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Unraveling the Nexus: The impact of economic globalization on the environment in Asian economies

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ABSTRACT

Even if the globalization of the economy has resulted in changes in environmental quality, environmental policy formulation still requires research that integrates the KOF Globalization Index and the load capacity factor Index into a single framework. From 1996 to 2020, the study examined the effect of economic globalization on the environmental integrity of Asian economies. Utilizing a load capacity factor index as a proxy for environmental quality and the KOF economic globalization index to measure economic globalization is distinctive to this study. Checking the independent and interactive effects of economic globalization and institutional quality on environmental quality is another innovative aspect of this study. This study modified the conventional environmental Kuznets curve based on economic globalization to derive the geometry of the environmental Kuznets curve based on economic globalization. The System generalized method of moment technique is used to determine the long-term relationship between economic globalization and environmental quality. The system GMM analysis demonstrates a positive correlation between the globalization of the economy and environmental performance. In addition, the results corroborate the inverted U-shaped relationship between economic globalization and environmental quality for the 48 Asian economies analyzed. In addition, the results confirmed the importance of institutional quality in mitigating the negative impact of globalization on environmental quality. Consideration is given to policy recommendations based on these findings.

Introduction

Sustainable Development Goal (SDG) 13 of the 2030 United Nations Sustainable Development Agenda addresses the urgent need for environmental sustainability. Carbon dioxide (CO₂) emissions, mainly from the combustion of fossil fuels, are a significant factor in global warming. Electricity production, the transportation system, individual households, and commercial enterprises contribute to these emissions. To effectively address climate change, it is crucial to fully comprehend and reduce these sources of carbon emissions, shifting to cleaner and more sustainable energy sources and practices to lessen their adverse effects on the ecosystem and the future of our world (Ngozi Adeleye et al., 2023). Climate change is undeniably a worldwide concern that affects all nations, irrespective of their developmental status. It serves as a poignant illustration of our interdependence, albeit in a detrimental

manner. One of the advantages of globalization is that it facilitates the unrestricted movement of individuals, financial resources, commodities, services, technological advancements, and cultural influences between other nations. The interconnectivity observed in various societies can catalyze fostering global harmony and cooperation by facilitating deeper interactions among distinct communities. Nevertheless, climate change proves that our acts in a particular geographical region can yield extensive and frequently adverse consequences for other areas. This statement underscores the pressing necessity for a unified international effort to tackle the everyday obstacles of climate change, emphasizing the significance of conscientious globalization that considers the welfare of individuals and the environment (Ahmed et al., 2021; Baajike et al., 2022; Cao et al., 2022; Xu et al., 2022; Yang et al., 2021b).

The relative significance of the demand side (as represented by the Ecological Footprints index) and the supply side (as defined by

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Biocapacity) in generating ecological deficits and surpluses is a matter of greater importance (Sarkodie, 2021). The Sustainable Development Goals (SDGs) emphasize the urgent need for nations to promptly take action to mitigate climate change and its associated consequences (Pallangyo et al., 2020). The Paris Agreement, adopted in 2015 and ratified by numerous countries, aimed to limit global warming to below 2 degrees Celsius above pre-industrial levels and pursue efforts to limit it to 1.5 degrees Celsius. Each country was responsible for setting its emission reduction targets, called Nationally Determined Contributions (NDCs). By 2015, global emissions had been steadily increasing, and the commitments made by countries under the Paris Agreement were seen as a vital step towards curbing this trend. However, many experts acknowledged that the initial NDCs needed more ambition to achieve the Agreement's temperature goals. As a result, the overall impact on global emissions was less substantial than required (Dong et al., 2018). Indeed, identifying and addressing the relevant causes of climate change remains one of the most urgent issues facing the world today. Climate change is a complex phenomenon influenced by various human activities and natural factors, and its impacts are being felt globally, affecting ecosystems, weather patterns, agriculture, water resources, and human livelihoods (Yang et al., 2021b). Globalization has significantly impacted the environment, and its influence on environmental quality, including climate change, is a complex and multifaceted issue. While economic globalization has brought numerous benefits to open economies, it has also led to various environmental challenges that cannot be overlooked. Positive aspects of economic globalization include increased trade, investment, and technological advancements, which have contributed to economic growth and improved living standards for many people. However, the environmental consequences of globalization must also be considered (Yang et al., 2021a). The debate around whether economic globalization can cause climate change is complex and multi-faceted, with scholars presenting various viewpoints. One school of thought suggests that economic globalization can contribute to climate change through the "pollution haven hypothesis." This hypothesis posits that some developing countries may relax their environmental regulations to attract foreign direct investment (FDI) and industrial activities from multinational corporations (Benzerrouk et al., 2021). The concept of "green growth" represents another school of thought that argues economic globalization, industry, capital flows, and innovation can be crucial in addressing environmental pollution and climate change. The green growth perspective emphasizes that economic development and ecological sustainability are not necessarily conflicting goals; instead, they can be mutually reinforcing (Ahmad et al., 2021).

The increasing importance of environmental issues, particularly global warming, moreover how the expansion of worldwide trade in consumer products contributes to the worsening of these challenges; one critical aspect is the issue of diffuse pollution, which refers to breakdown that does not come from a single, identifiable source but from various dispersed sources, such as roads, sea, aviation, and agriculture. While each of these diffuse sources might not individually be substantial contributors to pollution, when their cumulative impact is considered, they can have a significant overall effect on the environment. It makes addressing diffuse pollution complex since it involves dealing with numerous sources across vast areas. To effectively tackle these environmental challenges, international cooperation is crucial. International talks and burden-sharing agreements are necessary to promote collective action and responsibility among nations (Fakher et al., 2021; Ntow-Gyamfi et al., 2020; Shahbaz et al., 2018; L. Zhang et al., 2022). Achieving a global climate pact that is both effective and binding is a complex and instructive challenge, and it takes work. There is no denying that Earth's ecosystem is crucial to human survival and that our species cannot afford to disregard the effects of our actions. Therefore, humanity must act and maintain ecological balance. Good policies are necessary to deal with climate change. Environmental, social, and economic policies must be informed by solid research and analysis and deep

