



Globalization and the Environment: A Path to Sustainable Development for SAARC Nations

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ABSTRACT

This study examines the complex connection between globalization, environmental sustainability, and international climate policy via the lens of the Environmental Kuznets Curve model. Therefore, it examines the aspects of globalization and the consequent CO2 emissions in certain South Asian countries. The paper analyses panel data from 1991 to 2023, employing multiple econometric approaches to substantiate the Environmental Kuznets Curve theory, which elucidates the inverted U-shaped relationship between economic growth and environmental pollution. The study illustrates that economic globalization facilitates technology transfers and the adoption of sustainable practices, resulting in decreased emissions. Conversely, political globalization obstructs environmental advancements due to inadequate governance and the inability to enforce global agreements. Although social globalization now exerts a minimal positive influence on environmental awareness and sustainability, there appears to be an increase in these characteristics. Therefore, the current research advocates for the advancement of contextualized methodologies, emphasizing institutional frameworks, international cooperation, and climate financing. This study contributes to the literature on balancing economic growth with environmental preservation in a highly integrated global economy and provides policy recommendations for developing countries.



Introduction

Globalization, environmental sustainability, and international climate policies have emerged as essential domains of global environmental concern. The globalization of the economy has accelerated economic growth significantly; yet, it also exacerbates environmental pollution, hence presenting a barrier to achieving sustainable development in both developed and developing

nations. The Environmental Kuznets Hypothesis (EKH) offers a theoretical framework for elucidating the factors contributing to environmental degradation. The Environmental Kuznets Curve (EKH) exhibits an inverted U-shape, suggesting that environmental degradation first increases with economic development before decreasing as countries advance to higher income levels and adopt cleaner technologies (Grossman & Krueger, 1995). Subsequent studies have expanded the examination of this concept and its relevance to various globalization patterns and policy responses derived from the COP accords.

Global liberalization in trade, investment, and technology transfer indicates that globalization has a twofold impact on environmental circumstances; on one hand, it facilitates the dissemination of green technologies and fosters international collaboration in addressing climate change. Nonetheless, it exacerbates environmental concerns by promoting development and resource utilization, particularly in poor nations with lax environmental regulations (Shahbaz et al., 2020; Asghar et al., 2024). The combined impacts of globalization necessitate an examination of how policy frameworks, such as cop agreements, influence the sustainability trajectories of states at different stages of economic development. The Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change has significantly contributed to multilateralism, exemplified by the establishment of the Paris Agreement aimed at limiting global temperature rise and attaining net-zero emissions (United Nations, 2015).

Developed nations possess the financial and technological resources to mitigate environmental deterioration, whereas poor countries are constrained by poverty alleviation efforts, fragile institutions, and reliance on high-emission industries. Consequently, the routes to sustainability are distinctly varied and necessitate tailored solutions that adequately address the nation's socio-economic and environmental contexts. Research has demonstrated that effective environmental regulations and sustainable technologies positively impact industrialized nations by facilitating the dematerialization of the economy and the environment. Conversely, numerous developing countries remain situated in the ascending phase of the EKH curve, grappling with the trade-offs between fostering growth and development while simultaneously mitigating pollution (Zafar et al., 2022; Weimin et al., 2022; Sibte-e-Ali et al., 2023; Naveed et al., 2022; Asghar et al., 2024).

The findings of COP 26 indicate that nations must assume varying obligations and adopt equitable strategies to address climate change. The objective of funding mechanisms such as the Green Climate Fund is to support developing nations in their endeavours to transition to low-carbon economies while simultaneously adapting to climate change (Roberts et al., 2022). The functionality of these institutions primarily relies on multilateralism and the alignment of Member State policies with international obligations. Furthermore, the suitable integration of EKH within COP frameworks could serve as a blueprint for economic advancement and environmental preservation.

This study primarily investigates the relationship between globalization, the Environmental Kuznets Hypothesis, and the outcomes of COP concerning sustainability perspectives in South Asian countries. This study of theoretical and empirical research aims to enhance comprehension of how globalization dynamics and international climate policy might be used to foster sustainable development. The study's findings will enrich the discussion on the extent to which economic potential can be balanced with global ecological obligations and provide practical advice for politicians and investors.

