



Visiting Human Capital-Foreign Direct Investment-Environment Association for Attaining Environmental Sustainability: Fresh Insight from Pakistan

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ABSTRACT

The current study explores the association of human capital, foreign direct investment, economic growth and population with the environment in Pakistan. Our study adopted the time series econometric estimation methodology autoregressive distributed lag model (ARDL) over 1980-2019. Interestingly our study results show that increase in human capital will clean the environment in both the short and long run. The study also validates the pollution haven hypothesis by proving the positive link of foreign direct investment with the ecological footprint. The findings also corroborate the existence of the long-run linkage of economic growth with the environment. The study suggests that policymakers and government officials should develop and promote the education sector that eventually mitigates environmental degradation.

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1. Introduction

Nowadays, the worldwide agenda is to balance the environment that ensures the endorsement of the Paris Agreement (Li and Ullah, 2021). A sustainable environment depends on macroeconomic factors in an economy which contributes environment in different ways. To achieve the macroeconomic goals economies tries to catch high growth while using tremendous use of fossil fuel to fulfill the desired targets with continuous increase in population. The literature in the past few decades have proved the association among economic growth and the environment. Grossman and Krueger (1991)

introduced the concept of the correlation between growth and environment which is entitled environmental Kuznets curve (EKC). The empirics still found different results in different economies. Some proved in favour of the environmental Kuznets curve (EKC) while others do not support in their empirical findings. However, some prove the above mentioned curve with different inflexion points.

Apart from the relationship of economic growth with the environment, researchers and policymakers also tested the other macroeconomic factors like energy consumption, financial development, financial inclusion, ICT and technology, tourism, trade balance, natural resources, urbanization and globalization that are also responsible for environmental degradation and commonly used in different empirical studies in different regions (Rauf et al., 2020; Tahir et al., 2021; Chaudhry et al., 2021; N'dri et al., 2021; Ahmad et al., 2021; Bahtebay et al., 2021; Farooq et al., 2020; Tanveer et al., 2021; Chaudhry et al., 2021). Nowadays many studies focused on the association of human capital with the environment. Although previous literature has been proved that human capital uplifts the economic growth of any economy. So, many channels have been proved in the literature that human capital improves productivity, decreases the crime rate, and catches economic growth. Human capital is negatively linked with the environment as human capital trains the professional through enriching of knowledge through the use of latest equipment and technologies in production that will clean the environment as well. Human activities are a source and one of the responsible factors of environmental change and educated people are very helpful in the mitigation of environmental degradation (UNESCO, 2010). Education is the main source to understand complex and unfamiliar environmental problems. High educated people understand recycling activities and move toward renewable energy consumption as compared to people that have a low level of education.

In Pakistan the ratio of greenhouse gases (GHG) is increasing continuously and contributed in economy in different proportions (CO₂ (54%); CH₄ (36%); N₂O (9%); CO (0.75%) and F-gases about 0.3%). There are many key roots for the environmental degradation in Pakistan like high level fossil fuel consumption, deforestation, and many human activities. The fossil energy consumption due to transportation and manufacturing sectors plays a backbone role in degrading environmental sustainability in Pakistan. The study underwrites to the literature as mentioned: Firstly, this study will contribute to the literature by analyzing the impact of human capital on environment degradation which is rarely have been used in the case of Pakistan. Secondly, our study tries to investigate or conduct an empirical test Pollution Halo/Haven hypothesis (PHH) in Pakistan. Our study takes proxy for the environment will be the ecological footprint (gha per person) which is supposed to be a dynamic indicator.

The portion of this study is structured as mentioned: "Literature review" segment outlines the previous literature about human capital and the environment. "Data and Methodology" section labels data source and empirical method. Next section presents findings and discussions. In last section study discusses the conclusion.

2. Literature Review

The linkage of macroeconomic indicator with the environmental concerns has been proved in the previous literature. Different variables showed different associations with the environment in different regions. However, the connection of human capital with the environment is explored limited. The study of Yao et al. (2020) evaluated the correspondence of human capital with the environment during 1870-2014. The study concluded an adverse association between human capital and the environment in 20 OECD countries. Similarly, Li and Ullah (2021) scrutinized the association of human capital with the environment in BRICS. They employed a nonlinear panel autoregressive distributed

model over 1990-2019. The study increased human capital to reduce the CO₂ emission. In the same way, Ahmed and Wang (2019) explored the linkage of human capital with an ecological footprint for India under period 1971-2014 and revealed a negative association ecological footprint and human capital. The study conducted on Pakistan which is Bano et al. (2018) discloses the adverse impression of human capital on CO₂ emission. Apart from this, some studies found a positive association of human capital with environmental degradation. Such as, the study of Ganda (2021) scrutinizes the linkage of human capital with CO₂ emission in BRICS and concluded a positive association.

