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Environmental Kuznets Curve Approach to Estimate Ecological Footprint in Pakistan

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ABSTRACT

The aim of the study is to explore the various variables that lead to Pakistan's environmental deterioration. The impact of macroeconomic factors of environmental deterioration is investigated to fulfill the objective of the study. The impact of determinants on environmental degradation from 1990 to 2020 was explored in this study. The dependent variable is Ecological Footprint, which is used as a proxy for environmental deterioration, whereas the independent variables are Trade openness, Urbanization, foreign direct investment, and per capita income growth. However, square of per capita also included in a model to verify the phenomena of Kuznets curve. The variable's stationarity was checked and used the unit root test (ADF and PP), which indicated that it exists at the first difference. According to the result of stationary ARDL cointegration model is applied. The result of the test showed the long run relation among the variable. The coefficient of GDP is positive and squared GDP is negative, this means that if there is a consistent rise in GDP, then the negative effect of squared GDP will overcome the positive effect of level GDP. Beyond this point increase in GDP will reduce the ecological footprint. This phenomenon was discussed earlier as the environmental Kuznets curve.

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1. Introduction

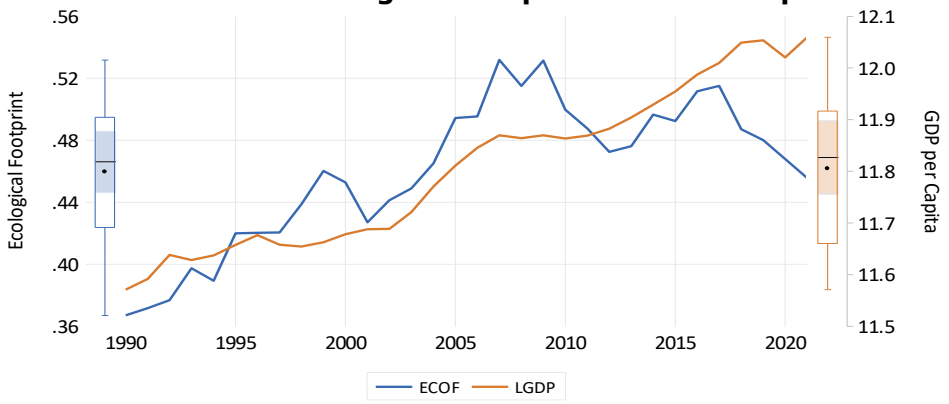
Due to its negative effects on the global climate, environmental degradation (ED) has become the most concerning issue for both developed and developing economies since the 1970s. The increasing levels of carbon emissions have drawn the attention of academics, environmentalists, and policymakers at national and international levels, driving them to seek solutions to various environmental challenges. Consequently, researchers have been actively investigating environmental protection and publishing their findings to identify the causes of environmental degradation and carbon emission. As a result, researchers began investigating the causes of carbon emissions in order to provide definitive solutions to protect the environment. According to one research group, the main cause of ED is increased economic activity and traditional energy consumption, which lead to a rise in CO_2 levels in the atmosphere. They suggest that factors such as ecological footprint, technology in businesses, trade openness, urbanization, and GDPpc growth, among others, could significantly contribute to reducing carbon emission. However, the current study challenges these findings. It contends that while an increase in the aforementioned factors may indeed help reduce carbon emissions, it does not necessarily guarantee an improvement in environmental quality.

According to the current study, reducing carbon emissions alone does not guarantee a sustainable environment because carbon emissions do not encompass all relevant indicators of

environmental deterioration. They primarily reflect the environmental pollution caused by various industrial activities or large-scale energy consumption. However, aside from greenhouse gas (GHG) emissions or carbon emissions, numerous other factors can contribute to the degradation of environmental quality, such as the demand or extraction of natural resources, ecological stress, human activities and orthographies, water scarcity, waste, and more). As a result, (Wackernagel & Rees, 2014) introduced ecological footprints as a comprehensive tool for measuring deterioration in environmental quality, which has gained importance among researchers during the second decade of the twentieth century. As a result, the current study utilizes the ecological footprint as a substitute for measuring the environment's impact. It is important to note that the environment includes the air, forests, land surface, mountains and other natural resources. All living things, including humans, rely on the quality of their surroundings to survive. When the environment's condition continues to deteriorate, life suffers.

