# Investigating The Impact Of Globalization And Energy Consumption On Environment In Developing Countries: Does Environmental Sustainability Exist?

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# ABSTRACT

The purpose of the study is to explore the impacts of globalization and energy consumption on environmental quality in emerging nations. The main goal is to compare the impact of economic, political, social, and overall Globalization and energy use, on environmental quality. Sixty-nine underdeveloped nations were chosen for comparison based on World Bank categorization. The System-GMM was used to get the empirical results in this study, which used a panel dataset from 1996 to 2018. To additional validate the empirical evidence, different interaction terms between globalization and energy consumption are regressed on environmental quality, such as the interaction terms of globalization, economic, social, and political with energy consumption. Globalization has a positive and statistically significant influence on emissions of CO2 in developing nations, according to the results of S-GMM estimators. The Pollution Haven Hypothesis proposes the link between globalization and CO2 emissions. The widespread use of nonrenewable energy, notably coal, fossil fuels, and oil power plants, is associated with a positive and statistically significant increase in carbon emissions.

# Introduction

Despite the incredible gains in economic development over the previous four decades, after the late 1970s reform and opening, criticisms and doubts about sustainability have lately surfaced. Environmental degradation is becoming the greatest impediment to long-term growth. World economies are experiencing considerable growth, but this achievement has not been accompanied by improvements in environmental quality (Xia et al., 2021). Natural gas, coal, and fossil fuels account for 75% of primary energy use (BP, 2019). The use of fossil resources for energy production raises GHG emissions, It contributes to environmental issues like climate change and global warming (Dudley, 2018). Despite several international accords aimed at mitigating the effects of climate change, including the Montreal Protocol in 1985, the Kyoto Protocol in 1997, the Millennium Development Goals in 2000, and the Sustainable Development Goals in 2015, carbon dioxide emissions continue to rise. Carbon dioxide emissions in 1965 were 11193.92 million tonnes, but this has climbed to 33890.85 million tonnes in 2018, putting a significant strain on the ecosystem (UN, 2019). The prior time's rise in carbon emissions, the greatest ever since 2013, was due to high global productivity (IEA, 2018). Due to this, the United Nations Framework Convention on Climate Change (UNFCC) has constantly recommended better adherence to the Paris Agreement, primarily among the state actors working in conjunction with other stakeholders. Although France, UK, Mexico, Germany, and Japan have claimed considerable reductions in CO2, USA, China, and India have added to an 85.7 percent rise in carbon emissions (IEA, 2019). In many developing nations, poor protection of the environment is unavoidable. Such pollutants can sicken and shorten the lives of people. Pollution's health consequences may lead to poorer output and greater healthcare expenses. Even though the too much cost of pollutants, Low rates of investment are made in environmental protection by emerging nations.

Globalization describes as the removal of barriers on or the cross-border flow of capital, products, people, and technology (Rourke, 2001). Globalization is a worldwide phenomenon that influences people's lives politically, economically, and socially (Solarin et al., 2017). Millions of people have been pulled out of poverty because of globalization. However, when Globalization accelerates, it is not sure that all individuals would be better off. Globalization is the principal cause of environmental degradation because of the large transfer of consumption from advanced to emerging countries. Globalization appears to have economic, social, and political effects on people all over the world, and the world is referred to as a Globalized village, in which individuals socially know one another through a variety of communication methods (Mishkin, 2009). Due to the inflow of cash for economic growth, globalization has drawn the world's recognized and emerging nations closer together. latest Pakistani study analyzed Α that globalization is having a bad effect on environmental quality in Pakistan and that developed nations all over the world are financing in Pakistan, without focusing environmental quality (Khan et al., 2019).

