Journal of Economic Sciences
Volume 3, Issue 2
https://www.jesciences.com

Globalization, Environmental Kuznets Hypothesis, and COP Outcomes: Pathways to Sustainability for Developed and Developing Countries

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Timeline
Received: Jul 06, 2024
Revised: Aug 06, 2024
Accepted: Aug 10, 2024
Published: Sep 15, 2024

DOI
https://doi.org/10.55603/jes.v3i2.a1

Abstract

Globalization, its dimensions, and the Environmental Kuznet Curve (EKC) in developed and developing countries are important in determining global environment sustainability in connection with COP. The role of globalization is analyzed in terms of emissions from 1991 to 2021 using a sample of 107 countries, estimated through Generalized Methods of Moments (GMM). The results show a U-shaped EKC in full panel of 107 countries and 72 developing countries. However, in 35 developed economies EKC is valid and shows the traditional inverted U-shaped curve, indicating the efforts of these countries towards sustainable development. Overall globalization differs in its impact in developed and developing countries in the case of developing countries it brings economic benefits but at the cost of environmental degradation while in developed countries it helps in reducing CO_2 emissions. Additionally, globalization's economic and social dimension decreases emissions while political globalization increases environmental degradation in full panel and developing countries. Whereas, in 35 developed countries, only social globalization is significant in tackling the issues of the environment. These insights show that overall globalization and specifically, political globalization in developing countries is not effective in achieving the target of sustainability. Economies at early stages of growth need effective political agreements, moreover, collaborative efforts particularly from the developed world are the only solution for sustainability.

Keywords: *Globalization, Carbon emissions, Environment, Growth*

JEL Classification: F6, F64, O47

1. Introduction

The extreme rise in environmental pollution in recent decades has been attributed to manufacturing activities and economic expansion. As a result, several countries have begun to look for other techniques to decrease pollution without jeopardizing their economic structures. Despite various efforts, worldwide environmental pollution has not been decreased to the necessary levels. Therefore, determining the causes of carbon emissions is critical for both selecting key policies for achieving sustainable goals and monitoring the effectiveness of policies that have already been implemented. In this study the issue of globalization has been taken to determine its impact on environment. Globalization has increased the scale of international trade; flow of goods and services has significantly increased during the last few decades. On one side globalization is stimulating higher growth through higher production, while on the other side it has negative consequences on environment (Destek, 2019).

The world's economies have benefited from globalization. One of its benefits is an increase in product quality due to global rivalry. It also has provided jobs in both developed and developing countries, as

well as aided in the rapid and effective dissemination of knowledge to everybody. Although globalization has helped many countries to flourish economically but many individuals believe that it has also harmful influence on the world economies. Globalization, according to environmentalists, is bad for our planet. They claim that globalization raises the amount of economic activity such as production, which leads to increase in environmental degradation. The integration of economies is blamed for climate change, pollution, deforestation, and other environmental issues (Timmons et al. 2016). For instance, higher production activities increases energy consumption which raises the level of carbon emissions, thereby, damages the air quality. In addition, mega scale production has significantly imposing environmental costs due to rapid depletion of natural resource. Furthermore, global interdependence has increased transportation and communication across the globe, which pollutes environment via higher energy consumption channel. Likewise, social globalization has increased the number of internet users which contributes to pollution through e-waste.

It's vital to note that globalization isn't the underlying cause of environmental degradation, but the government's ineffective policies and control strategies are important in determining environmental externalities. In this regard, government fails to regulate corporations' polluting action. Moreover, property rights alone are not able to prevent the exploitation of environmental assets. It is argued that globalization generates more wealth that can be used to improve the environment. Free trade generates cash for countries, which can be used to embrace new ways and technologies to address environmental issues. Globalization also facilitates the movement of environmentally friendly goods between countries. Hence, globalization is not the main cause of environmental pollution and can be used to benefit environment (Ahad and Khan 2016).

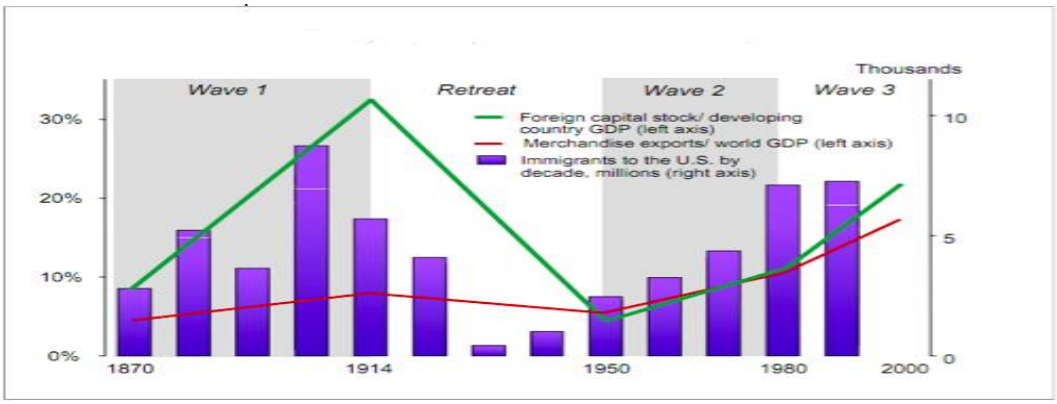
Globalization began at the start of human history, however, the period after the 1800s is referred to as modern age of globalization, which is also the fastest and the most impactful time in history of globalization. Figure 1 shows the three major waves of globalizations. The first wave is recorded during 1870 to 1914, showing a significant rise in economic activities but it went into reverse direction due to World War I and II. Later, the second wave generated by following the policies of trade liberalization and it was the new beginning of current form of globalization. Commercial trade lines, migration, military conquest, and exploratory expeditions contributed in advancement. Moreover, globalization accelerated with technical breakthroughs in transportation and communication, especially in the second half of the twentieth century. Since then, global trade has increased at such a rapid rate that the term "globalization" has become widely used. Globalization makes it easier for people from all backgrounds to come together. When people band together, they have more power. Instead of deforestation, they can assist in the establishment of nature reserves (Destek, 2019).