Alshery and Belloumi (2015) described the connection between energy consumption, CO₂ emission and economic growth for Saudi Arabia over the period 1975 to 2010. The study used the Johnson multivariate co-integration technique. The results set up a long-run relationship of energy consumption and economic growth with carbon dioxide emission. Bekun et al. (2019) investigated the interaction of economic growth with energy consumption in the African economy. The study used Buyer and Hanck co-integration method and found the long-run association exists in energy consumption and economic growth. Chang (2010) examined the correlation between economic growth, energy consumption and carbon dioxide emission. The study findings showed that carbon dioxide emission and energy consumption are linked with economic growth. Mohmmad et al. (2019) described the liaison between CO₂ emission, economic growth, and health in the ten emitting economies over the period 1991 to 2014. Results found that CO₂ emissions have a significant impact. Hassan et al. (2018) result showed that natural resources have a positively association on economic growth and as well as environmental Kuznets curve (EKC). Kiviyiro and Arminen (2014) employ the ARDL technique to describe the casual correlation among economic growth, foreign direct investment, energy consumption, and carbon dioxide emission in Sub-Saharan African economies.

Similarly, Fei et al. (2011) scrutinized the connection between energy consumption, economic growth, and carbon dioxide emission in China economy over the time period from 1957 to 2007. Results found the positive impact of real GDP per capita and energy consumption. Baz et al. (2020) investigated the interrelation between economic growth, energy consumption and the environment in Pakistan by applying the non-linear ARDL model during the period from 1971 to 2014. Their result showed that environmental quality and energy consumption has a positive asymmetric impact and as well as they found a neutral symmetric impact on economic growth, energy consumption, and capital. Munir et al. (2020) revealed the alliance of energy consumption, CO₂ emission and economic development in ASEAN 5 countries over the time span from 1980 to 2016. This study used Granger non-causality techniques and results showed that in Malaysia unidirectional Granger causality between Gross domestic product and CO₂ emission found in Malaysia, Thailand, Philippines and Singapore have unidirectional Granger causality between gross domestic production and energy consumption. Bidirectional causality was found in Singapore between gross domestic product and energy consumption.

3. Data and Econometric Strategy

The previous empirical studies employed various econometrics techniques to estimate the effect of several macroeconomic variables on the environment. Our study employed the autoregressive distributive lag (ARDL) method which is preferable over other traditional techniques due to various reasons. Firstly, the ARDL estimation method is appropriate in case of a small sample size. Secondly, it is more appropriate against mixed order of integration. Thirdly, the specialty of ARDL is that gives long and short-run outcomes at a time. (ECT) term in ARDL shows the surety of long-run equilibrium adjustment.

Before applying ARDL it is necessary to check the unit root test and make sure variables are in a mixed order of integration, many are on a level I(0) and some are on the first difference I(1). For the presence of co-integration amongst the variables, F bound test is more suitable in ARDL modelling that shows if the F-value higher than I(1) means co-integration exists. If the value is below lower bound I(0) that show no co-integration exists while the calculated value lies between upper I(1) and lower bound I(0) concludes indeterminate. After applying the ARDL estimation method to justify diagnostic checks like Jarque Bera for normality test, LM test for inspecting serial correlation test, Breusch Pagan test for investigating heteroscedasticity test and Ramsey Reset test for finding stability test.

The study model is based on one dependent variable which is ecological footprint and four independent variables like human capital, population, gross domestic product and foreign direct investment, respectively. The data is retrieved from world development indicators (WDI). To tackle issues, variables are used in logarithmic form.