comprehension of their interdependencies. Extensive debate and discussion between governments, corporations, scientific professionals, non-governmental organizations, and the public are necessary to develop and implement such policies. Developing international climate agreements and putting them into practice takes time and effort. The issue's intricacy presents a significant obstacle. It can be challenging to identify solutions to the problem of climate change that consider the demands and interests of a wide range of nations and groups. In addition, political and economic concerns sometimes influence conflicts and reluctance to commit to aggressive climate targets. Some countries may value quick economic gains more than environmental sustainability in the long run. However, others may feel weighed down by their obligations due to past emissions or few resources. In addition, not everyone may recognize the seriousness of climate change, which can lead to misinformation or skepticism that slows down or stops collective action. It becomes necessary to bridge the divide between those who recognize the gravity of the issue and those who are hesitant to act. Despite these obstacles, efforts to reach a worldwide consensus on climate action must continue. Ecosystems, food security, water resources, human health, and economies worldwide are all at risk if climate change is allowed to progress unchecked. We need unprecedented cooperation, teamwork, and creativity to solve these problems. The Paris Agreement and other international pacts are positive first steps, but more needs to be done to make them effective. Governments should foster renewable energy consumption, sustainable practices, and carbon footprint reductions. At the same time, local and global efforts significantly impact the climate change movement. Individuals, corporations, and governments all affect the environment through their decisions.

In conclusion, the difficulty of reaching a binding global climate agreement highlights the gravity of the issue. Ecological stability must be protected if humans are to continue Earth, and this can be done only by concerted efforts on the part of people from all walks of life. Humanity can lessen climate change's worst effects and create a sustainable future if its members recognize the gravity of the problem and work together.

Trends in Ecological footprint, biocapacity and load capacity factor index for Asian countries are plotted against 2020 in Fig. 1. The ecological footprint index (demand for the ecosystem) surpasses the supply of the ecosystem (Biocapacity), as seen by trends in the load capacity factor index and ecological footprint and biocapacity, indicating a deficit in the ecosystem in the Asian region. Biocapacity exceeds Mongolia's and Russia's ecological footprint index, making them two of the few Asian countries with an ecological surplus. Fig. 2.

According to the trends observed in the economic globalization of KOF, Singapore holds the top position, followed by the United Arab Emirates, Bahrain, Cyprus, Georgia, and Qatar. The Iranian economy has achieved a ranking of forty-eight among all Asian countries.

This work's primary objective is to contribute significantly to the existing empirical discourse on the correlation between institutional quality, globalization, and carbon dioxide emissions in the Asian context. The study utilizes an imbalanced panel dataset covering 1996 to 2020. The dataset includes variables such as ecological footprints, indicators of institutional quality, the Kof economic globalization index, and several control variables. The study aims to achieve three primary objectives: The primary objective of this study is to examine the potential influence of institutional quality and globalization on carbon dioxide emissions within the Asian area. Furthermore, the aim is to assess the degree of leverage exerted by these factors on emissions and ascertain whether one component holds greater significance. Thirdly, this study aims to elucidate the complex interplay among these variables, contributing to developing evidence-based policies and strategies for reducing carbon emissions in Asia. Additionally, it examines the influence of institutions and globalization on environmental results to provide a comprehensive understanding of the subject matter. By addressing these three dimensions, the article endeavors to shed light on how economic globalization, institutional quality, and their interaction influence the environmental performance of Asian economies. This

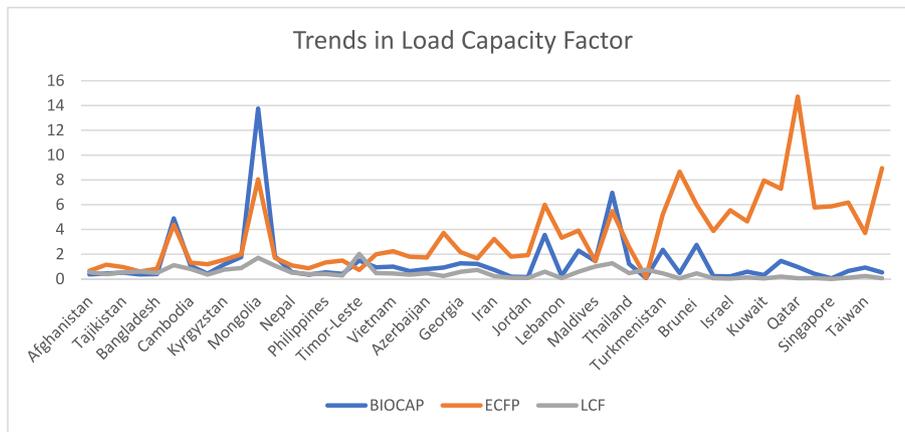


Fig. 1. Trends in Load Capacity Factor Index. Source: Global Footprint Network (Latif, 2022).

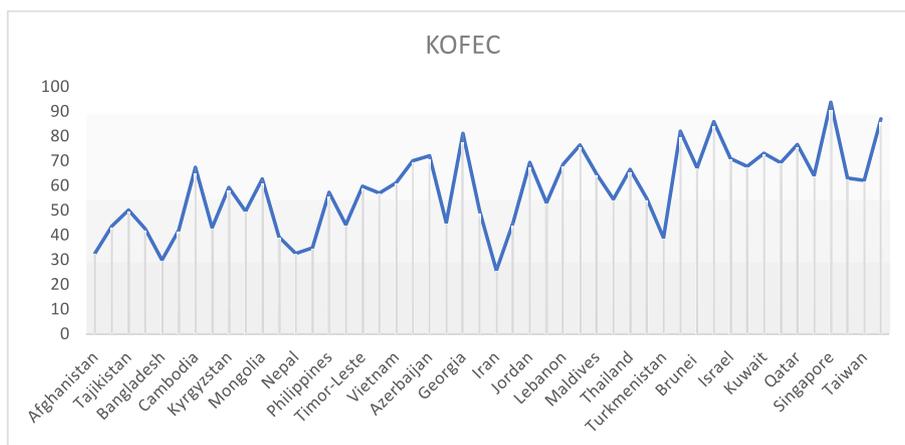


Fig. 2. Trends in KOFEC. Source: KOF Swiss economic Institute.

research is of particular importance given the significant share of the global economy held by Asia and the potential implications of globalization on the environment in the region.