Environmental depreciation and economic growth are inextricably linked, and numerous studies have investigated these connections (Figure 1). The notion of the Environmental Kuznets Curve (EKC) materializes during these endeavors. This concept has been evaluated by many researchers for individual economies or cluster of economies. Some studies have also investigated the environmental impact of demographic issues, economic growth, public health awareness, and industrial development. However, very few researcher have considered all of these variables simultaneously (ur Rehman & Zeb, 2020). During the 1990's, the idea of the EKC (Environmental Kuznets Curve) has been extensively established to explain the link between the growth of economies and environmental depreciation. According to the EKC phenomenon, the growth of an economy has an upturned U-shaped connection with environmental depreciation. In the early phases of economic enlargement, environmental pollution is substantial. However, after reaching a particular point, the growth of an economy may lead to the recovery of environmental damages, especially among high- income economies. While many studies support the phenomenon of the EKC, confirming the upturned U-shaped relationship between the expansion of an economy and environmental depreciation, some studies oppose this process (Demissew Beyene & Kotosz, 2020).

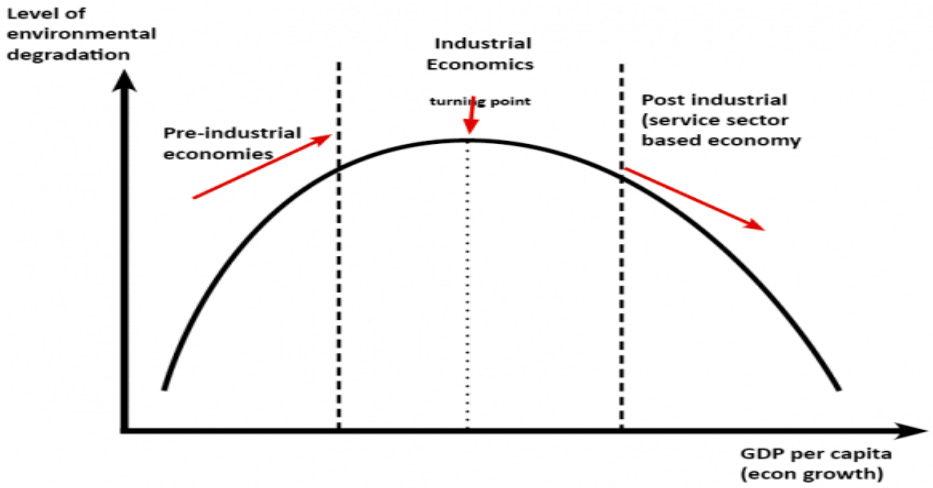
Figure 1: Historical Patterns of Ecological Footprints and Per Capita Income



Theoretically, an expansion in the growth of an economy will lead to the depreciation of environmental progress as the income of an economy reaches a certain level. After attaining that phase, economic growth will not continue to damage the atmospheric conditions, because people become more proactive in recovering their connection with the environment, leading to a reduction in the levels of environmental dilapidation.

This research aims to explore the primary factors that influence environmental degradation. Numerous studies have been conducted with this goal in mind. However, this study stands out by incorporating many critical variables into a single model to investigate their impact both individually and collectively. By utilizing longitudinal data from 1990 to 2020, the prime aim of this study is to scrutinize both short and long-run connections between per capita income growth, trade openness, foreign direct investment, urbanization, and environmental footprint. The environmental footprint (EF) variable will be calculated using global hectares per person. The ARDL method will be employed to inspect the short and long run links among macroeconomic factors and environmental deterioration.

Figure 2: Environmental dilapidation and Per capita Income



The Environmental Kuznets Curve (EKC) phenomenon assumes that environmental deterioration increseses until a certain income level is reached, after which it decreases (Figure 2). Furthermore, many academics believe that economic growth resulting from international trade may impact environmental quality. Indeed, the scale, composition, and technical consequences of trade can all affect environmental degradation (Kinda, 2013). Due to the massive environmental degradation in the world, a vast economic literature has been established to investigate the root causes of environmental deprivation (Isik, Ongan, & Özdemir, 2019). Bio-capacity and ecological footprints can be compared as they measure statistics of water areas and productive biological land, such as forests, farmland, and fishing grounds (Borucke et al., 2013; Kitzes & Wackernagel, 2009). However, several variables are used in the estimated model when evaluating the rationality of the EKC phenomenon. As quantified previously, the EKC process elucidates that economic expansion can improve the quality of the environment due to an increase in the employment of renewable energy sources, which aid in resolving this phenomenon (Dogru et al., 2020).

In addition, several economies exploit their natural capitals to achieve high levels of economic expansion in a competitive atmosphere at the cost of environmental quality. Other environmental indicators, such as ecological footprint and greenhouse emissions, have received increased attention in the context of the growth-energy-environment link in recent years. While carbon dioxide (CO_2) has been the most widely used proxy/proxies in recent years to test the EKC process, the prime question is whether we need suitable substitutions that encompass the entire environment. To make better decisions, it is now necessary to thoroughly cover the environment using a variety of dissimilar environmental variables (i.e., greenhouse gases & ecological footprint). In order to make better verdicts for guidelines of environment, researchers should work for true circumstances of environment among several economies. Many studies increasingly use alternative proxies (rather than CO_2 emissions) to quantify environmental degradation. As a result, the ecological footprint is the most comprehensive substitution for calculating environmental impact. Using the ecological footprint, some academics have recently investigated the EKC theory for environmental deterioration (Saleem & Shujah-ur-Rahman, 2019). The Resource Curse Hypothesis (RCH) investigates the effects of natural resource endowment on development, while the Environmental Kuznets Curve (EKC) investigates the effects of economic growth and development on the quality of the environment (Costantini & Monni, 2008).