Globalization encourages large-scale industrial production, which contributes to issues such as climate change. The transfer of raw materials and foodstuffs from one location to another has increased dramatically as a result of globalization. However, the amount of fuel utilized in the transportation of these goods, increases the level of pollution in the environment. Moreover, there has also been a rise in waste materials. The pollutants contain a variety of hazardous chemicals and radioactive materials which disturbs the flora and fauna's genetic makeup, causing a huge damage (Adkar, 2015). Global distribution of commodities is also causing a significant waste problem because a large amount of plastic is utilized to carry these raw materials. Plastic is extremely detrimental to environment because it is non-biodegradable.

Today's environmental problems are mostly the result of human actions. Pollution and resource depletion have resulted in a loss of wildness, ecological degradation, and climate change, as well as a decline in plant and animal biodiversity (Echazarreta and Costa, 2018). Major environmental challenges are jeopardizing the planet's future as a result of this catastrophe. Technology is currently helpless to save

the earth. Environmental deterioration caused by technology is a problem in practically all industrialized and emerging economies across the world. Huge amounts of money have already been spent to enhance the quality of the environment, with more to come. This study examines the dimensions of globalization that are hazardous to the environment. Furthermore, it will provide policymakers with the most relevant information concerning the effect of globalization on the environment. The latest round of COP is more focused for financing the damages of climate change. Hence, the estimates of developed and developing countries will provide fresh evidence of environmental damage due to interdependence of global economies. Therefore, it is important to study the connection between globalization and the environment. The aim of this study is to determine the impact of globalization on the environment in 35 developed and 72 developing countries from 1991 to 2021.

Figure 1: Three Waves of Globalization



Source: Foreign capital stock/developing country GDP: Maddison (2001), table 3.3; Merchandise exports as a percentage of world GDP: Maddison (2001), tableF-5; Migration: Immigration and Naturalization Service (1998).

The current study deviates from the standing literature in following ways. First, the study investigates the relationship between different types of globalization and the environment. Limited literature is available that establishes the relationship between globalization and the environment, particularly in the case of developed and developing economies. Most of the frequent literature uses the overall globalization index in the analysis. However, in the current study different dimensions have been taken into account to establish the association between globalization and the environment. Second, the current study adds to the current literature by providing empirical results in view of globalization and Environment Kuznet curve (EKC) in comparatively large data set of the developed and developing countries. The study of globalization and EKC is important in order to observe sustainable goals of development. Third, this study provides policy insight related to the environment and globalization and its dimensions.

The remainder of this study is as follows, Section 2 discusses review of literature. Theoretical framework and models are displayed in Section 3. Results are elaborated in section 4 and last Section presents the conclusion and policy suggestions.

2. Literature Review

Literature provides various studies on the nexus of globalization and environment (Lee, 2021; Wu et al., 2022; Awad and Mallek, 2023; Adeleye et al., 2023). In this regard, various factors have been used as a proxy of globalization and recently the focus has shifted on the globalization indices and its dimensions. Therefore, literature is divided into two parts. The first part deals with the studies that have utilized

different variables and proxies of globalization in order to determine the link between globalization and pollution. While, the second part is related to the research work that has used the globalization index to examine its impact on environment.

Bakirtas and Cetin (2017) used foreign investment (FDI), as a proxy of globalization. The study found that FDI lessens carbon emissions in MIKTA nations. In contrast, Behera and Dash (2017) claimed that FDI raises carbon emissions because the entrance of FDI causes serious environmental pollution in the host countries and worsen their environment. Moreover, Ali et al. (2017) and Park et al. (2018) observed that carbon emissions are reduced as a result of financial progress which is taken as a proxy of financial globalization. In addition, Jahangir et al. (2022), also reported that financial development and consumption of renewable energy considerably reduce environmental deterioration. However, Amri (2018) argued that financial development increases environmental pollution, because developed financial sector make it easy to access loans for durables, hence, rapidly deplete resources and pollute the environment.Trade openness has also been used as an indicator of global integration. For instance, the results of Longe et al. (2020) revealed that trade; transportation (export and import), energy use, and economic expansion are contributing to environmental degradation in Africa over time. According to Tsurumi and Managi (2014), increased trade openness leads to more deforestation. It is a major environmental issue that contributes to biodiversity loss, land degradation, soil depletion, and global warming (Ajanaku and Collins, 2021).