The remaining part of the paper is organized as the next section offers a literature review. The third part explains the theoretical framework of the study. The following section offers the data and methodology. The fifth section is devoted to presenting the results. The final section offers the conclusion and policy recommendations.

Literature review

Globalization has had significant impacts on animal species and their habitats. As human activities, such as deforestation, urbanization, and industrialization, expand, many animal species are losing their natural habitats. This forces them to adapt to new environments or migrate to find suitable living conditions, which often puts them in danger and can lead to widespread mortality. Deforestation is a significant concern. Forests are critical ecosystems that support various plant and animal species. When forests are destroyed for purposes like agriculture, logging, or infrastructure development, their biodiversity is severely affected. Many species lose their homes, and some may not survive adapting to new surroundings.

Furthermore, the excessive consumption of fossil fuels, such as coal, oil, and natural gas, has contributed to global warming or the increase in Earth’s average temperature. Burning these fuels releases greenhouse gases (such as carbon dioxide) into the atmosphere, trapping heat, and causing the planet to warm up. This warming has a range of adverse effects on the environment, including melting polar ice, rising sea levels,

more frequent and severe weather events, and disruptions to ecosystems. The warming climate can also impact animal habitats, making survival difficult for certain species. For example, some animals may struggle to adapt to changes in temperature or shifts in their natural food sources, leading to population declines or even extinction. It is crucial to recognize the importance of conserving natural resources and protecting the environment to preserve biodiversity and ensure a sustainable future for all living organisms, including humans. This involves reducing greenhouse gas emissions, promoting sustainable practices like reforestation and renewable energy sources, and protecting vital ecosystems. International cooperation and concerted efforts from governments, organizations, and individuals worldwide are necessary to address these global challenges (Fakher et al., 2021; Ntow-Gyamfi et al., 2020; Shahbaz et al., 2018; L. Zhang et al., 2022). Globalization indeed has significant impacts on the Earth, including environmental consequences. As mentioned, deforestation is a significant environmental issue associated with globalization. Some ways globalization contributes to deforestation and its implications: a) Globalization has increased the demand for agricultural products, such as soy, palm oil, and beef, leading to the expansion of agricultural land. Often, this expansion occurs at the expense of forests, as trees are cleared to make way for farms and plantations. This deforestation not only destroys valuable ecosystems but also contributes to the loss of biodiversity. 2) The demand for timber and wood products has risen with globalization. Uncontrolled logging for timber trade can lead to extensive deforestation, particularly in tropical rainforests, where some of the world’s most biologically diverse ecosystems exist. 3) As nations embrace globalization and economic growth, there is an increased need for infrastructure

development, such as roads, highways, and dams. These projects often require the clearing of forests, causing habitat fragmentation and degradation. 4) The interconnected nature of global supply chains means that products may have components from different parts of the world. For instance, furniture, paper, and packaging can contain materials from deforested areas, indirectly contributing to forest destruction. To address these challenges, international cooperation and responsible practices in trade and development are essential. It includes promoting sustainable agriculture, responsible sourcing of forest products, and supporting conservation efforts to protect and restore forests and their ecosystems. Additionally, implementing and enforcing stringent environmental regulations can help mitigate the negative impacts of globalization on the environment (L. Zhang et al., 2022). Environmental responsibility requires individuals, organizations, and nations to act now to preserve the environment for future generations. It involves acknowledging human impacts on nature and taking steps to mitigate them. Industrial and carbon transfer zones can degrade the environment. Industrial operations generate greenhouse gases and pollutants, causing climate change and environmental deterioration. Carbon transfer zones carry industrial pollutants to neighboring places. Economic globalization—integrating economies and the free flow of commodities, capital, and services across borders—has environmental benefits and drawbacks. Globalization can boost economic growth and technology, which may help develop and adopt cleaner technologies. Globalization increases consumption, resource depletion, and carbon emissions. Comprehensive environmental performance indexes analyze a country's environmental performance to solve globalization-related environmental challenges. These indices track environmental indicators and provide ways to improve environmental protection. The study noted that environmental issues can cause extreme weather, global warming, and environmental disasters. Growing emissions and pollution levels cause these issues. Sustainable global development balances economic growth and environmental protection. Clean environment laws govern industrial activity and limit harmful emissions. It also demands supporting sustainable economic growth and energy-efficient and renewable energy sources. China's carbon transfer example shows how certain countries may struggle with environmental management. Strategic strategies and initiatives must address carbon emissions from industrialized and energy-intensive regions. Environmental responsibility ensures a healthy and sustainable earth. Governments, corporations, communities, and individuals must work together to reduce human-induced environmental damage and create a greener, more sustainable future (Ntow-Gyamfi et al., 2020; Shahbaz et al., 2018; L. Zhang et al., 2022). Asia's developed economies—UAE, Kuwait, Bahrain, and Qatar—have the highest CEPI scores. These nations are doing well in environmental protection and sustainability. Bangladesh, Yemen, Timor Leste, Myanmar, Cambodia, and Afghanistan have CEPI minimums. It shows these countries have lower environmental performance and may need assistance with environmental challenges and sustainable practices. To evaluate a country's environmental performance, the CEPI evaluates air quality, water resources, biodiversity, climate change, and sustainable energy use. Asian and Middle Eastern developed economies with high scores may prioritize environmental protection and sustainability. Conversely, the lowest ratings for the above countries indicate the need for more support in strengthening their environmental practices and regulations (Latif, 2022). Another study found the highest energy efficiency in Australia, China, Japan, Saudi Arabia, and Poland. Mexico, Indonesia, Russia, and Brazil are the least productive of the 20 nations (L. Zhang et al., 2022). Many studies have examined how economic systems and human activities cause climate change and ecological deterioration. Burning fossil fuels, deforestation, industrial processes, and other economic development activities increase greenhouse gas emissions and environmental deterioration. These actions have caused global warming and environmental degradation, threatening Earth's sustainability. The "green economy" has emerged to address these challenges. Green economies reduce