It also depicts the ecological impairment caused by human energy demand, land expansion, nutrition, forests, and the sea etc. As a consequence, because it discloses a nation's or region's imprint on the atmosphere in terms of air, soil, and water, the ecological footprint can be a more accurate measure of environmental deprivation (Ozturk, Al-Mulali, & Saboori, 2016). A clean natural environment is regarded as a necessary component for enlightening the eminence of human life in contemporary societies. Natural resource management is a priority for the government and regulatory agencies to preserve the ecosystem. Natural capitals such as minerals and fossil fuels play a prime role in economic expansion by generating commodities and services. However, the burning of fossil fuels upsurge the emanation of CO_2 in the air, and this

gas will discharge several kind of radiation which contributes in the phenomenon of greenhouse effect. Over the past few decades, the emission of CO_2 has been considered the primary source of climate risk and environmental depreciation (Dabachi et al., 2020).

The prime aim of present study is to empirically explore the role of macroeconomic determinants of environmental degradation using a variety of variables (GDPpc growth, Foreign direct investment, Trade Openness, and Urbanization) from 1990 to 2020 using time series data for Pakistan. The study's specific objectives are as follows: To evaluate the short and long run possessions of macroeconomic factors on environmental deprivation in Pakistan. In order to suggests some policy recommendations. The research question is as follows, based on the problems of the study topic: What empirical relationship exists between macroeconomic determinants and environmental degradation?

When environmentalists, academics, and policymakers answer the question "how to achieve environmental sustainability?" using carbon emissions as a substitution for ED, the present study enters the field with an appropriate measurement of EFP, intending to scrutinize the role of macroeconomic determinants on the environment. According to the current study, reducing carbon emissions is a necessary but insufficient solution to promote environmental sustainability. However, after reviewing the existing environmental literature, the current study aims to address the following gaps and shortcomings in the current environmental debate. This study discovered that while a number of researchers have investigated the influence of foreign direct investment, per capita income growth, trade oppeness, and urbanization on the environment, most of them interprets their findings in terms of CO_2 emissions; only a few readings have been available on the connection among these variables that use EFP as a proxy for the environment. Thus, current study bridges the gap of existing literature in several ways. As previously stated, CO_2 is not an appropriate measure of the environment; rather, it is an indicator of environmental pollution. Thus, the current study re-examines the connection among FDI, GDP per capita income growth, TO, URB, and ED by employing a more appropriate proxy of ED [i.e., Ecological Footprint] so that the impact of the chosen variable on Environmental depreciation becomes clearer in the context of Pakistan.

Environmental degradation is a prime and urgent issue on the global agenda. The existing study contributes to the available literature by evaluating the utilization of the ecological footprint as a substitute for measuring environmental depreciation. However, the ecological footprint is not the only significant feature that contributes to environmental deprivation. Researchers should consider other indicators as well to understand the environmental conditions fully. Controlling environmental degradation and determining the processes that cause it are major challenges for researchers and policymakers at present. Moreover, rapid increase in temperature is also gaining importance among policy makers. Pakistan touches the grade of top five economies which are most vulnerable to the climatic fluctuations despite of the fact that Pakistan is not emanating the huge amount of CO_2 in the air.

This study is segregated into five sections. Section 1 is an introduction to the research project. Section 2 debates the significant contributions of well-known economists in the fields of macroeconomic determinants and environmental deterioration. Section 3 converses the empirical examination and methodology. Section 4 is about obtaining outcomes and debating the techniques used to test the data, which is about model estimation and interpretation. Section 5 summarizes the study's useful conclusion and the researcher's policy implications.

2. Review of Literature

The World Development Report (1992) and Grossman and Krueger (1995) gives a world of new agenda of discussion regarding environment. Keeping in view these lessons, upsurge in economic expansion generates pollution in atmosphere which depreciates the environmental eminence. On the other side of coin, escalation in per capita income makes individuals more cautious about the condition of their health and quality of life which entails the intellectual of human being towards good environment and this phenomenon will ensure the individuals the follow the guidelines of environment. These guidelines will make our production techniques more greener and environment friendly. The EKC process elucidates the connection which follows inverted U-designed. Moreover, (Ahmed & Long, 2013; Apergis & Payne, 2009; Bölük & Mert, 2015; Lean & Smyth, 2010; Saboori, Sulaiman, & Mohd, 2012) authorize the upturned U-designed among these two indicators. On contrary to the overhead debates Panayotou (2016)

elucidates that environmental depreciation will lead to increase in per capita income because of waste accretion, source mistreatment and surge in pollution. These indicators certainly minimize the planet's preoccupation volume which consequently reduces the welfare of human being. Environmental degradation which is instigated by intensifying the echelons of pollution and other greenhouse gases is one of the prime matters at local and world-wide levels. Keeping in view the risk of human life upsurge in temperature will depreciate environmental eminence which unswervingly impacts the climate change.