Literature review

This research demonstrates that the Environmental Kuznets Hypothesis remains the primary framework for examining the impact of development on the environment. Utilizing the framework established by Stern (2010), the empirical validity of EKH was confirmed, highlighting the theory's efficacy in elucidating pollution patterns in industrializing countries. Zaman et al. (2014) advanced the EKH model by integrating energy consumption, demonstrating that economic development initially drives carbon emissions, particularly in energy-intensive industries. Advanced economies also discovered that they underwent this period via the export of capital goods, and consequently, through green technologies, they transitioned to the dropping phase of the EKH curve. The earlier study emphasized the characteristics and significance of technological advancements and governmental initiatives in mitigating environmental degradation.

Simultaneously, globalization became firmly established as a catalyst for economic progress and a contributor to environmental issues. Shahbaz et al. (2016) investigated the influence of globalization on CO₂ emissions in East Asia, uncovering a dual effect: Globalization accelerates industrialization and resource consumption while simultaneously disseminating the usage of efficient technologies. Similarly, Hossain (2011) did a study on the relationship between globalization and the environment in developing nations, which found that severe environmental laws are often not implemented, hence exacerbating the effects of globalization. Consequently, there was a demand for budgetary interventions that would align economic integration with environmental goals.

During this period, the significance of international climate policy emerged, culminating in the signing of the Paris Agreement in 2015. In their review, Rogelj et al. (2016) elucidated the revolutionary significance of this agreement, emphasizing the objective of limiting the global temperature increase to below 2°C. The authors emphasized that achieving these aims necessitates substantial enhancements to national programs and climate financing. Zafar et al. (2022) assert that, within the EKH framework, a nation's shift to the dropping segment of the EKH curve is contingent upon the fulfilment of contractual obligations and financial portfolios that promote green innovation and efficient energy utilization.

As of 2018, the literature highlighted the interaction between globalisation and COP outcomes in relation to sustainability. Shahbaz et al. in the study conducted on a sample of developed and developing countries found that on one hand environmental pressure in low-income countries was enhanced due to globalization and on the other hand technology and policy coherence in high-income economies due to globalization. This perspective emphasized the importance of agent-structural dynamics that called for segmenting intervention approaches according to the evolutionary developmental levels of nations. Additional insights were found from Roberts et al. (2022) where the author discussed how climate finance mechanisms such as the Green Climate Fund work, but also stressed that the flow of climate finance needs to be made transparent and accountable, especially when it comes to supporting developing countries shift to sustainable energy systems.

The COVID-19 pandemic shed new light on the effects of globalization on the environment. Le Quéré et al. (2020) found a decrease in carbon emissions globally during the lockdown measures which they attributed to reduced commerce activity. But they also found that emissions rose as fast as the economy came back to normal, which explains why they called for system transformation instead of disruption. Similar observations were made by Huang et al. (2023), who also emphasized the specific importance of mobilizing the private sector for funding long-term sustainability projects.

Building on this, research in the recent past has focused on the contribution of economic development and energy technologies to attaining sustainability. Zafar et al. (2022) stressed that nations having diverse focused economic development and diversified investment portfolio in RE sources have better prospects of achieving the balance between economic development and environmental conservation. This is supported by Yao, et al (2021) who sought to analyze the effect of globalization on renewable energy utilization in emergent economies. Prabir and Rakhshi stated that their study proves that trade liberalization and FDI can enhance the prospects of renewable energy for weakening dependence on fossil fuels.

However, there has been a participation in the incorporation of the social as well as the environmental aspect in globalization structures. To this effect, Sarkodie and Strezov (2019) examined the interaction between environmental performance and income inequality while noting that equal income levels can spur green technologies. Such an attitude emphasizes the need to apply social justice to the fulfilment of the objectives stated in the CPAs' agreements. Likewise, Ahmed et al. (2021) investigated the relationship between trade openness and environmental regulations to show that policy stringency is essential for addressing the negatives of globalization.

Thus, there have been changes in the functions of Conferences of the Parties: the focus of the recent meetings has become equitable and transition to carbon-neutral economies. Thus, the concern with adaptation measures – especially for the communities most exposed – is a sign of an increased awareness of the magnitude of climate change effects. According to Roberts et al. (2022), COP27 provides a critical opportunity for progressing adaptation finance, but demands international coherence in implementation. These developments share views with other literature calling for synergistic development of economic and environmental objectives.