environmental dangers and ecological scarcities while promoting economic growth and social well-being. It aims to reduce climate change by shifting from unsustainable economic practices to more sustainable and resource-efficient ones. Green economic strategies include. 1) Switching from fossil fuels to solar, wind, hydro, and geothermal power can reduce carbon emissions and fight climate change. 2) Promoting chemical-free, biodiversity-preserving, and ecosystem-healthy farming. 3) Reducing, reusing, and recycling to reduce waste and resource use. 4) Conserving and restoring natural habitats, biodiversity, and ecosystems. 5) Sustainable, resilient infrastructure for low-carbon transportation, energy-efficient buildings, and water management. Promoting electric cars and other low-emission transportation. 6) Encouraging sustainable practices and discouraging ecologically destructive ones. A successful green economy transition can help address climate change and its various effects, including extreme weather events, rising sea levels, biodiversity loss, and poor health and well-being. A green economy can improve social fairness, poverty reduction, and human flourishing through meeting other sustainable development goals. Green economy transitions have been studied extensively. To ensure a sustainable and resilient future, researchers and policymakers worldwide study such a change's economic, social, and environmental effects (Chen et al., 2022; Etokakpan et al., 2020; Hossain et al., 2023; Kusumawardani & Dewi, 2020).

The research emphasizes the need to reduce carbon emissions by implementing renewable energy technologies in the context of reaching Sustainable Development Goal 7. It stresses the growing significance of switching to cheap and clean energy sources to reduce pollution and boost economic viability. Indicators of economic growth such as capital, trade openness, and government spending are discussed, along with the potential impact of renewable energy sources such as hydropower, wind power, biomass, geothermal, and solar photovoltaic. It also stresses the importance of using cutting-edge econometric methodologies and panel data analysis to examine these consequences over the long run for a subset of Asian countries. The review concludes that the study's findings provide valuable insights for stakeholders involved in achieving sustainable development goals in an integrated and coherent manner and that the empirical results demonstrate a significant and positive influence of various renewable energy sources on the economic growth of Asian economies (Jun et al., 2021; Li et al., 2023; Liu et al., 2022).

Research Gap Statement: Although there is a considerable corpus of scholarly literature investigating the environmental consequences of economic globalization in Asian economies, this study seeks to fill a significant research gap thoroughly. The current body of literature primarily examines the linear associations between economic globalization indicators, such as trade openness, foreign direct investment, and global value chains, and environmental outcomes, such as pollution levels and resource depletion. However, there needs to be sufficient exploration into the potential non-linear dynamics within this intricate relationship.

This study acknowledges the necessity of moving beyond linear assumptions and thoroughly evaluating the presence of non-linear associations between economic globalization and environmental consequences in Asian economies. Non-linear dynamics can be observed in ecological degradation, wherein its progression may initially accelerate due to globalization. However, if nations achieve certain levels of development or implement specific policies, this trend may eventually decelerate or even reverse.

Moreover, the existing body of research lacks a delineated and situation-specific conceptual framework for constructing an Environmental Kuznets Curve (EKC) rooted in globalization, which adequately considers the intricate environmental consequences linked to economic globalization in Asian economies. It is crucial to ascertain the presence of a curve, identify its inflexion points, and analyze the determinants influencing its form to develop efficacious environmental policies that account for the diverse ramifications of globalization.

Moreover, the unexplored domain of the Asian setting pertains to the interaction effect of economic globalization and institutional quality on

the environment. The impact of globalization on the environment can be either exacerbated or alleviated by the existence of solid institutional frameworks. Examining the role of institutional quality in moderating the link between globalization and environmental consequences is crucial for policymakers aiming to build regulatory and governance structures that foster sustainable development.

Hence, the primary objective of this study is to address these significant research deficiencies by utilizing a comprehensive and multifaceted methodology. The study aims to examine the linkages between economic globalization and the environment, considering both linear and non-linear associations. Additionally, the research will develop a specific Environmental Kuznets Curve (EKC) model based on globalization, focusing on Asian economies. Moreover, this study aims to investigate the combined impact of globalization and institutional quality on the environment in the Asian region to enhance our understanding of the complex relationship between globalization and the environment.

By undertaking this study, the research presented here enhances our understanding of the comprehensive environmental consequences associated with economic globalization. This research provides significant perspectives for policymakers and stakeholders committed to achieving a harmonious equilibrium between economic advancement and environmental preservation in Asian economies.

Theoretical framework

The 1995 research paper by Gene M. Grossman and Alan B. Krueger titled “Economic Growth and the Environment” discusses three channels through which economic globalization can affect the environment. 1) Technology Transfer (Technical Effects): This channel transfers environmentally friendly technologies and practices from developed to developing countries. As advanced technologies are adopted in developing nations, they can reduce pollution and improve environmental quality. 2) Composition of Output (Composition Effect): Economic globalization can influence the composition of industries and the types of goods produced in different countries. Specific industries may be more resource-intensive and polluting, while others may be cleaner and more sustainable. Changes in the composition of output can have varied effects on the environment. 3) Economies of Scale (Scale Effect): Globalization can increase economic activity and production on a larger scale. This growth in economic output can put additional pressure on natural resources and the environment, potentially leading to higher pollution levels and environmental degradation. These channels are expressed in Fig. 3.