In the second part of the literature, we evaluated past studies that looked into the association between the globalization index and carbon dioxide emissions. For instance, Shahbaz et al. (2013) and Khan et al. (2019) showed that globalization contributes in carbon dioxide emissions in Turkey and Pakistan respectively. Similarly, the recent work of Rehman et al. (2021) demonstrated that globalization has aided numerous technological developments, connecting people all around the world and propelling us into the contemporary economic system. However, the poor impact of globalization on biodiversity can be effortlessly overlooked in the face of speedy economic growth and industrialization. Pollutants, global warming and weather-altering globalization are an irrefutable aspect of planet's devastation. Environmental pollution is a new problem that contributes to weather changing due to greenhouse fuel line emissions. A good way to stimulate economic growth is to enforce modern regulations to make sure that CO2 emissions are reduced. Similar arguments are also found in the studies of Destek (2019), Kalayci and Hayaloglu (2019) and Lin et al. (2019). Moreover, Lee (2021) explained that over the last few years, globalization and population expansion have placed a significant strain on the environment, and global warming has exacerbated the negative consequences. The study of Awad and Mallek (2023) also found harmful effect of globalization on 44 sub Saharan economies

In contrast, beneficial effect of globalization is also found in the study of Destek and Ozsoy (2015) in Turkey over the period of 1970 to 2010. Moreover, Shahbaz et al. (2016) also showed that globalization reduces carbon emissions in few African countries namely as Angola, the Congo Republic, Libya, Tunis, and Zambia. However, Leito (2015) conducted an analysis that used the VECM Granger causality method to determine the extent to which greenhouse gases and globalization are linked in Portugal from 1970 to 2010. The finding suggests that there isn't much of an effect that globalization has on carbon emissions.

In addition, research is being done to investigate the outcome of different types of globalization on pollution. For example, Shahbaz et al. (2015) used the ARDL bound test to assess the influence of globalization in general, as well as economic, social, and political globalization indices, on carbon pollution in India between the years 1970 and 2012. According to the research results, economic globalization results in lower levels of carbon emissions. On the other hand, globalization in all of its forms—including overall social and political globalization—raises pollution. Xu et al. (2018) examined

the effects of global, economic, social, and political globalization indices on carbon pollution in Saudi Arabia between the years 1971 and 2016 by employing the ARDL bound test. They came to the conclusion that globalization of the economy causes carbon emissions, but globalization of the political and social spheres doesn't hurt the planet.

There are also contrasting results when it comes to social globalization. Ozcan and Apergis (2018) discovered that use of internet (an indicator of social globalization) reduces carbon pollution. On the other hand, Salahuddin et al. (2016) came to the conclusion that internet use is bad for the environment. Park et al. (2018) confirmed that telecommunications and information technology, including the internet has raised environmental degradation. Furthermore, tourism is also used as proxy of social globalization, in this context, De Vita et al. (2015) discovered that tourism payments or tourist arrivals increase carbon emissions in Turkey. Unlike this study, Dogan et al. (2015) concluded that boosting tourism reduces carbon emissions in OECD countries. According to Zhao et al. (2018), tourism is the world's largest industry. The impact of tourism on the environment is continually emerging, both in negative and positive elements, as the industry continues to grow. The environment is harmed by tourism because of transportation, tourist attractions, and tourist hotels. Dogan and Aslan (2017) supported that tourism has a favourable result on environmental quality.

In the case of political globalization, it appears that some researchers tracked environmental policy agreements using the Climate Agreement as a dummy variable. Grunewald and Martinez (2015) discovered that Kyoto Protocol reduced carbon emissions in 170 nations. Similarly, Bozkurt and Okumuş (2017) agreed that Kyoto Protocol cuts carbon pollution in 33 nations.

The literature on globalization, its dimensions and EKC is limited. The role of globalization and EKC is examined in the study of Shahbaz et al. (2016). The study reports mixed results in the existence of EKC in African countries. Likewise, the study of Adeleye et al. (2023) also stated mixed results in seven South Asian Economies concerning EKC. However, Akadiri et al. (2021) confirmed the globalization-tourism-induced EKC hypothesis and observed that globalization increases carbon emissions.

In a nutshell, previous studies have looked at the effects of globalization on different economies by using either a single indicator of globalization or a composite index. However, the results are not conclusive. Some country specific cases are showing unfavorable effect of globalization on environment while others have shown beneficial effect of globalization on environment. In this study, comparatively large data set of developed and developing countries has selected to deliver fresh evidence on the impact of globalization on environment. Moreover, existence of EKC in global integration is also examined.