Environmental Kuznets curve (EKC) hypothesis states that the relationship among economic growth and environment has been proven in economic theory. The EKC theory states that, up to a certain point, environmental degradation rose as per capita income rises. After that point, environmental deterioration starts to reduce, resulting in an inverted "U" shape (Dinda, 2004). Pollution haven theory claimed that polluting businesses migrate to low-income countries from high income countries via trade and FDI. Due to this, the EKC hypothesis, as well as the pollution haven hypothesis, are both reasonable policy alternatives for emerging countries. According to the Pollution Haven Hypothesis, corporations would attempt to escape the costs of strict environmental laws by locating manufacturing in nations with laxer environmental standards. This view is supported by research on the pollution haven hypothesis (Sun et al., 2017; Behera & Dash, 2017).

The reduction in environmental quality and increase in carbon dioxide emissions are mostly due to increased energy use. World energy consumption rise from 0.91% in 2016 to 2.11% in 2017 (IEA, 2018). Worldwide Atmospheric Research reports that global CO2 emissions were 22.62 million kilotons in 1990 and increased to 36.23 million kilotons in 2015 (Edgar, 2016). Carbon emissions have increased by 59.87% in twenty-five years, which is shocking since CO2 emissions have a substantial effect on GHG's, which eventually lead to Climate Change and Global Warming (Rahman, 2017).

Fresh study has discovered a detrimental relationship between Globalization and environmental quality (Saint et al., 2019; Ren et al., 2014; Lee & Min, 2014; Shahbaz et al., 2016). While some studies have found that Globalization has a significant beneficial effect on environmental quality (Ozcan et al., 2019; Sharif et al., 2020; He et al., 2012; Shahbaz et al., 2013). Some research has discovered a relationship between energy usage and economic disparity, as well as a favorable influence on environmental quality (Sarwar et al., 2019; Destek & Ozsoy, 2015). While some research indicated that energy usage degrades environmental (Sharif et al., 2019; Khan & Ullah, 2019; Shahbazet al., 2014; Baiet al., 2020). However, the significance of the findings is still unknown. As a result, there is a need to examine the true influence of Globalization and energy usage on environment in emerging nations. On the one hand, energy usage is one of the primary drivers of Globalization and growth, while it also degrades the environmental performing of emerging countries. As a result, there is an urgent need to investigate the many facets of Globalization, such as political, economic, and social Globalization, as well as the influence of energy consumption with environmental performance in emerging countries.

The study's structure is divided into five sections. Section one is an introduction, section two is a review of previous research, section three contains data and econometric methodology, section four is the results and comments, and last section is the study's conclusion.

# Literature Review

The scholar is investigating the relationship among Globalization, energy usage, Innovation, growth, resources, and emissions of carbon in this part. The scholar will attempt to identify these links by utilizing several macroeconomic channels found in previous empirical and theoretical study. Various empirical findings have been conducted to study the link among Globalization and macroeconomic indicators, along with other areas such as Globalization and growth. (Hassan et al., 2019; Kurniawati, 2020; Zahonogo, 2018) inflation (Lv et al., 2019;) education (Poddubnaya et al., 2020).

However, just a few papers have discovered a relationship among Globalization and environment (Yang, 2020; Aller et al., 2015; Cîrdei, 2019; Marceau, 2020). The earlier studies establishes that Globalization has a significant with environmental positive relationship deterioration, like (Farooq et al., 2020; Kalayc & Hayalolu, 2019), while other show a negative effect, such as (Zhang, et al., 2021). Xia et al. (2021) examined the association among globalization, energy use and environment by using panel data of industrialized and developing nations from 1971 to 2018. They estimated data using GMM and FE-2SLS algorithms. The study's results demonstrated that Globalization had a positive association with carbon emissions, and that GDP showed rises in CO2 emissions. Teng et al. (2021) reviewed the link among globalization and CO2 emissions. They used PMG, VECM and VAR techniques for estimation and found that Globalization has a considerable influence favorable on environmental deterioration.