Keeping in view the study of Malaysia, Saboori et al. (2012) utilize the phenomenon of EKC to clarify the connection between economic expansion, energy demand and emanation of CO_2 from 1980-2009 by incorporating the data of energy demand at aggregate and disaggregate level. The empirical outcomes confirm the bidirectional causality among economic expansion and emanation of CO_2 by utilizing ARDL (Autoregressive distributed lag) model and granger causality test. The above outcomes implicates that emanation of CO_2 can be minimized by tumbling the demand of electricity, coal, oil and gas. Similarly, Ozturk et al. (2016) evaluate the number of activities which results the environmental depreciation in North African and Middle Eastern economies. However, they study implicates the model of panel data which incorporates ecological foot prints as substitution of environmental depreciation for 14 MENA economies from 1996-2012. The co-integration test was discovered that the ecological footprint, urbanization, industrial development, trade openness, energy consumption, and political stability were all cointegrated. According to the Fully Modified Ordinary Least Square (FMOLS) model, energy demand, openness of trade, urbanization, and industrial development all contribute to increased environmental damage. Moreover, the indicators have causal association with EF for both long and short run.

Furthermore, the determinants of ecological footprints have been burning issues for several policy makers. However, several significant indicators have been meagerly debated in the existing literature. He evaluate the connection among per capita income, urbanization, renewable energy and EF from 1992-2016 for BRICS economies. The study integrates panel data estimators dynamic ordinary least square (DOLS) and fully modified ordinary least square (FMOLS). The estimated outcomes approves that renewable energy, natural capital minimize the ecological footprints which implicates the direct influence on environmental eminence. Moreover, it utilizes several emissions of gasses such as carbon, methane and nitrous oxide to evaluate the EKC phenomenon among BRICS economies from 1991-2014. The study also includes wide-ranging indicator of environment such as ecological footprints as well. The estimated outcomes elucidate that human capital and per capita incomes adds environmental depreciation by utilizing panel cointegration. The study also instigates some important policy implications for sustainable climatic conditions.

Moreover, (Bulut, 2021) evaluates the phenomenon of EKC in case of Turkey from 1970-2016 by utilizing ecological footprints as substitution of environmental depreciation. The study integrates per capita income and its square, renewable energy demand, FDI (foreign direct investment) and industrial development. It was observed that how globalization and technological innovation exaggerated CO_2 emanations in South Korea. Economic expansion, EC (Energy demand), REC (Renewable Energy demand), GLO (Globalization), and TI were all used as endogenous variables (Technological Innovation). CO_2 was the exogenous variable (emission per capita). The data of renewable and energy demand was utilized from 1980-2018. The ARDL bounds test method was utilized to assess long run co-integration. According to the ARDL, energy demand, economic growth, globalization all added to environmental deprivation, while technological innovation upgraded environmental eminence. Furthermore, the study evaluates the connection among human capital and emanation of CO_2 in case of China. However, new index has been generated which computes the number of patents applicants as human capital index. The emanation of CO_2, concentration of energy, population density was utilized. The study comprises of 30 provincial data from 2003-2017. The estimated outcome elucidates that EKC phenomenon exist among several provinces of china for the case of human capital by using system generalized method of moments. The empirical conclusions also approves that human capital plays a prime role in minimizing the emanation of CO_2 among the provinces of China.

In conclusion, the research gap in the existing literature regarding the EKC phenomenon and its implications for environmental sustainability calls for broader and more in-depth studies that encompass a global perspective, consider the effectiveness of green energy policies, explore

the role of technological innovation, incorporate human capital index, and examine various environmental indicators. Addressing these research gaps can contribute significantly to the development of effective and targeted policies to achieve sustainable economic progress while mitigating environmental degradation.