Therefore when integrating the current paper's findings on the environmental Kuznets hypothesis, globalization, and COP outcomes what emerges is a synchronized engagement of various economic, technological, as well as policy dimensions. Fundamental work involved an analysis of the effects of globalization on the environment and the EKH framework and hypotheses that were developed. Later on, subsequent research built upon these themes drew globalization into the debate on sustainability and investigated the part played by international treaties in environmental management. In recent contributions, scholars have paid much attention to the case-specific approaches, technology advancements and fair share transition for achieving both economic recovery and environmental protection. These thoughts offer a sound foundation for the political decision-makers and interested parties, who are trying to understand the challenges that sustainability implies in the world of globalization.

Theoretical Framework

The globalization process is a complex that impacts on the economies, societies and the environment through different modes. It encompasses three main dimensions: liberal, liberal political, and social globalization. All of these dimensions have their own relationships with the environment and they make direct and indirect impacts towards the environment. From the following literature and embracing the recent developments concerning globalization and environment an integrated theoretical framework is presented.

Economic Globalization and Environmental Impact

Economic globalization can be explained as the extent and growth of linkages between country-domestic economies by imports exports, foreign investment, FDI and the movement of people and

business processes. This dimension has been vested with a rich connection with the environmental outcomes of both the virtually favourable and adverse nature. Globalization and rapid liberalization of international trade and investment especially in developing countries have triggered increased industrialization which, in turn, has promoted economic growth but with negative impacts on the environment. It has been for example observed that economic globalization poses both positive and negative effects on the environment. For instance, several economic globalisation ventures such as trade and investment have positively pulled the living standards of developing countries (Kalayci & Hayaloglu, 2019), yet negatively, they have enhanced elevated carbon emission, deforestation, and pollution (Lin et al., 2019; Behera & Dash, 2017; Sibte-Ali et al., 2024). On the positive side, Foreign Direct Investment fosters economic development while on the negative side; it has equally been associated with major environmental degradation through the depletion of natural resources and ecosystem destruction as observed by Wang et al., 2019. Furthermore, the rise in production in developing countries that have high emission intensity has also been pointed out as a force behind global carbon dioxide emissions (Lin et al., 2019).

The current literature on economic globalization advances the argument that although productivity and, along with it, the creation of affluence offer some benefits, the ecological outlook is even worse in entities that have lax environmental policies. This underlines one issue of the world economy that has not been well solved by development policies and strategies – the combination of economic growth with the steady use of resources. Additionally, the application of technological means as one of the aspects of creating a positive social image which contributes to the lessening of negative effects on the environment by implementing green technologies and factors of cleaner production is an emerging research field to explore the complex interactions between economic globalization processes and the environment.

Social Globalization and Environmental Outcomes

Social globalisation indicates the trend of connection of societies through the exchange of persons, knowledge and cultural items. This dimension relates more to alterability in social change, mannerisms and cultural transformations that are closely related to the question of sustainability. International tourism, World Wide Web users and international migrations are some of the elements used to measure social globalization. Although some articles have considered that social globalization may have some positive influence including enhancing environmental consciousness and promoting sustainability through the diffusion of green behaviour (Ozcan & Apergis, 2018), other articles reveal how this pathway poses various negative impacts. For instance, there is the case of tourism, where, although is profitable, the has negative effects on the environment especially in ecologically vulnerable areas (De Vita et al., 2015). Likewise, expanding internet usage and the tags in turn lead to resource consumption and PUTM (Park et al 2018).

Furthermore, transport-related carbon emissions sources are also based on the mobility of individuals, say immigrants and expatriates. Liang et al. (2020) extend this research by showing that cross-national migration in countries with above-world average per capita income leads to an increase in total global per capita CO₂ emissions as the life cycle of migrants entails high emission rates. Social globalization, on the one hand, helps people become more aware of the world and to share culture but, on the other hand, it forms a problem of how to deal with such environmental impacts as the effects of mobility and consumption.

Political Globalization and Environmental Governance

Political globalization is the distribution in space of political decisions, institutions, and treaties. This dimension can be measured with indicators such as membership in international organizations, attendance at global summits, and bilateral or multilateral treaties as well. Environmental outcomes are highly reliant on the forces of political globalization in the sense that political governance implements international agreements and policies. Political globalization may have positive impacts on environmental degradation through writing international treaties such as the Kyoto Protocol and the Paris Agreement aimed at cutting emissions of carbon (Grunewald & Martinez, 2015; Bozkurt & Okumuş, 2017).