Similarly, Xue et al. (2021) explored the association between natural resources. Globalization, and environment from panel data of South Asian nations. In the empirical analysis, the dynamic common correlated effect (DCCE) is applied. Greenhouse gases such as ecological footprint, nitrous oxide, and methane emissions are employed as environmental indicators. However. the research revealed that Globalization had a negative correlation with N2O but a good connection to ecological footprint. Khan et al. (2018) use time-series data from Pakistan to study the effect of Globalization and various economic variables on CO2 emissions. They examined three dimensions of Globalization using the dynamic ARDL estimating approach. Lastly, the research discovered that globalization had positive effects on CO2.

Islam et al. (2021) estimated the effect of globalization, FDI and energy usage on

environment by using time series data of Bangladesh. They employed dynamic ARDL estimation approach and determined that Globalization reduces CO2 emissions while enhancing environmental quality. Farooq et al. (2020) investigated the influence of FDI and Globalization with environmental quality of lowincome and high-income nations from 1991 to 2017. The GMM approach was used to estimate data. The research's outcomes showed a favorable correlation among globalization and carbon emissions in low-income nations. While countries with high-income indicated a negative link among globalization and carbon emissions.

In contrast, there are a number of empirical studies that have explored the connection between energy and macroeconomic along with certain other characteristics like energy use and economic growth (Chen et al., 2020; Magazzino et al., 2021; Huang & Huang, 2020) employment (Payne, 2009; Muniyoor, 2020; Tiwari, 2010) inflation (Naraghi et al., 2021;Bassey & Ekong, 2019; Talha et al., 2021) trade (Farhani et al., 2014) financial development (Magazzino, 2018; Odhiambo, 2019; Yang et al., 2020).

Using the theoretical background Environmental Kuznets Curve, Jun et al. 2021 experimentally examined the association among

Variable	Sign	Measurement	Sources
CO2	CO2	CO2 emissions, kg per 2010 GDP of US\$	WDI
Globalization	GLO	It is calculated by social political and economic dimension of Globalization.	KOF index (Dreher, 2006)
Economic Globalization	EGLO	It is measured by FDI, portfolio investment and trade flow and limitations on these inflows and outflows.	KOF index (Dreher, 2006)

# **Table: 1 Variables Description**

energy usage and environmental damage. For panel data from a few South Asian nations, the completely modified ordinary least square approach is utilized. The existence of EKC theory was demonstrated in this study in several countries. They observed that the energy usage of Asian countries had a beneficial impact on CO2 emissions. Adebayo et al. (2021) examined the connection among renewable energy consumption and environmental deterioration in South Korea. The ARDL bound testing approach is used to estimate variable long-run cointegration. They concluded that South Korean energy use was harmful to the environment. Rahman et al. (2021) examined the connection among energy use and environment, they applied Fully Modified OLS technique by using the panel data of BRICS countries. Finally, they determined that energy usage is strongly related to carbon dioxide emissions. However, the EKC hypothesis was not found in the BRICS region in this research.

# **Data and Econometric Strategy**

The effect of Globalization and energy usage on environmental performance in emerging countries is explored with panel data gathered from 1996 -2018. This research is based on secondary data.

Political Globalization	PGLO	It is measured by the international organizations, embassies numbers, number of treaties signed by other nations, and meetings of UN Security Council.	KOF index (Dreher, 2006)
Social Clobalization	SCLO	It is measured by information flows,	KOF index
Social Giobalization	SGLU	personal contact, and cultural nearness.	(Dreher, 2006)
Energy Consumption	ENE	Energy use which is kg of oil equivalent	WDI
Linergy consumption		per capita.	
GDP per capita	GDP	GDP per capita constant US dollar 2010.	WDI
Innovation	INOV	Total trademark applications.	WDI
		Natural resources rents are the sum of	WDI
Natural recourses	NR	oil rents, coal rent, natural gas rents,	
Matural resources		forest rent and, mineral rents. (% of	
		GDP)	

As the Kuznets model is applied to examine the impact of Globalization and energy use on environmental excellence in emerging nations,  $CO2 = f(GLO, ENE, GDP, GDP^2, INOV, NR)$ 

the GDP per capita square is included in the model.