The Grossman and Krueger (1995) paper is a seminal work in environmental economics, providing valuable insights into the complex relationship between economic growth, globalization, and environmental quality. Stagl (1999) links the composition effect to environmental benefit—an economy’s income shifts from primary (pollution-intensive) to tertiary (environmental-friendly) operations. He said technical effects worsen environmental degradation as green technology replaces pollution-intensive technology. Combining these effects, the

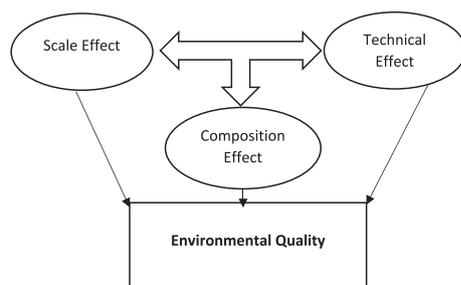


Fig. 3. Globalization- Environment Nexus. Source: Grossman and Krueger (1995).

scale effect hypothesis surpasses the composition and technological effects at the start of development; growth inversely influences environmental quality. The initial EKC slope would be positive. After a turning point, composition and technical effects degrade the environment more than scale effect hypotheses, resulting in a negatively sloped EKC (Clement and Meunie (2008).

Zhang, (2011) suggested that financial development affects environmental quality through three mechanisms: investment, financing, foreign direct investment, and growth avenues. Figure 4 shows these channels—the first channel related environmental quality to globalization through foreign direct investment and growth, increasing energy demand. The second channel highlighted financial sector intermediation and loan creation. The third channel highlighted the investment route between financial development and environmental quality. Soukhakian, (2007) and (Katircioglu, 2012) It has been confirmed that empirical evidence supports the notion that globalization is a crucial indicator of economic growth. It is imperative to take into account the environmental ramifications of globalization. Katircioğlu and Taşpinar, (2017) and Çetin and Ecevit, (2017) highlighted how rising incomes and associated increases in energy demand and investment negatively impact environmental quality due to globalization. Further, Chang (2014) highlighted that globalization improves environmental quality by channeling resources towards the most innovative companies and encouraging technological innovation in the energy industry.

Data and methodology

The empirical pattern we’re studying at is:

$$LCF_{it} = \varphi_1 LCF_{t-1} + \varphi_2 KOFEC_{it} + \varphi_3 IQ_{it} + \varphi_4 GDP_{it} + \varphi_5 KOFEC_{it}^2 + \varphi_6 KOFEC_{it} \cdot IQ_{it} + a_i + \epsilon_{it} \quad (1)$$

Where,

LCF → Load Capacity Factor Index → Biocapacity/ECFP.

KOFEC → KOF Economic globalization index as the indicator of economic globalization

IQI → stands for institutional quality indicator and we use Government effectiveness to measure the institutional quality.

To check for the shape of globalization based EKC (KOFEC) we use the quadratic term of KOF Economic globalization index.

KOFEC.IQ → represents the intersection between economic globalization and institutional quality to capture the intersecting effect on environmental quality.

a_i → represents the time invariant country specific effect, and ϵ_{it} is white noise error term. a_i , and ϵ_{it} have the common characteristics.¹

Data is collected from multiple sources. Data on LCF is extracted from (Latif, 2022),² and the data on KOFEC is obtained from the KOF Swiss economic Institute.³ The data for the indicators of IQI is taken from the Worldwide Governance Indicators,⁴ and the data for GDP is taken from the world development indicators.⁵ By combining these data sources, we can obtain an annual data set for 48 countries in Asia from 1996 to 2020. The methodological road map is the first to choose the suitable econometric technique we apply the diagnostic tests to check the cross-sectional dependence, stationarity, heteroscedasticity, autocorrelation, Multicollinearity, and endogeneity tests.

The present study can generate significant socio-economic advantages by investigating the intricate relationship between economic globalization, environmental issues, and their drivers in Asian

¹ $a_i \approx i.i.d(0, \delta_{ai})$, and $\epsilon_{it} \approx i.i.d(0, \delta_{\epsilon})$, $E(a_i, \epsilon_{it}) = 0$

² <https://www.footprintnetwork.org/>.

³ <https://kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html>.

⁴ <https://databank.worldbank.org/source/worldwide-governance-indicators>.

⁵ <https://databank.worldbank.org/source/world-development-indicators>.

economies. By analyzing linear and non-linear interactions, constructing a globalization-based Environmental Kuznets Curve (EKC), and investigating the combined impact of globalization and institutional quality, this study provides policymakers with significant knowledge to facilitate well-informed decision-making. This understanding can facilitate the development of more efficient and focused policies, fostering sustainable economic expansion while concurrently addressing environmental deterioration. These policies have the potential to attract foreign investment, maximize the allocation of resources, and improve the general welfare of communities. Furthermore, enterprises can synchronize their strategic approaches with the outcomes of research, making a valuable contribution to the preservation of the environment while simultaneously maintaining a competitive edge in the ever-changing global markets. This research possesses the capacity to cultivate enduring economic resilience, protect natural resources, and enhance the socio-economic circumstances of Asian economies and their inhabitants.

Results and discussion

We performed the descriptive statistics analysis shown in Table 1 to acquire some understanding of the properties of the dataset. The value of skewness for all variables is positive and exceeds zero according to the descriptive statistics. As a result, every variable has shown signs of skewness to the right. Additionally, since the excess kurtosis is greater than zero, it follows that the fat-tailed phenomenon occurs in the distributions of all variables. All variables are ruled out of having a normally distributed distribution based on the skewness and kurtosis findings. The results were subsequently verified by the Jarque-Bera test. These results lend credence to the idea that the quantitative methodologies described in the following section should be used.

We determined whether there is a cross-sectional dependency before using panel unit tests for stationarity of the variables. The results are shown in Table 2 after using the Pesaran (1980), Friedman (2004), and Frees (1995, 2004) tests.