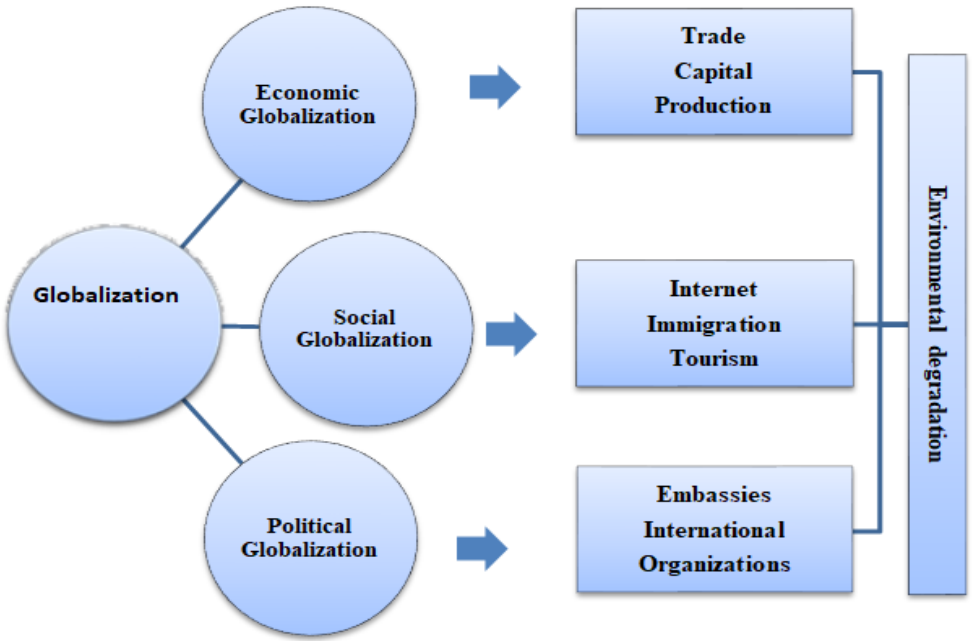
3. Theoretical Framework and Models

The three major dimensions of globalization differ in its effect on the environment through various direct and indirect channels. Figure 2 shows the different dimensions of globalization and their impact on the environment. Multiple indicators are used to define economic, political, and social globalization. For example, trade, flow of capital and production activities is considered in the dimension of economic globalization. While, indicators such as use of internet, tourism and movement of people is regarded as social globalization. Political agreement at regional and international level comes under the dimension of political globalization.

The indicators which are used to define the aspects of economic globalization include trade production, corporation capital, labor services, and direct investment. In both rich and developing countries, the impact of commerce on environmental quality is always equivocal. It takes a long time to see how commerce affects ecosystems. Behera and Dash (2017) claimed that increased FDI raises carbon emission; because the entrance of FDI will cause serious environmental pollution in the host countries and worsen their environment. Kalayci and Hayaloglu (2019), highlighted that economic globalization

is gaining attraction and has brought environmental concerns. Higher levels of production, particularly in developing nations that have relatively high emission intensities, will raise global carbon dioxide emissions and air pollution under the trade scenario (Lin et al. 2019). In general, economic globalization has validated improved living standards in developing countries but other analysts warn that it may have an undesirable impact on local or growing economies, as well as individual employees. It helps undeveloped regions to develop economically, but it also has an impact on their natural surroundings, such as forest deterioration (Wang et al., 2019).

Figure 2: Relationship between Different Dimensions of Globalization and Environment



The indicators which are used to define the aspect of social globalization include tourism, internet, immigration, culture etc. (ETH Zurich database). There are also discrepancies in the outcomes of social globalization indicators. For example, Ozcan and Apergis (2018) argued that social awareness decreases carbon emissions. However, Park et al. (2018) and De Vita et al. (2015) observed social globalization as a contributing factor in environment degradation. Furthermore, international immigrants are also responsible for the highest overall per capita CO_2 emissions (Liang et al., 2020).

Political globalization is defined as the spread of political policies and is assessed by the numbers of embassies, participation in international organizations, and membership in UN summits, as well as international treaties among two or more countries (ETH Zurich database). In this regard, Kyoto Protocol agreements are observed to be influential in reducing carbon emissions (Grunewald and Martinez, 2015 and Bozkurt and Okumuş, 2017).

It can be concluded that all the three types of globalization is effecting environment in developed and developing economies. For instance, economic globalization is effecting environment through trade, investment and more production. The higher economic integration can be viewed as a threat to environment in terms of more carbon emission. Similarly, social globalization is causing environmental issues through tourism, internet usage and free movement of people across globe. Political globalization also has its direct and indirect impact on environment through different environmental agreements.

3.1. Empirical Models

In this section Model 1 is constructed to observe the effect of overall globalization on environment.