(1)

Where CO2 denotes carbon dioxide emissions, GLO denotes Globalization, ENE denotes energy consumption, GDP denotes GDP per capita, INOV denotes total trademark applications, and  $CO2_{it} = \alpha_{0it} + \alpha_1 CO2_{it-1} + \alpha_2 GLO_{it} + \alpha_3 ENE_{it} + \alpha_4 GDP_{it} + \alpha_5 GDP_{it}^2 + \alpha_6 INOV_{it} + \alpha_7 NR_{it} + \alpha_6 INOV_{it} + \alpha_7 NR_{it} + \alpha_8 INOV_{it} + \alpha_8 INOV_{it$ 

lastly natural resources are denoted by NR. All variables are written in logarithmic scale. Econometric models are given below.

$$\varepsilon_{it} \tag{3}$$

$$\mathcal{CO2}_{it} = \alpha_{0it} + \alpha_1 \mathcal{CO2}_{it-1} + \alpha_2 \mathcal{E}GLO_{it} + \alpha_3 \mathcal{E}N\mathcal{E}_{it} + \alpha_4 GDP_{it} + \alpha_5 GDP_{it}^2 + \alpha_6 INOV_{it} + \alpha_7 NR_{it} + \epsilon_{it}$$
(4)

 $CO2_{it} = \alpha_{0it} + \alpha_1 CO2_{it-1} + \alpha_2 PGLO_{it} + \alpha_3 ENE_{it} + \alpha_4 GDP_{it} + \alpha_5 GDP_{it}^2 + \alpha_6 INOV_{it} + \alpha_7 NR_{it} + \alpha_6 INOV_{it} + \alpha_7 NR_{it} + \alpha_8 INOV_{it} + \alpha_8 INOV_{i$ (5) ε<sub>it</sub>

$$CO2_{it} = \alpha_{0it} + \alpha_1 CO2_{it-1} + \alpha_2 SGLO_{it} + \alpha_3 ENE_{it} + \alpha_4 GDP_{it} + \alpha_5 GDP^2_{it} + \alpha_6 INOV_{it} + \alpha_7 NR_{it} + \epsilon_{it}$$
(6)

To assess the impact of Globalization on moderating the effect of energy consumption on income disparities, the interaction term might be stated as follows.

$$CO2_{it} = \alpha_{0it} + \alpha_1 CO2_{it-1} + \alpha_2 GLO_{it} + \alpha_3 ENE_{it} + \alpha_4 GDP_{it} + \alpha_5 GDP_{it}^2 + \alpha_6 INOV_{it} + \alpha_7 NR_{it} + \alpha_8 (GLO * ENE_{it}) + \varepsilon_{it}$$
(7)

$$CO2_{it} = \alpha_{0it} + \alpha_1 CO2_{it-1} + \alpha_2 EGLO_{it} + \alpha_3 ENE_{it} + \alpha_4 GDP_{it} + \alpha_5 GDP^2_{it} + \alpha_6 INOV_{it} + \alpha_7 NR_{it} + \alpha_8 (EGLO * ENE_{it}) + \varepsilon_{it}$$
(8)

$$CO2_{it} = \alpha_{0it} + \alpha_1 CO2_{it-1} + \alpha_2 PGLO_{it} + \alpha_3 ENE_{it} + \alpha_4 GDP_{it} + \alpha_5 GDP^2_{it} + \alpha_6 INOV_{it} + \alpha_7 NR_{it} + \alpha_8 (PGLO * ENE_{it}) + \varepsilon_{it}$$
(9)

 $CO2_{it} = \alpha_{0it} + \alpha_1 CO2_{it-1} + \alpha_2 SGLO_{it} + \alpha_3 ENE_{it} + \alpha_4 GDP_{it} + \alpha_5 GDP^2_{it} + \alpha_6 INOV_{it} + \alpha_7 NR_{it} + \alpha_8 (SGLO * ENE_{it}) + \varepsilon_{it}$ (10)

Equation seven includes interaction term of GLO and ENE. The interaction term parameter expresses the effect of GLO on CO2 as a function of ENE.