The findings show the existence and strength of cross-sectional dependency. These tests proposed null hypothesis is that there is no cross-sectional dependency. These results indicate that here it is not feasible to proceed by applying the first-generation econometric approaches. The results of the second-generation unit root test (CIPS & CADF) and second generation cointegration test are reported in table 3 and 4 respectively.

All variables are stationarity at a significance level of 1 % under the stringent assumption and a wide range of tests from CIPS and CADF. The results in Table 3 guarantee that all panels are stationary, whether cross-sectional dependency occurs.

The results of Westerlund tests are shown in Table 4, and they indicate that four of the four tests reject the null hypothesis based on the crucial values produced by bootstrapped robust. These results provide more evidence that variables exhibit a long-term relationship based on cointegration.

The diagnostic tests (Autocorrelation, Heteroscedasticity, and Endogeneity) are reported in Table 5. Woolridge autocorrelation test utilized to measure the autocorrelation and Wald group wise heteroscedasticity test incorporated to check for heteroscedasticity. The Durbin chi square and Wu Hausman test applied to check for the problem of endogeneity. Results in Table 5 indicated the existence of heteroscedasticity, autocorrelation, and endogeneity at 1 % significance level. Thus, in the presence of cross-sectional dependence, heteroscedasticity, autocorrelation, and endogeneity the usual ordinary least square techniques provide misleading results. To overcome this issue, we can derive the long run estimate by applying the system generalized method of moment when N (Cross sections) are greater than T (Time period).

The main estimation results of system GMM⁶ analysis is reported in Table 1. We prefer to adopt the System GMM analysis proposed by

(Blundell & Bond, 1998) to address the problem of endogeneity in the explanatory variables combine with the issues of heteroscedasticity, autocorrelation, cross sectional dependence, and country fixed time invariant effect. Two additional methodologies, PMG (Pooled Mean Group) were used to test the robustness of the estimators. Because neither technique addresses endogeneity, omitted variable bias, or the time dimension of the data, they are not appropriate for dynamic panel estimation. The results are reported in Table 6.

Table 6 is divided into three panels. Where panel-1 establishes the independent relationship between economic globalization, instructional quality, and environmental performance, while the second panel trace about the shape of economic globalization based EKC (KOF_EKC) for Asian economies. The third panel traces the intersecting effect of economic globalization and institutional quality on environmental quality.

We use GMM-type instruments to measure the lagged dependent variable, LCF. The problem of having too many instruments is solved by using the "rule of thumb". We test with a variety of lag counts in the instrument matrix,⁷ and here provide a set of conclusions based on the minimum number of lags required to maintain the degree of freedom.⁸

We can also clearly see how KOFEK has benefited LCF, since the statistics show that a 1 % increase in economic globalization will result in a 0.23 %, 0.19 %, and 0.12 improvement in LCF. As a result, given other factors being equal, Asian economies with higher levels of economic globalization will exhibit superior environmental performance over time. The empirical evidence that supports a positive correlation between economic globalization and environmental improvement in Asian economies challenges prevailing beliefs and provides novel insights for both empirical investigation and theoretical advancement. The need to comprehend the intricate manners in which globalization might influence the environment is underscored, with a particular emphasis placed on the involvement of institutions and policies in effectively using the potential advantages of economic globalization to promote sustainability (Fakher et al., 2021; He, 2006; Nasir et al., 2019; Ntow-Gyamfi et al., 2020; Shahbaz et al., 2018; Solarin et al., 2017; Yang et al., 2021b). Interregional movement of production elements is made possible by economic globalization. In most Asian nations, advanced technologies and patents are exchangeable through sales and transfers. In this way, the environmental protection sector has also fully developed and changed as a direct result of sophisticated technology. Markets have been flooded with green patents and innovations. This has been extremely important in improving environmental performance. The empirical evidence suggests a correlation between GDP growth and environmental performance, wherein a 1 % increase in GDP is associated with a decrease of 0.13 %, 0.16 %, and 0.12 % in environmental performance. These findings are consistent with the widely recognized Environmental Kuznets Curve (EKC) hypothesis. Based on the idea above, throughout the initial phases of economic advancement, there is a tendency for environmental deterioration to escalate alongside the growth of Gross Domestic Product (GDP), mainly attributable to heightened industrialization and intensified utilization of resources. Nevertheless, as economies attain a certain threshold of prosperity, they tend to allocate more excellent resources towards preserving the environment, resulting in enhanced environmental outcomes. The discovered negative relationship suggests that the Asian economies being examined are currently in a stage where economic expansion is linked to a rise in ecological deterioration. The findings of this study highlight the inverse correlation between the Institutional Quality Index (IQI) and environmental performance. Specifically, an elevation in IQI is associated with a decrease of 0.18 % in environmental performance. This emphasizes the significance of institutions in influencing ecological outcomes. The results align with the theoretical predictions that solid

⁷ the results are widely consistent.

⁸ For the application of system GMM analysis follow <https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.612.3134&rep=rep1&type=pdf>.

⁶ Blundell and Bond (1998).

Table 1
Descriptive Statistics.

	LCF	KOFEC	GDP	KOFEC ²	IQI
Mean	-0.007476	55.27957	130.8592	19,047,776	-0.001947
Median	-0.267629	55.03095	4.998878	28.05755	-0.098004
Maximum	11.13860	94.62914	150934.0	2.28E + 10	5.568886
Minimum	-1.817693	18.02576	-54.01140	0.000300	-4.585284
Std. Dev.	1.186402	15.47208	4364.238	6.59E + 08	2.155166
Skewness	3.919394	0.071856	34.53975	34.53984	0.281708
Kurtosis	25.38490	2.576026	1193.996	1194.001	2.623455
Jarque-Bera	28032.77	9.986977	70,925,016	70,925,541	22.88468
Probability	0.000000	0.006782	0.000000	0.000000	0.000011
Sum	-8.940925	66114.37	156507.6	2.28E + 10	-2.328876
Sum Sq. Dev.	1682.021	286065.2	2.28E + 10	5.19E + 20	5550.467

Table 2
Cross Sectional Dependence.