Model 1: $Environment = f(Globalization)$

$$CO_{2it} = \alpha_0 + \alpha_1 Globalization_{it} + \alpha_2 X_{it} + \mu_{it} \quad (1)$$

In equation (1) CO_2 emission is used to measure environment degradation and globalization is referred as overall globalization that include three indices as it is a composite index constructed by using various indicators of economic, social and political aspect. This index is obtained from Zurich database. We are using CO_2 to measure environment degradation because it is the most dominant factor of greenhouse gas emissions. X shows set of control variables. Control variables are GDP, population and inflation. In Model 2; we have used different aspects of globalization (economic, social and political globalization). This model is constructed to examine the impact of each of the dimensions of globalization on environment.

$$CO_2 = f[Eco.\ Globalization,\ Political\ Globalization,\ Social\ Globalizaion]$$

Model 2: $$CO_2 = \alpha_0 + \alpha_1 Eco_{it} + \alpha_2 Pol_{it} + \alpha_3 Soc_{it} + \alpha_4 X_{1it} + \mu_{it} \quad (2)$$

In Model 2 'Eco' shows economic globalization, 'Pol' shows political globalization and 'Soc' shows the social globalization.

Model 3:

$$CO_2 = \alpha_0 + \alpha_1 Globalization_{it} + \alpha_2 GDP_{it} + \alpha_3 GDP_{it}^2 + \alpha_4 POP_{it} + Inf_{it} + \mu_{it} \quad (3)$$

The validity of EKC is tested by using Model 3. This model is helpful in determining the environment sustainability in the presence of overall globalization. In Model 4 overall globalization is used at disaggregated level by using its aspect of economic, political and social globalization. This model is unique in providing an insight to environmental sustainability along with different aspects of globalizations.

Model 4: $$CO_2 = \alpha_0 + \alpha_1 Eco_{it} + \alpha_2 Pol_{it} + \alpha_3 Soc_{it} + \alpha_2 GDP_{it} + \alpha_3 GDP_{it}^2 + \alpha_4 POP_{it} + Inf_{it} + \mu_{it} \quad (4)$$

All the models are estimated by applying Generalized Method of Moment (GMM) technique as it more appropriate. It provides consistent results in the presence of endogeneity and capable of handling unobserved individual heterogeneity, measurement error, simultaneity reverse causality, heteroscedasticity and omitted variable bias. Hence, the current study applies GMM to obtain efficient and unbiased results while addressing econometric issues.

3.2. Variables Description

The data set of 107 developed and developing countries are taken into consideration, covering the period from 1991 to 2021. Detail of each variable is provided below.

3.2.1 Economic Globalization

The movement of products, services, and capital is referred as economic globalization. The ETH (Eidgenössische Technische Hochschule) Zurich database provides the KOF (Konjunkturforschungsstelle) economic globalization index. It is a comprehensive indicator that is derived from eight variables. It takes into account commerce, FDI (Foreign Direct Investments), portfolio investment, and foreigners' income. Moreover, import limitations include tariffs, taxes on trade, and capital account constraints is also used in its construction.

3.2.2 Social Globalization

Information, ideas, and people spread throughout the world are regarded as social globalization. This index is acquired from database of ETH Zurich, and it displays three dimensions such as personal contact, information, and culture. The dimension of personal contact is measured by using the variable such as global tourism, international populations, transfers, phone traffic, and international correspondence. Information flows include television viewing by internet users and newspaper sales. The number of McDonald's restaurants, Ikea stores, and international book sales are used to gauge the cultural component.

3.2.3 Political Globalization

The dissemination of government policy is referred to as political globalization. It is made up of the number of embassies, membership in international organizations, involvement in UN peacekeeping missions, and international treaties among different countries. The data for this index comes from the ETH Zurich database.

3.2.4 CO_2 Emissions

Gaseous, liquid, and solid fuels are rated using a CO2 emission index, which is defined as the quantity of carbon dioxide released per amount of energy value. This index's data is collected from WDI (World Development Indicators).

3.2.5 Control Variables

Control variable are GDP, population and inflation. Control variables data has been taken from World Bank.

4. Results and Discussions

There is a plethora of empirical literature available which postulates that the validity of time series or panel data models demand the understudied data series is stationary. The stationarity can have a significant impact on the properties and behavior of the data series. Hence, in order to check the stationarity of the variables used in this study, we employed a series of panel unit root tests. There are several kind of panel unit root tests available in the literature that share a common null hypothesis. These tests are different from each other by enabling the autoregressive coefficient to be heterogeneous or homogenous. All tests employed in this study impose heterogeneity while Levin et al. (2002) enable homogenous autoregressive coefficient under the alternative hypothesis. Another distinctive feature of these tests is that they all are asymptotically normally distributed which is good for the estimation of big panel datasets. The results of panel unit root testing are reported in Table 1. It reveals that no matter which unit root test is employed; all understudied variables are stationary at 1st difference. These findings suggest that the Pedroni (1999) and Kao (1999) panel cointegration tests are appropriate to check the long-term association among the variables.