Equation Three assesses the influence of GLO and ENE on environment in emerging countries using various control variables. Equation 4 predicts the effect of EGLO on CO2 emissions in developing nations, by using same independent variables as in 2<sup>nd</sup> equation. Equation five calculates the effect of PGLO and ENE on CO2 emissions in emerging nations. Equation six evaluates the effect of SGLO and ENE on CO2 emissions in emerging nations. The analysis also includes four interaction terms. First is made up of GLO and ENE, while second is made up of EGLO and ENE. PGLO and ENE make up the third interaction term. SGLO and ENE comprise the fourth interaction term. The word "interaction" is employed because this study investigates if general Globalization, social, economic, and political Globalization mitigate the impact of energy use on environmental quality in developing countries.

#### System GMM estimation Technique

GMM estimator is created by Arellano and Bond in 1991. The lag of the dependent (Y) variable is taken on the right side of the model. The issue of association between the residual variance and the regressors occurs so when lag of the variables y is employed as independent variable. As an instrument, difference GMM is utilized with the lag of the regressor. Even if the model includes serial correlation, these tools may be inadequate. If there are continuous variables, the author argue that lags are insufficient instruments for estimating first difference GMM (Arellano & Bover, 1995). Using lag and lagged difference variable as an instruments in model, the authors claim, removes the problem of endogeneity and weak instruments. The two-step system GMM estimate technique was developed by Arellano and Bover (1995) and Blundell and Bond (1995). This strategy is used to circumvent the constraints of panel studies. The first issue is omitted variables bias, which is caused by heterogeneity and endogeneity. The equation of system GMM shown below.

$$\Delta y_{it} = \alpha + \alpha_1 y_{i,t-1} + \alpha_2 X_{it} + \Omega_i + \Omega_t + \mathcal{E}_{it}$$
<sup>(11)</sup>

Where,  $X_{it}$  are independent variable,  $\alpha_1$  is the parameter of lag of Y variable  $\Omega_i$  is the cross nation unobserved effect,  $\Omega_t$  is time effect.  $\mathcal{E}_{it}$  is error term, i denotes country and t denotes time.

# **Results and Discussion**

#### **Descriptive statistics**

The descriptive statistics shown in the table below include mean, minimum, maximum, median, Kurtosis, standard deviation, and skewness values.

Table 2: Descriptive Statistics								
	Mean	Median	Maximum	Minimum	Std. Dev.	Kurtosis	Skewness	
CO2	0.47	0.41	1.87	0.05	0.27	5.83	2.31	
GLO	54.90	54.99	89.54	26.32	12.62	3.76	0.11	
EGLO	51.11	48.72	86.01	19.22	14.28	3.97	0.34	
PGLO	68.07	69.02	92.51	26.31	14.74	3.43	-0.33	
SGLO	47.41	47.86	87.23	8.79	16.31	2.27	0.02	
ENE	1050.48	689.46	12372.42	114.08	1329.04	31.83	5.53	
GDP	5058.67	2848.23	64964.73	186.51	7146.34	27.57	5.18	
INOV	35593.11	8214.01	2142414.01	326.01	152369.81	138.93	12.13	
NR	7.08	4.76	67.68	16.25	11.67	9.41	3.23	

CO2 has a mean value of 0.47, a maximum value of 1.87, and a lowest value of 0.05, according to Table 2. The average value is the middle point between the highest and least values. CO2 has a standard deviation of 0.27. The average value of GLO is 55.90, with a high of 88.54 and a minimum of 27.33; the average value is between the maximum and minimum values. GLO has a standard deviation of 11.62.