The model specification extends the previous literature by taking the following combination of variables:

$$EFP = f(HC, FDI, GDP, POP) \tag{1}$$

$$EFP_t = \beta_0 + \beta_1 HC_t + \beta_2 FDI_t + \beta_3 GDP_t + \beta_4 POP_t + \mu_t \tag{2}$$

Concerning the ecological footprint $\beta_1, \beta_2, \beta_3, \beta_4$ are coefficients of elasticities of regressors HC, FDI, GDP) and POP, respectively. The study formulated ARDL modelling to test the short and long-run association.

$$\begin{aligned} \Delta EFP_t = & \gamma_0 + \sum_{i=1}^l \gamma_{1i} \Delta EFP_{t-i} + \sum_{i=0}^p \gamma_{2i} \Delta FDI_{t-i} + \sum_{i=0}^q \gamma_{3i} \Delta GDP_{t-i} + \sum_{i=0}^r \gamma_{4i} POP_{t-i} + \\ & + \delta_1 EFP_{t-1} + \delta_2 HC_{t-1} + \delta_3 FDI_{t-1} + \delta_4 GDP_{t-1} + \delta_5 POP_{t-1} + \mu_t \end{aligned} \tag{3}$$

The following equation shows the unrestricted error correction model (ECM):

$$\begin{aligned} \Delta EFP_t = & \gamma_0 + \sum_{i=1}^l \gamma_1 \Delta EFP_{t-i} + \sum_{i=0}^p \gamma_2 \Delta HC_{t-i} + \sum_{i=0}^q \gamma_3 \Delta FDI_{t-i} + \sum_{i=0}^r \gamma_4 \Delta GDP_{t-i} + \sum_{i=0}^s \gamma_5 \Delta POP_{t-i} \\ & + \lambda ECT - 1 + vt_t \end{aligned} \tag{4}$$

In the above equation, the adjustment parameter denotes by λ and ECT denotes the surety of long-run adjustment.

4. Results and Discussions:

4.1 Descriptive Statistics

The following table shows the descriptive statistics that comprise mean, maximum, median, minimum, standard deviation, and Kurtosis and Jarque-Bera values. The values of FDI and POP are positively skewed while EFP, HC and GDP are negatively skewed.

	EFP	HC	FDI	GDP	POP
Median	18.5518	0.4715	20.3984	1.5825	0.9248
Mean	18.5088	0.4596	20.4379	1.4525	0.9305
Minimum	17.9170	0.2803	18.4764	-0.0446	0.7299
Maximum	18.9523	0.5876	22.4442	2.0823	1.1888
Skewness	-0.4652	-0.2235	0.0734	-1.1648	0.1281
Std. Dev.	0.2949	0.1194	1.1098	0.4735	0.1494
Kurtosis	2.0626	1.3751	2.0635	4.3777	1.6057
Jarque-Bera	2.3988	3.9049	1.2355	10.0730	2.7632
Probability	2.3988	0.1419	0.5391	0.0064	0.2511
Sum	610.7915	15.1677	674.4513	47.9336	30.7085
Sum Sq. Dev.	2.7829	0.4566	39.4178	7.1773	0.7148

4.2 Stationarity Test Results:

For stationarity the employ the Augmented Dickey-Fuller test (ADF), and Phillips-Peron test (PP). The outcomes of tests show the variables are mixed order of integration.

Variables	Level		First difference	
	ADF	PP	ADF	PP
EFP	-4.726***	-4.7563***	-0.9857	-0.9865
HC	-1.9151	-1.9384	-3.8194**	-3.8427***
FDI	-1.3646	-1.4625	-4.046***	-4.0465***
GDP	-2.8864**	-3.5854**	-6.8435***	-11.1655***
POP	-0.1920	-0.8985	-5.4072***	-5.4336***

Note: *, **, and *** for 10%, 5% and 1 %, respectively.

4.3 F-Bounds Test Results:

Then after is the F-bound test provides co-integration values and the finding shows long-run co-integration as the calculated value is greater than the upper bound.

	F-Statistic	k	Range	Critical Values	
				I (0) bound	I (1) bound
Model	4.440	4	10%	2.45	3.52
			5%	2.86	4.01
			2.5%	3.25	4.49
			1%	3.74	5.06

4.4 Long Run and Short Run Estimations:

The long and short-run consequences indicate human capital is linked with the ecological footprint negatively. The findings are in line with Yao et al. (2020) in 20 OECD countries and Li and Ullah (2021) in BRICS revealed the adversarial upshot of human capital on the CO_2 . The conclusion describes that human capital is connected with the environment strongly and its effect is dynamic in different time periods. An upsurge in human capital will improve the quality of life of people through education that impacted all indicators including this. The long-run and short-run results for foreign

direct investment are positive and significant for ecological footprint. This effect or result validates the theory of pollution haven hypothesis (PHH) that shows the amplify in foreign direct investment leads to degrading the environment. This hypothesis is already proved empirically in different regions. For example, the study of Chaudhry et al. (2021) validates the pollution haven hypothesis in BRICS countries.