3. Specification of Model and Methodology

This section observes the theory elucidating the connection among environmental deprivation and its determinants. The EKC phenomenon for the environment connects environmental deterioration and economic growth or any indicator of economic expansion. According to this theory, economic development initially causes environmental degradation because countries are fulfilling their necessities and developing the infrastructure, which is prioritized over posterity or sustainability, but after reaches a certain phase of economic expansion is achieved where the basic necessities of the society are fulfilled, then the people collaboration with the environment progresses and stages of environmental deprivation accompanying with hominoid economic events decay. This section further discusses the data source from which data is gathered and estimation approaches that can be used to investigate the relationship between ecological footprint, economic activity and other independent variables. The literature reviewed for this study shows that macroeconomic factors significantly impact environmental deterioration in Pakistan. Most of these studies are empirical and based on them this study has quantified the influence of foreign direct investment, openness of trade, per capita income growth, and urbanization on environmental deterioration in Pakistan. This study aims to inspect the empirical affiliation between the ecological footprint and designated indicators. As a result, we used a model to construct our relationship between ef (ecological footprints), gdp (per capita income), to (openness of trade), urb (urbanization) and fdi (foreign direct investment).

$$ef = f(gdp, gdp^2, to, fdi, urb) \quad (1)$$

$$ef = \beta_0 + \beta_1 gdp + \beta_2 to + \beta_3 fdi + \beta_4 urb + \beta_5 gdp^2 + e_t \quad (2)$$

The variables used in the equation are described in Table 1. Here EF is the dependent variable, while the others are independent variables. The variable gdp is used in a quadratic transformation to estimate the environmental Kuznets curve. The annual time series data for the period of 1990 to 2021 is used in this analysis, focusing on Pakistan as the selected country. The data is sourced from WDI (Pakistan World Development Indicator), QIM and EF. The model estimation follows a three-step process. First, the nature of the data is assessed using ADF and PP unit root tests. If any of the variables are non-stationary, the estimation requires the variables to be cointegrated with each other in the second step. Finally, the ARDL model is used to estimate the coefficients of the long run and short run.

Table 1: Description of Variables

Variable(s)	Proxy	Proxy's description	Data Source
Environmental degradation (ef)	Ecological Footprints	Global hectares (GHA) per person	GCFN (Global Carbon footprints network)
Gross Domestic Product per capita growth (gdp)	Per capita growth proxy for economic growth	Per capita GDP	WDI
Foreign Direct Investment (fdi)	Foreign Direct Investment	% of GDP	WDI
Trade Openness (to)	Exports and Imports	(% of GDP)	WDI
Urbanization (urb)	Proportion of population living in the urban area	% of total population	WDI

4. Results and Interpretation

Table 2 delivers the descriptive statistics of the variables used in the model. Here we can see that for all variables, the mean value is higher than the standard deviation, which shows that the data is under dispersed for the selected time periods. Further Jarque Bera test shows that only fdi is not normally distributed while other variables are normal. This study uses the central limit theorem to assume that the data is normally distributed asymptotically. However, Table 3

provides the linear association among the variables. Here we can see that gdp, fdi and urb are positively associated with ef while to is negatively associated with ef.

Table 2: Descriptive Statistics

Statistics	ef	fdi	gdp	to	urb
Mean	0.4596	1.053	11.805	3.453	3.526
Std. Dev.	0.046	0.813	0.152	0.129	0.058
Skewness	-0.438	2.140	0.189	-0.299	-0.130
Kurtosis	2.278	6.645	1.704	1.954	1.916
Jarque-Bera	1.718	42.142	2.427	1.935	1.657
Probability	0.42	0.00	0.29	0.37	0.436
Observations	32	32	32	32	32

Table 3: Linear Association Matrix

Correlation Matrix	ef	fdi	gdp	to	urb
ef	1.00				
fdi	0.420 (0.01)	1.00			
gdp	0.764 (0.00)	0.058 (0.74)	1.00		
to	-0.445 (0.01)	0.317 (0.07)	-0.540 (0.00)	1.00	
urb	0.793 (0.00)	0.002 (0.98)	0.974 (0.00)	-0.619 (0.00)	1.00

Figure 3 matches the occurrence of ecological footprint with per capita income for the case of Pakistan. Here it can be seen that the link among these two variables are not linear, rather it is slightly bending downward. This shows that there is a hint of an environmental Kuznets curve between ef and gdp.