EGLO has an average value of 50.11, a maximum value of 87.01, and a minimum value of 27.33. EGLO has a standard deviation of 13.28. The mean PGLO value is 69.07, with maximum and minimum values of 93.51 and 27.34, accordingly, and a standard deviation of 93.51. SGLO has an average value of 48.41, with maximum and minimum values of 88.23 and 9.79, accordingly, and a deviation of 17.31.

Table 3 Correlation Matrix

1

CO2 GLO EGLO PGLO SGLO ENE GDP INOV NR

#### CO2

GLO	-0.04	1							
EGLO	-0.04	0.31	1						
PGLO	0.14	0.10	0.02	1					
SGLO	-0.05	0.35	0.39	0.06	1				
ENE	0.11	0.16	0.21	-0.02	0.22	1			
GDP	-0.09	0.24	0.27	-0.05	0.32	0.60	1		
INOV	0.31	0.04	-0.04	0.16	-0.04	0.06	-0.03	1	
NR	0.19	-0.12	-0.08	-0.03	-0.14	0.20	0.13	-0.03	1

Source: Author's calculation

Table 3 shows that the degree of correlation among the independent and dependent variable is less than 3, and the probability distribution is flatter, suggesting that it is Platykurtic. It is proved that there is a full positive relationship among CO2 value 1.00 and itself. GLO, on the other hand, has a value of -0.04, showing that the relationship among CO2 and GLO is not of typical strength. The value of EGLO is -0.039 and PGLO is 0.14, indicating that CO2 has a significant negative relationship with EGLO and a positive relationship with PGLO. The result of PGLO is 0.14, indicating a positive relationship between gross fixed CO2 and gross product growth rate. SGLO has a value of -0.05, indicating a negative connection with CO2, but ENE has a value of 0.11, indicating a positive association with CO2. GDP has a -0.08 value, showing a negative and weak

relationship with dependent. The INOV value of 0.31 suggests that CO2 is highly dependent on NR, which has a value of 0.19. The entire correlation matrix table shows a strong relationship among the independent and relationship between the dependent.

Table 4 shows short-run outcomes of S-GMM of selected emerging nations. Lagged of dependent variable is used in the models which are significant, showing that the research was done by applying a dynamic model and that one year's environmental quality is heavily influenced by the preceding year's environmental quality. The results are discussed in depth in the following section.

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Table 4: Short run results

(System GMM)

Dependent: Natural log of CO2 Emissions

VARIABLE	1	2	3	4	5	6	7	8
L.LNCO2	0.939***	0.939***	0.936***	0.962***	0.945***	0.953***	0.929***	0.921***
	(0.011)	(0.013)	(0.002)	(0.005)	(0.011)	(0.013)	(0.004)	(0.003)
LNGLO	0.050**				0.155***			
	(0.023)				(0.039)			
LNENE	0.047***	0.045***	0.050**	0.034***	0.169**	0.148***	0.041**	0.073***
	(0.012)	(0.016)	(0.025)	(0.003)	(0.084)	(0.033)	(0.021)	(0.003)
LNGDP	0.051***	0.064	0.044***	0.054	0.082***	0.059***	0.024**	0.085**
	(0.010)	(0.051)	(0.003)	(0.041)	(0.016)	(0.013)	(0.012)	(0.042)
LNGDP2	-0.026**	-	-	-	-	-	-	-0.043**
	(0.012)	0.028***	0.022***	0.026***	0.042***	0.030***	0.012***	(0.001)
	(0.013)	(0.007)	(0.001)	(0.002)	(0.008)	(0.006)	(0.001)	(0.021)
LININOV	0.008**	0.012**	0.00/*	0.003	0.011**	0.008**	0.006**	0.010***
	(0.004)	(0.006)	(0.004)	(0.002)	(0.005)	(0.004)	(0.003)	(0.001)
LININK	0.011	0.011***	$0.015^{***}$	$0.000^{****}$	0.014*	(0.012)	0.004	$0.007^{*}$
	(0.004)	(0.005)	(0.001)	(0.001)	(0.008)	(0.008)	(0.001)	(0.004)
LNEGLO		-				- 0 1 <b>07</b> ***		
		(0.030)				(0.032)		
INPCIO		(0.039)	0.035**			(0.052)	0.027	
			(0.033)				(0.027)	
LNSGLO			(0.017)	-0.033			(0.021)	-0.040
				(0.033)				(0.039)
LN(GLO*ENE)				(0.021)	0.115***			(0.057)
					(0.039)			
LN(EGLO*ENE)					()	0.019**		
· · · ·						(0.008)		
						. ,	0.120***	
LN(PGLO*ENE)							(0.033)	
IN(SCIO*ENE)								0.061
LN(SGLU·ENE)								(0.049)
Constant	-	-	-	-	-	-0 116*	-	-
Constant	0.248***	0.535***	0.240***	0.119***	0.238***	0.110	0.267***	0.270***
	(0.077)	(0.121)	(0.021)	(0.015)	(0.052)	(0.066)	(0.021)	(0.012)
Obs	1,220	1,220	1,220	1,220	1,220	1,220	1,220	1,220
Instru	61	59	58	59	65	61	62	64
AR (1) Prob	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR (2) Prob	0.167	0.161	0.169	0.168	0.384	0.383	0.398	0.371