In our study GDP is significant with a positive sign with an ecological footprint that suggests that improvement in economic growth will harm the environmental sustainability. Pakistan is on the list of developing nations and also trying to tackle the adverse sound effects of economic growth on the environment. But still, the country needs to improve their policies regarding the environment and focus on environment-friendly growth. The variable population is significantly affected environment with a positive sign in the long run estimates. This proposes that a tremendous increase in population in developing countries including Pakistan is a threat to environmental sustainability. Through different channels, it is already proved that population is one of the threat for environmental degradation that degrades the environment. The ECT indications towards the surety of the adjustment of the equilibrium in long run and it is negative and highly significant that

Results of Long-Run Estimation	
Variables	Coefficient [Prob]
HC	-1.088** [0.034]
FDI	0.101***[0.001]
GDP	0.039** [0.009]
POP	2.0499*** [0.0022]
C	18.7*** [0.0000]
Results of Short-Run Estimation	
D(HC)	1.9084* [0.054]
D(HC(-1))	-0.112[0.934]
D(HC(-2))	1.514[0.169]
D(FDI)	0.047*** [0.003]
D(FDI(-1))	-0.011[0.479]
D(FDI(-2))	-0.016 [0.227]
D(GDP)	0.039**[0.011]
D(POP)	5.641** [0.041]
D(POP(-1))	0.655[0.919]
D(POP(-2))	3.559[0.202]
ECT	-1.001*** [0.000]
Daignostic Checks	
R ²	0.996
Adj R ²	0.991
LM Test	1.137[0.367]
Normality Test	1.077 [0.583]
Hetero Test	0.631 [0.791]
Ramsey reset test	0.344 [0.572]

The values in [] denote probability value and *, ** and ***Shows 10%, 5% and 1% significance level, correspondingly.

To test the reliability and validity of the results it is compulsory to pass some diagnostic tests. The value of the coefficient of determination (R^2) shows how much variation is explained variable due to all explanatory variables that show the goodness of the fit of the model. Our model results are good fitted model results. Test, The results of all stability and residual test like normality, serial correlation LM test, the Breusch-Godfrey test for heteroscedasticity and the Ramsey RESET test shows the model is stable and free from these econometric issues. The study also reported the cumulative sum (CUSUM) and cumulative sum of square (CUSUMQ) graphs and the results validates the stability of the model (See fig.1 and fig.2).