Test	Statistics	Decision
Pesaran	-0.387 ^a	Cross Sectional Dependence
Friedman	13.785 ^a	Cross Sectional Dependence
Frees	6.961 ^a	Cross Sectional Dependence

The Null Hypothesis for all three tests → Cross Sectional Independence
 'a', 'b' and 'c' Denotes the Significance At 1 % and 5 % level respectively.
 Source: Own Elaboration

Table 3
Second Generation Unit Root Test.

Variable	Test	At Level	At First Difference	Conclusion
LCF	CIPS	2.12	-5.01 [*]	I (1)
	CADF	2.61	-4.53 ^{***}	
KOFEC	CIPS	4.32	-8.13 [*]	I (1)
	CADF	1.51	-9.37 [*]	
GDP	CIPS	2.63	-4.29 [*]	I (1)
	CADF	1.37	-4.61 [*]	
KOFEC ²	CIPS	3.01	-4.73 ^{***}	I (1)
	CADF	2.62	-7.58 [*]	
IQI	CIPS	-2.43	-3.81 ^{**}	I (1)
	CADF	-2.27	-6.83 [*]	

Source: Own Elaboration
 Symbol* → 1 % level of significance
 ** → 5 % level of significance
 *** → 10 % level of significance

Table 4
Westerlund Cointegration Test.

Gt	Ga	Pt	Pa
-2.97 ^a	-8.76 ^b	-5.77 ^a	-8.39 ^a

a, b, and c denote the significance level at 1 %, 5 %, and 10 % respectively.
 Own Elaboration

institutions can successfully enforce and implement environmental rules, resulting in improved environmental outcomes.

Nevertheless, it is essential to acknowledge that the causality and magnitude of this correlation might alter depending on various developmental stages and institutional settings, underscoring the intricate nature of the interaction between economic growth, institutions, and

Table 5
Diagnostic Test.

Wald test statistic	H ₀	Wooldridge test for Autocorrelation	H ₀	Durbin (χ ²)	H ₀	Wu-Hausman (F-Statistics)	H ₀
2.59 ^a	Rejected	68.46 ^a	Rejected	10.96 ^a	Rejected	-11.03 ^a	Rejected

H₀ = No Heteroscedasticity
 a → 1 % significance Level
 Source: Own elaboration

environmental sustainability. Policymakers should consider the above-mentioned facts when formulating policies to balance economic development and ecological protection harmoniously. They must acknowledge that establishing robust institutions is essential to attain sustainable growth over an extended period (Latif, Safdar, et al., 2023; Latif & Faridi, 2023; Ntow-Gyamfi et al., 2020; Usman & Jahanger, 2021). Including the squared variable of the KOFEC index in the subsequent analysis and confirming the curvilinear association between economic globalization (as assessed by KOFEC) and environmental well-being has compelling theoretical implications. This study's findings indicate a correlation between economic globalization and environmental quality that aligns with the theoretical framework proposed by the Environmental Kuznets Curve (EKC) hypothesis. During the earliest phases of economic globalization, when economies begin to engage in international commerce and investment, there is a possibility of observing a temporary rise in environmental degradation, likened to the upward-sloping phase of the conventional Environmental Kuznets Curve (EKC). Nevertheless, with the ongoing process of globalization and the advancement of economies, globalization could facilitate a shift towards sustainability. This phenomenon may be reduced by the widespread

Table 6
The effect of economic globalization on LCF: Two Step System GMM Analysis.

Panels	Panel-1 Independent on LCF	Panel-2 Validation of EKC	Panel-3 Intersecting Effect on LCF
Variables	Coefficient	Coefficient	Coefficient
LCF _{t-1}	0.71 ^a	0.87 ^a	0.79 ^a
KOFEC	0.23 ^a	0.19 ^a	0.12 ^a
GDP	-0.13 ^a	-0.16 ^a	-0.11 ^a
KOFEC ²	—	0.03 ^a	0.02 ^a
IQI	-0.18 ^a	—	—
KOFEC*IQI	—	—	0.25 ^a
Diagnostic Tests	Wald → 293.64 (0.000)	Wald → 128.22 (0.000)	Wald → 128.22 (0.000)
	Sargan → 4.41 (1)	Sargan → 1.41 (1)	Sargan → 1.41 (1)
	AR (1) → -4.67 (0.000)	AR (1) → -2.17 (0.000)	AR (1) → -2.17 (0.000)
	AR (2) → 0.34 (0.853)	AR (2) → 1.62 (0.18)	AR (2) → 1.62 (0.18)
	Hansen → 3.93 (0.73)	Hansen → 4.30 (0.65)	Hansen → 4.30 (0.65)

Symbol a < 0.01, b < 0.05, and c < 0.10
 Source: Own Elaboration

adoption of cleaner technologies, heightened consciousness regarding environmental issues, and enhanced international collaboration over ecological norms and regulations. The validation of the inverted U-shaped relationship of the squared KOFEC term implies that globalization, despite its initial environmental stress, can catalyze enhancing environmental quality. This finding contributes to the broader comprehension of the long-term impact of globalization on sustainability (Latif, Rafeeq, et al., 2023; Latif, Safdar, et al., 2023; Latif & Faridi, 2023).

