assets. In addition to human activities, this problem not only increases society's reliance on natural resources, but it also exacerbates environmental resource scarcity on the planet. As a result, the ecological footprint gathers together the different services that are required to keep the people alive [69–71].

All aspects of economic and non-economic activities in the globalized world economy are heavily reliant on energy inputs in one way or another, and thus, energy security and sustainability are its responsibilities, as is a major portion of greenhouse gas emissions (GHG). In contrast, the total usage of natural gas for electricity, driven mostly by oil and renewables, has increased the extreme energy demand. Depending on the market, energy demand and availability continue to grow. With regard to the above-mentioned evidence, the significant rise in the demand for energy would eventually contribute to a significant increase in greenhouse gas emissions. If stricter environmental policies are not implemented, greenhouse gas emissions will more than triple in the coming decades [12,72]. Emerging countries are also concerned with sustainable development models and the intentions of emerging economies with the rise in emissions of carbon. Nature-rich countries can reduce environmental pollution by curbing use of fossil fuels and reducing imports. On the other side, the use of natural resources can be slowed down by implementing environmental management methods and by continual improvement in the development and use of excess natural energy; as some resources can now be regenerated and replaced. One of the major sources of environmental destruction is human actions, including deforestation, logging, and cultivation [73–75]. The plots of CUSUM and its squares are illustrated in Figure 2 with a 5% significance level.

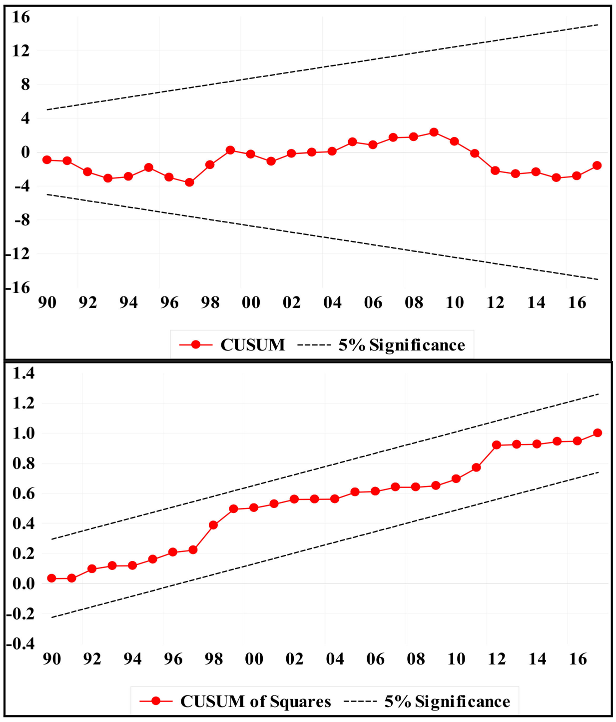

Figure 2. Graphical representation of CUSUM and its squares.

4.6. Consequences of Limited Information Maximum Likelihood and K-Class

Table 6 shows the outcomes of the limited information maximum likelihood and K-class.

Our findings show that globalization, energy usage, trade, and fuel importations have positive coefficients of (0.492), (0.802), (0.591), and (0.936) that demonstrate a constructive association to ecological footprint for the case of Pakistan with probability values of (0.000), (0.000), (0.000), and (0.031), while GDP growth exposes an adversative linkage with coefficients (−0.391) having a probability value of (0.004), correspondingly. The values of R2 and Adj-R2 and DW are (0.905), (0.917), and (1.738), respectively.

The consequences show that globalization and energy usage have positive linkages to the ecological footprint in Pakistan with coefficients of (0.229) and (0.122). The posterior, lower, and upper values at 95% are (0.314), (0.231), (−0.397), (−0.337), (0.849), and (0.575). Similarly, the variables trade, GDP growth, and fuel importation have a negative relation to ecological footprint with coefficients of (−0.468), (−0.089), and (−0.023), and have posterior, lower, and upper values at 95% (0.179), (0.053), (0.108), (−0.831), (−0.194), (−0.234), (−0.111), (0.015), and (0.195), reliably. Figure 3 depicts the plots of the posterior draws via linear Gaussian estimates.