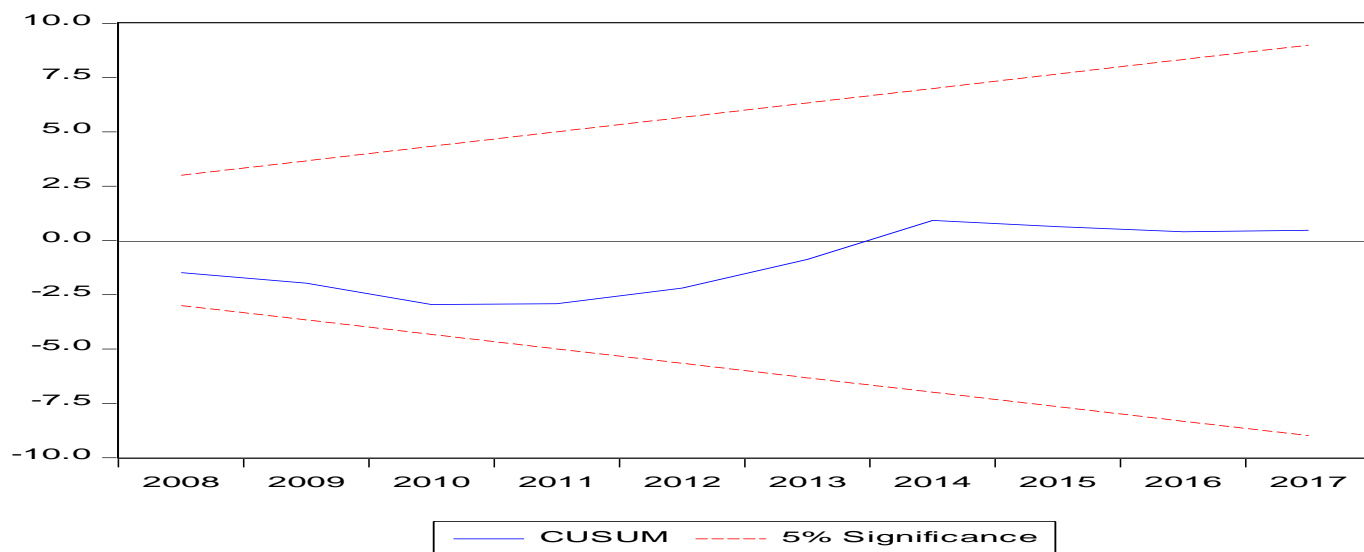


Fig.1: (CUSUM)

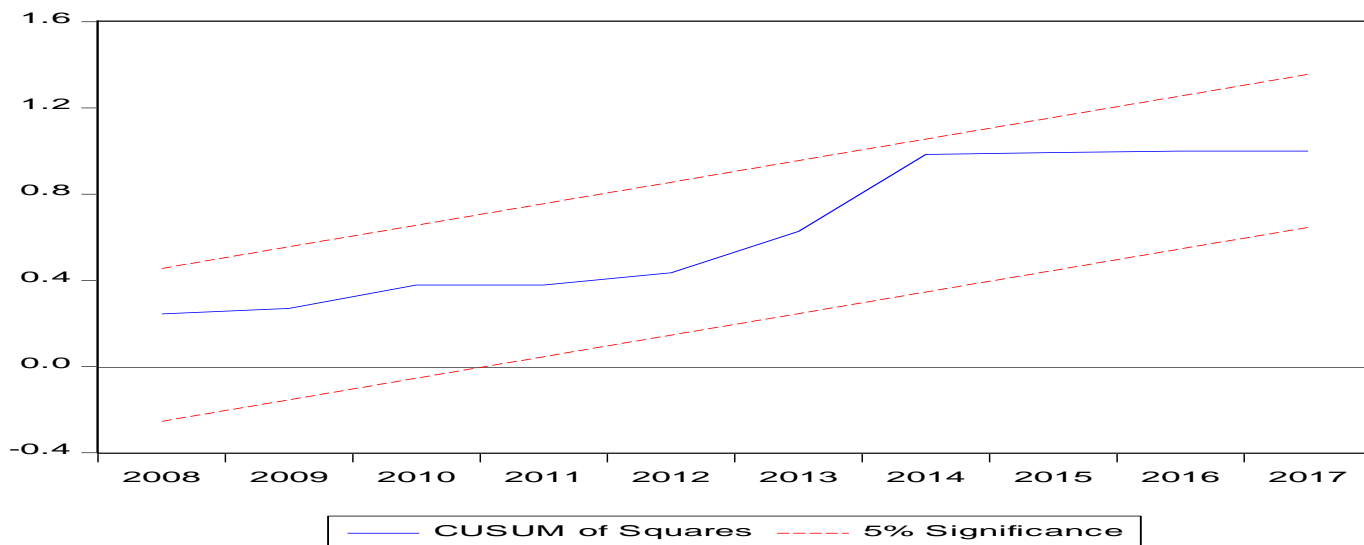


Fig2: (CUSUMQ)

5. Concluding Remarks

Our study explored the association of human capital, foreign direct investment, economic growth and population with the environment in Pakistan. The study adopted the time series econometric estimation methodology autoregressive distributed lag model (ARDL) over 1980-2019. Interestingly our study results show that an amplify in human capital will clean the environment. The study also validates the pollution haven hypothesis by proving the positive link of foreign direct investment with the ecological footprint. Pakistan is on the list of developing countries and mostly foreign direct investment in

Pakistan is increasing economic growth but meanwhile putting pressure on the environment eventually degrade the environment. The study results also corroborate the existence of the long-run linkage of economic growth with the ecological footprint. This result proves the environment is very sensitive to economic growth and eventually high growth move the economy towards worsening the environment. The study suggests that policymakers and government officials should develop and promote the education sector that eventually mitigates environmental degradation.

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