Table 1: Results of Panel Unit Root Test

Variable Name	Levin, Lin & Chu t*	Im, Pesaran and Shin W-stat	ADF - Fisher Chi-square	PP - Fisher Chi-square	Order of Integration
$C0_{2it}$	-24.6013 (0.0000)	-30.2929 (0.0000)	1262.72 (0.0000)	2253.52 (0.0000)	I (1)
Globalization Index (GI_{it})	-23.4842 (0.0000)	-24.5373 (0.0000)	1019.56 (0.0000)	1778.91 (0.0000)	I (1)

Economic Globalization Index ($ECOGI_{it}$)	-25.3850 (0.0000)	-27.2190 (0.0000)	1126.60 (0.0000)	1990.54 (0.0000)	I (1)
Social Globalization Index ($SOCGI_{it}$)	-16.276 (0.0000)	-19.1256 (0.0000)	775.144 (0.0000)	1594.66 (0.0000)	I (1)
Political Globalization index ($POLGI_{it}$)	-30.5909 (0.0000)	-32.8750 (0.0000)	1381.53 (0.0000)	2050.70 (0.0000)	I (1)
GDP_{it}	-16.8802 (0.0000)	-20.3321 (0.0000)	841.610 (0.0000)	1592.92 (0.0000)	I (1)
$Population_{it}$	-12.4925 (0.0000)	-8.9516 (0.0000)	678.777 (0.0000)	766.621 (0.0000)	I (1)
$Inflation_{it}$	-156.566 (0.0000)	-76.1031 (0.0000)	2157.91 (0.0000)	2687.24 (0.0000)	I (1)

Note: P-values are presented in the parenthesis.

The next step of our analysis is to examine whether the long-run or cointegration relationship exists among the understudied variables or not. For this purpose, we employed Pedroni (1999) test because all our data series are integrated at the first difference. The result of the test consists of two segments which report a total of 7 different statistics. The 1st segment reports four panel statistics whereas the 2nd segment presents three group statistics. The null hypothesis indicates there is no cointegration exists among the variables against the alternative hypothesis of cointegration. Moreover, to allow homogeneity among coefficients, we employed the Kao test of cointegration. Table 2 reports the results of both cointegration tests. According to Pedroni results, the majority of statistics both at common and individual AR coefficients are statistically significant at a 1% level of significance. It infers that the null hypothesis of no cointegration is rejected so there is a cointegration relationship that exists among variables. Similarly, the Kao (1999) test statistic is also statistically significant at a 1% level of significance which further verifies the existence of a cointegration relationship. Thus, both tests are indicating that there is a long-run relationship exists among the variables under consideration

Table 2: Cointegration Test Results

Pedroni Cointegration Tests				
	Satistic	Probability	Weighted Statistic	Probability
Common AR Coefficients Within Dimension				
Panel v-Statistic	-0.4674	0.6799	-3.3242	0.899
Panel rho-Statistic	-0.4717	0.3185	1.3756	0.797
Panel PP-Statistic	-9.7214	0.0000	-8.2717	0.000
Panel ADF-Statistic	-11.9304	0.0000	-10.5996	0.000
Individual AR Coefficients Between Dimension				
Group rho-Statistic	3.9113	0.8810		
Group PP-Statistic	-10.8169	0.0000		
Group ADF-Statistic	-10.5208	0.0000		

Kao Cointegration Test		
	t-Statistic	Probability
ADF	-2.3446	0.0095

After confirming the existence of long-run cointegration among the understudied variables, we applied the generalized method of moments (GMM) technique to our pre-defined econometric equations as the number of cross-sections i.e., countries are greater than the number of years of the selected data series. To get a more comprehensive picture of the impact of globalization on carbon dioxide (CO_2) emissions, we divided our regression analysis into three parts. First, we pooled our dataset, both for developed and developing economies having sample size of full panel is 107 countries. Second, we applied GMM estimation techniques to the data of 72 developing economies and repeat the analysis for the 35 developed economies. Table 3 presents the results of panel GMM to evaluate how overall globalization impacts CO_2 emissions across world in all three cases.

Table 3: GMM estimates of Model 1 in full panel, developing and developed countries

Model 1						
	Full		Developing		Developed	
Variable	Coefficients	t- Stats	Coefficients	t- Stats	Coefficients	t- Stats
Co_{2it-1}	0.657***	408.468	0.577***	170.841	0.751***	30.647
GI_{it}	0.015**	2.523	0.037**	2.448	-0.155*	-1.911
GDP_{it}	-0.198***	-65.316	-0.004	-0.168	-0.083***	-2.960
$Population_{it}$	0.234***	26.941	0.2028***	15.194	0.011***	3.699
$Inflation_{it}$	-0.015	-1.012	-0.012***	-19.471	-0.701	-1.534

Note: *, ** and *** is showing 10%, 5% and 1% level of significance

Results indicate that lag value of CO_2 is significant in determining the current rate of carbon emissions in all the three cases. Globalization has adverse effect on environment in full panel and developing case. It infers that higher globalization is directly linked with more economic activities which results in higher level of greenhouse gas emissions i.e., CO_2 emissions. Also, the economic integration of different economies means an increase in consumption of goods and services which further increases the production activities that put stress on the environment. The results are consistent to the studies of Frankel (2003), Shahbaz et al., (2013), Yang et al. (2021), and Jahangir et al. (2022). However, in case of developed economies, global integration is beneficial in reducing CO_2 emissions. This result may be due to the efforts of these economies in addressing the issues of environment. Developed economies are more concerned regarding environmental degradation. These economies have achieved the target of higher growth and now they are trying to prevent environment as it is evident from the results that higher connectivity with the rest of the world is increasing the pace of production and commerce while it is not hurting environment. Higher international collaboration results in reduction of CO_2 emission. Hence, these economies are not only achieving the traditional targets of growth but also taking care of environment.