Politics of globalization have therefore been observed to occupy a vital position in environmental management in relation to global environmentalism of the earth including climate change, loss of bio-diversity and pollution. However, it has been found that compliance with such agreements may sometimes depend on the level of commitment of developing nations with high emissions to stick to international environmental norms. In this regard, political globalization can work both constructive and destructive in terms of producing favourable shifts in the environmental regime and at the same time revealing the dilettante of international cooperation by conflicting political interests and the absence of any enforcement bodies to make international environmental agreements successful.

The Interconnectedness of Globalization Dimensions and Environmental Impact

Each of the economic, social, and political dimensions of globalization has its unique effect on the environment; their interconnections compound these direct and potential effects. Through increasing industrialization and trade liberalization economic globalization in a way increases the pressures on the environment, especially the developing countries. However, social globalization, because of the enhanced mobility of people and ideas, has both advantages and drawbacks when it comes to environmental consciousness and resource use. This is due to the fact that political globalization that involves international cooperation could go a long way in reducing such negative environmental effects, although is hampered by national selfishness and lack of stringent measures to compel nations into positive action.

Some of the recent literature surprisingly asserts that the impacts of globalization on the environment are not only a function of the first three dimensions but also the functional policies and institutional frameworks governing the dimensions. For example, the sustainable development goals and a global climate change agreement affect globalization results and help to combine economic growth and the preservation of the environment. Further, technology and innovation in the globalised economy as the factor which decreases the environmental costs has become one of the most crucial factors in elaboration of the impact of globalisation on the environment.

Therefore, it can be once again stated that the globalization of the postmodern economy together with social and political processes has a positive influence on the environment. It has provided growth in the economy and raised the standards of living besides bringing about major environmental problems. Globalization has both positive and negative impacts on environmental interactions as summarized in the previous discussion. Observing these factors entails embracing a plural perspective that factors in the aspect of trade, manners, policy and technology. As for the main research questions, further papers in the area should be devoted to the methods for managing globalization strength so that its positive effects outweigh its negative impact on the environment and worldwide climate change.

Empirical Model

In this section Model 1 is constructed to observe the effect of overall globalization on the 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), CO₂ emissions are used as an indicator of environmental degradation, while globalization is represented by an overall composite index that includes three dimensions—economic, social, and political globalization—constructed using various indicators. This composite index is sourced from the Zurich database. CO₂ emissions are chosen as the measure of environmental degradation due to their dominant role in greenhouse gas emissions. The variable X represents a set of control variables, including GDP, population, and inflation. In Model 2, we examine the impact of each dimension of globalization (economic, social, and political) on the environment, with the model designed to assess the individual effects of these globalization aspects.

$$CO_2 = f(Eco. Globalization, Political Globalization, Social Globalization, Trade Globalization)$$

$$Model 2: CO_2 = \alpha_0 + \alpha_1 EG_{it} + \alpha_2 PG_{it} + \alpha_3 SG_{it} + \alpha_4 TG_{it} + \alpha_5 X_{it} + \mu_{it} \quad (2)$$

In Model 2, 'EG' represents economic globalization, 'PG' denotes political globalization, 'SG' indicates social globalization, and 'TG' represents Trade Globalization.

Model 3:

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

The validity of the EKC is assessed using Model 3, which helps evaluate environmental sustainability in the context of overall globalization. In Model 4, globalization is examined at a disaggregated level by considering its economic, political, and social aspects. This model offers a unique perspective on environmental sustainability by incorporating the different dimensions of globalization.

Model 4:

$$CO_2 = \alpha_0 + \alpha_1 EG_{it} + \alpha_2 PG_{it} + \alpha_3 SG_{it} + \alpha_4 TG_{it} + \alpha_5 GDP_{it} + \alpha_6 GDP^2_{it} + \alpha_7 POP_{it} + \alpha_8 Inf_{it} + \mu_{it} \quad (4)$$

Variables Description

The data set is taken into consideration, covering the period from 1991 to 2023. A detail of each variable is provided below.

Economic Globalization

The process that was referred to as economic globalization is the movement of commodities, services and funds across nations. The occurrence of such a phenomenon is measured by the KOF economic globalization index, available in the ETH (Eidgenössische Technische Hochschule) Zurich database. This index is derived using eight components namely trade, FDI, portfolio investments, and income for foreign workers and immigrants. That's why import constraints, tariffs, trade taxes or capital Controls are also taken into account while computing it.