Figure 3: Scatter plot of ecological footprints and per capita income

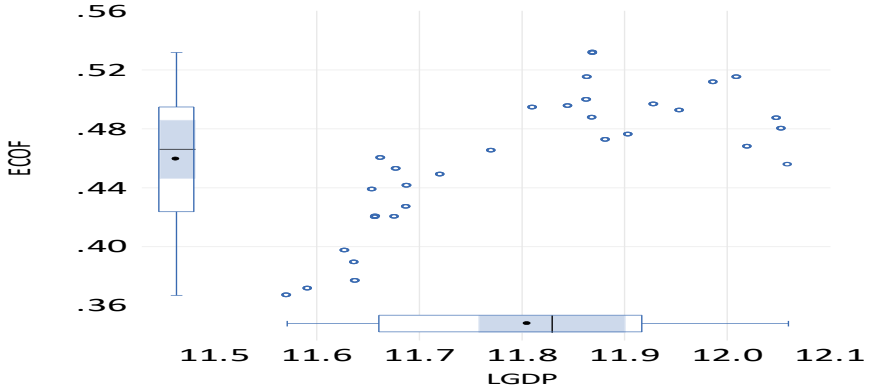


Table 4: Time Series Unit Root Tests

	T-Statistics (prob.) with null hypothesis of series having unit root				**Stationarity**
Test Spec.	Level with Intercept		1st Difference with Intercept		
Variables	ADF	PP	ADF	PP	
ef	-2.101 (0.24)	-2.101 (0.24)	-5.404(0.00)	-5.405 (0.00)	I(1)
fdi	-2.947 (0.05)	-1.806 (0.37)	-3.614(0.01)	-3.475 (0.01)	I(1)
gdp	-0.026 (0.94)	-0.098 (0.94)	-4.162(0.00)	-4.168 (0.00)	I(1)
to	-1.951 (0.30)	-1.951 (0.30)	-5.705(0.00)	-5.704 (0.00)	I(1)
urb	0.782 (0.99)	-0.789 (0.80)	-1.868(0.34)	1.089 (0.70)	I(0)

The Augmented Dickey Fuller (ADF) and Philips Perron test are utilized to determine the order of integration of the variables. As can be seen, all of the variables in Table 4 are non-stationary at the level and stationary at first difference. As a result, the integration order for all underlying variables is *I(1).*

Table 5 provides the cointegration test which is estimated using Bounds F test within ARDL model. Here we can see that the F test value of 8.22 is higher than the upper bound *I(1)* critical

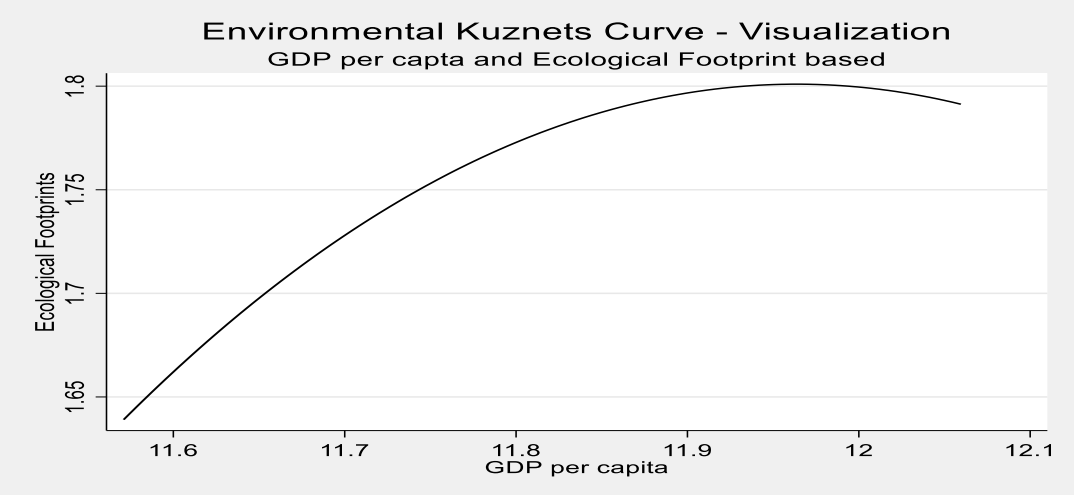
values, this shows that the selected variables are cointegrated in the long run. Hence we proceed towards the estimation of long run and short run estimates using ARDL model. Using the sample of 30 observations after adjusting for lags, the R squared is 0.82, which shows that the selected variables are able to explain 82% variations in the ecological footprint. Further, in the short run the coefficient of ect (-1) is negative and significant. It shows that if 1% shock is provided to the model via the independent variable, then the dependent variable adjusts accordingly to 0.84% in each time period. This means that policymakers can use these estimates to intervene for achieving a lower ecological footprint. Further Table 6 and Figure 5 and 6 provide the post regression diagnostics. Here it is confirmed that the model is normally distributed, estimates are efficient, and they are not disturbed by the structural changes in the data.