The control variable of GDP is statistically significant and has beneficial effect on CO_2 emissions in full panel and developed countries. It shows that higher GDP per capita is related to reduction in CO_2 emissions. Quantitatively speaking, a 1% increase in the GDP per capita leads to a 0.19% reduction in CO_2 emissions worldwide. The implication of this result shows that most of the world economies are achieving higher growth and the production activities are more focused towards sustainable growth particularly in developed countries. The prime objective of every economy is to achieve higher level of GDP per capita. Hence, in order to get this target most of the economies ignores environment and therefore contributes in higher level of CO_2 emissions. However, sustainable development not only focused on growth but also take the environmental issues. The current finding shows that now economies are also taking into account the environmental threats and GDP is increasing not at the cost of environment. This result is in line with the series of existing literature (Roca and Alcántara, 2001; Baek and Pride, 2014; Ajmi et al., 2015; Salahuddin et al., 2016; Dogan and Aslan, 2017). However, in case of developing countries this variable is turned out to be insignificant.

In all three cases, population is significantly increasing CO_2 emissions. Higher population increases the demand for goods and services, which in turn raises production activities, thereby contributing in CO_2 emissions. The coefficient of the inflation rate indicates that the increase in the general price level in an economy leads to a reduction in CO_2 emissions in developing economies. According to basic economics principles, a higher inflation rate means a low consumption level by the people which leads to a reduction in fuel consumption in terms of production and transportation activities of the business world. This finding is in line with the studies of Ronaghi and Scorsone (2019) and Setyadharma et al. (2021).

Table 4: GMM estimates of Model 2 in Full Panel, Developing and Developed countries

	Model 2					
	Full		Developing		Developed	
Variable	Coefficients	t- Stats	Coefficients	t- Stats	Coefficients	t- Stats
CO_{2it}	0.653***	187.131	0.559***	77.005	0.705***	25.459
$ECOGI_{it}$	-0.140***	-36.913	-0.046***	-4.136	-0.136	0.183
$POlGI_{it}$	0.199***	58.353	0.236***	6.269	-0.058	-0.433
$SOCGI_{it}$	-0.037***	-3.451	-0.1390***	-6.443	-0.279***	-3.149
GDP_{it}	-0.207***	-46.329	-0.031	1.070	-0.068	-1.492
$Population_{it}$	0.231***	13.871	0.183***	11.556	-1.070**	-1.979
$Inflation_{it}$	-0.004***	-10.355	-0.012***	-13.496	0.009**	2.193

Note: ** and *** is showing 5% and 1% level of significance

Results of Table 4 are based on Model 2; it inspects the impact of various dimensions of globalization on CO_2 emissions. The results reveal that economic and social globalization have a beneficial effect on CO_2 emissions, while political globalization has a detrimental impact on the environment because it increases the CO_2 emissions levels in full panel and developing case. Economic integration across globe is mitigating CO_2 emissions. It means that modern economic interdependence replaces the traditional modes of production and promotes efficient technologies which help in reduction of CO_2 emissions. Social globalization is also reducing environmental degradation. The role of media and awareness regarding environmental challenges increases the sense of responsibility at individual level which may results in beneficial effect on environment. Hence, social factors are also contributing in reducing environmental burden. However, political globalization seems to have negative impact on environment. It may be due ineffective political agreements between countries which seem to be powerless in affecting environmental conditions. As compare to economic and social globalization; political globalization has the strongest impact on CO_2 emissions. It means that political globalization damages the environment relatively more than the improvement of the environment from economic and social globalization. Additionally, the signs of control variables in Model 2 are similar to the results reported in Model 1. The results of this analysis conclude that economic and social globalization are good for developing economies, while political globalization has a severe impact on the environment. In case of developed economies only social globalization is significant in reducing CO_2 emissions.

The Environment Kuznets curve (EKC) is tested in the presence of globalization and the results are presented in Table 5. In full panel case and in developing countries, the coefficient of GDP ($\alpha_2 < 0$) is negative and the GDP squared ($\alpha_2 > 0$) is positive, indicating a U- shaped curve. It implies that with low level of GDP, environmental degradation is lower while with the rise of GDP it increses. Most of the low income and middle income economies are in the early stages of growth and development. These economies are experiencing structural transformation from agriculture to industrialization, therefore, contributing in CO_2 emissions worldwide. Another important factor is globalization, it is observed that the effect of globalization is not simialr across worlds. In this context, the developed economies shifts their polluting industries to low income countries, hence, there is more CO_2 emissions in these countries. The Table 5 shows that overall globalization is adversely effecting the global environment in full panel and developing countries. However, in case of

developed countries globalization is helpful in reducing environmental degrdadation along with the validity of EKC.