Social Globalization

Social globalization is an interconnectivity that is specifically marked by the exchange of information, opinion and people. This index, sourced from the ETH Zurich database, encompasses three dimensions, interpersonal communication, transfer of information, and sharing of culture. The personal contact dimension is obtained with the help of variables like staff tourism, International population, money remittances, phone traffic, and cross-border correspondence. Many of the media information flows are measured by such indicators as the Internet as a medium for watching TV programs and circulation of newspapers. The cultural dimension is measured by using proxies like the density of the McDonalds restaurants, selling outlets of IKEA furniture and foreign book sales.

Political Globalization

This is the process of the expansion of governmental policies across the globe. This is done by the level of participation in international organizations, the number of embassies, and foreign peacekeeping missions, and the number and types of treaties signed between two nations. The data for ETH Zurich for constructing this index was retrieved from the database of the university.

CO2 Emissions

The CO2 emissions index measures gaseous, liquid and solid fuels in terms of carbon dioxide emission per unit of energy. The data for this index is From the World Development Indicator (WDI).

Control Variables

The control variables include GDP, population, and inflation, with data sourced from the World Bank.

Results and Discussions

Table 1: Panel Unit Root Test

Variable	Levin, Lin & Chu t*	Im, Pesaran and Shin W-stat	ADF - Fisher Chi-square	PP - Fisher Chi-square	Order of Integration
CO2 Emissions	-18.501***	-22.302***	950.72***	1750.52***	I(1)
Globalization Index	-15.384***	-20.837***	820.56***	1500.91***	I(1)
Economic Globalization	-18.485***	-21.219***	920.60***	1650.54***	I(1)
Social Globalization	-12.276***	-15.225***	600.144***	1200.66***	I(1)
Political Globalization	-20.591***	-24.875***	1030.53***	1500.70***	I(1)
GDP	-14.881***	-18.332***	740.610***	1350.92***	I(1)
Population Growth	-10.492***	-6.951***	580.777***	650.621***	I(1)
Inflation	-130.566***	-60.103***	1900.91***	2200.24***	I(1)

Source: Author Estimation

Table 1 examines the stationarity status of each indicator for South Asian countries. The results confirm that all specified variables are I(1), indicating that the underlying variables do not exhibit stationarity at levels but will be stationary upon first differencing. This supports previous findings suggesting that macroeconomic and environmental variables are typically non-stationary, indicating the presence of unit roots. The assessment of stationarity is conducted to ensure improved econometric modelling in later phases.

Table 2: Cointegration Test Results

Test Type	Statistic	Probability
Pedroni Panel v-Statistic	-0.267	0.579
Pedroni Panel rho-Statistic	-0.371	0.218
Pedroni Panel PP-Statistic	-8.721***	0.000
Pedroni Panel ADF-Statistic	-9.930***	0.000
Kao ADF	-1.944**	0.025

Source: Author estimation

Table 2 illustrates that the results of the cointegration tests indicate that all four variables exhibit a long-run relationship among South Asian countries. Evidence for cointegration is established through the Pedroni PP and ADF tests, as well as the Kao ADF test, supporting the hypothesis that globalization, economic growth, and environmental degradation are interrelated in the long term for this region. The results are utilized to estimate long-term relationships using GMM.

Table 3: GMM Estimates for Model 1 (South Asian Countries)

Variable	Coefficients (t-Stats)
L.CO2 Emissions	0.645*** (190.47)
Globalization Index	0.020** (2.02)
GDP	-0.150** (-2.40)
Population Growth	0.120* (1.75)
Inflation	-0.005 (-1.01)

Source: Author estimation

The results in Table 3 offer a disaggregated perspective on the co-integration between CO2 emissions and macroeconomic factors, with globalization identified as a crucial component. The findings indicate an overview of the contextual developments within the South Asian setting. The

significant persistence in emissions, indicated by the lagged CO2 emissions variable (0.645***), suggests that the mechanisms driving emissions remain relatively inflexible over the long term. This discovery aligns with prior findings that highlight the entrenched industrial practices and reliance on fossil energy sources in the region. The persistence underscores the problem of

reevaluating patterns in environmental degradation, consistent with Shahbaz et al. (2020), who similarly noted the inflexibility in emissions linked to historical energy dependencies. The positive coefficient of the globalization index ($= 0.020^{**}$) indicates that globalization has exacerbated environmental challenges in South Asia. This data corroborates the pollution haven hypothesis, indicating that recipient countries for foreign direct investment (FDI) are frequently developing nations that allow elevated pollution levels due to lax environmental regulations. Grossman and Krueger (1995) provide substantial evidence that globalization correlates with economic expansion and industrialization, although it also leads to environmental damage, particularly in nations with fragile institutions. This simplistic conclusion overlooks the end-user dimension, which is crucial for the global dissemination of green technologies and cleaner industrial practices. Additional clarification of this dynamic is presented in the disaggregated models detailed in the next sections of the study.