Table 5: ARDL model of Cointegration

Long Run Estimates		**Short Run Estimates**	
Variable	**Coefficient (Prob.)**	**Variable**	**Coefficient (Prob.)**
gdp	25.139 (0.00)	Δef	-0.196 (0.04)
gdp^2	-1.051 (0.00)	Δgdp	9.069 (0.06)
fdi	0.019 (0.00)	Δgdp^2	-0.373 (0.07)
to	-0.112 (0.02)	$\Delta gdp^2(-1)$	0.010 (0.01)
urb	-0.269 (0.53)	Δfdi	0.002 (0.56)
		Δurb	-37.576 (0.00)
		$\Delta urb(-1)$	40.122 (0.00)
c	-148.579 (0.008)	ect_{t-1}	-0.848 (0.00)
Regression Statistics			
F Statistic	8.2259	K	5
Sample size	30	R squared	0.82
	Sig.	I(0)	I(1)
	10%	2.08	3
	5%	2.39	3.38
	2.5%	2.7	3.73
	1%	3.06	4.15

Now we are going to discuss the long run estimates from table 5. Here the coefficient of GDP is positive and squared GDP is negative, this shows that if there is a 1% increase in GDP it will increase ecological footprint by 25.139% on average but with each 1% increase in GDP there will be a 1.051% decrease in the marginal impact of GDP on ecological footprint. Hence this means that if there is a consistent rise in GDP, then the negative effect of squared GDP will overcome the positive effect of level GDP. Beyond this point increase in GDP will reduce the ecological footprint. This phenomenon was discussed earlier as the environmental Kuznets curve. Earlier studies like (Ahmed *et al.*, 2013; Apergis *et al.*, 2009; Bölük *et al.*, 2015) have also confirmed this estimate.

Figure 4: Environmental Kuznets Curve



Based on the estimates, Figure 4 visualizes the quadratic effect of GDP on ecological footprints, here it is evident that with the increase in GDP, we can eventually reduce the ecological footprint. Further increase 1% of FDI increases the ecological footprint by 0.019% on average. The reason behind this might be the pollution haven hypothesis; where by the dirty foreign industries is setting foot in Pakistan to exploit the weak institutions. Similar outcomes are suggested by Saboori et al. (2012).

Table 6: Post Regression Diagnostics

	Test (Prob)	Decision
Jaque Bera Normality Test	0.596 (0.74)	Normal distributed residuals
Heteroskedasticity Test	0.458 (0.91)	Homoskedastic residuals

Figure 5: CUSUM curve

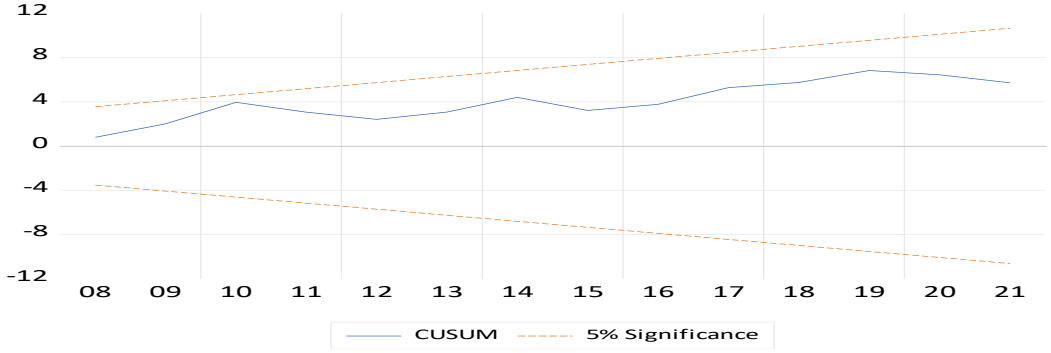
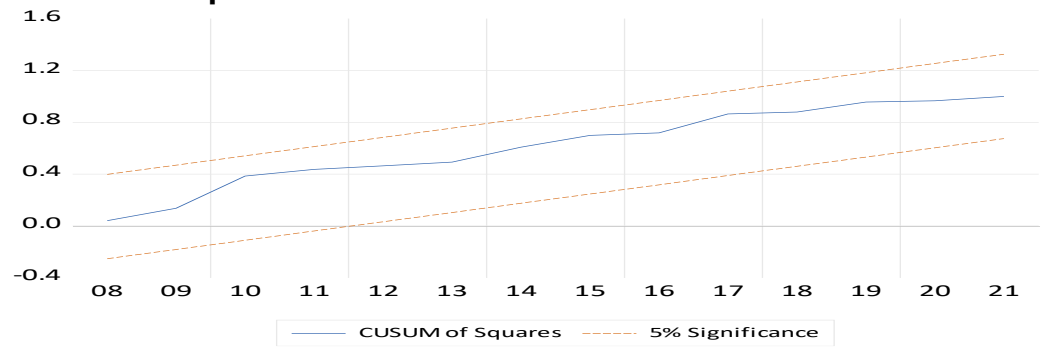


Figure 6: CUSUM of Square Curve



Further increase in 1% of trade openness leads to an average decrease in the ecological footprint by 0.11%. Lastly a 1% increase in urbanization leads to a decrease in the ecological footprint by 0.269% on average.