Table 6. Outcomes of limited information maximum likelihood and K-class.

Variables	Coefficients	S-E	T-S	*p*-Values
LnGLIN	0.492	0.096	5.125	0.000
LnENCO	0.802	0.062	12.935	0.000
LnTRA	0.591	0.060	9.850	0.000
LnGDPG	−0.391	0.130	−3.008	0.004
LnFUIM	0.936	0.421	2.223	0.031
C	−7.175	0.458	−15.666	0.000
R2	0.905	M-dependent var		−0.270
Adj-R2	0.917	S.D.D var		0.107
S.E. of regression	0.031	S-Squared-resid		0.032
D-Watson statistics	1.738	LIML min. eigenvalue		0.000

4.7. Linear Gaussian Model Estimation

The findings of the linear Gaussian model estimation are presented in Table 7.

Table 7. Outcomes of linear Gaussian model estimation.

Linear Gaussian Model Estimated by MCMC				
Variable	**Posterior Mean**	**Posterior SD**	**95% Lower**	**95% Upper**
LnGLIN	0.229	0.314	−0.397	0.849
LnENCO	0.122	0.231	−0.337	0.575
LnTRA	−0.468	0.179	−0.831	−0.111
LnGDPG	−0.089	0.053	−0.194	0.015
LnFUIM	−0.023	0.108	−0.234	0.195
Sigma Squared	0.026	0.006	0.016	0.040