The negative value (-0.150^{**}) of GDP further substantiates the concept that South Asia may be surpassing the metaphorical 'hump' of the EKH. The author posits that environmental degradation is inversely proportional to a country's income levels, initially rising with income and subsequently declining as higher income levels enable investments in cleaner technologies and the implementation of stricter environmental regulations. This transition aligns with the findings of Zaman et al. (2014), who indicated that economic development enhances access to new technologies for pollution management and resource optimization in industries of developing nations undergoing industrialization. The data suggest that South Asia is approaching the declining phase of the EKH curve regarding emission reduction as economic expansion starts to yield benefits.

The findings indicate that population expansion (0.120^*) exerts a positive but relatively mild impact on emission levels due to increased energy and resource demands associated with a growing population. This result aligns with demographic studies highlighting the environmental impact of population growth in developing countries. For instance, Hossain (2011) examined how population growth exacerbates negative environmental effects through heightened energy use and urban expansion. The integration of these rising demographic factors presents further challenges to South Asia regarding the development-environment equation.

Lastly, inflation, which is negative although statistically insignificant at (-0.005), suggests the manner in which macroeconomic stability may affect environmental management. Nonetheless, citing claims that stable economic conditions may enhance the implementation of environmental regulations by diminishing uncertainty in investment and governance, this outcome is not statistically significant. It is beneficial to persist in this observation to ascertain its practical use. Consequently, the data in Table 3 underscore that globalization, economic growth, and environmental sustainability exhibit a dynamic association. Despite the environmental pressures induced by industrial growth stemming from globalization, this experience may serve as a reference point for the adoption of environmentally responsive technology and policies. The negative GDP coefficient supports the EKH framework, as the region begins to experience the environmental benefits of growth. Nonetheless, total population increase continues to be an issue, highlighting the challenge of demographic control alongside environmental policy initiatives. These findings align with the existing literature about the debated topic and the demographic characteristics highlighted in recent studies, such as those by Sarkodie and Strezov (2019) and Zafar et al. (2022).

Table 4: GMM Estimates for Model 2 (Dimensions of Globalization)

Variable	Coefficients (t-Stats)
L.CO2 Emissions	0.630*** (180.00)
Economic Globalization	-0.120** (-2.50)
Political Globalization	0.150*** (3.00)
Social Globalization	-0.050 (-1.20)
GDP	-0.130* (-1.75)
Population Growth	0.110 (1.60)
Inflation	-0.004 (-1.02)

Source: Author Estimation

Table 4 highlights the decomposition of the globalization index into its economic, political, and social components, providing a nuanced understanding of the extent to which these factors influence CO2 emissions in South Asia. The findings indicate significant and diverse implications for each factor elucidating the complex relationship between globalization and environmental sustainability in the region. Technological transfers and the liberalization of trade and foreign direct investment through economic globalization have led to a reduction in emissions, evidenced by a coefficient of -0.120**. This outcome corroborates the perspective of Shahbaz et al. (2020), which emphasized the significance of economic globalization in facilitating the importation of sophisticated technology and the implementation of sustainable practices in manufacturing for underdeveloped nations. Yao et al. (2021) assert that trade liberalization and foreign direct investment facilitate the transfer of renewable energy technologies, elucidating the inverse relationship between economic globalization and emissions.

Conversely, when the degree of political globalization is elevated, overall emissions in South Asia rise, as indicated by a positive and statistically significant coefficient (0.150***). This outcome also highlights the challenges confronting WEOFs, including the obstacles in implementing provisions of international environmental agreements. The authors assert that political globalization fosters international collaboration; yet, it does not ensure compliance with environmental norms among post-socialist nations that lack institutional capability. This conclusion underscores the necessity for enhancing governance institutions to promote the establishment of effective local implementations of international accords. The particular emission reduction targets of the Paris Agreement (UNFCCC, 2015) are ambitious; nevertheless, the implementation of activities primarily relies on the members' commitment and enforcement capabilities.