4.1. Discussion

In this section, we provide a detailed explanation of the results obtained and their practical implications. It is important to note that we use the Environmental Kuznets Curve (EKC) as an indicator of environmental degradation. The analysis yields valuable insights into the relationship between economic growth and environmental sustainability, specifically concerning the ecological footprint. The discussion is based on the key findings and their implications in the context of urbanization, foreign direct investment, economic growth, and trade openness. Based on these findings, we derive practical implications that can guide policymakers in promoting sustainable development and addressing environmental concerns. The study revealed a significant positive association between economic growth (GDP per capita) and the ecological footprint in Pakistan. This aligns with the expected positive impact of economic development on resource consumption and environmental degradation. However, the EKC analysis unveiled and inverted U-shaped relationship between economic growth and ecological footprint, confirming the existences of the Environmental Kuznets Curve for Pakistan. For instance, Ahmed and Long (2013) found evidence of the EKC relationship in Pakistan, indicating that as GDP per capita increases, the ecological footprint rises, but after a certain income level, it starts to decline Apergis and Payne (2009) and Bölük and Mert (2015) have also confirmed this estimate in their respective studies.

Furthermore, the study highlighted a negative correlation between urbanization and the ecological footprint. This suggests that urbanization, which often accompanies economic growth and industrialization, can have a beneficial impact on the environment. Similar results have been reported in previous studies. For instance, it was found that urbanization in chinma had a negative impact on the ecological footprint, indicationg that well- planned urban development can contribute to environmental sustainability. The positive association between FDI and the ecological footprint suggests that foreign direct investment may contribute to increased environmental pressures in Pakistan. Saboori et al. (2012) found evidence supporting the pollution haven hypothesis, indicating that FDI in developing countries could lead to increased ecological footprints due to weaker environmental regulations. However, the study revealed a negative correlation between trade openness (exports+import) and the ecological footprint. This indicates that increased international trade might lead to a reduction in the country's ecological footprint. Lin et al. (2021) found that trade openness in china had a negative impact on the ecological footprint, suggesting that engaging in international trade could help promote environmentally friendly practices.

5. Conclusion

The main aim of this study is to scrutinize how determinants affect environmental deprivation in the short and long run. To accomplish this, the long run effects of macroeconomic dynamics on the environment have been combined with ARDL techniques. The environment is a major issue on the global stage. It gained significance as the average global temperature began to rise at a faster rate. Every year, the world gathers in Davos to discuss potential solutions to global warming and deteriorating environmental conditions. The critical position of environmental issues poses a potential threat to both the economy and people's lives. Numerous indicators have highlighted that the current level of economic growth is unsustainable, leading to significant environmental problems such as climate change, air pollution, water contamination, and biodiversity loss. To address these environmental challenges, governments are actively seeking ways to achieve sustainable economic progress. Pakistan does not have the highest CO_2 emanations in the world, but it is the most exposed to global warming and climate transformation.

This study looks at four major causes of environmental degradation. The four factors are gdp growth, foreign direct investment, trade openness, and urbanization, the study collected the data from WDI, over the period of 1990 to 2020. Study incorporates the square of per capita income to investigate the validity of EKC hypothesis. The study incorporates ARDL model to investigate the long-run and short run relationship between the discussed variables. The bounds test confirm the presence of long-run association among the discussed variables. The estimated findings reveal that per cpita income exhibits negative and significant association with ecological footprints while square of per capita income shows positive association with dependent variable. However, rest of the variables shows negative and significant association with ecological footprints except foreign direct investment. All of these factors have a significant impact on the environment, causing environmental damage. The study disproves the notion that economic growth is bad for the environment.

The analysis of the Environmental Kuznets curve approach to estimate the ecological footprint in Pakistan revealed valuable insights into the relationship between economic growth and environmental sustainability. The presence of an inverted U-shaped curve implies their potential for achieving economic growth while simultaneously reducing the ecological footprint beyond a certain point. Policymakers can use this information to design and implement strategies that promote sustainable development, prioritize green investment, and foster responsible trade practices. By adopting these policy recommendations, Pakistan can move towards a more sustainable and environmentally conscious future. However, it is essential to continuously monitor the impact of policies and adapt them as necessary to achieve lasting environmental improvements. The following policy recommendations can be proposed to promote environmental sustainability:

The study offers a valuable policy framework for promoting sustainable development in Pakistan. Policymakers can utilize the positive association between FDI and the ecological footprint to attract green investment. Government should focus on green economic growth without compromising the quality of environment. Moreover, state needs to control urbanization by providing more facilities to the people in their parent districts. Population advancement should

be limited. There are numerous ways in which you can contribute to the reduction of environmental degradation. Conserve water; avoid littering and throwing trash in inappropriate places, and so on. Energy conservation is critical. Join an awareness-raising organization. Discuss the consequences of environmental degradation with others and become an advocate for the preservation of our planet!

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