Table 4 shows the short-run outcomes for emerging nations. Model one empirically evaluates the factors of environmental quality as Globalization and energy consumption, with other determinants like natural resources, Innovation, and GDP per capita. The findings show that Globalization has a favorable and substantial influence on environmental quality in underdeveloped nations ( $\alpha_2 = 0.050, p < 0.05$ ). As a result, it is determined that Globalization reduces environmental quality through increasing CO2 emissions. It was determined that increased Globalization degrades environmental quality in underdeveloped countries. The findings back up the pollution haven idea. This theory holds when industrialized countries seek to build offices overseas or factories, they usually select the cheapest option for labor and resources that also provides the material access and necessary land. However, this typical practice leads to high cost of environmentally hazardous activities. Developing countries did not focus on environmental regulations because resources and labor are available at cheap price, Due to this, corporations who want to invest physically in another country choose to do so in developing countries with laxer environmental regulations. All of this contributes to deteriorating environmental performance in low-income emerging economies. In this study, other researchers' conclusions were comparable, such as (Crawford- Marceau, 2020; Pischke, 2018; Suki et al., 2020).

First model also revealed a substantial positive association among energy usage and carbon emissions ( $\alpha_3 = 0.047, P < 0.01$ ). It signifies that energy use degrades environmental quality. The primary cause of the positive association among ENE and CO2 is the extreme

use of nonrenewable energy, particularly oil power plants, coal, and fossil fuels. This imply that higher energy use results in greater carbon emissions. These studies also demonstrate that increasing energy use by 1% raise in CO2 by 0.047 % on average. These results are consistent with previous studies like (Jun et al., 2021; Qu et al., 2017; Rahman et al., 2021). The GDP per capita coefficient indicates a positive association among growth and CO2 ( $\alpha_4 = 0.0511$ , P < 0.01). This suggests that economic expansion has a considerable beneficial impact on CO2. Furthermore, the computed GDP square coefficient indicates a negative relationship among GDP and CO2 ( $\alpha_5 = -0.0261, P <$ 0.05). Some empirical findings that are comparable to ours include: (Suki et al., 2020; Filippidis et al., 2021; Chaudhry et al., 2021).