Social globalization exerts a marginally negative influence (-0.050) on emissions in South Asia. In the realm of social globalization, while it can promote environmental awareness by disseminating ideas and information regarding eco-friendly practices, it has yet to exert a substantial influence on the region. Ozcan and Apergis (2018) thus employ an extended time frame to aggregate and examine its impact on the environmental dimension within the context of social globalization. In this context, Liang et al. (2020) have underscored the significance of social globalization. The

environmental impact is significantly affected by the region's socio-economic state, which may contribute to the limited effects of social globalization in South Asia.

The factors for GDP (-0.130*) and inflation (-0.004) corroborate the results shown in Table 3, so reinforcing the EKH for South Asia. The negative GDP coefficient underscores the potential for a transition from a high-emission economy to clean technologies and improved environmental management. The insignificant negative inflation coefficient aligns with the idea that a favourable macroeconomic environment can bolster the objectives of environmental policies by mitigating risks and promoting investments in sustainable development (Huang et al., 2023).

The results in Table 4 delineate the unique contributions of globalization factors on environmental impacts. Initially, technological advancements and more efficiency in trade resulting from economic globalization emerge as beneficial factors for the reduction of emissions. Political globalization emphasizes addressing governance challenges within the region to provide robust frameworks that assure adherence to environmental agreements. The weakness of the social aspect of globalization indicates significant potential for the dissemination of cultural and informational messages that advocate for ecological awareness and sustainable practices. These results affirm that globalization, as a complex phenomenon, necessitates examination and management of its multidimensionality, with attention to the implementation of solutions designed to augment its benefits while mitigating its drawbacks.

Table 5: GMM Estimates for Model 3 (Globalization and EKC)

Variable	Coefficients (t-Stats)
L.CO2 Emissions	0.655*** (382.37)
Globalization Index	0.031*** (4.18)
GDP	-0.431*** (-10.69)
GDP Squared	0.024*** (5.56)
Population Growth	0.208*** (21.06)
Inflation	-0.004*** (-6.95)

Source: Author Estimation

Table 5 examines the EKH by incorporating globalization, CO2 emissions, and GDP, along with the quadratic factor of GDP that signifies EKH. The positive coefficient for the globalization index (=0.031 ***) indicates that globalization-driven activities, such as industrialization and resource exploitation, result in elevated emission levels and hence increased total environmental costs. The negative coefficient for GDP (-0.431***) and the positive coefficient for GDP squared (0.024***) provide robust and accurate support for the EKH framework. The results indicate that economic growth initially leads to increased emissions during the early phases of development, but subsequently enhances environmental conditions in later stages due to the adoption of cleaner technologies. The EKH curve shift at this juncture illustrates the conceivable domains of SD routes identified by Zafar et al.(2022).

The demographic factor of population growth in the region significantly positively influenced emissions (0.208***) with a p-value of less than 0.001. Population density increases as a result of accelerated population growth, which drives high energy consumption and resource depletion, thus resulting in environmental damage. This perspective aligns with Hossain (2011), who emphasized the environmental factors contributing to high population increase in emerging communities. The macroeconomic variable of Inflation exhibits a negative coefficient (-0.004***), indicating that macroeconomic factors might effectively diminish emissions by promoting investment in sustainable initiatives and improving policy efficacy, as shown by Huang et al. (2023).

Table 6: GMM Estimates for Model 4 (Globalization and EKC Dimensions)

Variable	Coefficients (t-Stats)
L.CO2 Emissions	0.645*** (190.75)
Economic Globalization	-0.122*** (-34.74)
Political Globalization	0.248*** (38.25)
Social Globalization	-0.085*** (-5.34)
GDP	-0.645*** (-17.68)
GDP Squared	0.046*** (11.88)
Population Growth	0.233*** (11.44)
Inflation	-0.004*** (-10.19)

Source: Author Estimation

Table 6 enhances the analysis by categorizing globalization into economic, political, and social dimensions, indicating more precise consequences within the EKH framework. Maintaining (-0.122***) economic globalization seems to be a pivotal element in enhancing efficiency in technology transfer. This outcome corroborates Yao et al. (2021), who emphasized the significance of trade liberalization and foreign direct investment in augmenting renewable energy utilization and diminishing dependence on fossil fuels. Political globalization ($r = 0.248$, $p < 0.001$) positively influences emissions, highlighting governance challenges and inadequate adherence to regional and global environmental agreements in South Asia. This clearly implies the necessity for developing more robust institutional frameworks and enhanced accountability procedures, as suggested by Roberts et al. (2022).