The findings in panel three of Table 6 indicate a noteworthy positive correlation between the interaction term KOFEC (economic globalization) * IQI (Institutional Quality Index) and environmental performance (LCF). This suggests that globalization and high institutional quality can produce favorable environmental outcomes in Asian economies. The finding has various theoretical ramifications. Firstly, this statement highlights institutions' crucial significance in moderating economic globalization's effects on the environment. Robust institutions can function as proficient regulatory entities, guaranteeing that economic activities associated with globalization are executed in a manner that upholds environmental responsibility. These institutions have the authority to implement and enforce environmental regulations, advocate for sustainable practices, and ensure that firms are held responsible for their ecological footprint. Furthermore, the positive correlation between the interaction term and environmental performance implies that economic globalization could benefit environmental sustainability when accompanied by robust institutional frameworks. This statement questions the widely held belief that globalization always results in negative environmental consequences and emphasizes the significance of effective governance systems in maximizing the potential advantages of globalization for the environment. Furthermore, it underscores the importance of Asian economies placing institutional development on par with their efforts towards economic globalization. Establishing and enhancing institutions capable of efficiently managing and overseeing worldwide economic operations can contribute to attaining economic growth and environmental sustainability (Fakher et al., 2021; Latif, Safdar, et al., 2023; Latif & Faridi, 2023). Rest of the results are same as we have discussed in panel one and 2. These findings are consistent with the findings of (Sinha and Shahbaz, 2017; Fakher et al., 2021; Latif & Faridi, 2023; Nasir et al., 2019; Usman & Jahanger, 2021; Yang et al., 2021b). The diagnostic tests for both panels are reported in the last row of Table 1. The AR2 test suggests that there is no second-order serial correlation, and the Hansen test does not reveal any indications of improper over-identifying limitations, indicating that the system GMM estimate is consistent in our scenario.

To ensure the reliability of the findings, Table 7 presents the results of the PMG and fixed effect estimates. The primary results remain unchanged, as we can observe.

Conclusion and policy recommendations

The present study has examined the intricate interplay between economic globalization, environmental quality, and institutional quality within a sample of 48 Asian economies. This investigation has provided

Table 7
The impact of KOFEC on LCF: PMG.

Panels	Panel-1 Independent effect on LCF	Panel-2 Validation of EK
Variables	Coefficient	Coefficient
KOFEC	0.13 ^a	0.21 ^a
GDP	-0.09 ^a	-0.08 ^a
<i>KOFEC</i> ²	_____	0.01 ^a
IQI	-0.06 ^a	_____

Symbol a < 0.01, b < 0.05, and c < 0.10
Source: Own Elaboration

valuable insights into the fundamental dimensions of sustainable development. The study results are significant and offer practical perspectives for policymakers and stakeholders.

The initial finding of this study affirms the presence of a curvilinear association, namely an inverted 'U' shape, between economic globalization, as quantified by the KOF Economic Globalization Index, and environmental performance, as assessed by the Load Capacity Factor Index. This observation indicates that as Asian economies participate in global trade and economic integration, they experience an early period of environmental deterioration, followed by enhancements in ecological conditions, resembling the Environmental Kuznets Curve.

Furthermore, the research emphasizes the crucial significance of institutional quality in alleviating the adverse environmental impacts associated with economic globalization. Establishing robust institutional frameworks is essential to effectively exploit the advantages of globalization while mitigating its negative effects on the environment.

Policy recommendations

The prudent management of economic growth and environmental sustainability should be a priority for Asian nations. To accomplish this objective, individuals must prioritize shifting towards sectors and technologies that exhibit reduced resource consumption and enhanced environmental sustainability. Promoting the development of innovative green technologies and resource-efficient production methods might serve as a pivotal strategy.

Policymakers should emphasize the prioritization of the building and strengthening of institutional frameworks. Establishing robust governance frameworks is crucial in enforcing environmental rules, fostering the adoption of sustainable practices, and ensuring industries are held responsible for their ecological footprint.

- In the nascent phases of economic advancement, nations should contemplate diminishing their reliance on industries that heavily consume natural resources. Implementing green policies and promoting sectors that generate environmental benefits can be a viable approach towards achieving economic growth and environmental enhancement.
- The active pursuit of international investment and engagement in trade exchanges through environmentally sustainable methods is vital for developing economies to attract foreign capital. This can be in line with Sustainable Development Goal (SDG) 17, which aims to promote economic globalization to facilitate the attainment of broader sustainable development goals.
- The proposition of decreasing trade barriers warrants consideration by all nations to foster economic openness and mitigate the environmental consequences of international commerce. This method aims to reduce disparities and promote long-term economic development, as the Sustainable Development Goals (SDGs) articulated.
- The prioritization of expanding renewable energy sources is crucial for governments to effectively achieve the targets outlined in Sustainable Development Goal 7 (SDG7). Increasing the proportion of renewable energy in the global energy system by 2030 is imperative to combat climate change and implement sustainable energy practices.

In summary, this study presents empirical findings that substantiate the notion that economic globalization can positively impact environmental performance in Asian nations. However, it is essential to note that robust institutional frameworks are crucial for this outcome. The policy above recommendations aim to guide countries in attaining a harmonious equilibrium between economic advancement and environmental preservation while adhering to the Sustainable Development Goals.

Limitations and avenues for future research

Limitations

This research, although providing significant insights, possesses several drawbacks. First and foremost, the analysis is contingent upon the data that is accessible, which may be susceptible to inaccuracies in measurement and may not encompass the entirety of the intricate connections being examined. Additionally, the research used simplified models that do not prove a causal relationship, allowing for more comprehensive analyses. Furthermore, it is essential to note that the generalized findings presented in the study may not adequately include the contextual variables within Asian economies. These economies exhibit diversity in terms of their development stage and institutional frameworks.

Future research

To address the constraints above, future research in this field can undertake longitudinal analyses to observe and document changes over an extended period. Additionally, investigating sub-regional differences can provide valuable insights. Moreover, applying qualitative approaches can offer a more comprehensive knowledge of the institutional variables. Moreover, scholarly inquiry might focus on assessing the significance of specific policies and technological advancements in addressing globalization's ecological consequences. Further refinement of our comprehension of the complex interplay among economic globalization, environmental sustainability, and institutional quality can be achieved through comparative analyses with other locations and a continuous focus on providing policy recommendations.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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