Table 5: GMM Estimates of Globalization and EKC in Full Panel, Developing and Developed Countries

	Model 3					
	Full		Developing		Developed	
	Coefficients	t- Stats	Coefficients	t- Stats	Coefficients	t- Stats
Co_{2it-1}	0.655***	382.376	0.573***	122.162	0.754***	43.412
GI_{it}	0.031***	4.187	0.0506**	2.460	-0.122*	-1.743
GDP_{it}	-0.431***	-10.692	-0.289**	2.370	0.104**	2.096
${GDP_{it}}^2$	0.024***	5.569	0.030***	-3.043	-0.026*	-1.968
$Population_{it}$	0.208***	21.068	0.232***	8.959	-0.544	-1.405
$Inflation_{it}$	-0.004***	-6.950	-0.011***	-9.321	0.009**	3.764

***Note**: *, ** and *** is showing 10%, 5% and 1% level of significance*

The result of Model 4, which is testing the validity of EKC along with the dimensions of globalizations are presented in Table 6. The results related to the dimensions of globalization are same as reported earlier in Table 4. However, the U-shaped EKC is observed in full panel and developing case while inverted U-shaped EKC is valid in developed countries. Therefore, it can be concluded that overall globalization and political globalization is putting pressure on environment in developing countries while in developed economies globalization and its social dimension are influential in reducing CO_2 emissions.

Table 6: GMM Estimates of Dimensions of Globalization and EKC in Full Panel, Developing and Developed countries

	Model 4					
	Full		Developing		Developed	
	Coefficients	t- Stats	Coefficients	t- Stats	Coefficients	t- Stats
Co_{2it-1}	0.645***	190.7548	0.558***	74.050	0.680***	18.32178
$ECOGI_{it}$	-0.122***	-34.74230	-0.042***	-2.608	-0.171	1.368328
$POlGI_{it}$	0.248***	38.25048	0.173***	11.312	-0.054	-0.337387
$SOCGI_{it}$	-0.085***	-5.343189	-0.149***	-4.177	-0.342***	-3.298430
GDP_{it}	-0.645***	-17.68216	-0.028	-0.901	0.688**	1.938248
GDP^2	0.0461***	11.88748	0.004	0.208	-0.091**	-2.116284
$Population_{it}$	0.233***	11.44965	0.266***	5.421	-1.130*	-1.737668
$Inflation_{it}$	-0.004***	-10.19645	-0.012***	-12.554	0.011481**	2.313820

Note: *, ** and *** is showing 10%, 5% and 1% level of significance

5. Summary and Conclusion

The integration of world economies is a result of higher international trade and investment (Fernando, 2021). The pace of globalization has affected various economic, political, environmental, cultural and social variables by allowing free and frictionless movement of goods and services across different countries. Among all these variables environmental aspect is important as it refers to the locality or a condition in which humans, animal or plants live and operate. Therefore, in the current study globalization and its dimensions has been taken to observe its influence on environment.

The current study looks into the connection between three types of globalization and environment. In this regard, overall, social and political globalization has taken into the analysis. This research offers policy recommendations on environmental issues and globalization in all of its forms. The balanced panel data is used for this investigation. Stationarity has thus been checked as a prerequisite which

implies that all the data series are stationary at first difference. Further, Pedroni test of cointegration reveals cointegration among all the series. The coefficients are estimated by using the GMM technique. It does a good job of dealing with endogeneity and therefore is able to generate effective results despite the fact that there are many time dimensions that are limited. GMM achieves a higher level of productivity than MM as a result of its use of additional moment conditions (Drukker, 2013).

According to Model 1, in case of full panel and developing countries the overall KOF globalization index has a statistically significant and has unfavourable effect on environment as it increases CO2 emissions. In developed countries case overall globalization appeared as an important factor in reducing carbon emissions. It indicates that overall globalization differs in its impact on environmental quality in developed and developing countries. Model 2 investigates the influence of different dimensions of globalization on CO2 emissions. According to the findings, economic and social globalization has a statistically significant beneficial influence on CO2emissions, whereas political globalization has increasing CO2 emissions in full panel and developing case. Social globalization is appeared to be significant in developed countries in addressing the issue of environmental challenges. Model 3 and 4 are constructed to examine the validity of EKC in existence of globalization and its dimensions respectively. In developing and full panel case U- shaped EKC is observed, showing more environmental degradation with the increase in GDP. However, in developed countries inverted U- shaped EKC is valid, indicating that these economies are on right path in achieving the target of growth along with environment.

In the end, this study came to the conclusion that globalization, both economically and socially, has a promising effect on the environment despite the fact that globalization as a whole and political globalization lead to increased environmental pollution. In context of policy implications, our results indicate that lawmakers of developing nations should supervise the wave of globalization in order to minimize its harmful effects on the environment. There is need to for collective efforts, particularly from developed world to assist developing countries in controlling environmental challenges. Moreover, the imposition of stringent environmental regulations on both domestic and international businesses, with the goal of having those businesses which implement environmentally friendly production structures is desirable. The point of fact related to developed countries is that globalization has hastened the spread of environmentally friendly technologies by means of globally connected channels of industry, capital flows, and research and innovation that results in favourable effect on these economies.

Acknowledgments

The authors acknowledge the useful comments from the Editor and anonymous reviewers. Certainly, all remaining errors are our own.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding if any

Nil

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