In this regard, social globalization exhibits a negative coefficient of (-0.085***), indicating that it contributes to emission reduction, but to a lesser extent than economic globalization. The negative coefficient can be elucidated by the potential for cultural and informational exchanges in the development of environmental alarms and the implementation of sustainable practices. Ozcan and Apergis (2018) indicated that the overall index for social globalization significantly contributes to sustainability but with long-term consequences and culturally contingent implications. The EKH dynamics are robust in this model, with GDP (-0.645***) and GDP squared (0.046***) indicating trajectories conducive to sustainable growth. Consistent with prior results, population growth exhibits a positive change of 0.233***, but inflation demonstrates a negative change of -0.004***.

In conclusion, the findings in Tables 5 and 6 compel the research authors to endorse the EKH framework and elucidate the varied impacts that different elements of globalization exert on environmental outcomes. Moreover, economic globalization emerges as a possible catalyst for achieving emission reductions, alongside political globalization, which highlights governance-related challenges that must be addressed to attain sustainability. Social globalization presents an opportunity for the enhanced promotion of environmentally sustainable behaviours through cultural interaction. Consequently, these findings highlight the necessity of addressing the youthful ambition to implement policy interventions that use the advantages of globalization while mitigating its detrimental effects on the environment, thus facilitating the formulation of a sophisticated policy for sustainable development in South Asia.

Conclusion

The theme highlights the dual impact of globalization on the environmental sustainability of South Asia, as revealed by the research. Economic globalization functions as a facilitator of efficiency and a mitigator of emissions through technical transfers and collaboration. Nonetheless, the adverse effects of political globalization suggest that additional resources should be allocated to the implementation of cooperative climate change accords, while national policies must be more effectively aligned with international goals. The validation of the EKH confirms that South African states are progressively advancing towards sustainable development, since economic enhancement results in environmental betterment. Considering these findings, international cultural and informational interactions may promote environmentally sustainable behaviour, but these tendencies are still developing. In summary, globalization and climate agreements such as COP play significant although complex roles in the formulation of sustainable development routes. Nonetheless, numerous national variables necessitate the implementation of targeted policies to attain equilibrium between economic and environmental objectives.

Policy Recommendations

Sustainable development within globalization must be process-oriented, and policy advancements should align with the complex context of economic, social, and political globalization. In essence, all South Asian countries might significantly benefit by seizing the opportunity afforded by economic globalization, either by acquiring technology with lower emission requirements or by liberalizing their markets to enhance access to technology that meets such criteria. The government's influence in the green technology sector should prioritize enhancing regulations on foreign direct investment and trade to promote corporate adoption of sustainable resource utilization. This necessitates the establishment of a regional framework that implements processes and practices ensuring openness in the appropriation process for users and society.

Political globalization facilitates states in reaching agreements, hence creating a significant vulnerability in enforcement and compliance procedures. Clear measures must be devised to establish effective institutional support for aligning national goals with the Paris Agreement. The incorporation of enhanced governance frameworks and the facilitation of climate finance mechanisms, such as the GCF, can assist South Asian nations in mitigating governance deficiencies and improving adherence to international environmental regulations. There must also be a commitment to contextualizing these frameworks to the developmental and institutional settings of other countries, as well as a commitment to equity and reasonableness in policy implementation.

The potential for social globalization to improve environmental awareness can be further augmented by legislative initiatives that include both cultural and informational elements to

promote sustainability. The government is urged to develop comprehensive programs that incorporate awareness initiatives in schools regarding environmentally friendly practices and conservation efforts. Collaborating with civil society organizations and utilizing information technology to promote sustainable behaviours among the people. Thus, social globalization, which seeks to enhance social awareness and public engagement, might facilitate greater cohesion of the sustainability agenda alongside economic and political globalization initiatives. These recommendations emphasize the integrated use of the solutions presented in the study, wherein economic progress, international relations, and public engagement do not conflict with environmental deterioration. South Asia must implement policies that address governance deficiencies, demographic challenges, and geographical differences in innovation to mitigate the effects of pro-globalization and global environmental liabilities.

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