The Innovation coefficient value indicates a positive relationship among INOV  $(\alpha_6 = 0.0081, P < 0.05).$ and CO2 This demonstrates that as Innovation develops, the condition of the environment in emerging countries deteriorates. Industrial Innovation s that did not focus on sustainable growth resulted in a rise in CO2, which harmed environmental quality, particularly in emerging nations. A few studies discovered a negative relationship between INOV and CO2 like (Solarin & Bello, 2020; Selvaraj & Joseph, 2020; Khan et al., 2019). While few researchers, discovered similar outcomes to ours like (Saudi et al., 2019; Muhammad & Khan, 2021). The natural resources coefficient ( $\alpha_7 = 0.011, p < 0.01$ ) demonstrates a positive association among NR and CO2. As a result, it is stated that increases in natural resources degrade environmental quality in emerging nations since governments in all countries did not adopt safe and sound natural

resource extraction technology. As a result, all emerging countries' carbon emissions will rise. Few investigations reached comparable conclusions to ours like (Grossman & Krueger, 1991; Cole & Elliott, 2003).

In developing nations, EGLO has a connection with negative CO<sub>2</sub>  $(\alpha_8 =$ -0.153, p < 0.01). Previous research backs up our conclusions like (Xu et al., 2018; Kayikci, 2019; Gallagher, 2009). PGLO is associated with higher carbon emissions in poor nations ( $\alpha_9 =$ 0.035, P < 0.05). PGLO has a favorable impact on CO2 emissions. PGLO rises CO2 since poor nations are not politically powerful, and their economy lack effective carbon-reduction technology. In poor nations, SGLO has a negative minor influence on CO2 but  $(\alpha_{10} =$ -0.0331, P > 0.1). It follows that SGLO has no discernible impact on CO2 in rising economies.

This study introduces four interaction terms in the last four model. First interaction term is of GLO and ENE its coefficient revealed a statistically positive connection between CO2 emissions ( $\alpha_{11} = 0.115, P < 0.01$ ). As a result, it found that the joint effect of GLO and ENE, has affected the environment in emerging nations significantly. Second interaction term is of EGLO and ENE its coefficient indicates a positive connection with environment quality ( $\alpha_{12}$  = 0.0191, P < 0.05). As a result, it concluded that the joint effect of EGO and ENE is lowering the quality of the environment in emerging nations. Third interaction term is of PGLO and ENE its coefficient value demonstrated a positive connection with CO2 ( $\alpha_{13} = 0.121, p < 0.01$ ). As a result, interaction term determined that the joint effect of PGLO and ENE has a detrimental influence on environmental quality in emerging nations. Fourth interaction term is of SGLO and ENE its coefficient value showed a positive connection with CO2 ( $\alpha_{14} = 0.061$ , P > 0.1). As a result, it found that the joint effect of SGLO and ENE has no substantial influence on CO2 in emerging nations. Finally, it concluded that the interaction term of EGLO and PGLO with ENE has a positive relationship with CO2. While there is no substantial relationship between SGLO and ENE in terms of CO2 emissions.

### **Conclusion and policy recommendations**

The major goal of this study is to examine the effects of Globalization and energy consumption on environmental quality in emerging nations. The study's goal is to test the theory that globalization and energy usage boost growth but environmental degrade quality. This investigation will focus on 69 developing nations and System-GMM estimating approach was utilized. The study's major conclusions are that GLO has a positive link with CO2 in poor nations. The Pollution Haven theory supports the positive relationship between GLO and CO2, whereas the Pollution Halo hypothesis supports the negative relationship among GLO and CO2. The extreme use of nonrenewable energy, particularly oil power plants, coal, and fossil fuels have a positive correlation with CO2. Furthermore, the interaction terms of GLO and ENE, EGLO and ENE, PGLO and ENE all have a negative influence on environmental quality in emerging nations. While the interaction term of SGLO and ENE indicates a positive but insignificant link with CO2 emissions.

Globalization and energy usage have a negative influence with environmental quality, owing mostly to the vast consumption of fossil fuels. To save future generations, growing nations should develop regulations that promotes sustainable growth of globalization and energy consumption, as well as foster ecologically friendly and cleaner technologies. The studies also demonstrated that Globalization is important for economic progress, but it comes at the expense of rising income disparity and pollution. So this research suggests that the governments of developing countries concentrate their efforts on improving environmental quality and developing such policies that ensure sustainable economic growth.

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