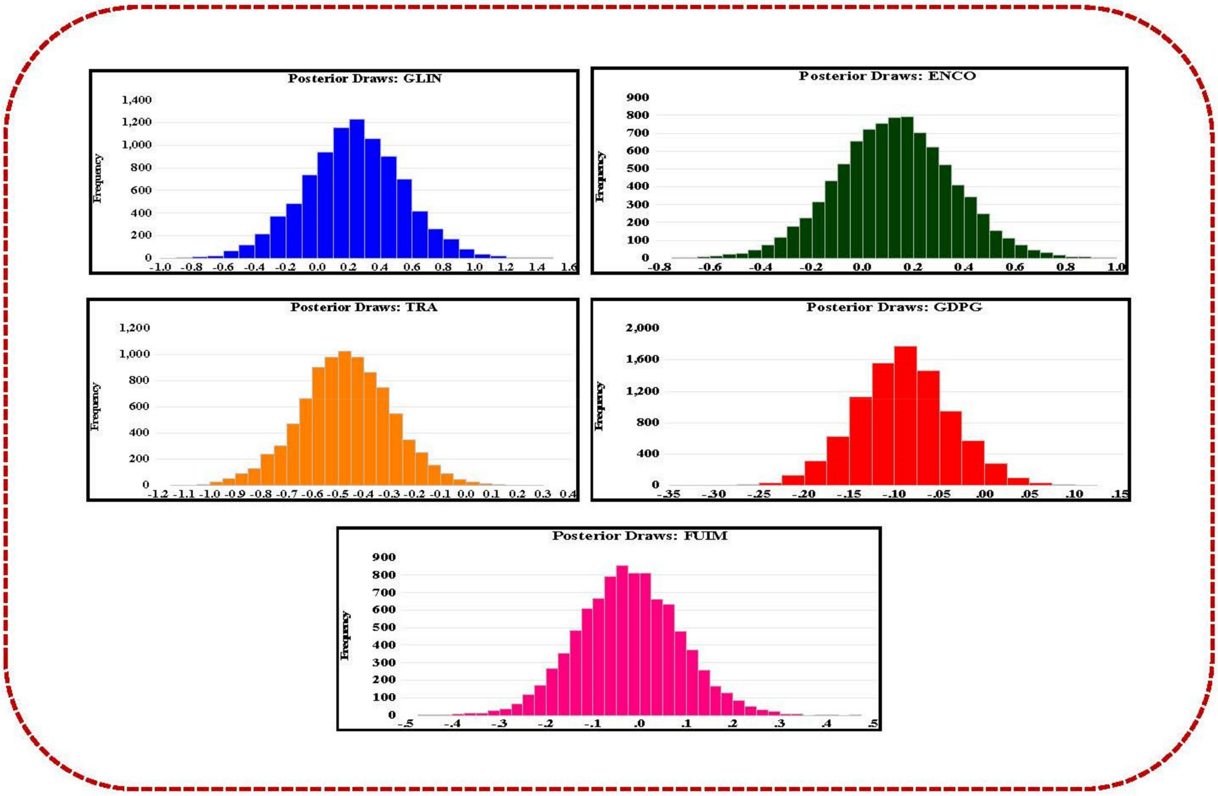

Figure 3. Plots of the posterior draws via linear Gaussian estimates.

5. Concluding Remarks and Policy Implications

High-level policies (European Green Deal and the United Nations Sustainable Development Goals) aim to decouple the economic growth from extensive resource use and environmental degradation and suggest the efficient use of resources as a solution. Scientific debates on these issues were initially launched in the 19th century and there is still no consensus. Recent studies find no clear proof of a significant decoupling between growth and environmental degradation at a global scale [76–78].

While some EU countries achieved a decrease in some types of environmental degradation between 1995–2015, the decoupling between growth and environmental footprints is very relative and varies among economies [79]. Such developments are determined by many factors such as structural economic change of non-EU countries and the financialization of EU ones [80]. A total and significant decrease in the environmental pressures and impacts would require some dramatic transformations of economic systems and of society as a whole, rather than some relative efficiency achievements.

In time, the entire world has realized the need to adapt the new policies regarding climatic changes, and started to accepted an environmentally friendly behaviour [81]. Sustainability, green innovation, and investment in no-waste and green initiatives have been proven to promote sustainable economic growth and wealth [82] and represent the most efficient way to elevate a country [83]. The relationship between pollution, globalization, and economic growth has been investigated by many researchers because of global warming that causes increasingly negative socioeconomic effects [84].

The main aim of the current analysis was to expand existing knowledge by bringing together and investigating, in the same model, the impact of globalization, energy consumption, trade, economic growth, and fuel importation on the ecological footprint in Pakistan. The study used annual data from 1974–2017 and its stationarity was rectified by using two-unit root tests. A linear ARDL technique with limited information maximum likelihood and linear Gaussian model estimation were exploited to check the relationships between the variables. Th outcome shows that in the long-run, globalization, energy usage, trade, and GDP growth have a productive interaction with the ecological footprint, while fuel importation reveals the adversative linkage to the ecological footprint in Pakistan. Likewise, the findings of the short-run scenario also display that globalization, energy usage, trade, and GDP growth have a constructive linkage, but fuel importation uncovers an opposing linkage to ecological footprint. The results of limited information maximum likelihood also revealed that the variables globalization, energy usage, trade, and fuel importation have a productive linkage, while GDP growth uncovers an adversative linkage to ecological footprint. Moreover, the results of linear Gaussian model estimation also revealed that globalization and energy usage have a constructive linkage, while other variables including trade, GDP growth, and fuel importation demonstrated an adversative linkage to the ecological footprint in Pakistan.

Based on this study's analytical findings, it is proposed that policymakers and officials continue to enhance their interventions aimed at promoting successful trade strategies, economic development, fuel use, and, in particular, reducing carbon emissions. This would limit the extent of harm to ecosystems, maximise economic productivity, and maintain sustainable environments. In Pakistan, globalization, politics, environment, and legislation have had a severe effect. Pakistan has faced both the beneficial and detrimental impacts of globalization, as have many other developed countries. The community and lifestyle of each municipality is its own. Pakistan has a diverse and interesting culture and has maintained historical practises. Economic globalization also offers emerging countries the possibility to increase their export markets and draw foreign investments and thereby achieve growth. Another positive impact of globalization, which is beneficial for customers who obtain goods at progressively lower costs, is represented by the higher competition between firms. Free exchange between industrialized and developing countries is more advantageous, since they can purchase products at lower rates and therefore provide a better living standard. Trade openness should also be seen as a various action of poverty reduction.

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